Sector Report

Clean Fuels Investment in Canada

Advanced Biofuels & Synthetic Liquid Fuels - Roadmap to 2030

November 2019

Advanced Biofuels Canada
Biocarburants avancés Canada

Preface

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Advanced Biofuels Canada is the national voice for producers, distributors, and technology developers of advanced biofuels in Canada. Our members are global leaders in commercial production of advanced biofuels and technology development, with over 14 billion litres of installed annual production capacity worldwide. Since 2005, we have played a leadership role in the development of federal and provincial renewable and low carbon fuel standards. Our team represents industry's interests in the design and deployment of carbon pricing schemes, fuel quality standards, international standards setting, and programs and tax policies to support advanced biofuels production and use. Our members and staff work collaboratively with governments, industry counterparts, and non-governmental organizations to support clean growth economic development and effective climate action policies.

Clean Fuel Steering Committee

The Clean Fuel Steering Committee (CFSC) is a government and industry collaboration whose objective is to assess and review investment conditions and identify measures required to increase investment in the domestic production of clean fuels and electric vehicles (EV) adoption to meet climate action commitments and help with the successful implementation of the federal Clean Fuel Standard. The CFSC conducted its review over April to September 2019. Clean fuel industry sector leads were: Advanced Biofuels Canada (liquids), Canadian Gas Association and Canadian Biogas Association (gaseous), Electric Mobility Canada (electric vehicles), and the Wood Pellet Association of Canada (solids). Natural Resources Canada was the lead department on behalf of the Government of Canada, with the support of other government departments: Environment and Climate Change Canada, Agriculture and Agri-Food Canada, and Innovation Science Economic Development Canada.

Clean Fuels Investment in Canada: Advanced Biofuels and Synthetic Liquid Fuels – Roadmap to 2030

While Advanced Biofuels Canada endeavored to ensure accuracy of the data, estimates, and forecasts contained in this report, we do not represent and warrant the information for any purpose: any decisions based on them (including investment and planning) are at the party's own risk. This report was developed and prepared by Advanced Biofuels Canada to support the work of the CFSC, but the information, analysis, and recommendations do not necessarily reflect the views of any other party. Advanced Biofuels Canada accepts no liability regarding information, analysis, or forecasts contained in this report.

Note to Reader on "Clean Fuels"

In this report, we refer to non-fossil, low-carbon fuels as "clean fuels." Clean fuels are liquid, gaseous, and solid fuels produced from sustainable biomass, wastes, or renewable electricity, such as:

- **Renewable liquid fuels (biofuels) and synthetic liquid fuels**
- **Renewable gases (biogas, renewable natural gas, renewable hydrogen)**
- **Renewable solid fuels (wood pellets, torrefied biomass)**
- **Renewable electricity powered electric vehicles (EVs)**

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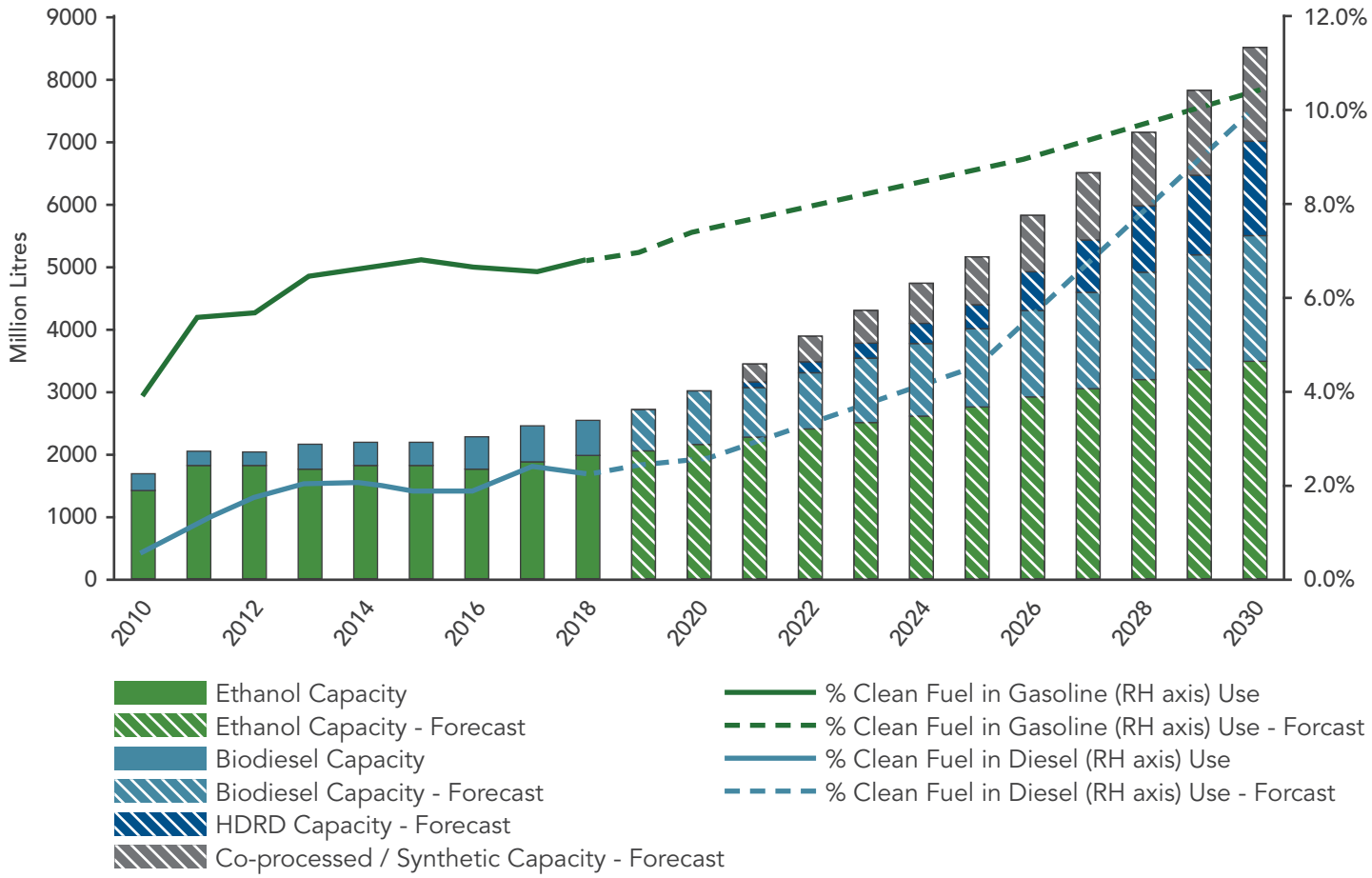
Executive Summary

The development of the clean fuels sector in Canada represents an opportunity to reach Canada's greenhouse gas reduction targets and transition to a sustainable and low carbon economy, while fostering investment, new economic growth, and supporting clean tech jobs across the country.

Canada's clean liquid fuel sector targets growth in production capacity from 3 billion litres per year to 8.5 billion litres by 2030. Capital investments of over $6 billion over the period would create 30,000 person-years of construction jobs and add 10,000 new full-time clean tech jobs. In addition to adding $15 billion per year in economic output, the sector would strengthen the resiliency of Canada's agricultural, forestry, and rural communities and improve waste management practices.

Expanding use of biofuels and other non-fossil clean fuels from 7% in 2017 to 10-15% by 2030 would reduce greenhouse gas emissions by 15 million tonnes per year. Clean fuel use will mitigate energy security risks and high fuel costs from the 12 billion litre/year fuel supply deficit in western and central Canada. This sector report describes Canada's clean liquid fuels sector and how to manifest these 2030 results.

Figure 1: Prospective Growth of Clean Liquid Fuels in Canada (2010 – 2030)



Source: Advanced Biofuels Canada

The overarching goals of the clean fuel sectors' policy and program recommendations are to:

1. Improve Canadian economic competitiveness
2. Reduce greenhouse gas emissions from fuels and support compliance with federal regulations and international climate action agreements
3. Establish globally competitive, commercial production of low carbon clean fuels in Canada
4. Facilitate the advancement of clean fuels innovation and the commercialization of 'first-of-kind' clean fuel technology platforms in Canada
5. Provide new opportunities for Indigenous Peoples, agricultural producers, value-added agricultural and forestry processing and waste management, and rural and remote communities

Despite taking actions under federal and provincial climate action policies, Canada is not on track to meet its 2030 targets. Canada is behind its global competitors in establishing clean fuel production capacity and use. Use of low carbon biofuels in Canada lags market adoption rates in the US, EU, and other regions, contributing to Canada's high transportation sector greenhouse gas emissions. While progressing through the regulatory development stage, the current design of the proposed *Clean Fuel Standard* will not achieve the targeted incremental emission reductions (30 Mt) and lacks a clear market demand signal for clean fuels. Emerging clean fuel technology solutions are at a competitive disadvantage to scale-up and commercialize in Canada.

While Canada has world-class energy, forestry, and agricultural sectors on which to build a strong, competitive clean fuel sector, political uncertainty in Canada over climate action policies, regulations, and programs is impairing deployment of the necessary capital investment in clean fuels. Without prompt action, Canada will forgo economic gains from the global shift to clean fuels, and deepen economic risks associated with over-reliance on fossil fuels.

To meet our emissions reduction commitments and improve the competitiveness of the Canadian economy, Canada must implement a **Clean Fuel Strategy** to establish competitive conditions to attract private sector investment in the production and use of clean fuels in Canada.

The Clean Fuel Strategy should be implemented in 2020 with four core components that establish clear market signals to 2030:

1. Define clear clean fuel goals and set firm targets for the production and use of non-fossil clean fuels in Canada
2. Align federal fuel regulations and complementary policies to meet the targets
3. Establish core funding via existing programs and align tax policies to attract private sector capital investments in clean fuel capacity buildout and infrastructure
4. Establish core funding and improve tax policies to advance Canadian leadership in clean fuels innovation

Core Recommendations

Recommendation 1: Establish a Clean Fuel Strategy

That Canada establish a comprehensive, long-term Clean Fuel Strategy to address the climate emergency, attract investment in sustainable growth, and ensure competitiveness of the production and use of clean fuels in Canada. The Clean Fuel Strategy must establish clear market goals for non-fossil low carbon liquid fuels and align renewable and low carbon fuel regulations and complementary policies to meet defined clean fuel production and use targets.

Recommendation 2: Build Clean Fuel Capacity

That Canada commit core funding over 2020 – 2030 to directed initiatives within established investment banking programs.[1] Prescribe program mandates for Crown entities and funds, and develop Canadian standards, to attract private sector capital investment to build commercial clean fuels production capacity and distribution/use infrastructure:

I. Clean Fuel Capacity Program (Liquid Fuels) - $2.5 billion

II. Clean Fuel Infrastructure Program (Liquid Fuels) - $250 million

III. Mobilize federal financing and develop standards

Recommendation 3: Competitive Tax Policies

That Canada establish stable and fair tax policies to create a competitive investment climate for clean fuel production capacity and use infrastructure:

I. Capital investment measures

II. Fair transport fuel taxation

III. Carbon capture tax credit

Recommendation 4: Leadership in Clean Fuel Innovation

That Canada commit support over 2020 - 2030 to advance Canadian leadership in pre-commercial clean fuel technology and innovation systems through targeted measures. Designate policies/programs for clean fuel sector development:

I. Refundable tax credits for clean fuel research and development expenses

II. Extend flow-through share eligibility to clean fuel technology development expenses

III. Recapitalize grant programs[2] for clean fuel innovation and pilot/demonstration stage technologies

IV. Core funding for applied research

1. *Federal investment banking entities: Business Development Bank of Canada (BDC), Canada Infrastructure Bank (CIB), Export Development Canada (EDC), Strategic Innovation Fund (SIF), Western Economic Diversification Canada (WED).*

2. *Federal grant program funds: Clean Growth Hub programs, Sustainable Development Technology Canada.*

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Clean Fuels Overview

Clean fuels are non-fossil liquid, gaseous, and solid fuels produced from sustainable[3] biomass, wastes[4], or renewable electricity, such as:

- Renewable liquid fuels (biofuels) and synthetic liquid fuels
- Renewable gases (biogas, renewable natural gas, renewable hydrogen)
- Renewable solid fuels (wood pellets, torrefied biomass)
- Renewable electricity powered electric vehicles (EVs)

Each of the four clean fuel sectors, led by their respective national industry associations, undertook a joint assessment and review, with the Government of Canada, of investment conditions to identify measures required to increase investment in the domestic production of clean fuels and EV adoption to meet climate action commitments and help with the successful implementation of the federal Clean Fuel Standard.

The overarching goals of the clean fuel sectors' policy and program recommendations are to:

1. Improve Canadian economic competitiveness
2. Reduce greenhouse gas emissions from fuels and support compliance with federal regulations and international climate action agreements
3. Establish globally competitive, commercial production of low carbon clean fuels in Canada
4. Facilitate the advancement of clean fuels innovation and the commercialization of 'first-of-kind' clean fuel technology platforms in Canada
5. Provide new opportunities for Indigenous Peoples, agricultural producers, value-added agricultural and forestry processing and waste management, and rural and remote communities

This report summarizes the clean liquid fuels sector analysis and recommendations of Advanced Biofuels Canada.

3. *Sustainable biomass in the context of this report broadly refers to clean fuel feedstocks that are eligible under an approved sustainability scheme in Canada. Sustainable biomass feedstocks do not 'high-ILUC risk' sources, such as defined in the EU Renewable Energy Directive.*

4. *Waste derived fuels include organic and non-organic wastes (landfill, emissions). Synthetic fuels utilize non-organic feedstocks to produce low carbon fuel alternatives.*

Clean Liquid Fuels in Canada

Canada has world-class energy, forestry, and agricultural sectors. While Canada is a net exporter of finished fossil fuels (gasoline and diesel) due to large refining capacity on the east coast, the core economic/population regions (western and central Canada) are deeply reliant on imported fuels. Regional supply shortages and over-reliance on fossil fuel imports drives up fuel costs and expose the economy to supply shocks.

Table 1: Canadian Market Reliance on Fossil Fuel (Gasoline, Diesel) Imports

Oil Barrels/Day	Western Canada (BC, AB, SK, MB, west-ON)	Central Canada (Ontario, Quebec)
Demand - Actual Market Use	808,000	923,000
Supply - Maximum Refining Capacity	706,000	810,000
Fuel Deficit (barrels/day) Litres/year	102,000 5,625,000,000	113,000 6,230,000,000

Source: Capacity and demand data from Canadian Fuels Association, 2019

Over 2010 – 2019, expanded use of biofuels helped relieve regional fuel demand pressures which reduces fuel costs and market volatility for consumers. Ethanol is commonly blended at 10% in gasoline (E10), and biodiesel blends of 5% (B5) are available seasonally and year-around.

Our agricultural and forestry biomass supply chains grow and harvest sustainable biomass, largely destined for (and vulnerable to) export commodity markets. Integrating biofuels production and use into our economy is a significant opportunity to attract new investment in value-added manufacturing, create new jobs, reduce greenhouse gas emissions, and enhance the resilience of Canada's rural communities.

Canada's first national renewable fuel strategy was launched by Prime Minister Harper in December 2006 to support the expansion of Canadian production of liquid biofuels. The key components of the strategy, the federal Renewable Fuels Regulations (RFS) requiring 5% biofuel blending in gasoline and 2% biofuel blending in diesel fuel, came into effect on December 15, 2010 and July 1, 2011, respectively. Provincial renewable fuel regulations and a low carbon fuel standard in BC (BC- LCFS) have also established market access for biofuels in Canada. The primary biofuels used in Canada are ethanol (corn-based), biodiesel (canola, soy-based) and renewable diesel (palm, fats-based).

Canadian biofuels production has historically been limited to conventional biofuels: biodiesel and ethanol. Despite a surge in global demand and ample domestic feedstocks, hydrogenation-derived renewable diesel (HDRD, termed 'renewable diesel' in the US) production has not been established in Canada. Advanced biofuel production platforms – including waste-based ethanol, wood residue-based renewable fuel oil, and biomass co-processing technologies - were commercialized since 2015. Other novel production pathways, based on agricultural and forestry residues, wastes, and carbon capture technologies, are approaching commercial readiness.

Figure 2: Ethanol in Canada (2015 – 2018)

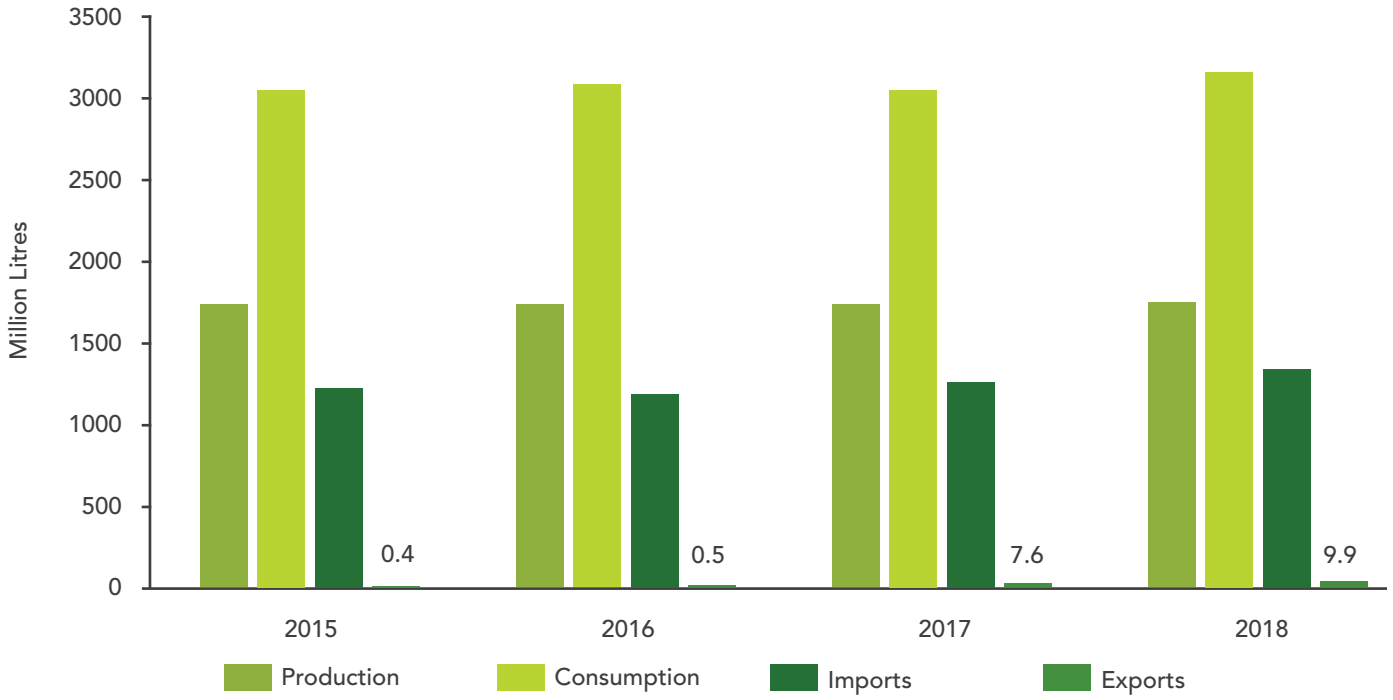
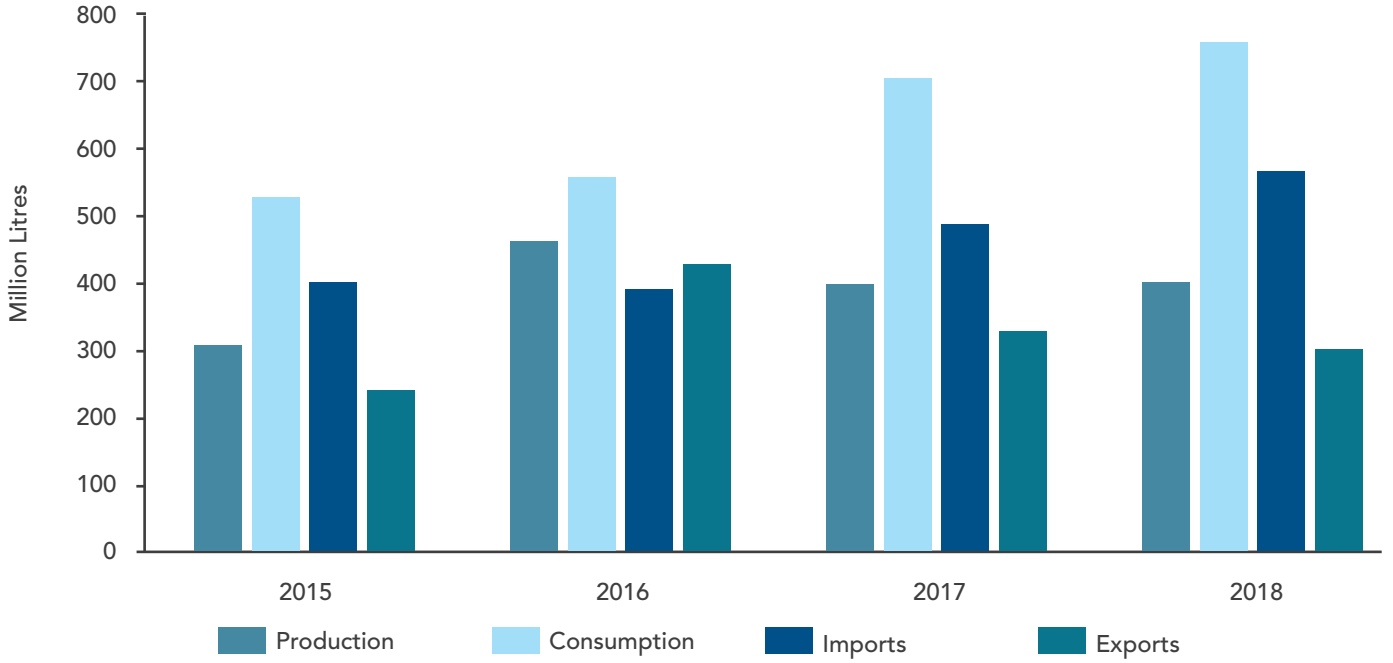


Figure 3: Biomass-based Diesel in Canada (2015–2018)

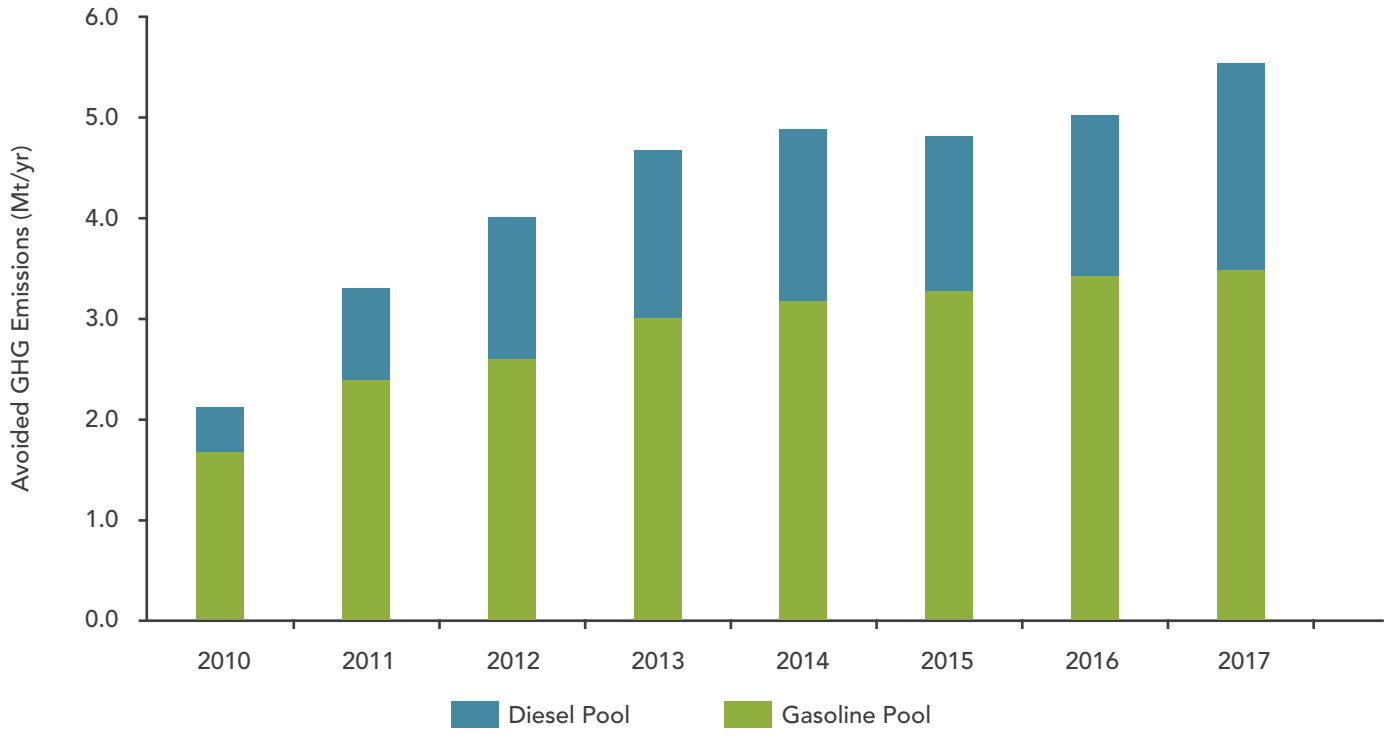


Source: Environment and Climate Change Canada, Statistics Canada, Navius Research, USDA (2018). Biomass-based diesel production is biodiesel; imports are biodiesel and HDRD.

The use of biofuels in Canada has significantly reduced greenhouse gas emissions from avoided fossil fuel use. Biofuels produced in Canada generally have a low lifecycle[5] carbon intensity and have steadily improved emissions reductions over the past decade through adoption of innovations in biomass production, processing, and energy efficiency (for example, see the certified carbon intensity of biofuels registered in BC-LCFS).

Aggregate greenhouse emissions reductions improved during periods of increasing regulatory stringency (renewable blend and carbon intensity requirements).

Figure 4: Avoided Greenhouse Gas Emissions from Biofuels Use in Canada



Source: Navius Research

5. Lifecycle carbon intensity measures greenhouse gas emissions from the full biomass production, transport, refining, and combustion stages.

Comparative Assessment: Canada vs. United States

In Canada, primary drivers for modern (post-2000) biofuels sector development were: support for farmers; economic development and rural jobs; and, climate change mitigation. In the US, biofuels policies were initially advanced to support farmers and rural communities and to address energy security issues (note - prior to the advancement of oil and gas fracking technologies, US dependence on foreign oil was a more significant public policy issue).

Despite strong public policy support, renewable fuel market development in Canada has been slowed by opposition from the incumbent fossil oil production/ refining industry and the pace of government policy development and regulatory action. As a result, Canada is behind its global competitors in establishing renewable fuel production capacity. In addition, use of low carbon biofuels in Canada lags market adoption rates in the US, EU, and other regions, contributing to Canada's high transportation sector greenhouse emissions (2017: 174Mt CO2e – 24%; excludes oilsands emissions).

The US renewable fuels market has outpaced development in Canada due to progressive market signals from federal and state fuel regulations, and support for private sector capital investment through long-term fiscal stimulus programs. The 2007 revision of the US federal Renewable Fuel Standard (RFS2), and the 2010 California Low Carbon Fuel Standard (CA-LCFS), pioneered effective compliance credit market designs to support market-based demand for biofuels and performance-based recognition of improved carbon intensity.

Canada's federal and provincial fuel regulations typically relied on a static biofuel blend requirement. However, the BC Low Carbon Fuel Standard (BC-LCFS) and the ON Greener Diesel Regulation employed progressive stringency signals over 2013-2020 and 2014-2017, respectively. Except for the BC-LCFS, Canadian fuel regulations lack a compliance credit market system that supports market competition and transparency; this omission has compromised clean fuel market development.

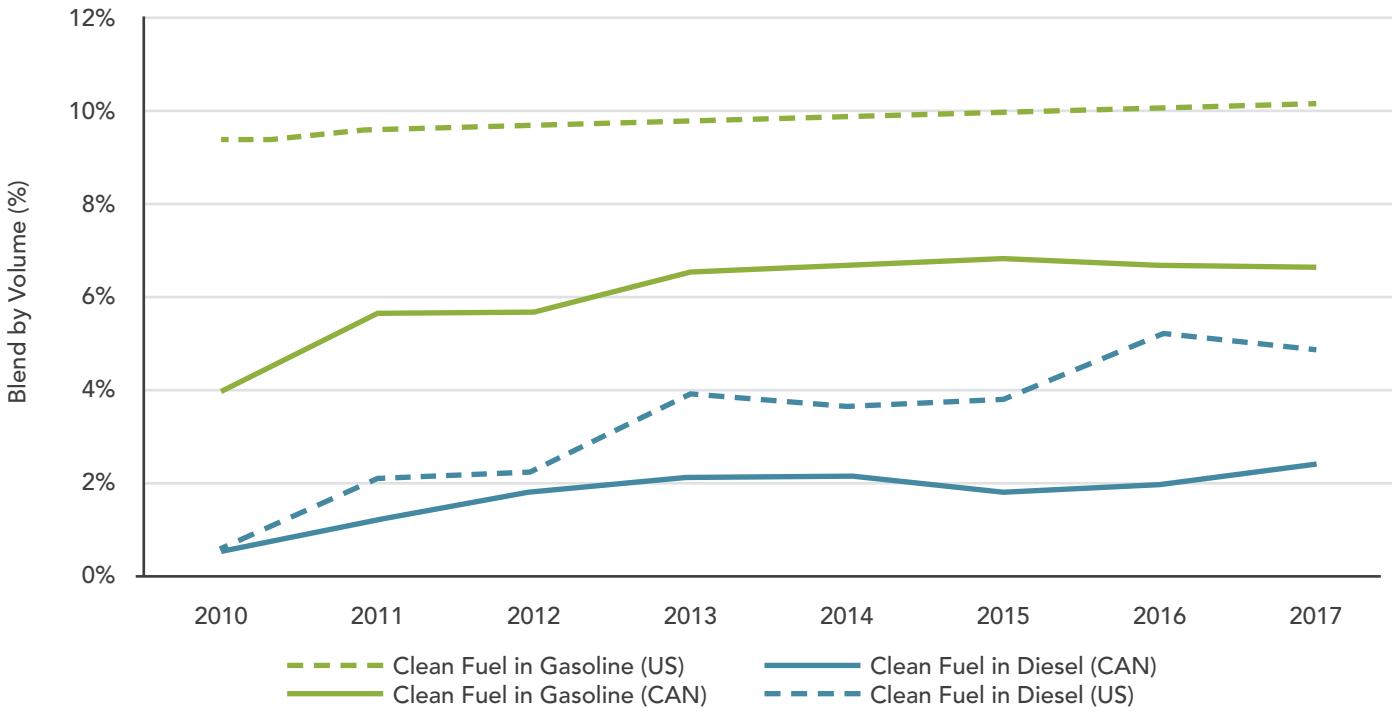
Table 2 provides a qualitative assessment and comparison of the two most significant fuel regulations in Canada and the United States. In both countries, the federal RFS preceded implementation of later low carbon fuel standards; national RFS regulations established a market-based demand signal for renewable fuels, and the state/ provincial LCFS regulations later added a performance-based (carbon intensity) requirement. Sub-national government regulations (e.g. BC-RFS and MN-RFS) often exceed the federal RFS standard.

The development of the biofuels supply chain – feedstock supply, biofuel refining, distribution infrastructure – under the RFS programs assisted an orderly market development for the fuel supply chain to transition to the lower carbon fuel requirements. Both countries have additional state/ provincial policies that reinforce the clean liquid fuel signal regionally.

Table 2: Comparison of Clean Fuel Regulations in Canada and United States

	Canadian RFS	US RFS2	BC LCFS	CA LCFS
Date Implemented	2010 / 2011	2008	2013	2011
Blend Requirements	Static	Annual increase	n/a	n/a
Carbon Intensity Requirements	None	Yes – thresholds	Yes - annual increase	Yes - annual increase
Compliance Credit Market	Closed (obligated parties)	Open (by fuel type)	Partially Open (per tonne GHG)	Open (per tonne GHG)
Flexibilities	Exempt parts of CDA and some fuel types	Exempt small refineries	Part 3 credits reduce target by 25% each year	Minimal
Clean Fuel Market Demand Signal	Weak	Strong	Moderate	Strong

Figure 5: Comparison of Biofuel Blends in Canada and United States (2010 – 2017)



As a result of stronger regulatory designs and stringency, a more competitive fuel supply sector, and aligned fiscal policy programs, the US biofuels market successfully developed sales of mid- and high-blend biofuels (e.g. E15, E85 and B6-B20) over the past decade. Improved supply of biofuel blends has enhanced market competition, improved compliance flexibility for regulated parties, and lowered fuel costs for consumers.

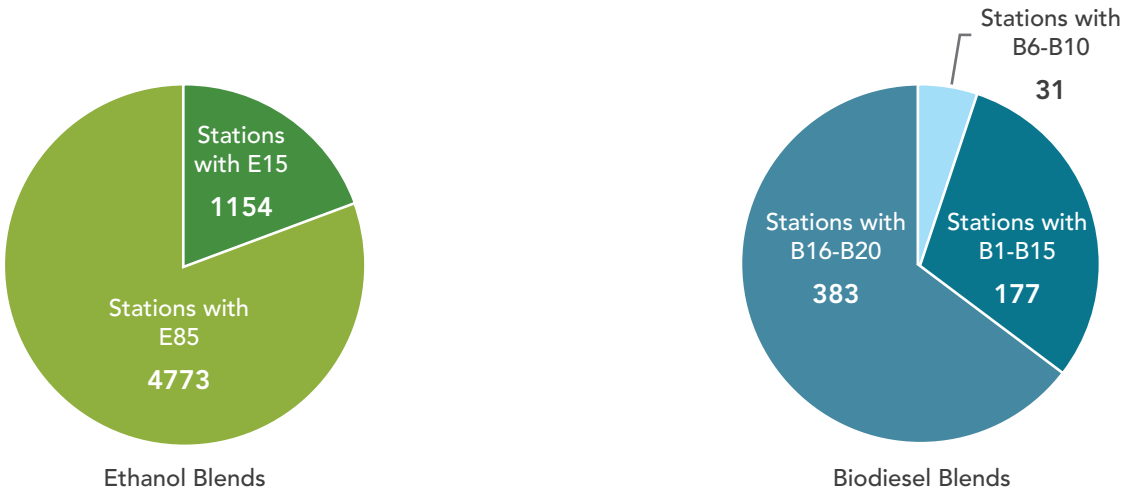
Despite proven fuel quality, and comparable vehicle models/engines and operating conditions, Canadian fuel distributors do not supply blends above E10 and B5. Renewable diesel blends of up to 20% in diesel (R20) are reported in Canada; blends to 100% (R100) are sold in the US.

Table 3: Market Comparison of Ethanol Blending – Canada and United States (2019)

	Canada	United States	Notes
Fossil Fuel Industry Concentration Ratio	82%	46%	5-firm industry ratio
E10 Availability	- Most regular gasoline - 6.6% national blend average (2017)	- 98% of US market - 10.1% national blend average (2018)	CDN gasoline approximately 70% sub-octane
E15 Availability	None	1,154 stations	31 states
E85 Availability	None	4,773 stations	40 states
E15 Pricing	n/a	-17%	Savings (below regular gasoline)
E15 Credit Generation	- Closed credit market - LCFS credits in BC	- Open RIN market - CA/OR-LCFS credits	
Vehicle Approvals	- Tier II/III harmonized across NA since 2004	EPA – 2001 and newer vehicles E15 approved	
Federal Biofuel Blending Infrastructure Program	- No - Biofuels excluded from EVAFIDI	- Yes - up to 25% - Ethanol Infrastructure Grants & Loan Guarantees	- State programs - BC Part 3 program

Source: CAPP, ECCC, EIA, EPA, E85Prices

Figure 6: Mid- and High-Blend Biofuel Availability in the United States



Source: AFDC, DOE, E85 Prices

Fiscal Stimulus Programs

The Canadian renewable fuels strategy provided fiscal stimulus to support expanded production of biofuels in Canada. Approximately $2.2 billion was allocated in 2007 across three programs to support conventional biofuels production, commercialization of next generation biofuels, and investment by agricultural producers. The programs assisted industry development (approximately 50% of funds were deployed) but failed to meet the strategy's goals.

The ecoENERGY for Biofuels Fund (ecoEBF - $1.5 billion) was the primary fiscal stimulus policy to support private sector investment in biofuels production capacity. After a 30-month delay to design, revise, and adopt a final program design, ecoEBF ultimately supported new investment in biofuel capacity in Canada. In the ethanol sector, 14 of 17 (82%) projects completed eligibility under the program and 13 of these facilities remain operating. Only 6 of 21 (29%) biodiesel facilities completed eligibility under the program and 4 of these remain operating. Over the program period, ecoEBF helped establish new, viable (i.e. not pre-existing, still operating) production of approximately 1.1 BLY of ethanol capacity and 45 MLY of biodiesel capacity (eligibility was not awarded to Canada's two largest biodiesel facilities, with combined capacity of 490 MLY).

Table 4: Summary Performance Metrics of ecoEBF Program (2008-2017)

CAD $ million	ecoEBF Program Funding	ecoEBF Program Expenditures	Target ecoEBF Capacity	ecoEBF Capacity*
Ethanol	$1,000	n/a	2,000	1,785 (89%)
Biodiesel	$500	n/a	500	144 (29%)
TOTAL	**$1,500**	**$930 (62%)**	**2,500 MLY**	**1,929 (77%)**

** ecoEBF contracted capacity as at November 2014, operating as of October 2019*

Less than one quarter of the funding reserved under the ecoAgriculture Biofuels Capital Initiative was allocated ($47 of $200 million), but final contributions were not reported. The NextGen Biofuels Fund deployed 16% of program funding ($80 of $500 million), to two advanced biofuels plants that were commissioned. Industry sources report that significant program design issues, primarily with the ecoEBF program and the NextGen Biofuels Fund, and overall poor market conditions relating to the 2007-2009 financial crisis and recession, limited the ability to access funding programs and complete project financing.

In the US market, stable long-term fiscal support has been in place through production/blending tax credits, grants, and loan guarantee programs. While stability was subject to Congressional budget cycles and sometimes retroactive tax-extender approvals, the US biofuels stimulus proved durable through the implementation and expansion of both the federal RFS2 and CA-LCFS regulatory periods (2008 to 2017). The alignment of a clear market signal with dedicated, stable fiscal policies is a key take-away to understanding the success of the US market development.

Table 5: Comparison of Legacy Federal Stimulus Programs in Canada and United States

Program Target	Canada	United States
Ethanol Production	ecoEBF Program *2008-2017* Production credits - CAD / litre $0.10 to 0.03 (2008-2017) Closed – March 31, 2010 Program type: Application	VEETC Program *2004-2011* Production credits – USD/gallon $0.51 to 0.45 (2004-2011) $0.10 - small producers (15MG) Import tariff: $0.54 (exp.2011) Closed - December 31, 2011 Program type: Open Basis
Biodiesel Production	ecoEBF Program *2008-2017* Production credits - CAD / litre $0.26 to 0.04 (2008-2017) Closed – March 31, 2010 Program type: Application	Blender's Tax Credit *2005 – 2017 (may extend)* Blending credits – USD/gallon $1.00 – biodiesel / HDRD $0.10 – small producers (15MG) Expired – December 31, 2017 (may retroactively extend) Program type: Open Basis
Advanced Biofuel Production	No federal program	Producer Tax Credit *2005-2017* Production credits – USD/gallon $1.01 – second gen biofuels No maximum Feedstocks: non-grain ethanol Program type: Open

Continued on next page

Table 5: Comparison of Legacy Federal Stimulus Programs in Canada and United States (cont'd)

Program Target	Canada	United States
Advanced Biofuel Production Capacity	SDTC Next Gen Biofuels Fund *2007-2015* Repayable grants - CAD $500 million fund Max. per project - 40% ($200m) Feedstocks: non-food IP: restrictive rights Projects: 2 - $80m total Program type: application (closed)	USDA Biorefinery Assistance *2008-2019* Loan guarantees - USD Max. $250m/project Max. per project – 50% ($250m) Max. federal stacking – 80% Feedstocks: non-grain (ethanol) Projects: 10 - $661m total Program type: application (open)
	ecoABC Initiative *2008-2013* Repayable grants - CAD $200 million fund Max. per project - 25% ($25m) Min. 5% farmer equity Projects: 8 - $47m total (max) Program type: application (closed)	Recovery & Reinvestment Act *2009-2014* Grants – USD >$1 billion Pilot - $25m Demonstration - $50m Commercial - $70m (3 projects) Program type: application (closed/other DOE programs)

Generally, fiscal stimulus programs in the US supported open, competitive access over a sustained period, especially through the 2007-2009 financial crisis. The US programs successfully attracted private sector capital investment by off-setting nascent market development and policy (regulatory) risks. Some programs also bore a significant portion of technological risk for 'first-of-kind' commercial plants.

Canadian programs relied on a selection process with application windows, which failed to accommodate project development timelines and accurately identify viable projects. Notably, Canada failed to bring HDRD capacity to market, despite strong domestic and global demand and active Canadian projects. Over the period, Canada did not meet its capacity buildout targets and remains import-dependent to meet current biofuels demand, while the US sector built excess (export) capacity and established global leadership in biofuels production, use, and export.

Table 6: Comparison of Biofuels Production Capacity in Canada and United States

Biofuel Production Capacity Million Litres per Year (2019) Percent change (2010-2019)	**Canada**	**United States**
Ethanol	2,150 (51%)	63,845 (24%)
Biodiesel	629 (144%)	9,663 (26%)
Renewable Diesel / HDRD	0	1,226 (n/a)
Total Production Capacity	2,779 (65%)	75,015 (21%)
Capacity to Biofuel Use Ratio (2019 capacity: 2018 use)		
Ethanol	71%	117%
Biodiesel	90%	122%

Section Summary

Despite significant progress, Canada did not meet its clean fuel production capacity goals and fell behind the United States in the production/use of biofuels over the past 10-15 years. Market evidence from US demonstrates that open, stable production credit schemes (programs, tax policies) are effective in supporting private sector investment in viable domestic clean fuel production capacity. Further, grant and/or loan guarantee programs that mitigate technology and market policy risks will enhance private sector investment in capital intensive, late-stage pre-commercial (TRL 7-8) projects. Lessons learned from the first phase of regulatory and fiscal stimulus policies over the period should be incorporated into the Clean Fuel Strategy for the decade ahead.

Renewable fuels, and other non-fossil low carbon liquid fuels, have proven to be very responsive to market-based and performance-based regulatory and policy signals. Canada's biomass supply chains, conversion technologies, and fuel quality/performance have been evaluated and verified in multiple studies. The potential scope of scaling up clean liquid fuel production and use in Canada, and the economic and environmental impacts associated with this growth are evaluated in the next two sections.

Market Demand to 2030

While progressing through the regulatory development stage, the current design of the proposed regulatory approach for the Clean Fuel Standard lacks a clear market demand signal for clean liquid fuels. Factors that compromise the potential clean fuel demand signal include:

- Unlimited compliance category 1 credits (CC1) from emissions reductions projects related to fossil fuels production (crude oil, oilsands) and finished fuel refining (gasoline, diesel), supported by:
  - o Double crediting of emissions reductions from oil production/refining under both industrial emissions regulations and fuel regulatory systems (non-additionality)
  - o Credit retention/banking/use on exported fossil fuel products (crude oil, finished fuels)
  - o Preferential eligibility/certification/reporting requirements for fossil fuel emissions reduction credits
  - o Preferential financial returns for obligated parties to create/purchase CC1 credits
- Unlimited CC1 credits from non-fuel related industrial carbon capture and use/storage projects (CCUS)

CC1 credits generated from emissions reduction projects/technologies in the above two categories eliminate incremental credit demand in the liquid fuel class over the 2022 to 2030 period.

Table 7: Select Estimates of CC1 Credit Generation – Clean Fuel Standard (2020 – 2030)

CC1 Credit Estimate (M credits)	**Low**	**High**	**Notes**
Alberta Carbon Trunk Line	3.9	14.6	2020 – 2030
COSIA	7.3	21.9	10-30% lower in 5 years
IHS Markit	11.7	16.8	16-23% lower by 2028
CERI (estimates to 2030)	~40	~50	80% lower by 2036
ECCC (CFS TWG estimates)	8.8	11.3	ECCC TWG Jan 2019

In addition to credit market over-supply from CC1 credits, general flexibilities to the Clean Fuel Standard regulatory design will further dampen market demand for clean fuels:

- Cross-class credit trading (up to 10% per year)
- Compliance fund credits (up to 10% per year)
- Carry-in credits:
  - Surplus federal Renewable Fuel Standard credits
  - Early-action credits (pre-2022 implementation date)
- Deficit carry-forward (up to 10% per year)

Liquid fuel class credits will be generated annually from biofuels and low carbon, non-fossil liquid fuel use (compliance category 2 – CC2) and from transportation fuel switching (compliance category 3 – CC3) from gasoline or diesel powered transport to electric vehicles (EVs) and gaseous fuel platforms (e.g. CNG, LNG, RNG, hydrogen). CC2 and CC3 credits will be generated based on all use of these fuels (no baseline adjustment), which provides a certain supply of credits each year pursuant to provincial fuel regulations and policy programs that are in place (e.g. RFS, LCFS, ZEV mandates).

An over-supplied credit market functionally erodes or eliminates the performance-based signal meant to drive the transition to low carbon fuels (e.g. CC2, CC3 fuels). A poorly designed credit market will impair capital investment and compromise performance of the system (see EU ETS). To posit new, incremental demand for clean liquid fuels under the Clean Fuel Standard, the design of the regulation will have to:

I. Limit aggregate utilization of CC1 credits in each compliance year

II. Prescribe minimum utilization of CC2/CC3 credits in each compliance year

III. Increase the liquid fuel class emissions reduction target (currently 10gCO2e/MJ by 2030)

Clean Fuel Standard Modeling

Prior to the release of the proposed regulatory approach design paper in June 2019, modeling of the Clean Fuel Standard market impacts was based on traditional low carbon fuel standard design systems (e.g. BC-LCFS, CA-LCFS) and regulatory design details released by ECCC up to May 2019. Two principal analyses of the clean liquid fuel sector were undertaken (Table 8 below):

Table 8: Emission Reductions from Clean Liquid Fuels – Clean Fuel Standard Modeling (2030)

Study Author (million tonnes/year)	**Low Estimate**	**High Estimate**	**Notes**
Navius Research *July 2019*	11.9	15.0	- High EV credits - Low CC1 credits
WAEES *June 2019*	10.9	15.3	- Low EV credits - Moderate CC1 credits

While seemingly comparable in terms of results, the two modeling studies utilized different assumptions about the generation/use of CC1 credits, cross-class credit trading, compliance fund payments, etc. The Navius work identified 14.8 to 16.1 MT of EV credits by 2030, which significantly exceeds the 3.1 MT of EV credits incorporated into the WAEES study. As the studies pre-dated the June 2019 proposed regulatory design, both analyses did not incorporate the full impact of the CC1 credit surplus impacts detailed above.

On balance, the WAEES modeling is a more rigorous analysis of the Clean Fuel Standard design and impacts on global supply chains and fuel markets. The section below overviews the high-level results of the WAEES study.

WAEES Model Results: Clean Fuel Standard (Liquid Fuels)

Advanced Biofuels Canada contracted World Agricultural Economic and Environmental Services (WAEES) to model the impacts of the Clean Fuel Standard on domestic biofuel production and consumption, global and domestic feedstock demand and pricing, as well as the compliance credit price out to 2030. The WAEES partial equilibrium modeling system is made up of a set of global econometric models emulating the behavior of the global agricultural sector and includes renewable and low carbon fuel policies in place in Canada, the US and globally (see Appendix I for a detailed description of the model).

Four scenarios were modeled: a baseline scenario without a Clean Fuel Standard, and three scenarios with differing model parameters.

Baseline Scenario

Assumes that there is no Clean Fuel Standard in place in Canada and current biofuels and blend levels are constant out to 2030. Canadian biofuel production, feedstock supply, demand, and prices are determined by changes to the global market, mainly the US RFS2 and CA-LCFS policies.

Clean Fuel Standard Scenarios

The scenarios were designed according to material presented by ECCC in the *Clean Fuel Standard* Regulatory Design Paper and in the Technical Working Group meetings, with additional assumptions provided by Advanced Biofuels Canada where necessary. Each scenario achieves a 10 gCO2e/MJ reduction in liquid fossil fuel emissions by 2030, following a reduction schedule of 3.6 g CO2e/MJ in 2022 and progressing linearly each year to 10 g CO2e/MJ in 2030. To reduce model complexity and isolate impact analysis on the biofuels market, some parameters are held constant across all scenarios: pyrolysis oil and biojet volumes, CC3 fuels (transport fuel switching to EVs and gaseous platforms), cross-stream trading, and compliance fund credits.

For the purpose of this report, we utilize the two WAEES scenarios which represent the range of CC1 credits modeled. In Scenario 1, 2.5 MT of CC1 credit generation in 2030 is modeled; Scenario 2 models 7.5 MT of CC1 credits. The modeling determines the volumes of biofuels (ethanol, biodiesel, HDRD) produced, consumed, imported, and exported, and quantity of feedstocks required in each year from 2022-2030, based on costs, availability, and carbon intensities of each feedstock and biofuel pathway.

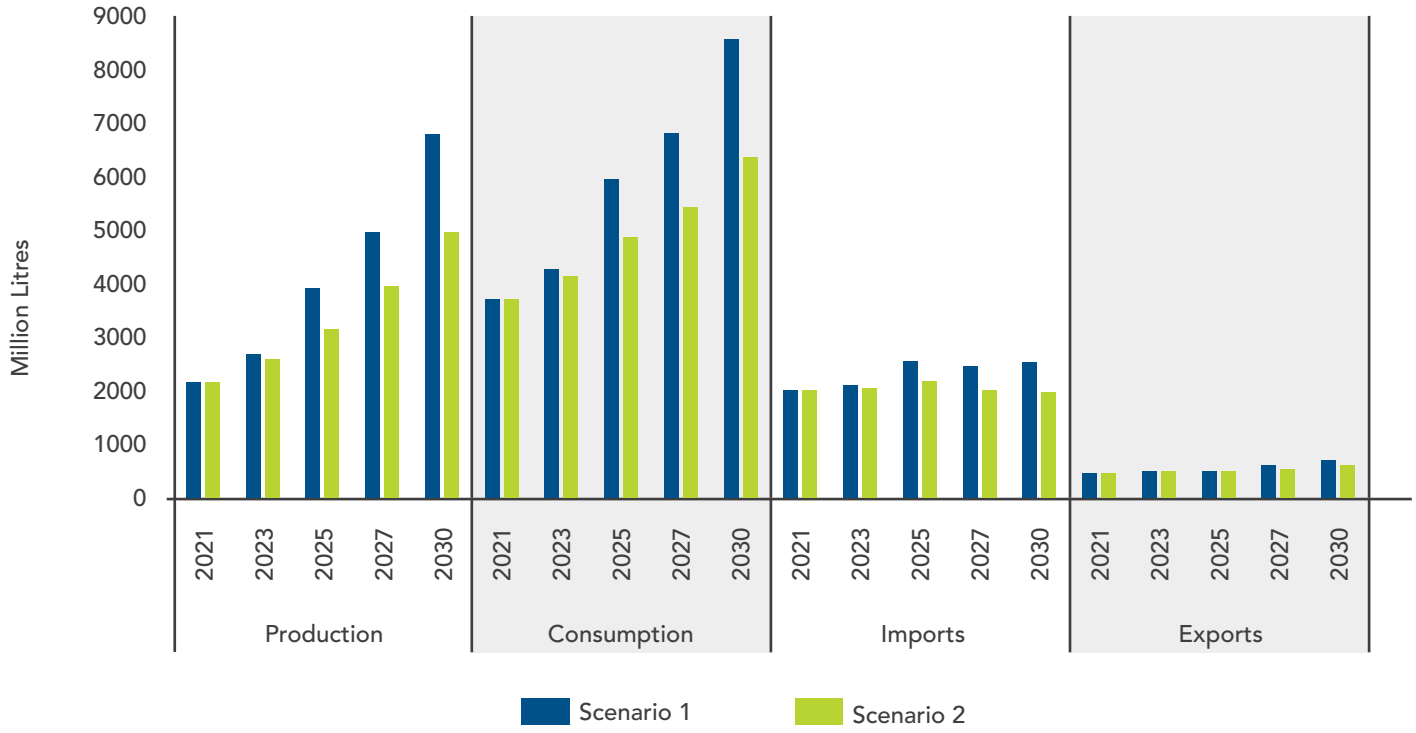
Given uncertainties around calculation methodologies and carbon intensities, the model did not incorporate fungible finished fuels derived from co-processed bio-oils (fats, oils, grease, bio-crude) at petroleum refineries. However, Parkland Fuel Corporation has announced its intention to implement co-processing in 2020 and these fuels will generate credits. Due to the substitutional nature of feedstocks and fuels, the volumes of biofuels in the modeling can represent prospective volumes of renewable fuels from co-processed bio-oils and synthetic fuels derived from carbon capture or wastes. An overview of the baseline and two modeled scenarios, including assumptions and results, is presented in the table below.

Table 9: Liquid Fuels – Clean Fuel Standard Scenario Modeling Results (WAEES)

Scenario	Baseline		Scenario 1		Scenario 2	
2030 Parameters						
CC1 credits	N/A		2.5 MT		7.5 MT	
Cross-class credits	N/A		10% per year			
Compliance fund credits	N/A		5% per year			
CC3 - EV credits	N/A		3.1 MT			
CC3 – Gaseous transport	N/A		0.5 MT			
Biojet volume	N/A		30 ML (1% by volume of domestic flights)			
Pyrolysis oil volume	N/A		249 ML (10% by volume of heavy fuel oil)			
Credit balance	N/A		2 MT			
Biofuels Consumption - 2030						
	ML	**%**	**ML**	**%**	**ML**	**%**
Ethanol	2,536	6.8%	4,099	10.9%	3,433	9.2%
Biodiesel	518	1.6%	2,042	6.0%	1,393	4.1%
HDRD	297	0.9%	2,400	7.0%	1,505	4.4%
Domestic Biofuel Market – 2030 (ML)						
	Prod.	**Imp.**	**Prod.**	**Imp.**	**Prod.**	**Imp.**
Ethanol	1,919	625	3,181	935	2,643	803
Biodiesel	567	390	2,179	576	1,493	497
HDRD	0	297	1,401	999	831	674
Total	2,486	1,312	6,762	2,510	4,967	1,973
Feedstock Demand for Biofuels – 2030 (1,000 tonnes)						
Domestic Corn	4,636		7,016		6,002	
Canola Oil	538		3,464		2,262	
Other (wheat, fat, oil)	816		2,363		1,664	
Feedstock Prices – 2030 ($/tonne)						
Corn	$201.49		$202.73		$202.19	
Canola Seed	$554.38		$576.59		$567.09	
Canola Oil	$1,232.43		$1,343.05		$1,296.33	
Clean Fuel Standard – Compliance Credit Price – 2030 (CAD $/tonne)						
2030 credit price	N/A		$262		$151	

In the WAEES modeling, the scale-up of biofuels production and use follows a linear trend over the Clean Fuel Standard compliance period, as expected due to the linear increase in stringency of the liquid fuel emission reduction requirement.

Figure 7: Canadian Clean Fuel Production, Consumption, Export, Import



Source: WAEES

The table below summarizes the scope of and key impacts from scaling-up biofuels and non-fossil low carbon liquid fuel production under each of the WAEES scenarios.

In both WAEES scenarios, exports of ethanol and HDRD from Canada are essentially zero. Biodiesel is exported from Canada and imported from the United States; through the period, biodiesel exports exceed imports (note - the model resolves trade flows based on regional commodity markets and clean fuel demand).

Table 10: Clean Liquid Fuel Growth – Summary Modeling Results (2030)

Million Litres / Million Tonnes	2020	2030	10-Year Change
Clean Fuel Production			
Ethanol	1,632	2,643 – 3,181	62% – 95%
Biodiesel	598	1,493 – 2,179	150% – 264%
HDRD	0	831 – 1,401	n/a
Total	2,230	4,967 – 6,761	123% – 203%
Clean Fuel Use			
Ethanol	2,919	3,433 – 4,099	18% – 40%
Biodiesel	524	1,393 – 2,042	166% – 290%
HDRD	292	1,505 – 2,400	415% – 722%
Total	3,735	6,331 – 8,541	70% – 129%
Feedstock Price (CAD/T)			
Corn	$199	$202 – 203	2%
Canola Oil	$1,107	$1,296 – 1,343	17% – 21%
Clean Fuel Standard			
CC2 Credits (MT)	n/a	10.9 – 15.3	n/a
Compliance Credit Price	n/a	$151 – 262	n/a

Source: WAEES

2030 Clean Fuel Capacity Target

To take maximum advantage of Canada's abundant supply of sustainable feedstocks and robust energy infrastructure, and the inherent clean economic growth benefits, Canada should seek to be a net exporter of clean fuels by 2030 to supply rapidly expanding global demand for non-fossil low carbon fuels.

Based on the foregoing modeled clean liquid fuel demand and market impacts, Canada can expand proven production platforms and commercialize emerging technologies to increase clean liquid fuel production from 3.0 billion litres in 2020 to 8.5 billion litres by 2030.

Table 11: Clean Fuel Supply and Demand Targets (2030)

Million litres Percent clean fuel[1]	2020	2025	2030	% Change
Demand				
Clean Fuels in Gasoline • Ethanol, other	3,000 (7.5%)	3,500 (9.5%)	4,000 (11.5%)	33%
Clean Fuels in Diesel • Biodiesel, HDRD, other	600 (2.0%)	1,500 (5.0%)	3,500 (11.25%)	485%
Total	**3,600**	**5,000**	**7,500**	**110%**
Supply (Capacity)				
Ethanol	2,150	2,750	3,500	65%
Biodiesel	700	1,250	2,000	185%
HDRD	0	400	1,500	n/a
Co-processed[2]/ Synthetic Fuels	150	750	1,500	900%
Total	**3,000**	**5,150**	**8,500**	**185%**

[1] *Percent based on clean fuel volume/baseline fossil fuel volume (WAEES).*

[2] *Co-processed fuels at 0.5% / 1.0% of refining capacity in 2025/2030. Balance non-fossil, synthetic clean fuels.*

Based on the foregoing targets and given the relative comparability with WAEES modeling scenarios, the availability of feedstocks and impacts on commodity prices and Clean Fuel Standard compliance credit values are within the range of the WAEES results.

An estimate of total capital expenditures over 2020-2030, based on Navius Research's capex ratio for ethanol, biodiesel, and industry data for HDRD production is set out below. Capital cost estimates for co-processing facilities and most synthetic fuel production facilities are not publicly available (and range from low capital cost (integrated refining/co-processing) to very high capital costs reported for novel (demonstration stage) technologies (e.g. Red Rock and Fulcrum).

Table 12: Clean Fuel Capacity Buildout – Estimated Number of Facilities and Capex (2030)

Clean Fuel Type	New Capacity Million Litres	Expansion / New Facilities	Estimated Capex CAD $ Billion
Ethanol	1,350	4-6	$1.12
Biodiesel	1,300	4-6	$0.93
HDRD	1,500	2-4	$1.89
Co-processing / Synthetic Fuel	1,350	2-4	tbd
Total Estimate	**5,500**	**12-20**	**$6 billion +**

2040-2050 Outlook

While there is considerable uncertainty with respect to government policy and the nature and stringency of future climate action measures, climate scientists and economists are certain that deep de-carbonization in Canada is not possible without switching to non-fossil clean fuels.

The 2030 targets defined above introduce blends of 10 to 15% clean fuels, on average, into the fossil fuel system (2017 – 6.6%). While seemingly modest, the establishment of clean fuels production capacity and distribution infrastructure that is incremental to existing supply chains is fundamental to enabling long-term de-carbonization. To be clear, taking early steps (2020-2030) to develop the clean fuels supply chain infrastructure is necessary[6] to ensure the transition to lower carbon fuels over 2030-2050 can scale to achieve future targets.

In addition to blending clean liquid fuel with fossil fuels to decarbonize transportation, industry, and buildings, other clean fuels will help decarbonize other parts of the economy: electrification (cars, buses, short-haul trucking, industry), gaseous fuels (RNG in CNG, LNG platforms, and renewable hydrogen), and solid biomass fuels (heat/power for industry, buildings).

To achieve 80% reduction targets or net-zero emissions by 2050, the Clean Fuel Strategy should establish targets to maintain an orderly market transition to non-fossil clean fuels.

Section Summary

The proposed regulatory approach for the Clean Fuel Standard lacks a clear clean fuel demand signal. Provided changes are made to align the regulatory design with the goal to increase the production and use of non-fossil clean fuels in Canada, and fiscal policies and programs are established to attract private sector capital investment in Canadian assets, significant growth in the sector is predicted over the next decade.

2030 Clean Liquid Fuel Highlights

- Expansion of clean fuel production capacity from 3.0 to 8.5 billion litres per year
- Over $6 billion in new clean fuel capital investment
- Significant new demand for Canadian crops, biomass residues, and wastes
- Increase of clean fuel blending levels to 10 - 15%, on average
- Reduction in greenhouse gas emissions of over 15 MT/ year by 2030

6. De-carbonizing upstream fossil fuel production and refining emissions (e.g. CC1 credit activities) only address the 20-25% of emissions related to oil production and refining; the remaining 75-80% of greenhouse gas emissions result from combustion of fossil fuels (gasoline, diesel). Only fuel switching to non-fossil clean liquid fuels can address long-term decarbonization of transport and other liquid fuel uses.

Clean Fuel Investment - Economic Impacts

An economic impact study of increased investment and jobs from supply chain development and clean fuels production and use defined by the WAEES model scenarios has not yet been undertaken. Given the broad incorporation of CC1 credits, it is not appropriate to compare market-based impacts of the Clean Fuel Standard design with traditional RFS and LCFS regulations.

However, a 2018 study by Doyletech Corporation did analyze the economic impact of increased conventional biofuel production on the Canadian economy. The report looked at a first phase buildout where biofuel production in Canada would equate to blending 10% and 5% in gasoline and diesel fuels, respectively, and a second phase buildout that increased domestic capacity to meet stronger demand for renewable fuels. In the second phase, biofuels production/use was increased to reduce greenhouse gas emissions by 21 million tonnes per year by 2030.

The Doyletech study utilized established economic data from conventional biofuels facilities (ethanol and biodiesel only). As with the WAEES study, one can substitute more capital-intensive HDRD, renewable fuel oil, or synthetic fuel production, and lower capital-intensive co-processing production, to be illustrative of overall economic impacts.

To establish a framework for the economic impact associated with the WAEES scenarios in the proceeding section, we compared 2030 domestic biofuels production data (WAEES) with the Doyletech biofuels production levels associated with both phases. In the previous section, a capacity buildout target of 8,500 million litres per year by 2030 was established, which is lower than the Doyletech Phase 2 capacity; however, economic impacts from more capital intense advanced technologies will be higher than from conventional biofuels platforms.

Table 13: Comparison of Domestic Biofuels Production Models – Doyletech / WAEES (2030)

Biofuel Production / Use (MLY)	**Doyletech** Phase 1	**Doyletech** Phase 2	**WAEES** Scenario 1	**WAEES** Scenario 2
Ethanol	3,759	7,919	2,643	3,181
Biodiesel	1,398	3,955	1,493	2,179
HDRD	0	0	831	1,401
Total	**5,157**	**11,874**	**4,967**	**6,761**

Summary economic results, based on direct and indirect impacts, are differentiated in the Doyletech study for construction (one time) and operation (ongoing) phases.

Table 14: Economic Impacts of Conventional Biofuels Production in Canada (2030)

	Phase 1 Increase Renewable Fuel Blending (10%/5%)	**Phase 2** Deepen GHG Emission Reductions to 21 MTY
Ethanol Production - Investment ($B) - New capacity (MLY)	 $1.84 1,910	 $3.68 4,160
Biodiesel Production - Investment ($B) - New capacity (MLY)	 $0.60 670	 $1.20 2,557
Construction Phase - Economic Impact ($B) - Jobs - Taxes Remitted ($B)	 $3.19 15,700 job years $1.73	 $6.40 31,000 job years $3.36
Operations Phase - Economic Impact ($B) - Jobs - Taxes Remitted ($B)	 $5.66 3,983 annual full-time $1.02	 $12.78 8,631 annual full-time $2.25

Source: Doyletech

Section Summary

The Clean Fuel Strategy will enable a closer analysis, based on defined goals and clean liquid fuel targets, of the economic impacts of expanding clean liquid fuel production/use. The preliminary work by Doyletech provides a rough estimate of direct and indirect economic impacts, which would be revised to reflect advanced biofuels and synthetic fuel capacity buildout to 2030.

2030 Clean Liquid Fuel Investment Impacts (Direct & Indirect)

- **Construction Phase**
  - **>$6 billion capital investment**
  - **35,000 job years**
- **Operations Phase**
  - **$15 billion per year in economic output**
  - **10,000 new full-time jobs**

To meet the over-arching goals of the clean fuel investment review and achieve these targeted results for the clean liquid fuel sector, the core recommendations from this study are detailed in the following section.

Clean Fuel Investment in Canada – Detailed Recommendations

Canadian Political Context

Over 2015 - 2016, the federal and provincial governments actively developed an economic growth strategy that addresses climate mitigation and adaption needs for Canada. The 2016 Pan-Canadian Framework on Clean Growth and Climate Change (PCF) was the first comprehensive attempt to establish a national framework for both energy and climate action policies. The PCF initiative followed earlier work (2012 – 2015) on the Canadian Energy Strategy by the Council of the Federation (Canada's Premiers), which defined recommendations regarding Canada's future energy systems. The PCF sought to establish clear goals, with defined measures and emissions reductions attributed to discreet actions. Setting clear, stable policy goals and establishing specific sector targets is the first step towards creating market conditions to attract private sector capital in new manufacturing new products, such as clean fuels.

Key recommendations in the PCF regarding clean liquid fuels included:

1. Develop a Clean Fuel Standard (PCF Section 3.3, Action 4)
    a. Clean Fuel Standard regulation announced November 2016
    b. Publication of draft regulations delayed to 2020; final regulations in 2021
    c. Implementation date - 2022
2. Support refueling stations for alternative fuels for light- and heavy-duty vehicles (PCF Section 3.3, Action 3)
    a. EVAFIDI program established in Budget 2018
    b. Notwithstanding PCF scope, EVAFIDI excludes clean liquid fuels

The pace, complexity, and proposed design of the Clean Fuel Standard have not created conditions to support clean liquid fuel investment in Canada. The exclusion of clean liquid fuels from the infrastructure program targeting alternative fuels does not align with the policy mandate and puts the Canadian clean fuels sector at a competitive disadvantage to US counterparts.

In 2017, the federal government initiated a broad, Canada-wide consultation called Generation Energy on the transition to a low-carbon economy. A 14-person council was established to provide expert advice to the Natural Resources Canada minister. The final Generation Energy Council Report was released in June 2018, which included clear differentiation of a two-track energy transition strategy to: (1) rapidly transform energy production, distribution, and consumption systems to clean energy platforms; and (2) accelerate development of low-carbon technologies for use in the existing oil and gas sector. Specific council recommendations related to the clean fuel sectors were:

Recommendation #2: Switching to Cleaner Power
- Support electrification of transportation and industrial processes

Recommendation #3: Using More Renewable Fuels
- Expand Canada's capacity to produce and use cleaner fuels (biofuels and biogas from plants and wastes)

The Generation Energy Council Report gives clear direction on how to de-risk investments in clean energy systems. The two-track principle is a key pillar in their report, to create clear clean fuel market signals distinct from actions to improve upstream oil and gas sector emissions; the proposed regulatory design for the Clean Fuel Standard compromised this principle by combining a generous CC1 credit system with the proven low carbon fuel standard design (BC-LCFS, CA-LCFS).

Provincial elections over 2015-2019 led to energy/climate action policy reversals/significant changes in many provinces, which has eroded the stability of the Canadian market. Federally, political discord over carbon pricing policies and the Clean Fuel Standard between the Liberal Party of Canada and the Conservative Party of Canada have made policy risk the primary impediment to private sector clean fuel project finance in Canada. Industry experts report that merchant risk, largely driven by regulatory uncertainty, is the largest source of investor concern in clean fuels.

The global transition to clean energy and clean fuels is well underway. The opportunity cost of political inaction or delayed action will negatively impact Canada's energy, agriculture, forestry sectors and impair the future competitiveness of our clean technology and clean energy sectors. Canada's new government must take immediate action to:

1. Assure greenhouse gas (GHG) emissions reductions targets are achieved by 2030; and
2. Create stable clean energy policy conditions to attract private sector capital to transition Canada to a lower carbon economy

Sustainable Finance Context

In 2018 and 2019, the federal government conducted two important consultations on the economy and how to create competitive conditions to attract capital investment to Canada. Both consultations recognized the global nature of competition for capital and sought to identify systemic barriers and solutions that could unlock Canada's economic potential inherent in our abundance of sustainable natural resources, skilled labour, energy infrastructure, clean energy resources, access to global markets, etc.

The June 2019 final report of the Expert Panel on Sustainable Finance noted *(emphasis added)*:

> *"Canada should put forward a renewed long-term vision for its transition, with focused policies to help businesses and investors of all sizes effectively respond to the economic opportunity. Mapping Canada's climate goals into* ***clear industry competitiveness visions and capital plans would spell out the size and horizon of the investment opportunity.****"*

We strongly endorse the Expert Panel's first recommendation:

> *"Recommendation 1: Map Canada's long-term path to a low-emissions, climate-smart economy,* ***sector by sector, with an associated capital plan.****"*

The September 2018 report from the Economic Strategy Tables started with a similar observation that:

> *"We need to be competitive. We need to push forward with a sense of purpose to achieve growth targets. That means* ***establishing a competitive system that is attractive to private investors.****"*

The first recommendation from the table on Resources for the Future noted the need for agile regulations that:

> *"Make Canada's regulatory system* ***outcomes-driven, stringent, flexible, timely and predictable; align with global best practices.****"*

The table on Clean Technologies also endorsed agile regulations as its number one recommendation, and noted the need for governments to:

> *"... de-risk compliance in a thoughtful, staged and controlled way,* ***supporting deployment of technologies through clear rules that increase investment certainty*** *for customers and innovators alike"*

Public and Private Sector Risk

One of the key considerations to designing effective clean fuel policies and programs is to ensure that risks are properly apportioned to the party best-able to mitigate or manage the risk. In the case of novel, clean energy sector investments, there is a well-defined and accepted role for government to address public policy risks related to market access, performance, and fairness. Energy markets are regulated systems, with monopoly- and oligopoly-level industry concentration. Over the past twenty years, governments have been designing and implementing new regulations and programs to attract private sector investments ($ billions) in clean energy systems (renewable power, transport fuels). Where efforts have proven more costly and/or less effective than alternative approaches, lessons learned can be adopted into modern policies.

Private sector capital markets are well-equipped to manage business risks, such as feedstock, technology, plant capacity, location strategies, and financing structures. In contrast, governments are often not successful in identifying winning business strategies; for example, the ecoEBF program limited eligibility based on their perspective of advanced state of readiness of biofuels projects and the SDTC NGBF program limited eligibility based on prescribed feedstock and IP (Intellectual Property) criteria – both strategies imposed non-commercial metrics that proved ineffective in supporting investment in Canada at a time where US competitors moved forward.

The table below defines risks and roles of the public sector (government) and private sector (capital markets) in clean fuel investment and proposes policy design options based on proven solutions in more mature (competitive) markets (EU, US).

Table 15: Clean Fuel Project Investment Risks – Public and Private Sector Implications

Policy Risks	Policy Instrument	Design Principles
Core Policies	Climate/energy policies Regulatory policies Fiscal policies	• Non-partisan stability (2030) • Aligned with goals/targets • Aligned with goals/targets

Global Competitiveness
- Best Practices
	Fuel regulations
	Fiscal stimulus programs
	
	Tax policies
	Trade
		• See below
		• Competitive to alternative supply jurisdictions
		  • Stable (2030)
		  • Performance-based
		  • Open access
		• Aligned with goals/targets
		• Fair trade agreements

Market Access	Fuel regulation	• Clear non-fossil clean fuel demand signal (e.g. BC-LCFS, US RFS2, CA-LCFS)
		• Market-based neutrality for clean fuels
		  • Feedstocks
		  • Technologies
		  • Fuel products
		  • Intellectual property
		• Performance-based (carbon intensity)
		• Competitive compliance credit market

Performance - Fuel Quality	CGSB standards	• Science and evidence-based • Procedural fairness
Fairness - Programs - Taxation	Program eligibility Fuel taxation Carbon taxation	• Equitable access for clean fuel types • Comparable treatment for clean fuel types • Relevant basis (energy)

Continued on next page

Table 15: Clean Fuel Project Investment Risks – Public and Private Sector Implications (cont'd)

Project Risks	Mitigation Options	Private/Public Sector Role
Feedstock (medium risk)	Biomass rating standards Waste regulations Secure supply Quality Sustainability Legal	• Public • Public • Private • Private • Public/private • Private - counterparty contracts
Technology (low risk - conventional) (high risk – novel)	Performance contracts Technology insurance Experienced EPC contractor	• Private (conventional) • Shared (novel) • Private
Market Access (high risk)	Fuel regulations Trade Business strategy – sales Public procurement	• Public (see above) • Public (see above) • Private • Public
Permitting (medium risk)	Land use bylaws Emission standards Compliance	• Public (all levels – municipal, provincial, federal) • Private
Project Finance (high risk)	Finance structure: debt/ equity Allocation of: • Policy risks • Business risks	• Shared – nascent market development phase • Public • Private

The recommendations presented below represent an integrated set of policy, regulatory, tax, and program measures that – combined – will create competitive investment conditions to expand the production and use of clean and renewable liquid fuels in Canada. The recommendations have been designed to respect the core objectives of the *Pan-Canadian Framework* and reflect the expert advice developed in the 2018-2019 consultations. These measures will achieve the targeted clean liquid fuel objectives of the *Roadmap to 2030*.

Recommendation #1. Establish a Clean Fuel Strategy

That Canada establish a comprehensive, long-term Clean Fuel Strategy to address the climate emergency, attract investment in sustainable growth, and ensure competitiveness of the production and use of clean fuels in Canada. We recommend the Clean Fuel Strategy establish:

I. Clear emission reduction and economic development goals for non-fossil clean and renewable fuels over 2020 to 2030

II. Firm, differentiated targets for clean fuel production and use in Canada:

- Renewable fuels (biofuels) and low-carbon synthetic fuels
- Renewable gases (biogas, renewable natural gas, renewable hydrogen)
- Renewable solid fuels (wood pellets, torrefied biomass)
- Electric vehicles (EVs)

III. Align the federal Renewable Fuels Regulations and/or Clean Fuel Standard regulations to meet the clean fuel economic development goals and emission reduction targets.

Recommendation #2. Build Clean Fuel Capacity

That Canada commit core funding over 2020 – 2030 to directed initiatives within established programs to attract private capital investment to build clean and renewable fuel production capacity and distribution/use infrastructure:

I. Clean Fuel Capacity Program – Liquid Fuels

- $2.5 billion invested over the period through the Strategic Innovation Fund
- Clean liquid fuel production credit facility
- Program eligibility: non-fossil, low-carbon liquid fuel production capacity
- 10-year program (2020-2030), with year 5 review/renewal evaluation (2025)
- Public funding 10-50% (leverage ratio 9:1 to 1:1)
- National framework – part of the Clean Fuel Strategy (achieve production targets)
- Align with regional governments (Indigenous communities, provincial, territorial) to reflect regional interests, natural resources (agriculture, forestry, waste, renewable power, fossil fuels) and industrial/energy infrastructure
    - i. Enable stacking with provincial/territorial programs
- Utilize a competitive, market mediated process to optimize fund deployment
    - i. Rate setting based on contract for differences to RFS/CFS credit price
    - ii. Contract participation for eligible clean fuel producers (CGSB certified fuels)
- Levelized market impacts for clean and renewable fuels
    - i. Neutrality with respect to feedstocks, technologies, fuel products
    - ii. New and established clean liquid fuel producers

II. Clean Fuel Infrastructure Program – Liquid Fuels

- $250 million invested over the period through the Canadian Infrastructure Bank (CIB)
- Clean liquid fuel infrastructure grant fund
- Program eligibility: new/expanded liquid fuel infrastructure to establish/convert fossil fuel (gasoline, diesel, jet, marine) supply systems to support non-fossil, low-carbon liquid fuel storage, distribution, blending, and use
    - i. Align with CIB mandate by aggregating relatively small infrastructure capital projects under a larger capital allocation
    - ii. Implementation/oversight could be managed by national industry organizations and/or local government organizations
    - iii. Specified use of funds to establish eligibility (i.e. do not use application/challenge program design)
      Reporting/verification/audit controls
- 10-year program (2020-2030), with year 5 review/renewal evaluation (2025)
- Public funding: 10-50% (leverage ratio 9:1 to 1:1)
- National framework – part of the Clean Fuel Strategy (achieve use targets)
- Align with regional/community governments (Indigenous communities, provincial, territorial, municipalities, counties, remote communities) to reflect regional/community-level clean fuel needs/opportunities
    - i. Community level - formal structure with local government organizations
    - ii. Align with local government economic/environmental plans, land use regulations
    - iii. Enable stacking with provincial/territorial/regional government programs

III. Mobilize Federal Financing and Develop Standards

- Ensure eligibility and access for clean fuel technologies and infrastructure under the federal clean technology and green infrastructure program initiatives
- Develop Canadian standards that enable clean liquid fuel market growth, such as:
    - Canadian General Standards Board (CGSB) – biofuel blend standards, new fuels
    - Biomass Supply Chain Risk Standards (BSCRS) – biomass credit rating system
- Direct federal clean growth commercialization and infrastructure funding corporations and agencies to support the *Clean Fuel Strategy* objectives by developing financing facilities and deploying capital to support clean fuels production and use in Canada. Specifically, open access to project finance for clean liquid fuels from the following Government of Canada financing bodies:
    - Business Development Bank of Canada
    - Canada Infrastructure Bank
    - Export Development Canada
    - Strategic Innovation Fund
    - Western Economic Diversification Canada

Recommendation #3. Competitive Tax Policies

That Canada establish stable and fair tax policies to create a competitive investment climate for clean and renewable fuels production and use infrastructure:

I. Capital Investment Measures

- Accelerated Investment Incentive
    - o Target Accelerated Investment Incentive measures (below) to support investment in clean liquid fuel production and use assets
    - o Extend timeline to support long-lead time capacity building and enable orderly market deployment of clean fueling assets
      Re-set last available for use date to March 31, 2031
- Expensing for manufacturing and processing machinery (Class 53)
    - o Define eligibility for clean liquid fuel production assets
    - o Extend 100% write-off for clean fuels production assets to 2026-27
      Phase-out per schedule to 2030-31
- Expensing for clean energy investments (Class 43.1, 43.2)
    - o Define eligibility for clean liquid fuel infrastructure (use) assets as specified clean energy equipment under Class 43
    - o Extend 100% enhanced allowance for clean energy equipment to 2026-27
      Phase-out per schedule to 2030-31
    - o See Recommendation 4(II) below

II. Fair Transport Fuel Taxation

- Transport fuel taxation review – 2020/2022
    - o Expand interim report review (2020) and five-year review (2022) of carbon pricing under the Pan-Canadian Framework on Clean Growth and Climate Change to include a full analysis of transport fuel taxation in Canada
    - o Scope: fuel (excise) taxes and carbon pricing on transport fuels
    - o Align recommendations with the Clean Fuel Strategy
- Apply transport fuel taxes based on:
    - o Energy service provided (not volumetric)
    - o Greenhouse gas emissions
- Ensure tax fairness (equal treatment) for all transport energy fuels:
    - o Include electricity, gaseous, alternative fuels

III. Carbon Capture Tax Credit

- North American alignment for CCS/CCUS
    - o Adopt carbon capture and sequestration/use tax credit provisions under the Canadian Income Tax Act equivalent to Section 45Q of the US tax code
    - o Eliminate generation of CCS/CCUS credits under the Clean Fuel Standard (include in lifecycle assessment of carbon intensity for certified pathways)
      Ensures additionality of CFS emissions reductions

Recommendation #4. Leadership in Clean Fuel Innovation

That Canada commit support over 2020 - 2030 to maintain and expand Canadian leadership in clean and renewable fuel technology and innovation systems through targeted use of measures, such as:

I. Refundable tax credits for clean fuel research and development expenses

- Enhance the federal Scientific Research and Experimental Development (SR&ED) tax credit facility for clean fuel research and development
- Encourage provincial/territorial alignment by stacking sub-national tax credit programs with the SR&ED facility

II. Extend flow-through share eligibility to clean fuel technology development expenses

- Amend Section 1219 of the Income Tax Regulations to qualify clean liquid fuel technology development for pre-commercial (e.g. laboratory, pilot, demonstration scale: TRL 1-8) project expenses as a Canadian renewable and conservation expense (CRCE)
- Maintain inclusion of CRCE in definition of Canadian Exploration Expense (CEE)
- Extend 100% enhanced allowance for pre-commercial clean fuel technology development expenses to 2030-31
    - o Longer term to reflect timeline of innovation to commercialization
    - o Phase-out after 2031
- Also see Recommendation 3(I)(ii) above

III. Capital grants for clean fuel technologies and pilot/demonstration projects

- Recapitalize Sustainable Development Technology Canada (SDTC) to provide longer term (2022 – 2030) stability and support for the development and pre-commercial demonstration of clean fuels technologies in Canada
    - o Budget 2017 provided $400 million to SDTC over 5 years .Extend funding commitments to 2030
    - o Remove artificial barriers (e.g. feedstock restrictions, technology/products, intellectual property ownership) and focus on results: development and deployment of non-fossil low carbon fuel technologies in Canada
- Expand support for clean growth
    - o Enhance resources to support and expand the Clean Growth Hub services provided to the clean technology sectors by Innovation, Science and Economic Development
    - o Ensure eligibility and access for clean fuel production technologies and infrastructure under the federal clean growth program initiatives
    - o Ensure scope of clean growth programs fairly applies to include all commercially deployed technologies (e.g. include clean liquid fuels in next phases of the Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative)

IV. Core funding for applied research

- Ensure stable funding for clean fuels production and use technology research to 2030
- Direct a portion of funds established under federal or provincial equivalent industrial carbon pricing programs (e.g. Greenhouse Gas Pollution Pricing Act, Greenhouse Gas Emissions Performance Standards) to support clean fuel applied research in Canada.

APPENDIX 1 - WAEES Modeling

Overview of the WAEES Modeling System

The WAEES partial equilibrium modeling system is made up of a set of global econometric models emulating the behavior of the global agricultural sector. The partial equilibrium models can be broken down into crops, livestock and biofuels components encompassing feed grains, food grains, cotton, sugar, oilseeds, ethanol, biodiesel, beef, pork, and poultry.

The WAEES models cover 46 countries/regions with an additional 12 regional aggregates including the world total. WAEES follows USDA's reported data coverage which may mean that a zero is reported for a particular commodity which USDA does not cover or has discontinued covering. USDA currently covers at least 90 percent of global production; therefore, the countries which are omitted represent a small portion of total global production. Specifically the WAEES model includes Canada, Mexico, the United States, Caribbean and Central America, Argentina, Brazil, Bolivia, Chile, Colombia, Paraguay, Uruguay, Other South America, the European Union 28, Other Europe, Russia, Ukraine, Uzbekistan, Other Former Soviet Union, Iran, Saudi Arabia, Turkey, Other Middle East, China, Japan, South Korea, Taiwan, Other East Asia, Bangladesh, India, Pakistan, Other South Asia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Vietnam, Other Southeast Asia, Australia, Other Oceania, Egypt, Other North Africa, Kenya, Nigeria, South Africa, and Other Sub-Saharan Africa. WAEES also reports projections on crop area, yield and production for each of the EU-28 countries.

Partial Equilibrium Models

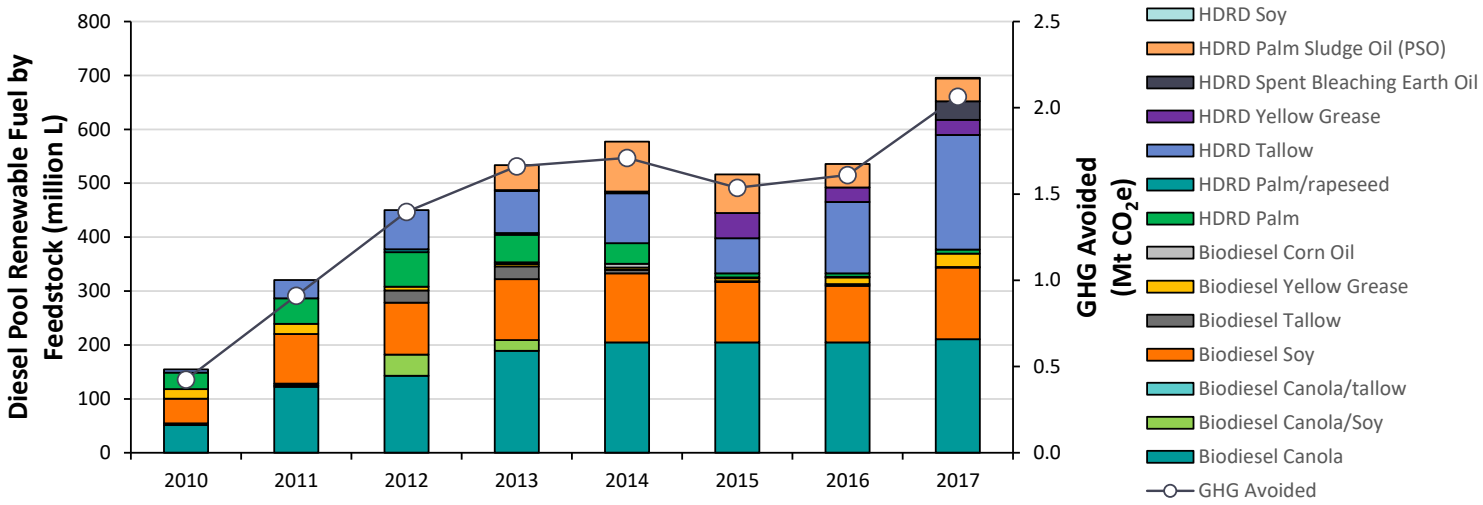
Each partial equilibrium module is broken down into commodities with a system of structural equations capturing the supply and demand components for each of them.

- Profit maximization by the market participants and utility maximization by consumers are the behavioral drivers (subject to various domestic and international trade policies).
- Inter-linkages of crops and livestock are captured. Key drivers of the agricultural sector including income, population, culture, inflation, exchange rates, domestic and trade policy, technology and input costs.
- Crude oil prices (and policies) drive the demand for biofuels. As demand increases, crop prices increase providing an incentive for production expansion.
- Technology growth drives yield expansion providing much of the needed production. Crop area may also grow to meet demand needs although in developed countries this often amounts to trade-offs among crops.
- Ultimately supply and demand are balanced via commodity prices. If demand is stronger than supply, commodity prices increase until demand growth is slowed, and supply growth is increased enough for supply and demand to balance.

The WAEES partial equilibrium models solve iteratively to find equilibrium by balancing global supply and demand. This occurs at the individual country level for each commodity.

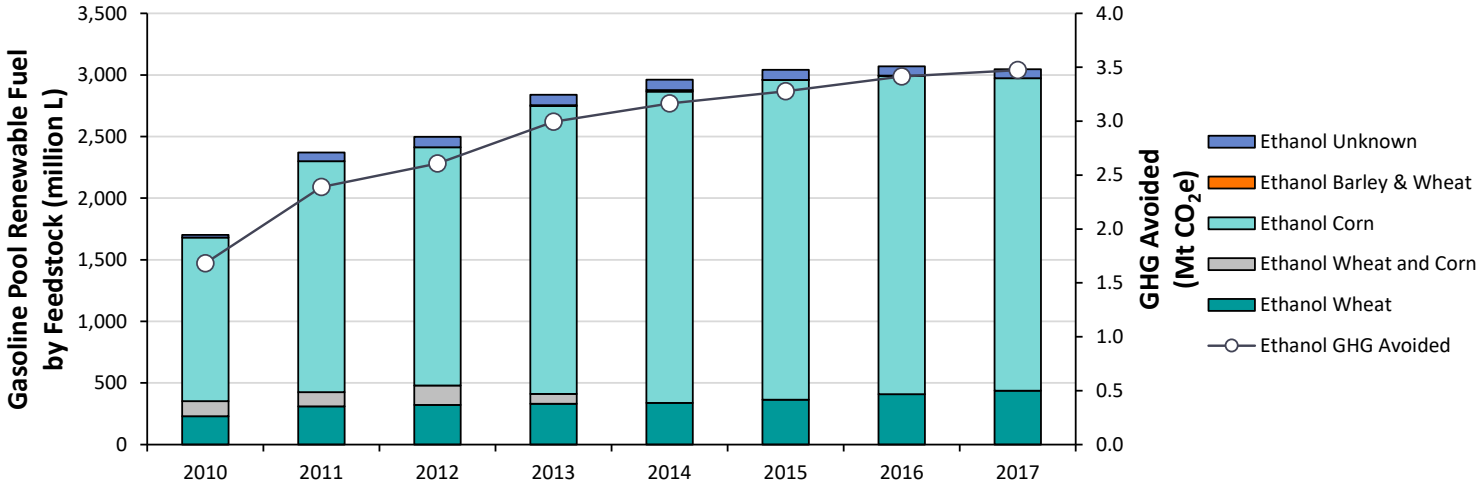
APPENDIX II – Biofuels in Canada (2010 – 2017)

Renewable Fuel Use and Feedstocks – Diesel Pool (2010-2017)



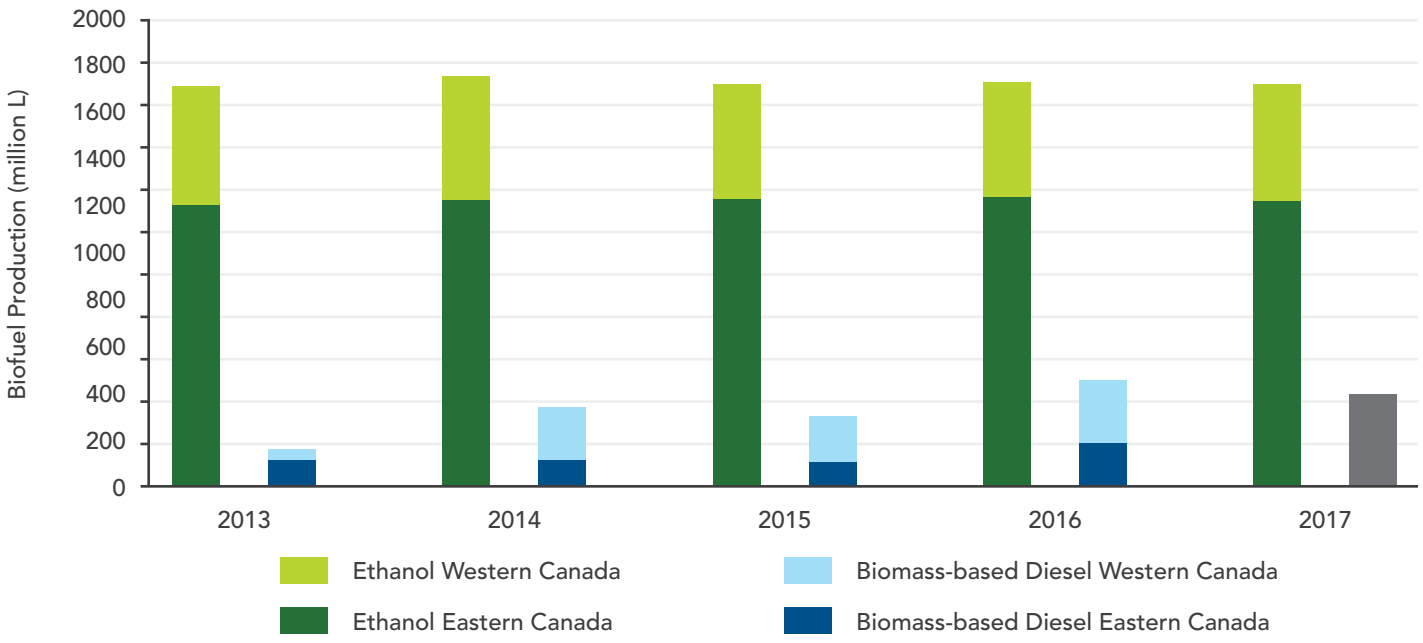
Source: Navius Research, Biofuels in Canada 2019

Renewable Fuel Use and Feedstocks – Gasoline Pool (2010-2017)



Source: Navius Research, Biofuels in Canada 2019

Canadian Biofuel Production (2013 – 2017)



Source: Environment and Climate Change Canada (2017 diesel data aggregated)

Renewable and Low Carbon Fuel Regulations in Canada

Region	RFS	LCFS / CFS	LCFS Year	Status
Canada	5% 2%	10-12%		Clean Fuel Standard will decrease fuel carbon intensity by 10gCO2e/MJ in liquid fuels by 2030
British Columbia	5% 4%	10% 20%	2020 2030	CleanBC plan will decrease fuel carbon intensity by 20% from 2010 by 2030
Alberta	5% 2%			RFS expires January 31, 2020
Saskatchewan	7.5% 2%			No announced changes
Manitoba	8.5% 2%			Climate and Green Plan: Campaign pledge by current government to increase blend levels to 10%/5% (gasoline/diesel)
Ontario	10% 4%		2025	Gasoline RFS increases from 5% to 10% in RUL in 2020. Environment Plan proposes to increase blend level to 15% (2025-2030) and support other clean fuels
Quebec	10% 2%	-	-	New RFS announced October 3, 2019. Proposed RFS implemented July 1, 2021. Increases to 15%/4% (gasoline/diesel) in 2025
Atlantic provinces	-	-	-	No announced plans

Renewable Fuel Producers in Canada (2019)

Facility Owner - Town	Province	Year Commissioned	Annual Capacity (MLY)
Ethanol Plants			
Grain Ethanol			
Greenfield - Chatham	ON	1998	200
Greenfield - Johnstown	ON	2008	260
Greenfield - Tiverton	ON	1989	32
Greenfield - Varennes	QC	2007	190
Husky - Lloydminster	SK	2006	150
Husky - Minnedosa	MB	2008	150
IGPC - Chatham	ON	2008/2018	380
Kawartha - Ethanol	ON	2010	110
NorthWest - Unity	SK	2009	25
Permolex - Red Deer	AB	1997/2004/2008	45
Poundmaker - Lanigan	SK	1991	15
Suncor - St. Clair	ON	2006/2011	400
TerraGrain - Belle Plain	SK	2008	150
Advanced Ethanol			
Enerkem - Edmonton	AB	2017	38
Total Ethanol	**14 plants**		**2,145**
Biodiesel Plants			
ADM - Lloydminster	AB	2013	320
BIOX - Hamilton	ON	2007	60
Consolidated - Delta	BC	2009	11
Darling - Montreal	QC	2005/2008	56
Innoltek - St. Jean	QC	2014	12
Verbio - Welland	ON	2015	170
Total Biodiesel	**6 plants**		**629**

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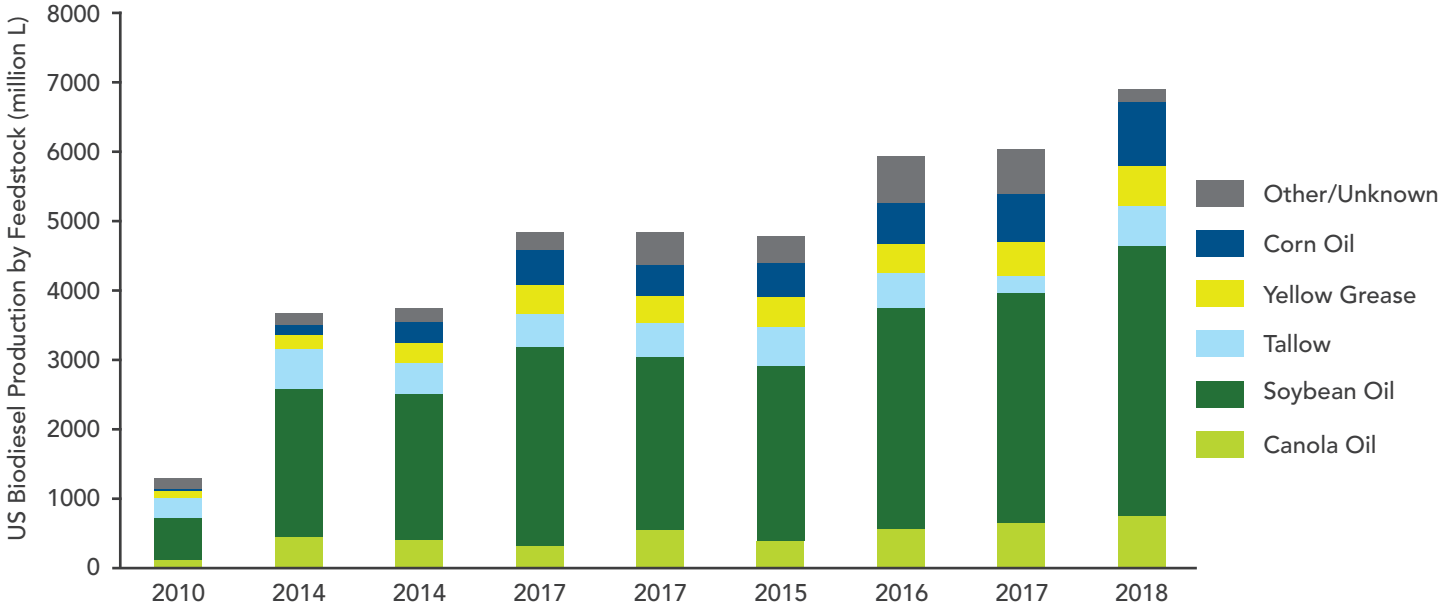
Renewable Fuel Producers in Canada (2019) (cont'd)

Facility Owner - Town	Province	Year Commissioned	Annual Capacity (MLY)
Renewable Fuel Oil (RFO) Plants			
Ensyn - Renfrew	ON	2014	11
Ensyn – Port Cartier	QC	2018	40
Total RFO	**2 plants**		**51**
HDRD Plants			
None			
Co-Processing Refineries			
Parkland – Port Moody	BC	2020(e)	150(e)
Total Renewable Fuels	**23 plants**		**2,975**

Source: Advanced Biofuels Canada

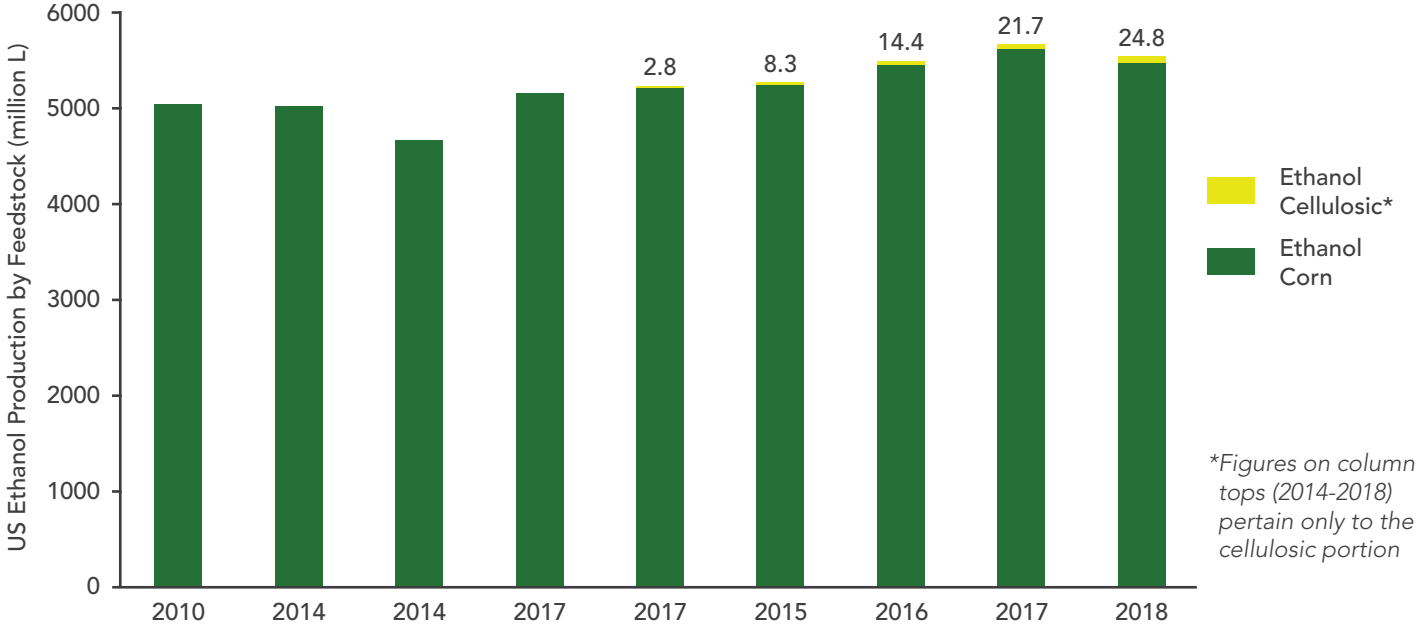
APPENDIX III – Biofuels in the United States (2010-2018)

Biodiesel Production and Feedstocks (2010-2018)



Source: EIA

Ethanol Production and Feedstocks (2010-2018)

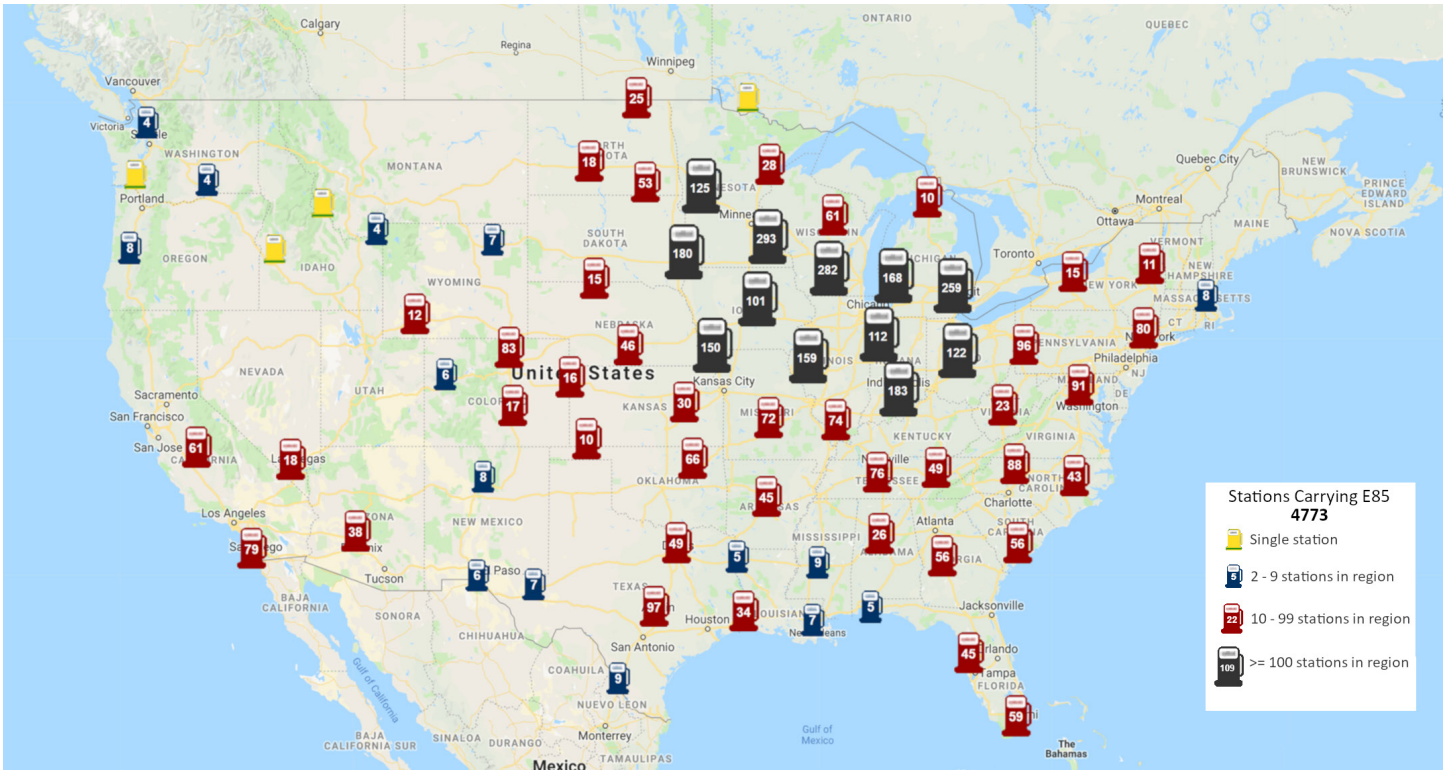


Source: EIA, USDA

B6-B20 Blend Availability (Sep-2019)

E15 Blend Availability (Sep-2019)

E85 Blend Availability (Sep-2019)



Source: Maps prepared by Advanced Biofuels Canada – station data from following sources:

B6-B20	*AFDC, plus station data for Truck Stops of America, Loves, Pilot Flying J*
E15	*E85 Prices website*
E85	*AFDC, DOE, E85 Prices website*

APPENDIX IV – Clean Fuel Fiscal Programs in Canada

	Amount	Timing	Status
Federal Programs			
Strategic Innovation Fund (ISED)	$1.26 B	2017-22	• Repayable and non-repayable contributions (min $10 M ask) to firms across all industry and tech sectors
Canada Infrastructure Bank	$5 B	Established 2018	• Arm's length crown corporation offering support to private sector and new revenue-generating infrastructure projects that are in the public interest • $5 billion earmarked for green infrastructure
Clean Technology Financing Business Development Bank of Canada (BDC) Export Development Canada (EDC)	$1.4 B	2018+	• Equity investments - $380 M over 3 years • Working capital - $570 M over 3 years • Project finance - $450 to enable early commercial scale high capital cleantech
SDTC Tech Fund	$965 M	Ongoing	• Non-repayable contributions up to 33% of project costs to support clean technology development and demonstration projects
Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative (NRCan)	$113 M	2018-28	• Deploy infrastructure for EV charging, natural gas, hydrogen refueling, and support technology demonstration projects • Phase 2 open - does not permit biofuels
Federal Tax Policies – Fall Fiscal Update			
Accelerated Write Off of Manufacturing Equipment	N/A	2018-2023 Phase-out from 2024-2027	• Businesses can write off the full cost of machinery and equipment for manufacturing or processing of goods (includes biofuels)
Immediate Expensing for Clean Energy Investments	N/A	2018-2024 Phase-out from 2024-2027	• Businesses can write off the full cost of specified clean energy equipment
Accelerated Investment Incentive	N/A	Proposed	• Capital investments eligible for 3x deduction rate in first year
Darling - Montreal	QC	2005/2008	56
Innoltek – St. Jean	QC	2014	12
Verbio - Welland	ON	2015	170

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	Amount	Timing	Status
British Columbia			
BC RLCFRR Part 3 Agreement Programs	~$50M / year	2017-20 +	• Annual program, 230K – 500K LCFS credits per year (estimate based on $100/ credit)
Innovative Clean Energy (ICE) Fund	$40 M	2017-20	• Funding for clean energy projects and technologies that reduce GHG emissions • Continuous intake
Alberta			
Bioenergy Producer Program	$63 M	2017-20	• $0.10 - $0.14 per litre ethanol • $0.13 per litre renewable diesel • Program expires Mar31-20
Quebec			
Refundable tax credit for biofuel production	N/A	2018-23	• Tax rebates on biofuel production ($/L) - Biodiesel: 0.14 - Ethanol: 0.03 - Cellulosic ethanol: 0.16 - Pyrolysis oil: 0.08