

Country Reports

IEA Bioenergy: 09 2018

This report was prepared from the 2018 OECD/IEA World Energy Balances, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report¹ for all country reports.

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NATIONAL POLICY FRAMEWORK IN CANADA

In 2015, at the United Nations Climate Conference (COP21) in Paris, Canada together with 194 other participating countries, agreed to take steps to support the transition to a global low-carbon economy that would limit the global temperature increase to less than 2 degrees Celsius above pre-industrial levels. Canada’s government at both federal and provincial and territorial levels is committing to policies such as supporting renewable/clean technology innovation as announced in the Federal Budgets 2016², and 2017³. Furthermore, to support the COP21 commitment, the federal government in partnership with provinces and territories, and in consultation with Indigenous peoples has developed a pan-Canadian Framework on Clean Growth and Climate Change⁴. It includes a federal carbon pricing framework and measures to achieve reductions across all sectors of the economy. The Pan-Canadian Approach to Pricing Carbon Pollution was announced October 3, 2016.

On November 25, 2016, the Government of Canada announced its intent to develop a Clean Fuel Standard (CFS). The objective of the Clean Fuel Standard is to achieve 30 million tonnes of annual reductions in GHG emissions by 2030 and thereby contribute to Canada’s effort to achieve its overall GHG mitigation target of 30% emission reduction below 2005 levels by 2030⁵. The Clean Fuel Standard will establish lifecycle carbon intensity requirements separately for liquid, gaseous and solid fuel pools that supply transportation, industry and buildings sectors. This performance-based approach is intended to incentivise innovation, development and the use of a broad range of low carbon fuels, energy sources and technologies. It will be a non-prescriptive, market-based approach that includes a crediting and trading system. A Regulatory Framework was released in December 2017 providing further details on the scope of the regulations; regulated parties; the carbon intensity approach; the timing for the

¹ Available at <https://www.ieabioenergy.com/iea-publications/country-reports/2018-country-reports/>

² <https://www.budget.gc.ca/2016/docs/plan/ch4-en.html>

³ <https://www.budget.gc.ca/2017/docs/plan/chap-01-en.html#Toc477707359>

⁴ <https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html>

⁵ <https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html>

regulations; and compliance mechanisms. The Framework provides the foundation for launching further consultations with stakeholders on the regulatory design. Publication of proposed regulations in the Canada Gazette will occur first for liquid fuels, followed a year later by gaseous and solid fuels. The target date for coming into force is 2022 for liquid fuels, and 2023 for gaseous and solid fuels.

The long standing Federal Renewable Fuel Regulations, finalized and established in September 2010, require fuel producers and importers to have an average renewable fuel content of at least 5% based on the volume of gasoline that they produce or import into Canada as of December 15th 2010. A 2% requirement for renewable content in diesel fuel and heating oil began on July 1st 2011. Five provinces have also developed biofuel polices with specific per cent volume mandates. The federal ecoENERGY for Biofuels Program that was launched on April 1, 2008 and ended March 31, 2017, provided C\$1.5 billion over nine years for operating incentives to stimulate domestic biofuels production.

Canada does not have any binding national or provincial targets concerning the share of renewable energy in gross final consumption – apart from the transport sector. An overview on important policies and measures is provided in Table 1.

Table 1: Canada’s renewable energy targets.

Sector	Share in gross final consumption per sector
Overall target	No national or provincial targets
Heating and cooling	-
Electricity	-
Transport	Federal Renewable Fuel Regulations, 5 provinces have renewable fuel mandates

While government policies and incentives were initially focused on liquid biofuels, more recently there has been increased focus on policy development that supports areas such as bio-heat, clean electricity and renewable natural gas. Federal and provincial governments are helping the bioenergy industry, based on sustainably managed renewable resources, with initiatives and programs targeting R&D and innovation, greenhouse gas (GHG) reductions, energy efficiency, and tax incentives. Programs support the development of biotechnologies at the R&D stage, and also help move demonstration projects through to commercialization. Links to some of the main federal programs that are supporting clean technology projects can be found at the Clean Growth Hub (<http://www.ic.gc.ca/eic/site/099.nsf/eng/home#p1>).

In 2018 a Forest Bioeconomy Framework for Canada was released that describes a comprehensive approach to stimulating new economic activity by converting sustainably managed renewable forest-based resources into value-added products that includes biofuels and services using novel and repurposed processes.

Besides participation in the IEA, Canada is active in a number of other international initiatives such as Mission Innovation and the BioFuture Platform. Of special note is the Mission Innovation Sustainable Biofuels Innovation Challenge that is being co-lead by Canada, India, Brazil and China.

TOTAL PRIMARY ENERGY SUPPLY (TPES) AND THE CONTRIBUTION OF BIOENERGY

The total primary energy supply of Canada in 2016 amounted to 11,727 petajoule (PJ), with an export surplus of electricity of 231 PJ (2% of Canadian TPES). About 75% of TPES comes from fossil fuels, including 4,126 PJ oil products, 3,967 PJ natural gas and 710 PJ coal products (Figure 1). Nuclear energy in nuclear power stations represents 1,103 PJ or almost 10% of total primary energy supply. Renewable energy sources have a share of 17.4% or 2043 PJ – 4.5% bioenergy and 12.9% other renewable energy sources.

Compared to 2011, the share of oil products has gone down slightly from 35.8% to 35.2%, and coal from 7.5% to 6.1%. On the other hand, the share of natural gas has increased from 31.3% to 33.8% and nuclear slightly from 9.1 to 9.4%. In the same period the share of renewable energy remained stable at 17.4%.

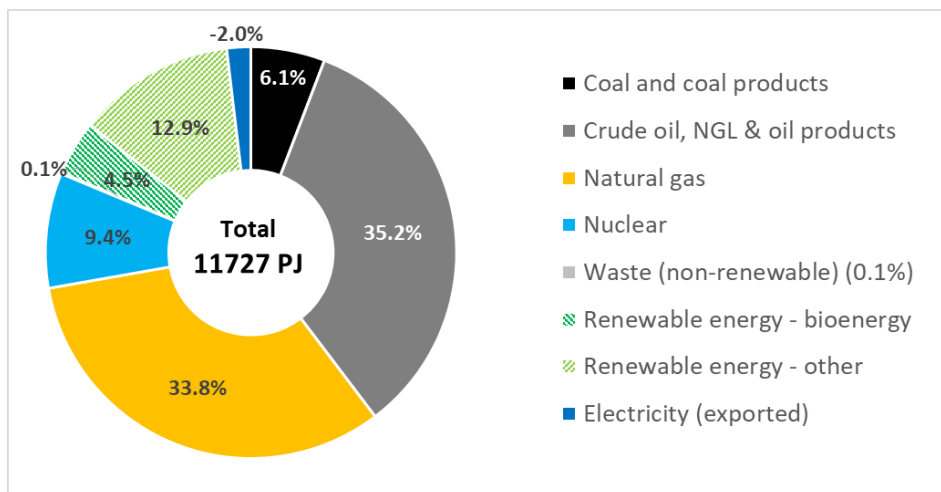


Figure 1: Total primary energy supply⁶ in Canada in 2016 (Source: World Energy Balances © OECD/IEA 2018)

Most of the total primary energy supply of renewable energy sources (Figure 2) is covered by hydropower (1,394 PJ), followed by bioenergy (526 PJ) and wind energy (111 PJ). The role of solar is limited to 13 PJ. Canada ranked 7th in the world for renewable energy production in 2014.

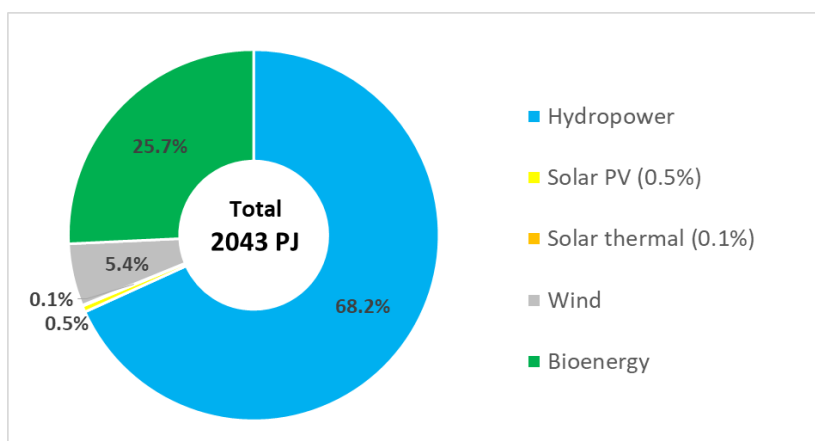


Figure 2: Total primary energy supply of Renewable Energy Sources in Canada in 2016 (Source: World Energy Balances © OECD/IEA 2018)

⁶ TPES underestimates the actual role of pure electricity sources like PV, wind or hydro energy, and overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

Most bioenergy in Canada is from solid biomass (432 PJ), of which 126 PJ is consumed in the residential sector (Figure 3). Bioethanol, referred to as Biogasoline in the chart below (59 PJ) represents a little over 10% of bioenergy supply. Biogas (17 PJ), biodiesel (12 PJ) and renewable municipal solid waste (MSW) (5 PJ) reach lower shares.

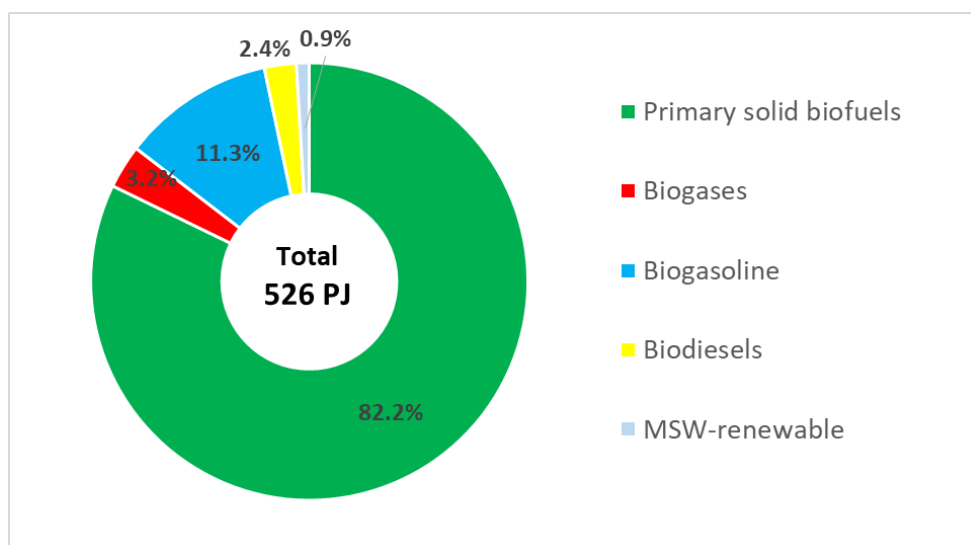


Figure 3: Total primary energy supply from bioenergy in Canada in 2016 (Source: World Energy Balances © OECD/IEA 2018)

On a volume basis, Canada ranked 5th in the world for liquid biofuels production in 2016. In 2016, Canadian production of biofuels reached 1,700 million litres of ethanol and 430 million litres of biodiesel. Ethanol is produced predominantly from corn and wheat, while biodiesel is produced from animal fats and vegetable oils. More information can be found in an industry map of production facilities⁷ and in a table that provides further details on the facilities⁸.

By the end of 2016, Canada had 42 pellet plants with a total nameplate capacity of just over 4 million tonnes per year. Over 80% of Canada's pellet production was exported, mostly to the United Kingdom, Japan and the United States. There are 135 facilities in Canada with an electricity generating capacity of at least 0.8 MW that use biomass. Together these facilities have an aggregate capacity of approximately 3,000 MW. Additionally, there are 282 bio-heat facilities that use biomass to produce heat for largely industrial purposes. Currently, there are 32 on-farm digesters in operation across Canada.

(https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf)

The share of bioenergy in TPES in Canada has been relatively stable around 5% in the past 20 years (Figure 4), with a slight decrease in recent years. The use of solid biomass peaked at 581 PJ in 2005, went down to 477 PJ in 2010 and stabilized afterwards. This decline is attributed to the closure of a number of older pulp and paper mills. Liquid biofuels had a high increase between 2005 and 2011 (from 7 PJ to 67 PJ) to meet federal and provincial renewable fuel mandates, and stabilized around 70-80 PJ afterwards. Biogas had a similar trend, with a doubling between 2005 and 2010, and stabilization around 17 PJ afterwards. The role of renewable MSW remains low, but could increase as more provinces ban organic waste from landfills. With Canada's large biomass resource, there is potential for a larger bioenergy contribution to Canada's TPES.

⁷ <http://ricanada.org/industry/industry-map/>

⁸ <http://ricanada.org/wp-content/uploads/2015/03/Canadian-Ethanol-and-Biodiesel-Facilities-Producer-Tables-for-Website.pdf>

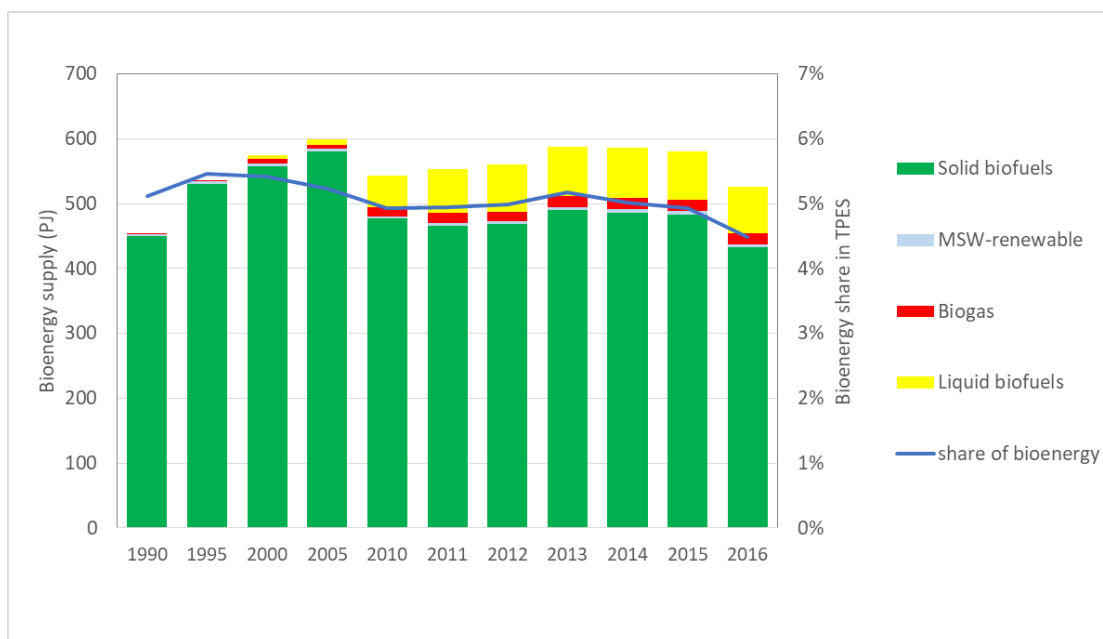


Figure 4: Development of total primary energy supply from bioenergy in Canada 1990 – 2016 (Source: World Energy Balances © OECD/IEA 2018)

Table 2 expresses the 2016 TPES figures per capita, considering Canada’s population of 36.3 million people. Compared to the other 22 member countries of IEA Bioenergy (expressed per capita), Canada ranks in the top 5 for liquid biofuels, top 10 for solid biofuels, halfway for biogas and in the low end for renewable MSW. Mind that total TPES per capita is the highest of all IEA Bioenergy members.

Table 2: Total primary energy supply per capita in 2016

	GJ/capita
Total energy	323.2
Bioenergy	14.5
Solid biofuels	11.9
Renewable MSW	0.1
Biogas	0.5
Liquid biofuels	2.0

Source: World Energy Balances © OECD/IEA 2018

Role of bioenergy in different sectors

Canada has a high share of renewable electricity (90% of it is related to hydropower), with a small part through electricity from biomass.

The share of biofuels for transport was around 3% in 2016.

Overall, the direct share of biomass for heating in the different sectors is around 12%. In the residential sector, biomass represents 17% of fuel/heat consumption. Heat output generated and sold by CHP

plants and heat plants represents only 1% of fuel/heat provided, of which around 16% is produced from biomass.

Table 3: Role of bioenergy and renewable energy in electricity production, transport and heat production/consumption in 2016 (Source: World Energy Balances © OECD/IEA 2018)

Sector	Share of bioenergy	Share of renewable energy	Overall production/consumption
Electricity production	1.9%	66% (hydro: 58%)	667 TWh (2,402 PJ)
Transport energy (final consumption)	2.9%	3.4%	2,559 PJ
Overall fuel and heat consumption⁹	Direct biomass: 11.7% Biobased heat: 0.1%	11.8%	2,773 PJ

Regarding biomass supply for bioenergy, Canada has the third largest total forest area and the sixth largest cultivated land area in the world. The large supply of biomass in Canada combined with a strong innovation system and companies with globally leading bioenergy technologies indicates that the potential contribution of bioenergy to Canada’s energy supply could be considerably increased. Bioenergy is an important component to Canada’s commitment to reduce emissions 30% below 2005 levels by 2030.

RESEARCH FOCUS RELATED TO BIOENERGY

In 2015-2016, federal expenditures on energy RD&D totalled C\$500 million, with provincial/territorial (P/T) government energy RD&D expenditures including those of utilities and other publically owned entities amounting to C\$394 million, for a combined total of \$894 million. This value is slightly lower than the total expenditure of C\$936 million in 2014-2015. The Canadian industry spent about \$2.1 billion on energy R&D in 2014, which was slightly more than the C\$2.0 billion that was spent in 2013.

Expenditures by the federal, provincial, and territorial governments on renewable and clean energy RD&D amounted to \$356 million in 2015/16 with industry spending C\$509 million in 2014 for a total estimated expenditure of \$864 million (<https://www.nrcan.gc.ca/energy/facts/energy-economy/20062#L8>).

Bioenergy related research is being conducted across Canada in universities and colleges, federal and provincial laboratories, and industry. RD&D has been supported at both the federal and provincial/territorial levels. At the federal level there are a number of programs that support research and development of bioenergy.

The Canadian Forest Service (CFS) of Natural Resources Canada has identified the emerging bioeconomy as an important driver for transformation and change in the Canadian forest industry. The recently developed Forest Bioeconomy Framework for Canada¹⁰ outlines the approach to convert forest biomass

⁹ This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

¹⁰ <http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/39162.pdf>

into value added products including bioenergy and to stimulate new economic activity and has support of innovation as one its four pillars. CFS has a number of programs¹¹ that support the development of the bioeconomy such as the Forest Innovation Program (FIP). This program supports research, development and technology transfer activities across Canada's forest sector that will develop and adopt innovative science-based solutions. As well, the Investments in Forest Industry Transformation (IFIT) program offers non-repayable contributions to successful applicants in the Canadian forestry industry to implement innovative, first-in-kind technologies in their facilities. The program focuses on funding projects at the pilot to commercialization phase, with the intent of helping these technologies get to market. Importantly, CFS also conducts economic and market research on bioenergy, bioproducts, and biochemicals to estimate the size and potential of the Canadian industry. Also, CFS scientists are conducting research to determine biomass availability and sustainable harvesting guidelines.

The bioenergy research conducted by the CanmetENERGY Laboratories of Natural Resources Canada focuses on the conversion of biomass to energy and fuels.¹² Through collaborations with industry and in-house research, these national laboratories are exploring biogas (gasification and anaerobic digestion), biofuels (2nd generation biofuels and pyrolysis oil), biomass resources (biomass to gas, catalytic conversion and biomass densification), biorefineries, combined heat and power, and air emissions reduction.

The National Research Council of Canada conducts bioenergy research including the Bioenergy Systems for Viable Stationary Applications (BSVSA) program that works on overcoming the technical and cost barriers involved in the integration of locally-sourced biomass into stationary energy (heat and power) systems¹³ and the Algal Carbon Conversion (ACC) Flagship program that is focussed on converting CO₂ emissions into algal biomass, renewable biofuels and other value-added products.

The Natural Sciences and Engineering Research Council of Canada (NSERC) is a federal granting council which funds research and training in Canadian postsecondary institutions.¹⁴ The agency supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects. NSERC has funded several large bioenergy initiatives including the BiofuelNet Network of Centres of Excellence (2012 to 2017), the NSERC Bioconversion Network (2010-2015), the NSERC Biomaterials and Chemicals Strategic Network (2010-2015) and the NSERC Industrial Biocatalysis Network (2014-2019). In 2015, NSERC undertook a review of the research priorities for its Strategic Partnership Grants, the goal of which is to increase research and training in targeted areas that could strongly enhance Canada's economy, society and/or environment within the next 10 years. Bioenergy and Bioproducts are one of four research areas under the Natural Resources and Energy Target Area.

The Office of Energy Research and Development of Natural Resources Canada manages a suite of programs¹⁵ that include support for the advancement of bioenergy. The Program of Energy Research and Development (PERD) provides funding to federal departments and agencies for internal R&D or collaborative Grants and Contributions with outside organizations working with the federal department or agency that supports the development of sustainable energy. The Clean Energy Innovation Program (CEIP) supports clean energy innovation, including renewable energy. The Clean Growth Program (CGP) funds clean technology research and development (R&D) and demonstration projects in Canada's energy, mining and forestry sectors. The Clean Energy for Rural and Remote Communities (CERRC): BioHeat, Demonstration & Deployment Program Streams are focused on reducing the reliance of rural and remote communities on diesel fuel for heat and power. These programs fund bioenergy research and development both within and outside the federal government, along with demonstration projects

¹¹ <https://www.nrcan.gc.ca/forests/federal-programs/13123>

¹² <http://www.nrcan.gc.ca/energy/renewable-electricity/bioenergy-systems/7311>

¹³ https://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/bioenergy_index.html

¹⁴ http://www.nserc-crsng.gc.ca/index_eng.asp

¹⁵ <https://www.nrcan.gc.ca/energy/funding/4943>

across Canada, in order to support energy technology innovation that produces and uses energy in a cleaner and more efficient way. As well, the Impact Canada Initiative has launched The Sky's the Limit Challenge with a Green Aviation Fuels Innovation Competition and a Cross-Canada Flight Competition. Financial prizes are to be awarded in both competitions (<https://impact.canada.ca/en/challenges/green-aviation>).

RECENT MAJOR BIOENERGY DEVELOPMENTS

Bioenergy AE Côte-Nord Canada Facility

This 10.5 million gallons/year (approximately 40 million litres/year) biocrude production facility is located in Port-Cartier, Quebec. The Côte-Nord Project is being developed by Ensyn, Arbec Forest Products and Groupe Rétabec, and is sited adjacent to Arbec's sawmill on the north shore of the St. Lawrence Seaway. The project will convert approximately 65,000 dry metric tons per year of slash and other forest residues from local sources to biocrude. The biocrude will be sold to customers in the U.S. Northeast and in Eastern Canada for heating purposes and as a renewable feedstock. Project start-up is scheduled for mid-2018.



Figure 5: Ensyn Côte-Nord Biocrude Facility

Enerkem Alberta Biofuels Facility

Enerkem Inc. has built the world's first commercial biorefinery to use municipal solid waste to produce low-carbon methanol and ethanol in Edmonton, Alberta. Based on its proprietary thermochemical processing technology, it has an annual capacity of over 38 million litres per year. Commercial-scale production was initiated in late 2015. The company produced over five million litres of biomethanol before it expanded its facility in September 2017 to start commercial production of cellulosic ethanol. Enerkem is the first ever EPA approved municipal solid waste-to-cellulosic ethanol production plant. The facility also received certification from the International Sustainability and Carbon Certification (ISCC), and was granted the lowest carbon intensity value ever issued by the British Columbia Ministry of Energy and Mines for its ethanol product under the Renewable and Low Carbon Fuel Requirements Regulation.



Figure 6: Enerkem Alberta Biofuels Facility

Other Developments

Operational since 2008, Integrated Grain Processors Co-operative Ethanol Inc. recently completed a \$120 million expansion that doubled its production capacity to 380 million litres of denatured fuel grade ethanol and 360,000 tonnes of distillers' grains. In addition, IGPC has partnered with Air Liquide Canada to capture its facility's CO₂ emissions. For more information, please visit www.igpc.ca.

Forge Hydrocarbons is building a 25 million litre renewable hydrocarbons plant alongside where BIOX is investing C\$5 million to upgrade the former Methes biofuel facility. This lipid to hydrocarbon plant will produce renewable liquid hydrocarbons using a technology developed at the University of Alberta. (<http://www.biofuelsdigest.com/bdigest/2017/03/14/forge-hydrocarbons-sees-canadian-biodiesel-plant-online-h2-2018/>).

Greenfield Global Inc., Canada's largest ethanol producer, will complete in 2019, a feasibility study to significantly expand operations for sustainable biofuel production at its biorefinery in Varennes, Quebec. The potential expansion stands to increase its annual ethanol production capacity by 70% (from 170 to 300 million litres per year). The feasibility study will also incorporate the adaptation of emerging advanced biofuels technologies using non-traditional feedstocks. (<http://www.greenfield.com/announcements/greenfield-global-evaluating-major-expansion-biofuels-production-varennes-quebec/>).

LINKS TO SOURCES OF INFORMATION

Energy Fact Book 2016–2017 (Natural Resources Canada):

https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf

Energy Facts of Canada: <https://www.nrcan.gc.ca/energy/facts/renewable-energy/20069#L8>

Clean Fuel Standard - Regulatory Framework: <http://gazette.gc.ca/rp-pr/p1/2017/2017-12-23/html/notice-avis-eng.html#ne1>

A Forest Bioeconomy Framework for Canada: <http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/39162.pdf>

Research, development and demonstration Expenditures: <https://www.nrcan.gc.ca/energy/facts/energy-economy/20062#L8>



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