CSA GROUP™

Supporting the Diverse and Expanding World of Bioenergy

How standards can help advance bioenergy initiatives and the clean-tech economy

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The 2016 signing of the Paris Agreement by 195 countries demonstrates that climate change is a global challenge that requires a great deal of leadership and innovation to reduce greenhouse gas (GHG) emissions while protecting global economies. Canada signed the Agreement and, as a result, adopted the Pan-Canadian Framework on Clean Growth and Climate Change. The latest report published by ECCC indicates that Canada's climate has warmed on average at double the global warming rate and is expected to continue in the future. Among the sources of renewable energy and clean technologies being considered to meet GHG reduction goals is bioenergy. However, the industry is challenged with assessing a variety of sources, processing industries, and final uses under a holistic approach. Standards can address that challenge to help support the development of global markets – all with safety in mind.

As Canada and other parts of the world develop plans for a more sustainable low-carbon future, bioenergy is gaining ground in the global market. Bioenergy is derived from biomass, which is in turn defined as "any material of biological origin excluding material embedded in geological formations and/or fossilized."[1] Biomass may be processed into biofuels – solid, liquid, or gas – for use as a substitute for fossil fuels in many industries and applications. Based on material that is derived from recently living organisms, biofuels form part of the natural carbon cycle. As a result, they can play an important role in our present and future.

Taking a holistic approach to the use and promotion of bioenergy is challenging since it includes different raw materials, processes, and end-uses. Here are some examples:

- forestry industry by-products are used to create wood pellets that are then used for power generation.
- corn processing produces bioethanol that is then used for transportation.
- landfill gas is collected and refined into renewable natural gas that is then injected into the pipeline to heat homes.

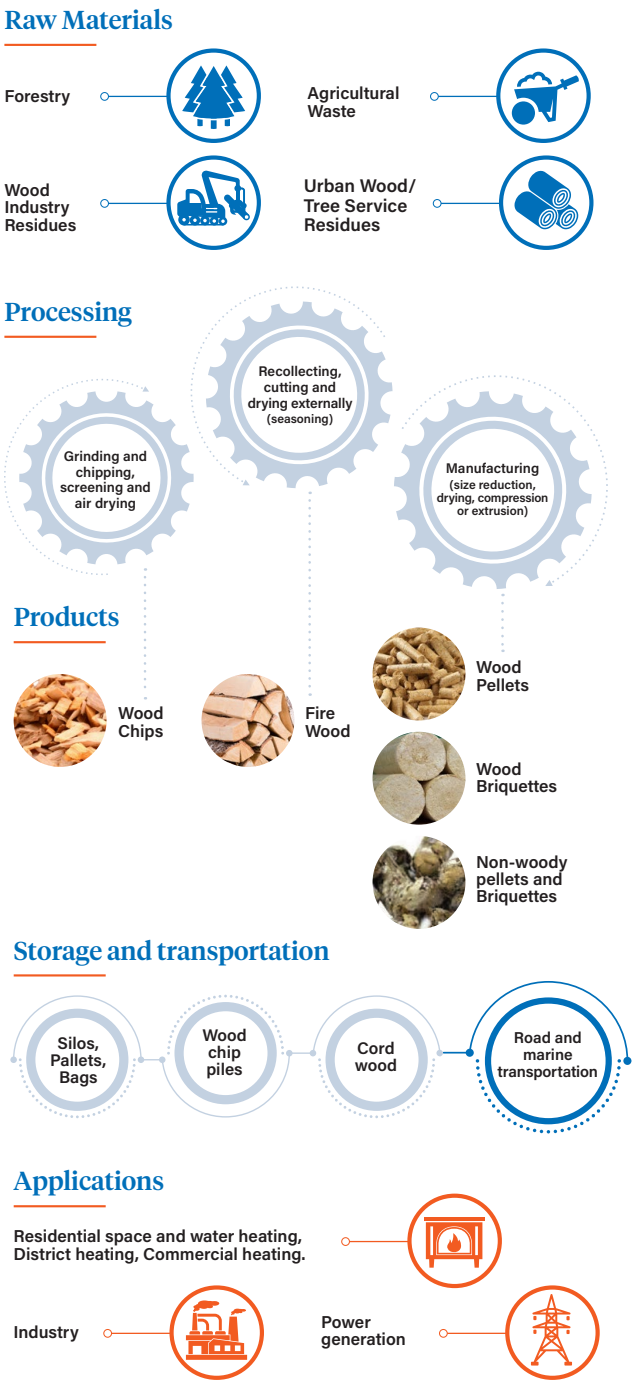
Each one of the different sectors that make up the diverse world of bioenergy fall under a variety of technical requirements and are covered by different sets of legislation. **CSA Group is the leader in bioenergy standardization efforts through our collaborative domestic and international work.** This white paper explores market dynamics, current technologies, as well as standards, legislation, regulations, and initiatives in other jurisdictions that can help pave the way for bioenergy in the global clean economy.

[1] CAN/CSA ISO 16559:15

I. Solid Biofuels

A. Market and technologies

Figure 1 – *Solid biofuels flowchart*



The global market for wood pellets has developed and grown significantly in the past 10 years and is on its way to becoming a worldwide commodity. There are two distinct major markets for wood pellets:

a) Small scale application for residential heating, which require high-quality wood pellets for automatic stoves and boilers; and

b) Large scale application in industrial sectors, which requires lower quality wood pellets; used mostly to substitute coal in large power plants.

There are also mid-sized applications like district heating or combination heat and power plants, but these still contribute only a minor share of the market.

In 2015, Intercontinental trade was led by the exports of North America to Europe (the UK in particular), with a stronger focus on industrial use. Canada and the United States were the largest producers in the world, with a majority of products exported to the European Union primarily for use in its industrial sector. Currently, the domestic market for solid biofuels is – gaining traction.

B. CSA Group's leadership in solid biofuel standards

International involvement and development of new guidelines

CSA Group manages the Mirror Committee of the **International Standards Organization (ISO) Technical Committee for Solid Biofuels (ISO/TC 238),** which upholds Canada's position as a voting member.

The ISO Technical Committee for solid biofuels divides biofuel standards into three major categories:

1. fuel specifications and classes[2];
2. chemical testing methodologies; and
3. physical and mechanical testing methodologies.

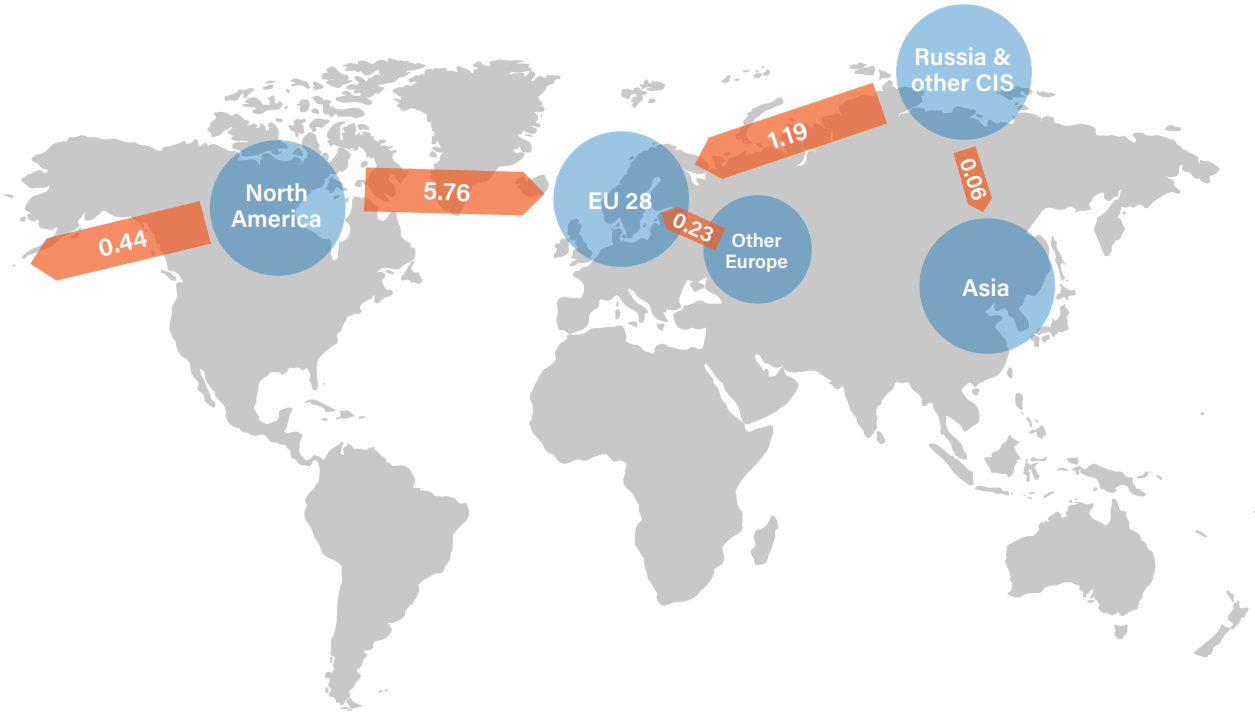
The standards landscape for solid biofuels is relatively mature but still evolving in response to the increased use of these resources worldwide. For example, wood pellets have had incidents of carbon monoxide off-gassing during storage and transportation. The industry has taken preventative measures to mitigate future incidents and started developing two international standards for the safe handling and storage of wood pellets.

[2] A more comprehensive description of the standards may be found in this web page of Natural Resources Canada https://www.nrcan.gc.ca/energy/renewable-electricity/bioenergy-systems/biofuels/7399

Table 1 – *Solid biofuel standards and special publication*

			Standards	
Raw Material Processing				
Products	Solid biofuel specifications		CAN/CSA-ISO 16559:15	Solid biofuels – Terminology, definitions and descriptions
			CAN/CSA-ISO 17225-1:15	Solid biofuels – Fuel specifications and classes –Part 1: General requirements
			CAN/CSA-ISO 17225-2:15	Solid biofuels – Fuel specifications and classes – Part 2: Graded wood pellets
			CAN/CSA-ISO 17225-3:15	Solid biofuels – Fuel specifications and classes – Part 3: Graded wood briquettes
			CAN/CSA-ISO 17225-4:15	Solid biofuels – Fuel specifications and classes – Part 4: Graded wood chips
			CAN/CSA-ISO 17225-5:15	Solid biofuels – Fuel specifications and classes – Part 5: Graded firewood
			CAN/CSA-ISO 17225-6:15	Solid biofuels – Fuel specifications and classes – Part 6: Graded non-woody pellets
			CAN/CSA-ISO 17225-7:15	Solid biofuels – Fuel specifications and classes – Part 7: Graded non-woody briquettes
	Solid biofuel test methods		CAN/CSA-ISO 16948:15	Solid biofuels – Determination of total content of carbon, hydrogen and nitrogen
			CAN/CSA-ISO 16967:15	Solid biofuels – Determination of major elements – Al, Ca, Fe, Mg, P, K, Si, Na and Ti
			CAN/CSA-ISO 16968:15	Solid biofuels – Determination of minor elements
			CAN/CSA-ISO 16993:15	Solid biofuels – Conversion of analytical results from one basis to another
			CAN/CSA-ISO 16994:15	Solid biofuels – Determination of total content of sulfur and chlorine
			CAN/CSA-ISO 16995:15	Solid biofuels – Determination of the water soluble chloride, sodium and potassium content
			CAN/CSA-ISO 17827-1:17	Solid biofuels – Determination of particle size distribution for uncompressed fuels – Part 1: Oscillating screen method using sieves with apertures of 3,15 mm and above
			CAN/CSA-ISO 17827-2:17	Solid biofuels – Determination of particle size distribution for uncompressed fuels – Part 2: Vibrating screen method using sieves with aperture of 3,15 mm and below
			CAN/CSA-ISO 17828:16	Solid biofuels – Determination of bulk density
			CAN/CSA-ISO 17829:16	Solid Biofuels – Determination of length and diameter of pellets
			CAN/CSA-ISO 17830:17	Solid biofuels – Particle size distribution of disintegrated pellets
			CAN/CSA-ISO 17831-1:16	Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 1: Pellets
			CAN/CSA-ISO 17831-2:16	Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 2: Briquettes
			CAN/CSA-ISO 18122:16	Solid biofuels – Determination of ash content
			CAN/CSA-ISO 18123:16	Solid biofuels – Determination of the content of volatile matter
			CAN/CSA-ISO 18134-1:15	Solid biofuels – Determination of moisture content – Oven dry method – Part 1: Total moisture – Reference method
			CAN/CSA-ISO 18134-2:15	Solid biofuels – Determination of moisture content – Oven dry method – Part 2: Total moisture – Simplified method
			CAN/CSA-ISO 18134-3:15	Solid biofuels – Determination of moisture content – Oven dry method – Part 3: Moisture in general analysis sample
			CAN/CSA-ISO 18846:17	Solid biofuels – Determination of fines content in quantities of pellets
Storage and Transportation				
Applications			CSA B365	Installation code for solid-fuel-burning appliances and equipment
			CSA B366.1	Solid-fuel-fired central heating appliances
			CSA B415.1	Performance testing of solid-fuel-burning heating appliances
			CSA B51	Boiler, pressure vessel, and pressure piping code
			Special Publications	
			CSA SPE 2254:19	Guide to wood chip fuel: Characteristics, supply, storage, and procurement

Figure 2 – *World pellet flows (2015)*



2015, in million tonnes; based on (AEBIOM, 2016)

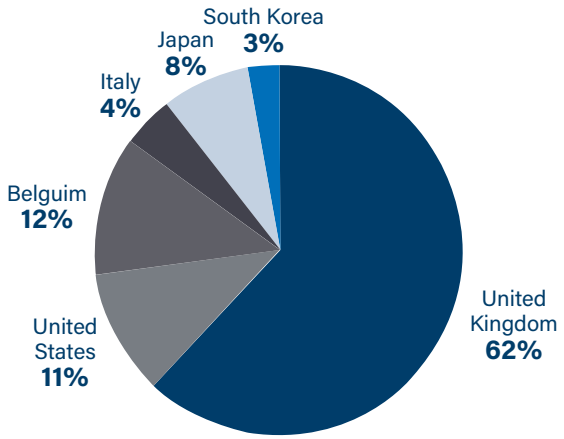
Courtesy of IEA Bioenergy Taskforce 40

Source – *Global Wood Pellet Industry and Trade Study 2017, IEA Bioenergy: Task 40: June 2017*

The storage of wood chips has safety challenges as well, but there is less data available. These are normally stored outdoors in ventilated areas, so off-gassing is not as much of an issue. However, physical and biological processes may result in decomposition, the loss of woody substance, and possible self-heating and self-ignition. That is why CSA Group has developed and recently published in May 2019 a new document: **SPE 2254 – Guide to Wood Chip Fuel Characteristics, Supply, Storage and Procurement**.

This project has been led by CanmetENERGY of Natural Resources of Canada and funded by the Office of Energy Research and Development. CSA SPE-2254 is the first edition of a homegrown guidance document presenting wood chip fuel as a consistent and reliable renewable low carbon fuel source in Canada. With the purpose of building confidence in an emerging market, the guide aims to link the players in the wood chip fuel supply chain. It serves as a knowledge tool by describing the supply chain and offering recommendations and best practices. It also serves as a communication tool by providing clear and unambiguous fuel specification that will enable efficient trade of wood chip fuel. This guide applies to small-scale to medium-scale facilities used in commercial and institutional buildings and larger-scale facilities, such as light industrial sites and district heating. The development process for this guide follows a simplified version of CSA Group's accredited procedures, so while not a standard, it offers valuable guidance, informed by the expertise of industry contributors. In addition, guides are developed faster, allowing us to respond to challenges relatively quickly.

Figure 3 – *Canada Wood pellets export Canada (2015)*



Courtesy of IEA Bioenergy Taskforce 40

Source– *Global Wood Pellet Industry and Trade Study 2017, IEA Bioenergy: Task 40: June 2017*

North American collaborations

Canada not only has vast natural resources of woody biomass, but also agricultural biomass. Funded by the AgriMarketing Program of Agriculture and Agri-Food Canada, The Biomass Quality Network of Canada (BQNC) consists of several organizations that are supporting the commercialization of agricultural biomass for industrial applications. CSA Group participated by preparing a standards landscape that studied feedstock availability, mapping, supply chain pathways, the potential of heat markets, and the feedstock grading system. A proposal to follow up on the work is currently under way.

The solid biofuels market is inevitably intertwined with the market of the appliances that require these fuels to function. The development of the market of solid biofuels is influenced by the regulations and technical requirements on the appliances that burn the fuel. These will be based mostly on energy efficiency and quality of air emission requirements. The highest rate of success will be achieved when there is an optimal relationship between the quality classes of the fuel and those that are required by the equipment, and this can be achieved when the standards for biofuels are aligned with the standards for appliances.

Clean air legislation in Canada is managed between multiple government jurisdictions, and varies across the country. The standard, **CSA B415.1, *Performance testing of solid fuel burning heating appliances,*** offers test procedures for measuring the emissions, heat output and efficiency of heating appliances, and it may be used by different jurisdictions for regulating air emissions. At the same time, many jurisdictions also recognize the US EPA New Source Performance Standard.

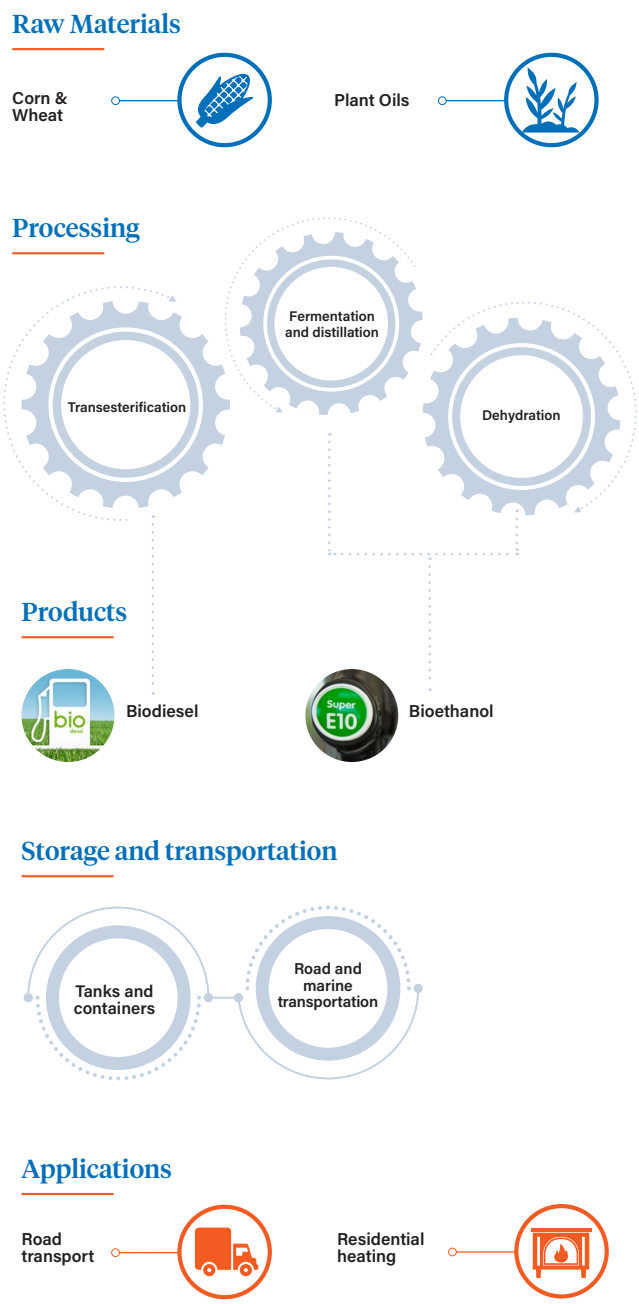
Ontario has recently published air quality guidelines that refer to the international solid biofuel standards adopted by CSA and also include the European EN 303-5 standard. CSA Group is participating as a member of the small scale biomass combustors (SSBC) project within the Canadian Council of Ministers of the Environment (CCME). The CCME is composed of the environment ministers from the federal, provincial and territorial governments, and it is the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern. The CCME is working on a Canada-wide guideline to assist jurisdictions in developing policies, programs, and regulations to effectively manage air emissions from SSBC and it is expected to reference the standards mentioned above.

Safe installation is covered by the code, **CSA B365, Installation code for solid fuel burning appliances and equipment** which in turn requires testing for safety requirements from many standards, one example being **CSA B366.1, Solid fuel fired central heating appliances.**

II. Liquid biofuels

A. Market and technologies

Figure 4 – *Liquid biofuels flowchart*



Biodiesel and bioethanol are the most common forms of liquid biofuels and are mainly used for transportation. Liquid biofuels may reduce the carbon footprint of fossil fuels by blending with or substituting them.

Bioethanol is a natural byproduct of the agricultural industry; produced from the fermentation of sugar or converted starch contained in grains and other agricultural or agri-forest feedstocks. The major sources in North America are corn and wheat.

Ethanol fuel is bioethanol that has been distilled and dehydrated to create a high-octane, water-free alcohol. Two types are:

- Low-blend 10 percent ethanol (used since the 1980s and available across Canada).
- High-blend 85 percent ethanol (used by some organizations that have large vehicle fleets, but it is not yet commercially available in Canada).

The benefit of ethanol is that it burns more cleanly and completely than gasoline or diesel fuel. Low-blend ethanol from corn produces about 3 to 4 percent fewer GHG emissions than gasoline.

Cellulosic ethanol is manufactured from agricultural and wood waste products as well as fast-growing trees. It is a developing technology in which potential feedstocks include wheat straw, corn stover, wood residue, switchgrass, and poplar. Plant co-products can be used to generate the energy that runs cellulosic ethanol-manufacturing processes. Low-blend made from wood or agricultural cellulosic materials would produce 6 to 8 percent fewer emissions compared with gasoline.

Biodiesel that is created from natural fats like plant oils, waste cooking oil, animal fats and fibrous plants goes through a process called *transesterification*. Biodiesel is mixed with diesel to create a blend. This blend is comprised of pure biodiesel, also referred to as B100, blended with petroleum diesel at varying concentrations (B*n*). Common blends are:

Blend	Pure Biodiesel (B100)	Petroleum Diesel
B2	2%	98%
B5	5%	95%
B10	10%	90%
B20	20%	80%

B. Future legislation and the role of CSA Group

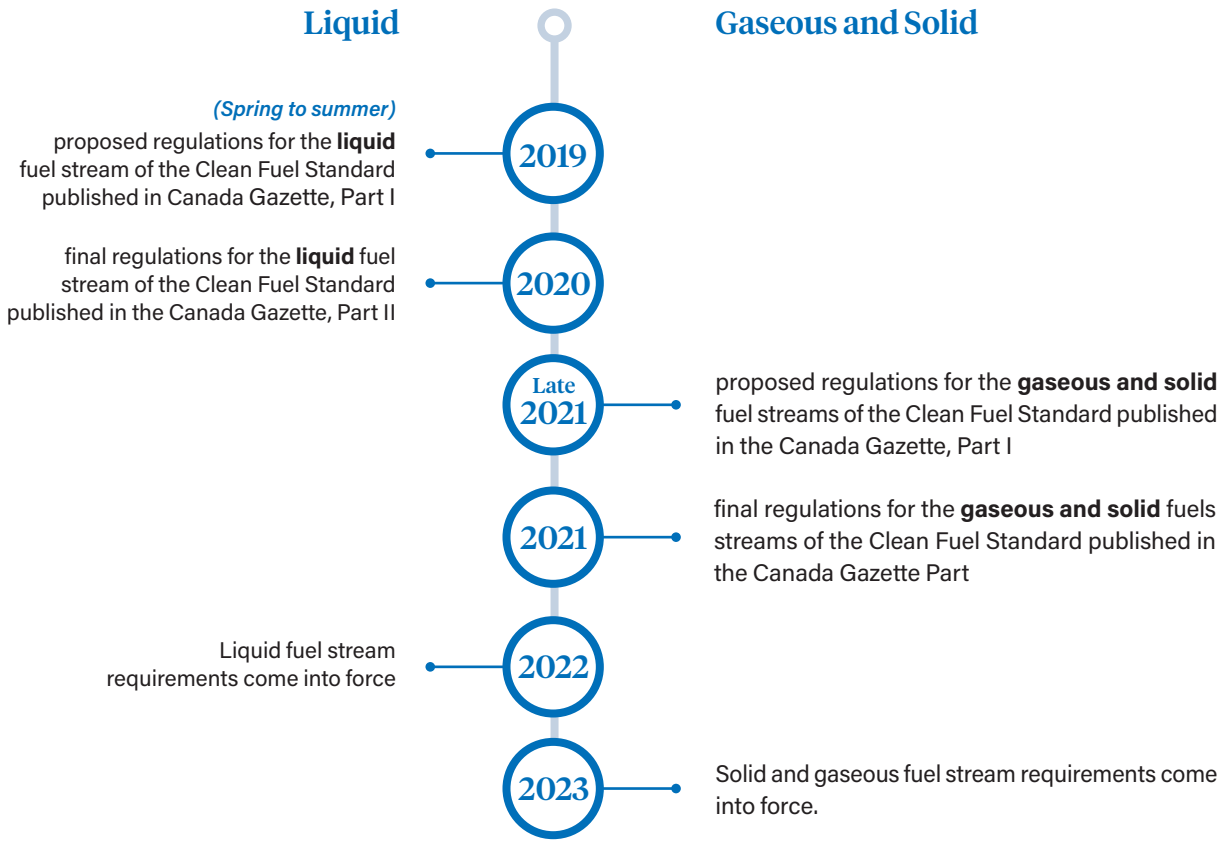
Awaiting a new clean fuel standard to disrupt the biofuel industry

Liquid biofuels fall under the Renewable Fuels Regulations SOR/2010-189, which aims to reduce GHG emissions by mandating a 5 percent renewable fuel content based on the gasoline volume and a 2 percent renewable content in diesel fuel and heating oil. The regulation is expected to be replaced by a new standard that will have a significant impact on all types of biofuels, and it will go beyond the transportation sector.

As part of the Pan-Canadian Framework on Clean Growth and Climate Change and Canada's efforts to reduce GHG emissions by 2030 (30 percent below 2005 levels), the Clean Fuel Standards (CFS) Regulations are to be published under the *Canadian Environmental Protection Act.* **The scope of the CFS will apply to liquid, solid and gaseous fuels in the sectors of transportation, industry and buildings.** Other CFS policies exist already in British Columbia or California, but they apply only to transportation. This will be the first policy in the world of its kind to extend its scope to buildings and industry. They are expected to become an incentive for innovation, development and use of a broad range of low carbon fuels, energy sources and technologies which will include biofuels.

The CFS Regulations will use a life cycle approach to assess and drive actions to reduce GHG emissions. This assessment will include all stages in a product's life, from cradle to grave (from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling where applicable).

Expected timeline for development of Clean Fuel Standard Regulations



There will be carbon intensity requirements on the different fuels, as well as rules surrounding credit trading. Carbon intensity values will be expressed in grams of carbon dioxide equivalents (gCO_{2e}) per unit of energy in Mega Joules (MJ) and will account for GHG emissions over the lifecycle of a fuel. These carbon intensity requirements will have the goal of achieving at least 30 Mt CO_{2e} of emissions reductions annually commencing in 2030 and may vary in the future.

The regulated parties will either be the producers or the importers of the fuel. The CFS will provide other ways of complying besides reducing GHG emissions, such as including renewable fuel content in the case of fossil fuels. Credits will be tradeable within each stream of fuels (solid, liquid or gaseous), meaning **biofuel producers will be able to obtain and sell credits**.

The CFS Regulatory Framework was published in December 2017. Draft regulations for the liquid fuel stream are expected for summer of 2019 and for solid and gaseous fuel streams for late 2020. The final regulations for the liquid fuel stream are expected for 2020 and for the solid and gaseous fuel streams are expected in 2021. The period for enforcing them is expected in 2022 and 2023.

CSA Group's experience in environmental management standards and Registry Services

Within the CFS Regulations, the carbon intensity of each fuel will have to be determined and verified. Although the methodology to do this is yet to be decided, CSA Group has experience in this field through its Registries and experience in international standardization.

Canada holds the secretariat for ISO Technical Committee TC207 Environmental Management, which has developed the standards that will form the foundation for the calculation of the carbon intensity throughout the life cycle of a biofuel.

CSA Group provides registry services to clients across multiple sectors in Canada and around the world. A company is eligible to be listed on a CSA Group Registry once it has demonstrated compliance with specific program rules through a third-party assessment. CSA Group ensures completeness and accuracy by monitoring the process. Registry listings are independent, transparent, and provide a platform for organizations to showcase emission reductions, carbon offset projects, sustainable products and building accessibility.

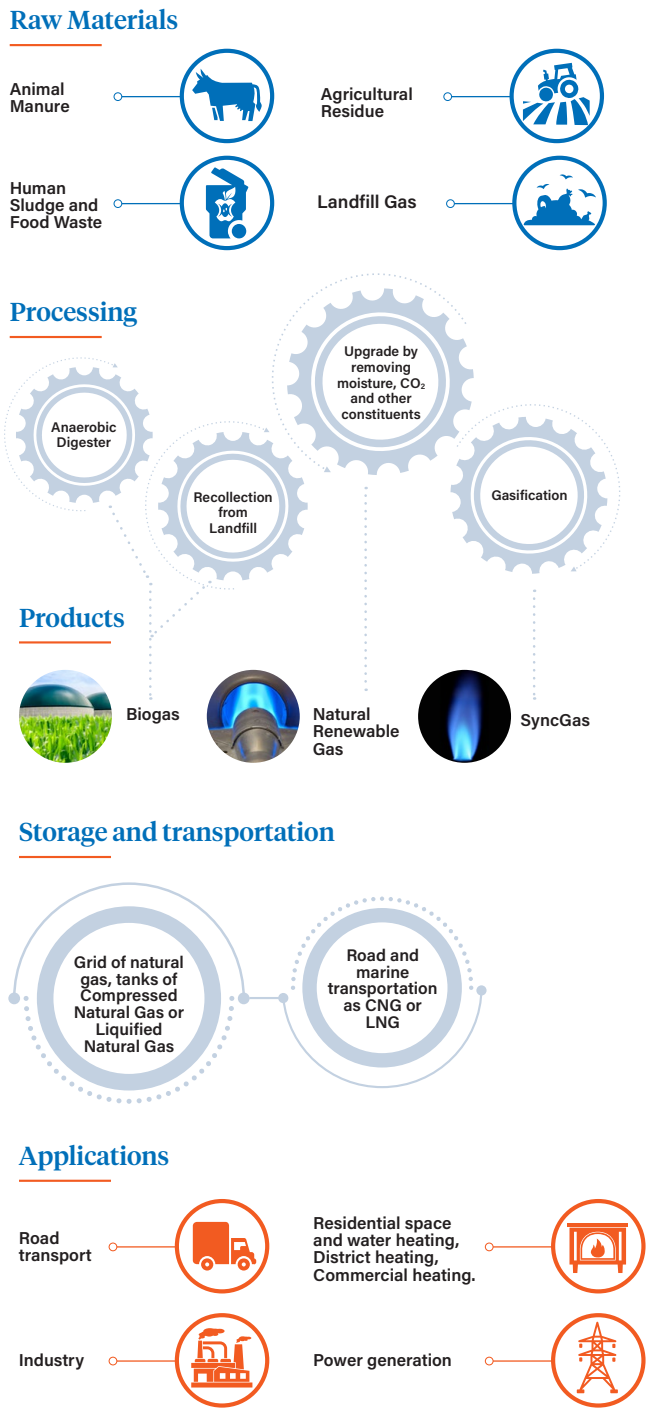
CSA Group currently operates eight different Registries, like the Alberta Carbon Registry (aligned with ISO 14064) and the Rick Hansen Foundation Accessibility Certification Registry (aligned with CSA B651), and has the capacity and experience to support the development of Registries in new areas.

III. Gaseous biofuels

A. Market and technologies

Gaseous biofuel offers a dual solution of producing renewable energy and managing waste

Figure 5 – *Gaseous biofuels flowchart*



Whether it is the manure from dairy or hog farms, crop residues, human or food waste, as a society, we are continuously producing organic waste that needs to be managed to avoid contamination and GHG emissions. A good solution, both economically and environmentally, is to convert the waste into gaseous biofuel. There are three common ways of naming gaseous biofuels: biogas, renewable natural gas (RNG) and syngas. These names depend on the way the gas is processed and also refer to different concentrations of their constituents.

Biogas is a mixture of methane and other elements, and may be collected from landfills or produced through anaerobic digestion. During anaerobic digestion, organic material is broken down by micro-organisms in the absence of oxygen. Feedstock in this case may be manure from dairy or hog farms, or biological municipal waste. Biogas will be used locally for generating electricity or heat. The anaerobic digestion also produces a liquid effluent called digestate, which is used as fertilizer by farms.

A further step may be taken when a biogas upgrading unit removes the moisture, carbon dioxide, and other constituents yielding biomethane, which is commonly referred to as RNG. RNG may be transferred into the pipeline or transformed into compressed natural gas (CNG) and used for transportation.

Syngas is created following a process called gasification by which the biomass is heated to a high temperature (>700 °C) without combustion and a controlled amount of oxygen and/or steam. The resulting gas biofuel includes carbon monoxide and hydrogen, which may be used for power and heat generation.

State of gaseous biofuel projects in North America

Canada currently has over 60 operational anaerobic digester facilities, the majority of which are generating electricity for the grid. These facilities are found mostly in British Columbia, Ontario, and Quebec, the three provinces that are leading the way with RNG policies and programs. In particular, Quebec has announced in March of 2019 a new regulation that will require that a minimum amount of 1% of natural gas distributed must be renewable natural gas by 2020 and the goal is to reach 5% by 2025.

The Landfill Methane Outreach Program (LMOP) was established in 1994 and has helped the US reach 632

Landfill Energy Projects in operation, most of which are for production of electricity. The LMOP indicates a trend towards a higher megawatt output in electricity projects and a higher total gas flow output towards renewable gas projects. California is considered by many to be a world leader in environmental policies. For example, its 2017 scoping plan to fight climate change has many ambitious targets for 2030. These policies affect the development of biogas projects, in particular the California Air Resources Board has continuously worked to establish policies that encourage dairy biomethane projects.

B. CSA Group's leadership in gaseous biofuel standards

International involvement

CSA Group is involved in international standards activities, managing the Canadian Mirror Committee for the **International Standards Organization (ISO) Technical Committee on Biogas (ISO/TC 255)**, which aims to:

- Facilitate and advance international trade of biogas installations
- contribute to international co-operation on technical regulations, standards and assessment procedures;
- curb discriminatory technical requirements; and
- reduce and eliminate the technical barriers for international trade.

ISO/TC 255 is responsible for developing two standards for biogas with scope covering the field of biogas produced by anaerobic digestion, gasification from biomass, and power to gas from biomass sources.

Along with managing the mirror committee, CSA Group is actively participating in a leadership role as convenor for one of the working groups of the ISO TC WG 5 – Biogas systems – Non-household.

North American bi-national code development

Just like any voluntary standard, a code is developed following accredited procedures. The main difference is that **a code is adopted by Authorities Having Jurisdiction as a regulation**.

CSA Group manages the CSA B149.6 Code Technical Committee (TC) for digester gas, landfill gas, and biogas generation and utilization. The TC members are comprised of a balanced representation of provincial gas inspection authorities, biogas and waste management entities, certification organizations, and representatives from the Canadian and US federal governments.

The Code evolved between 2011 and 2015, initially covering production, handling, storage and utilization of digester and landfill gas systems for newly constructed wastewater treatment plants and landfill sites, to including biogas facilities. In that time, the code also became a bi-national document for the US and Canada. The bi-national ANSI/CSA B149.6-15 Code specifies minimum requirements for the design, operation and maintenance of digester gas, landfill gas and biogas systems, and is made up of three main parts:

- Part 1 applies to the installation of systems for the production, handling, storage, and utilization of digester gas in newly constructed wastewater treatment plants, as well as additions to, and the upgrading of, existing systems.
- Part 2 applies to the installation of systems for the production, handling, and utilization of landfill gas in newly constructed landfill gas systems, as well as additions to, and the upgrading of, existing systems and temporary systems.
- Part 3 applies to the installation of systems for the production, handling, storage, and utilization of biogas in newly constructed biogas systems, where biogas is defined as any gas produced in a digester at a location other than a municipal wastewater treatment plant.

IV. Looking ahead

Bioenergy connects multiple industries and creates new opportunities in the global clean economy. As policies around the world increasingly focus on fighting climate change and reducing GHG emissions, the market for bioenergy will continue to evolve. CSA Group offers different standardization solutions like guidelines, standards and codes that may adapt to each particular need. CSA Group's active involvement in standards development for bioenergy plays an important role in that evolution, and is in line with our mission to help create a better, safer, and more sustainable world.

CSA Group Research

In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.

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