BIOENERGY DEVELOPMENT PROGRAM

INDUSTRIAL INNOVATION GROUP

CLEAN ENERGY TECHNOLOGIES

BIOENERGY AND BIOMASS

Not that long ago in Canada combustion of biomass was a principal method for providing heat for the home. Wood was the fuel of choice for cooking and heating water. In effect bioenergy is one of the oldest energy resources.

A key difference that distinguishes this source of energy from other natural resources such as petroleum, coal and nuclear is that bioenergy is renewable energy.

What is happening to bioenergy in Canada now?

Canada is presently utilizing approximately 6% of its energy demand from the combustion of biomass. This amount of renewable bioenergy ranks second to hydropower in Canada's primary energy production. This is striking given the diverse existing and new biomass supplies available.

Haystack supply for Biomass

WHAT ARE BIOENERGY AND BIOPRODUCTS?

Bioenergy, simplified, is energy made available by the conversion of materials derived from sources of either living organisms or their metabolic by-products. Biomass can be converted into solid, liquid or gaseous energy sources, which allows a wide range of applications. It can be:

- burned directly to produce heat and/or electricity,
- converted biochemically to produce liquid fuel;
- digested or gasified to produce gaseous fuel; and finally,
- pyrolized to produce oils and high value chemicals.

Canada has an abundant supply of many types of biomass, which is important in the production of energy, biofuels, materials and chemicals.

Bioproducts can be defined as the resulting product from running sources of biomass through a series of bioprocesses that convert them into bio-materials, chemicals or fuels.

Some examples of bioproducts in Canada are:

- bio-diesel;
- ethanol;
- industrial plant-based oil products (such as fertilizers, plastics);
- plant-made industrial products (such as composites);

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- modified proteins;
- adhesives and resins; and
- solvents and lubricants.

NEW AND EXISTING BIOMASS SUPPLY

Currently in Canada research is being done to develop new and improve current technologies to make bioenergy a more sustainable, efficient and cleaner energy source.

Typical biomass supply is derived from:

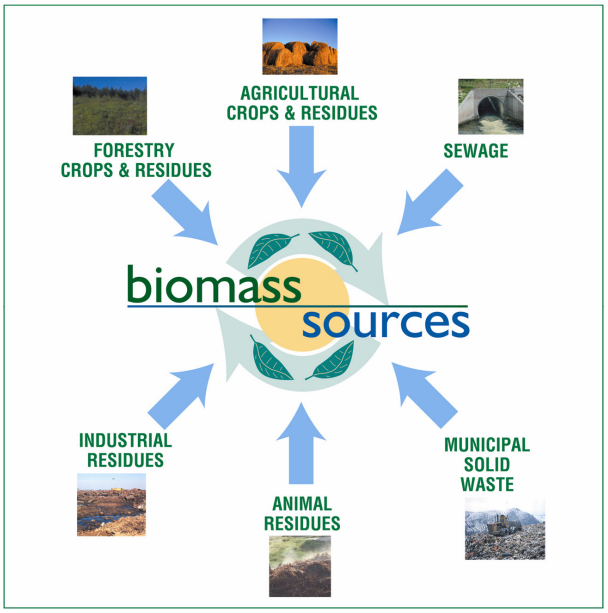
- Woody forest residue, fuelwood, mill residues, short rotation crops;
- Non-woody agricultural crops, crop residue, processing residues; and
- Animal waste such as manure from feed lots and municipal sewage and waste.

The two largest sources of biomass supply in Canada come from forestry and agricultural operations.

BIOMASS CONVERSION & UTILIZATION TECHNOLOGIES

Six key biomass energy conversion technologies are under study at CETC:

- Combustion – convert forestry and agricultural residues and pulp and paper residues into heat and power under environmentally sound conditions;
- Gasification – conversion of forestry and agricultural residues and municipal wastes into syngas, a fuel and/or chemical feedstock;
- Pyrolysis – conversion of forestry and agricultural residues into bio-oils and value added products;
- Fermentation – conversion of starch and cellulose components in biomass to bio-ethanol
- Transesterification – conversion of variety of new and used vegetable oils; tall oils; and other agricultural crops and residues into bio-diesel
- Anaerobic Digestion – conversion of manures, food processing residues and organic fraction of municipal wastes into methane rich biogas



Biomass handling technologies including harvesting, transportation, storage and pre-processing are also included in the R&D activities.

Combustion. The most common conversion of biomass is through combustion. It produces electric power, steam and heat. It is commercially available and regarded as proven technology. However, improvements to further the technology are being developed to help increase efficiencies, reduce emission levels and reduce costs.

Gasification. Production of a sythesis gas (syngas) in an oxygen-starved environment at high temperatures. The syngas can be used either as fuel gas for production of heat, electricity and process steam or the syngas can be cleaned to remove contaminants and used for production of synthetic natural gas, high value chemicals.

Pyrolysis. In a process that involves rapidly heating biomass at high temperatures in the absence of oxygen results in producing vapours from the decomposition. Upon cooling, the vapour condenses to form a liquid fuel. This process is known as pyrolysis of biomass. Bio-oils are produced from the pyrolysis of various biomass feedstocks such as hardwoods and softwoods, grasses and agricultural residues for example.

Fermentation. In simple terms, fermentation is a specialized method of decomposition. A key

product of one particular fermentation process is ethanol. It is produced mainly by the traditional fermentation/distillation process of using sugars from sugar crops or derived from the starch in cereal grain and corn. Increased environmental awareness and the commitment to reduce greenhouse gases have heightened the need for increased production of ethanol in Canada. At present about 200 million litres of fuel ethanol are produced in Canada each year from cereal grain and corn. On a full life cycle basis, ethanol made from corn or grain reduces greenhouse gases by 30% to 40% compared to gasoline while that made from the cellulosic part of biomass is approximately double that number.

Transesterfication. When vegetable or animal fats are treated sodium hydroxide and methanol to yield glycerine and fatty acid methyl esters. These esters are referred to as biodiesel.

Anaerobic Digestion (AD) is a naturally occurring process whereby biomass is broken down or 'digested' by bacteria in an air free environment. AD takes place in landfills and is used to treat certain fractions of municipal waste water and other industrial waste waters. More recently, AD has been introduced to the Canadian farming community to treat manure, animal processing wastes and other agricultural residues. The anaerobic bacteria produce methane rich biogas which can be converted to heat, electricity and/or ethanol.

The key intentions of CETC's current research are making these bioenergy technologies more efficient and in turn more viable.

INTEGRATED BIO APPLICATIONS

Future research is being directed to developing integrated bio-processes whereby two or more technologies are used at the same site. An example of this is distiller grains from ethanol production and glycerine

Iogen Corporation Fermentor

from biodiesel production being gasified or anaerobically digested to produce heat and power. This would not only replace fossil fuel used in the production of the fuel, but also increase the overall economic viability of the plant.

CROSS-CUTTING ACTIVITIES

Natural Resources Canada's Bioenergy Development Program (BDP) exists to assist Canadian industry in the research and development (R&D) and commercialization of bioenergy technologies that can serve as reliable, cost-effective and environmentally responsible alternatives to conventional energy production.

The Canadian Biomass Innovation Network Research and Development Program (CBIN) is a combined bioenergy/greenhouse gas mitigation program to harness the potential for bioresources, inter-departmental government research program established to maintain a nationally focused effort

on the development of biomass conversion technologies. The bioenergy component of CBIN, the Bioenergy Development Program, provides cost-shared support in partnership with industry for the development of new, or improvement of existing, technologies for conversion of biomass to energy. Combustion, biochemical and thermochemical, and anaerobic digestion technologies for the production of fuels and chemicals from biomass are all under development in Canada.

FOR MORE INFORMATION

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AT A GLANCE

- Part of the suite of clean energy programs at CANMET Energy Technology Centre - Ottawa, Natural Resources Canada
- Supports research and development of bioenergy technology, through cost-shared agreements
- Supported R&D on cellulosic ethanol production technology at IOGEN, now moving to commercial scale implementation

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