



A Canadian Perspective for Bioenergy (Biomass) and Solar Energy

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Just a word ...

This paper is the product of the research that was conducted to clear up the confusion associated with the bioenergy (Biomass) and Solar Energy. The findings of this research are divided into the following categories:

1. Canadian Resources;
2. Description;
3. The Use of Biomass and Solar Energy in Canada;
4. Future Potential in Canada;
5. Promotion of Biomass and Solar Energy in Canada;
6. Advantages;
7. Disadvantages;
8. Challenges and Opportunities; and
9. Conclusion

The focus of this research was on the Canadian perspective for these technologies. Readers may or may not agree with the conclusion but it was based on the expert opinions.

This paper is based on the information available in the public domain and necessary hyperlinks are created to navigate readers to the respective sources where additional information can be accessed.

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	Bioenergy (Biomass)	Solar Energy
1. Canadian Resources	<ul style="list-style-type: none"> ▪ Access to one of the largest biomass resources in the world; forest biomass only is over 26 billion dry tons; ▪ Ethanol production 1.3 billion liters in 2007; ▪ Government sponsored biofuel programs to increase ratio of ethanol-gas users from 7% to 35% by 2010; and ▪ Bio-diesel production currently yields 97 million liters per year; a new 275 million liters per year facility is under construction. 	<ul style="list-style-type: none"> ▪ Photovoltaic (PV) Technology – estimated capacity 28 MW. Over 50 companies, mostly designers/installers of residential systems; ▪ Off-grid applications comprise close to 98 percent, compared to 32 percent within the global market; ▪ Annual industry revenues are estimated in excess of \$100 million; ▪ Past decade, average annual market growth was 24 percent; ▪ Air Heating Technology - total installed capacity from 45.6 MW in 2004 to 70 MW in 2007; and ▪ Water Heating Technology - 2007 estimated capacity 600 MW.
2. Description	<p>Bioenergy is renewable energy made from any organic material from plants or animals. Sources of bioenergy are called "biomass," and include agricultural and forestry residues, municipal solid wastes, industrial wastes, and terrestrial and aquatic crops grown solely for energy purposes.</p> <p>Biomass is an attractive petroleum alternative because it is a renewable resource that is more evenly distributed over the Earth's surface than finite energy sources, and may be exploited using more environmentally friendly technologies.</p> <p>There are the following two types of biomass:</p> <ol style="list-style-type: none"> 1. Raw Biomass: Raw biomass consists mainly of trees and shrubs from forests, or crops such as 	<p>There are many ways to transform sunlight into energy, but the main types are solar panels that convert sunlight directly to electricity (also called photovoltaic or PV panels), and panels that absorb heat from the sun and transfer it as space heating or water heating.</p> <p>Solar is the Latin word for "sun" – and it's a powerful source of energy. In fact, the sunlight that shines on the Earth in just one hour could meet world energy demand for an entire year!</p> <p>We can use solar power in two different ways: as a heat source, and as an energy source.</p> <p>People have used the sun as a heat source for thousands of years. Families in ancient Greece built their homes to get the most sunlight during the cold winter months.</p>

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	<p>grasses, legumes, oilseeds, cereal grains, rushes etc. It can also be aquatic materials such as kelp, seaweed or algae. It can even be animal manure. Raw biomass is also obtained from energy crops that are grown specifically to provide biofuels. Typical energy crops include hybrid poplars, willows, switchgrass and reed canary grass; and</p> <p>2. Secondary biomass Secondary biomass is any material that was derived from raw biomass but has undergone significant chemical and physical changes. Secondary biomass includes paper and cardboard, leather, pulping liquors, cotton, linen, hemp, natural rubber products, cellulose-derived casings, used cooking oils, tall oil, cheese whey, etc.</p>	<p>In the 1830s, explorer John Herschel used a solar collector to cook food during an adventure in Africa. You can even try this at home!</p>
<p>3. The Use of Biomass and Solar Energy in Canada</p>	<p>Today, biomass resources are used to generate electricity and power, and to produce liquid transportation fuels, such as ethanol and biodiesel. Ethanol is the most widely used liquid transportation fuel, or biofuel. Currently, a majority of ethanol is made from corn, but new technologies are being developed to make ethanol from a wide range of agricultural and forestry resources.</p> <p>However, biomass remains an important part of our country's energy picture, supplying nearly six per cent of our primary energy demand, the second largest source of renewable energy after hydroelectricity.</p> <p>Beyond the pulp and paper industry, several</p>	<p>Canada has abundant solar energy resources, with the largest resources being found in southern Ontario, Quebec and the Prairies. The territories have a smaller potential because of their higher latitude, which results in less direct sunlight. The amount of solar energy available across the country varies with the season, latitude, weather conditions and the time of day.</p> <p>To date, the main applications of solar energy technologies in Canada have been for non-electricity active solar system applications for space heating, water heating and drying crops and lumber.</p> <p>In 2001, there were more than 12,000 residential solar water heating systems in homes and 300 commercial and industrial solar hot water systems in</p>

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independent power producers generate electricity from the burning of wood wastes and other biomass materials. Currently there about 12 of these plants, with an installed capacity of about 130 megawatts.

There are also a few biomass-based district heating systems in Canada. These systems burn biomass to provide heat or electricity, and sometimes both, to buildings in a community. Communities such as Grande Prairie, Alberta, have invested in new district systems fuelled by wood waste from nearby sawmills. In Atlantic Canada, existing district heating systems have been modified to burn wood wastes, thereby lowering reliance on fossil fuels.

In addition to the use of biomass to generate heat and electricity, there is also growing interest in developing liquid fuels from biomass.

Canada already has a large and growing fuel ethanol industry, producing about 175 million litres of ethanol each year, mainly from corn and wheat. With the addition of new production plants currently under construction, this production could triple over the next few years. Currently ethanol is used as an additive, mixed with gasoline in blends containing up to 10 per cent ethanol. About 1,000 retail stations sell ethanol-blended gasoline, with ethanol sales totaling about 240 million litres each year.

Canada currently produces approximately five million litres of biodiesel fuels per year. Various tests are also being carried out by utilities and others to explore the use of vegetable-based biodiesel fuels in their vehicle fleets.

use. These systems make up a small fraction of Canada's energy use, but some government studies suggest they could make up as much as five per cent of the country's energy needs by the year 2025.

Canada has many regions that are sparsely populated and somewhat inaccessible. In these places, the nearest power line can be hundreds of kilometers away. For that reason, PV cells are increasingly used as standalone units across the country, mostly as off-grid distributed electricity generation to power remote homes, cottages, telecommunications equipment, oil and pipeline monitoring stations and navigational devices.

One of the most important potential uses for PV cells is in northern communities, many of which depend on high-cost diesel fuel to generate electricity. Since the 1970s, the federal government and industry have been actively involved in developing solar technologies for these communities. Some of these efforts have focused on the development of hybrid systems that provide power 24 hours a day, using solar power when sunlight is available and another energy source the rest of the time.

The Canadian PV market has grown at an average rate of 25 per cent each year for the last eight years. Canadian companies make solar modules, controls, specialized water pumps, high efficiency refrigerators and solar lighting systems. In early 2003, Canada's installed capacity of PV systems was about 10 megawatts, compared with one megawatt in 1992.

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4. Future Potential in Canada

There is significant potential to increase the use of biomass energy in Canada, because of our country's enormous forest resources (we have 10 per cent of the world's forests) and our large agricultural sector.

Government and industry are exploring the potential of quick-growing crops, such as poplars and willows which can be planted and harvested as energy crops. They are also collaborating on technology projects to improve the combustion efficiencies of biomass furnaces and wood fireplaces.

It is estimated that wood wastes in Canada alone could produce all of our country's fuel ethanol needs. The challenge is that these wastes contain wood materials that require special treatment not needed in traditional production of ethanol from grains. Innovative technologies are being developed to produce ethanol from wood, hay, straw and other wastes.

Government Programs:

Government policies and incentives can play an important role in encouraging the adoption of biomass energy. These can take the form of:

- Research programs to develop the potential of biomass energy technologies;
- Investment subsidies (such as grants and loans) to developers to support the capital cost of biomass power plants;
- Renewable portfolio standards that require utilities and retailers to provide a certain portion of their power and energy sales from renewable sources such as biomass; and

Government policies and incentives can play an important role in encouraging the adoption of renewables, such as solar energy. These can take the form of:

- Research programs to develop the potential of solar energy technologies;
- Investment subsidies (such as grants and loans) to developers to support the capital cost of solar energy technology;
- Renewable portfolio standards that require utilities and retailers to provide a certain portion of their power and energy sales from renewable sources such as solar; and
- Procurement of new generation from renewable energy sources for government facilities.

The CANMET Energy Technology Centre in Ottawa is one of the main research arms of Natural Resources Canada. Among its areas of focus, it supports research and development on renewable energy and distributed power. Currently, CANMET is developing pilot projects with Canadian companies to help demonstrate the capabilities of solar photovoltaic technologies.

Some provinces and territories have introduced renewable portfolio standards in their electricity markets that include solar. For example, the Government of the Northwest Territories has developed an energy strategy that sets targets for renewable energy, including solar energy. The territory plans to obtain 10 per cent of its energy from renewable energy sources, such as solar, wind, biomass and hydro, by 2010, and 25 per cent by 2025

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	<ul style="list-style-type: none"> • Procurement of new generation from renewable energy sources for government facilities <p>The Canadian government has established the Ethanol Expansion Program, which is offering \$100 million in funding toward ethanol development facilities across the country. The program is intended to expand fuel ethanol production and use in Canada and reduce transportation-related greenhouse gas emissions.</p> <p>Other federal measures include the CANMET Energy Technology Centre, which assists the development of green power technologies in Canada. Much of the centre's effort is focused on the development of biofuels, including the production of ethanol from forestry and agricultural wastes.</p> <p>Provincial governments are also taking actions to promote biomass as part of their generation mix. Quebec, for example, has invited energy developers to respond to a request for proposals (RFP) to add 100 megawatts of biomass generation by 2012. Ontario has issued an RFP for 300 megawatts of green power. And Nova Scotia has issued an RFP for 60 megawatts of renewable energy, including biomass.</p>	
<p>5. Promotion of Biomass and Solar Energy in Canada</p>	<p>A number of important initiatives are under way at government, utility and industry levels to encourage the development of biomass energy in Canada.</p> <p>Government Programs: Government policies and incentives can play an</p>	<p>The following two programs are promoted:</p> <ul style="list-style-type: none"> • Utility Programs: Utilities are starting to encourage the development of renewable energy by others to supplement their power supplies. In Saskatchewan, for example, SaskPower's

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important role in encouraging the adoption of biomass energy. These can take the form of:

- research programs to develop the potential of biomass energy technologies
- investment subsidies (such as grants and loans) to developers to support the capital cost of biomass power plants
- renewable portfolio standards that require utilities and retailers to provide a certain portion of their power and energy sales from renewable sources such as biomass
- procurement of new generation from renewable energy sources for government facilities

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Environmentally Preferred Power program creates the opportunity for the company to partner with independent power producers to build and operate small-scale generation projects, such as solar power, with up to five megawatt capacity. In 2003, SaskPower issued requests for proposals for innovative environmentally preferred power generation projects.

- **Industry Investments:**

Canada has a small but growing PV cell industry with over 150 organizations actively promoting PV power in the country. Most of these are system resellers, distributors and installers. In 2002, the Canadian PV cell industry generated revenues of about \$95 million.

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	<p>generation by 2012. Ontario has issued an RFP for 300 megawatts of green power. And Nova Scotia has issued an RFP for 60 megawatts of renewable energy, including biomass.</p>	
<p>6. Advantages</p>	<p>Biomass energy is increasingly popular as an alternative energy source for a variety of reasons:</p> <ol style="list-style-type: none"> 1. It is widely available; 2. It is a renewable resource, when it is sustainably used and managed; 3. It results in less waste being sent to landfills. Burning unusable waste materials such as bark, construction wastes and tree clippings helps to reduce the pressure to expand local landfill sites while generating useful energy; 4. It can help provide answers to the climate change issue. Using biomass energy does not increase atmospheric levels of carbon dioxide, a primary greenhouse gas, because of the cycles of re-growth for plants and trees. The use of biomass can also decrease the amount of methane, another greenhouse gas, which is emitted from decaying organic matter; and 5. It can be converted into several forms of energy. For example, wood can be processed and converted to gas. Landfills can produce methane, and corn, wheat and other materials can be used to manufacture liquid fuel ethanol. 	<p>1. Saves you money:</p> <ul style="list-style-type: none"> • After the initial investment has been recovered, the energy from the sun is practically FREE. • The recovery/ payback period for this investment can be very short depending on how much electricity your household uses. • Financial incentives are available from the government that will reduce your cost. • If your system produce more energy than you use, your utility company can buy it from you, building up a credit on your account! This is called net metering. • It will save you money on your electricity bill if you have one at all. • Solar energy does not require any fuel. • It's not affected by the supply and demand of fuel and is therefore not subjected to the ever-increasing price of gasoline. • The savings are immediate and for many years to come. • The use of solar energy indirectly reduces health costs. <p>2. Environmentally friendly:</p> <ul style="list-style-type: none"> • Solar Energy is clean, renewable (unlike gas, oil and coal) and sustainable, helping to protect our environment. • It does not pollute our air by releasing carbon

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dioxide, nitrogen oxide, sulphur dioxide or mercury into the atmosphere like many traditional forms of electrical generations does.

- Therefore Solar Energy does not contribute to global warming, acid rain or smog.
- It actively contributes to the decrease of harmful green house gas emissions.
- It's generated where it is needed.
- By not using any fuel, Solar Energy does not contribute to the cost and problems of the recovery and transportation of fuel or the storage of radioactive waste.

3. Independent/semi-independent:

- Solar Energy can be utilized to offset utility-supplied energy consumption. It does not only reduce your electricity bill, but will also continue to supply your home/ business with electricity in the event of a power outage.
- A Solar Energy system can operate entirely independent, not requiring a connection to a power or gas grid at all. Systems can therefore be installed in remote locations (like holiday log cabins), making it more practical and cost-effective than the supply of utility electricity to a new site.
- The use of Solar Energy reduces our dependence on foreign and/or centralized sources of energy, influenced by natural disasters or international events and so contributes to a sustainable future.
- Solar Energy supports local job and wealth creation, fuelling local economies.

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		<p>4. Low/No Maintenance:</p> <ul style="list-style-type: none"> • Solar Energy systems are virtually maintenance free and will last for decades. • Once installed, there are no recurring costs. • They operate silently, have no moving parts, do not release offensive smells and do not require you to add any fuel. • More solar panels can easily be added in the future when your family's needs grow.
<p>7. Disadvantages</p>	<p>Here are some disadvantages:</p> <ul style="list-style-type: none"> • Biomass produces greenhouse emissions: The biggest argument against biomass is that it produces carbon dioxide and other greenhouse gases; • Biomass consumes more energy: It takes more energy to plant, cultivate and harvest the crops and trees than it is worth to get a net energy gain. It also takes up more water from the earth and other fossil fuels to make the fertilizers and fuels for planting and harvesting. It also, supposedly, takes up more land for the crops and trees; • Collection of Biomass is difficult: There was a man who, in 1979, traveled from Jacksonville, Fl to Los Angeles on wood he was using in his biomass gasifier attached to a Chevy Malibu. He would travel 1 mile for every pound of wood. Not the most efficient use of fuel; and • Biomass crops not available all year. Corn, wheat, barley and the like are seasonal crops. They are not available all 	<ul style="list-style-type: none"> • The initial cost is the main disadvantage of installing a solar energy system, largely because of the high cost of the semi-conducting materials used in building one. • The cost of solar energy is also high compared to non-renewable utility-supplied electricity. As energy shortages are becoming more common, solar energy is becoming more price-competitive. • Solar panels require quite a large area for installation to achieve a good level of efficiency. • The efficiency of the system also relies on the location of the sun, although this problem can be overcome with the installation of certain components. • The production of solar energy is influenced by the presence of clouds or pollution in the air. • Similarly, no solar energy will be produced during nighttime although a battery backup system and/or net metering will solve this problem. See www.dsireusa.org for details on how net metering allows you to save electricity and money.

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	<p>year. Trees are also a slow growing resource even though they are renewable. This would also tend to be a negative on the side of biomass fuels.</p>	<ul style="list-style-type: none"> As far as solar powered cars go - their slower speed might not appeal to everyone caught up in today's rat race.
<p>8. Challenges and Opportunities</p>	<p>Biomass is being applied in new and innovative ways to heat homes, generate electricity and fuel vehicles. This has led to a growing biomass energy industry in Canada and worldwide. Future growth of the industry will be shaped by different challenges and opportunities:</p> <ul style="list-style-type: none"> Huge Untapped Potential: Canada has vast amounts of biomass, much of which remains unused. For example, BIOCAP Canada Foundation, a university-based research organization, estimates that there may be enough unused biomass (agricultural wastes, mill wastes, unused tree branches) from Canada's forestry and farming operations to provide about 27 per cent of Canada's energy needs. However, the economic costs of gathering and processing this energy resource are not well understood. Cost Competitiveness of Technologies: One of the barriers facing expansion of biomass power is the need to make the industry more competitive with traditional fossil fuel power plants, which often can produce electricity at much lower costs. The technology used to generate electricity from biomass has become more efficient and cleaner over time, but the costs of capital equipment are relatively high and fuel costs remain high, because of collection, transportation and handling 	<p>Solar power currently makes up a small part of Canada's energy pie, but its use is growing, as it is applied in new and innovative ways to heat buildings and generate electricity in remote areas. Future growth of solar power in Canada will be shaped by different challenges and opportunities:</p> <ul style="list-style-type: none"> Costs of Solar Energy dropping but still a barrier: Costs for solar energy have been declining, as technology improves. For example, production costs for PV cells have come down steadily over the last decade to between 50 cents to 30 cents per kilowatt-hour, and lower for some applications. Based on this progress, Industry Canada predicts that industry could further reduce generation costs to between eight and 14 cents per kilowatt-hour between 2010 and 2020. Even so, much of the solar power industry's future will depend on improving economics. PV cells are expensive to produce because of the high cost of semi-conducting materials. Cost reductions can be achieved over time by reducing manufacturing costs through economies of scale and increased public acceptance. Currently, concentrating solar power systems are the least expensive solar technology for large-scale power generation. In the United States, government, industry and utilities have formed partnerships to reduce the manufacturing costs of concentrating solar power technologies.

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costs. Currently the average cost of electricity from new biomass power plants is about five cents per kilowatt-hour, compared with about 10 cents per kilowatt-hour in the early 1980s.

- **Transmission Issues:**

Another barrier to developing more electricity from biomass is access to transmission. Often the best sources of biomass materials are in remote locations, distant from power grids and far from cities where electricity is heavily used. So the development of biomass plants, which supply power to the grid, may require the need for new or expanded transmission facilities.

- **Environmental Concerns:**

Biomass energy has some environmental impacts. When burned, biomass resources release air emissions, such as particulate matter and sulphur dioxide, to the atmosphere. These emissions depend on the choice of biomass materials and the technologies and pollution controls used. The development of large-scale energy crops, such as corn, for the production of biofuels could lead to increases in pesticide and fertilizer use that are harmful to wildlife and habitat. And producing energy, in addition to lumber and paper, could put more stress on Canada's forest resources. For more information, see renewable energy and the environment.

- **Competing Demands for Biomass Feed-stocks:**

One of the uncertainties facing future development of biomass energy is

- **Government incentives needed:**

Active solar power systems usually require several years of operations to recover their initial capitals cost in fuel savings. Similarly, PV cell technology is well developed but the capital costs of installing PV cells remain high. Solar power companies, therefore, are lobbying the government to increase incentives and funding to support research, development, demonstration and commercialization of solar technologies. They say that increased regulatory and financial incentives, such as tax credits, low interest loans, grants and utility rebates, are needed to encourage the installation of PV cells and other solar energy technologies in Canada.

- **Variable source of supply:**

Solar is a variable energy resource, providing electricity only when the sun is shining. This has prompted researchers in Canada and elsewhere to work on the development of experimental hybrid solar systems that can run on solar energy (PV cells, hybrid power towers) and other fuels such as natural gas. The advantage of these hybrid systems is that they can run continuously.

- **New engineering standards required**

Inconsistent standards and interconnection guidelines continue to be a challenge to implementing distributed generation systems such as solar PV cells in Canada. Work to standardize interconnection rules for distributed generation is under way in Canada. In 2003, Natural Resources Canada and Industry Canada partnered with industry to develop a set of guidelines for distributed generation and submitted them to the Canadian Standards Association. These

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	<p>competition for biomass materials. For example, animal manures have value as fertilizers, waste paper can be recycled and wood chips can be used in landscape mulches. Also using crops such as corn or sugar cane to produce biofuels could potentially conflict with the need to produce food.</p> <ul style="list-style-type: none">• Government Policies: Environmentalists and industry say that more government support and policies are critical to stimulating a strong biomass industry in Canada. For example, they argue that government programs such as the Wind Power Production Incentive (a program that pays an incentive of about one cent per kilowatt-hour to Canadian wind power producers) should be increased and broadened to support markets for other renewable technologies such as biomass. They also say that tax credits and renewable portfolio standards should be considered to further development of biomass energy.	<p>standards could help to facilitate the installation of PV cells.</p>
9. Conclusion	<p>The experts in the field believe that:</p> <ul style="list-style-type: none">• After direct solar energy and hydroelectricity, biomass is one of the most important renewable energy forms (wood and dung burning account for about 14% of the world's energy supply) and its use in Canada involves both the oldest and the newest of energy technologies.	