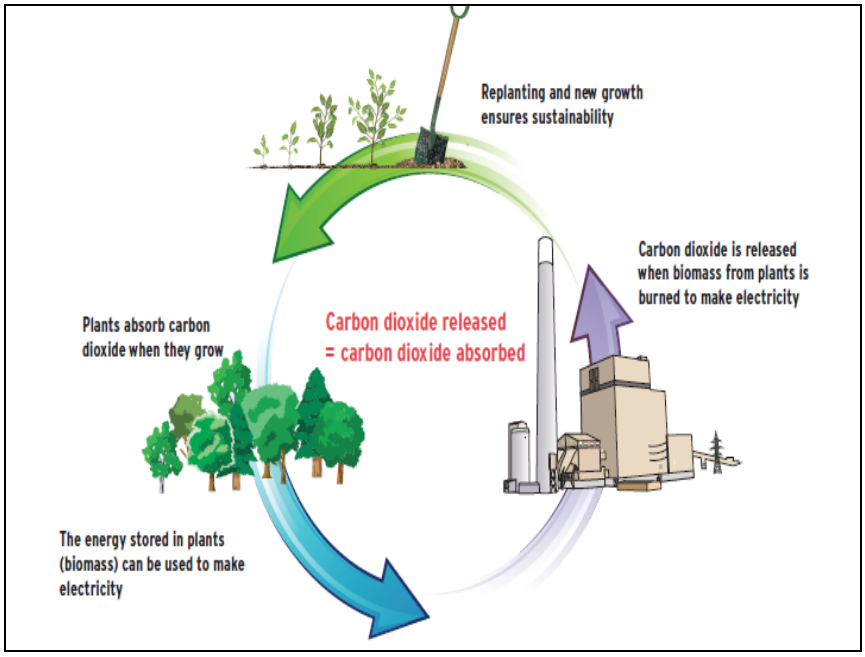
A Green Sector Overview

Biomass

Biomass such as wood waste or energy crops such as high-yielding grasses can be burned in high-efficiency combustion systems to produce electricity, heat, or bio-oils. The renewable feed stocks for these systems can be readily grown in rural Ontario.

As plants grow, carbon dioxide, a greenhouse gas that contributes to climate change, is absorbed from the atmosphere. When biomass is used to make electricity, heat, or bio-oils, the carbon dioxide stored by the biomass is released. With new high-efficiency biomass conversion systems the emissions are very low. No new greenhouse gases are produced making biomass fuel "carbon neutral". As long as replanting and new growth can sequester the same amount of carbon as the biomass removed from the system for burning, biomass can be used as an alternative to fossil fuels in order to mitigate the impacts of climate change.

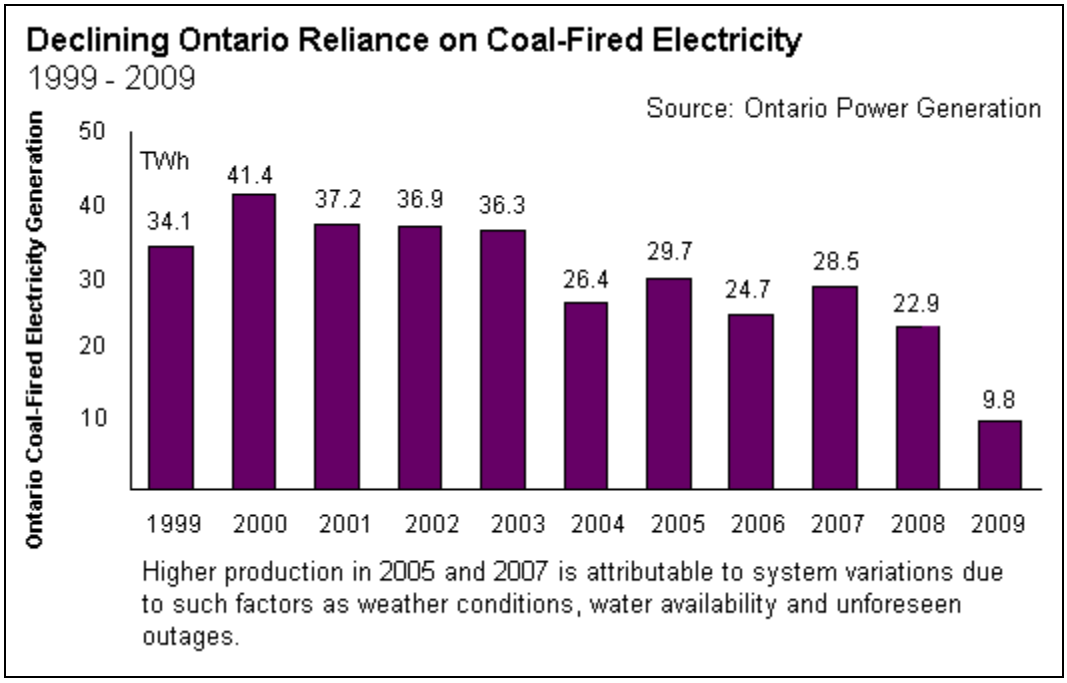
Biomass Lifecycle



The Ontario government has committed to phasing out coal at Ontario Power Generation (OPG) facilities by December 2014, which is a key strategy to meet greenhouse gas reduction targets in Ontario. Other coal users are looking at alternative energy feed stocks (e.g. cement industry, some greenhouse operations, etc.) as the need to reduce GHG emissions increases.

The elimination of coal can be achieved by using either wood pellets from northern Ontario or pellets made from purposely grown crops in southern Ontario. In 2010, OPG made the decision to use wood

pellets for its two smaller northern hydro generating stations. No decision has been made on what will be used for the two larger southern Ontario hydro stations. A decision to use southern Ontario-grown agri-biomass would create a robust market for Ontario agriculture products and would support an energy supply chain of growers, pellet processing plants, and transportation. Along with crop value, growers would also have the opportunity to participate in a carbon trading market through a potential GHG cap-and-trade system.



Biomass sources include:

I. Forest residues

- Wood pellets are made from finely ground wood saw dust. The dust particles are forced through a pellet mill which forms them into a long cylinder shape that has a diameter of 6-8mm and a length of 38mm. The most likely place to find a wood pellet mill would be at a large saw mill in northern Ontario. Of the 71 million hectares of forest in Ontario, 89% is provincially owned crown land in Northern Ontario.
- Hog fuel or forest harvest slash is unprocessed wood pieces, usually tree tops or small trees that are left over from large forestation. This product commonly contains large amounts of mud, stones, and other debris. It can be used in large wood burners for heat but the material has problems due to its high moisture content.

II. Purposely grown crops

- Switchgrass is a perennial prairie grass that is native to North America. It can be planted with conventional planting equipment and can also be harvested using conventional cutting and baling equipment. After planting, switchgrass takes 2-3 years before full yields are achieved; however, the same crop will continue to yield for 25 or more years. Typical yields are from 3-4 metric tonnes per acre.

- Miscanthus is perennial grass, native to Africa and Asia that must be transplanted from shoots. Miscanthus can be harvested using conventional cutting and harvesting equipment and, like switchgrass, it takes 2-3 years to establish but will continue to yield for many years. Miscanthus will yield slightly more than switchgrass but has the potential to spread to the adjacent field from root runners.
- Fast growing willows and poplar trees are grown from small stem pieces and are hand planted using special tree planting equipment. Harvest is also done using specialized equipment very similar to forage equipment or mobile tree shredders. The trees can be cut every 3 years, so there are two years in between with no harvest.
- Agricultural residues are the parts of the crop that are left over after harvesting the seeds. Examples include corn stover (stock, leaf, and husk), corn cobs, wheat straw, barley straw, vegetable plant material, and soybean stover. They can be compacted and used for heat generation to drive Ontario Power Generation facilities.

The Market

Co-firing Coal Plants:

The "Go Green: Ontario's Action Plan on Climate Change" includes greenhouse gas reduction targets of:

- Six per cent below 1990 levels by 2014 – a reduction of 61 megatonnes relative to business-as-usual:
- 15 per cent below 1990 levels by 2020 – a reduction of 99 megatonnes relative to business-as-usual;
- 80 per cent below 1990 levels by 2050

Much of these reductions will come from phasing out coal for electricity generation. The government has mandated that this will be accomplished by the end of 2014.

Ontario Power Generation (OPG) operates four coal-fired generating stations at Atikokan, Thunder Bay, Nanticoke, and Lambton. Starting with Atikokan, these will be converted over to biomass between 2012 and 2014. Atikokan is the smallest facility and produces 200 MW.

In northern Ontario, the Ministry of Natural Resources estimates that 8.4 million cubic meters of unused wood is available per year. Of this, about 3 million cubic meters is classified as "unmerchantable or undersized" – mainly treetops, branches, and limbs (harvest slash). It will be important to understand how much of this material can be removed without affecting the stability of the forest.

Talks in southern Ontario between OPG and the agriculture sector have been ongoing since 2007. At the time of the Ontario BioMass Conference 2010, OPG and the agriculture sector could only report that they were still at the feasibility study stage in the decision process.

Commercial Greenhouses:

Traditionally, commercial greenhouse growers have used natural gas as their primary source of fuel to heat greenhouses with light fuel oil as a backup. With the rising cost of oil, more and more greenhouses

have switched to burning coal. It was estimated that in 2008, the greenhouse industry was using 1,000,000 tonnes of coal. Unlike cement plants, greenhouses are exempt from obtaining MOE Certificate of Approvals as they fall under the agricultural purposes clause.

Greenhouses that are setup to use coal can also use biomass. Greenhouses could use either wood pellets, hog fuel, or switchgrass pellets. When coal prices sky rocketed in 2008, greenhouses began experimenting with all of these. It was found that hog fuel had too many problems due to its variability, and thus pellets were best. Locally grown switchgrass or miscanthus pellets were found to be the cheapest and the most dependable; however, when the price of coal returned to normal pricing levels in 2009, most greenhouses returned to coal use because it is much easier from an operator stand point.

In order to utilize biomass, greenhouses require boiler heating systems that were designed originally for dual fuel – natural gas and coal. The only time that biomass is considered is when coal prices are high, as in 2008.

Residential:

The biomass stove and furnace market is very small in Ontario. There are very few manufacturers currently pelletizing and bagging biomass. In the Midwestern Ontario region, there is currently only one company processing switchgrass for the home heating market. In addition, it is often difficult to find locally supplied pellets that work with the furnaces and stoves because the burners are setup for specific types of fuel. To be effective, the pellet stove burners must be setup for the biomass that is being burned.

The following chart outlines some of the options that would be available to home owners heating in the rural area. (Prices may vary based on local pricing). In this scenario, it is assumed that there is no natural gas pipeline in the area, as gas would be about half the price of furnace oil.

Product Form	Product	BTU / unit	$0.00/ unit	cents / 1000 BTU
Bulk Liquid	Furnace Oil	37,000BTU/Litre	$0.80 / litre	$0.0216
Bagged pellets	Wood pellets	8,000 / lb	$0.16 / lb	$0.0200
Bagged pellets	Switchgrass pellets	8,000 / lb	$0.12 / lb	$0.0150
Bulk pellets	Switchgrass pellets	8,000 / lb	$0.06 / lb	$0.0075
Bulk large blocks	Cordwood - Ash	20,000,000 / cord	$70.00 / cord	$0.0035

Per 1000 BTU's of heat supplied to the home, furnace oil is the most expensive option, yet is a convenience factor associated with furnace oil. Local companies can come to fill the tank and the homeowner only needs to adjust their thermostat.

At the other end of the spectrum is cordwood. Currently ash is in good supply as a result of tree disease problems. Ash is in the mid range for BTU/weight from various types of wood found in Midwestern Ontario woodlots. This chart shows that cordwood is about 1/7th the price of furnace oil, but there are additional requirements placed on the homeowner related to operations and maintenance.

Between furnace oil and cordwood is biomass pellets. A typical home would use about 3 – 4 metric tonnes of wood pellets during a heating season. This is about 1 ¼ 50 lb bags per day. The pellet stoves have a hopper that holds about 50 lbs, so the homeowner would have to fill the in-feed hopper about once or twice a day. Currently, the savings between furnace oil and wood pellets is very little, especially when the cost to buy a new pellet stove (between $2,000 and $5,000) is included.

The most attractive fuel source is bulk switchgrass pellets. Homeowners only need to purchase a pellet stove and a bulk hopper that would hold about 3-4 metric tonne (250-300 ft^3). Pellets can be delivered from the processing plant directly to the homeowner. However, a pellet processor would require a sufficient quantity of stoves in the area to justify the processing facility. Once a processor is established in an area, it becomes easier to supply additional homeowners in adjacent areas.

Government Programs

The **Green Energy and Green Economy Act (GEA)** focuses on the generation of renewable electricity. The Feed-in Tariff (FIT) component of the GEA guarantees specific rates for energy generated from renewable sources. The rate for biomass is 13.8 cents per kWh for plants under 10 MW and 13.0 cents per kWh for larger facilities. Ontario has the potential to become a very significant biomass region. As of the writing of this report there is no small scale equipment in the Ontario marketplace that creates electricity from biomass. Currently, the only potential is using biomass in the existing four coal-fired electrical generating stations.

Investment in Forest Industry Transformation (IFIT) is a $100 million, 4 year, Natural Resources Canada program. The objective of the IFIT is to invest in innovative technologies to support a more diversified, higher-value product mix in the forest sector. These products include bioenergy, biomaterials, biochemicals, and next generation building products. The maximum amount payable by IFIT is 50% of total project costs.

ecoENERGY for Renewable Power is a $1.48 billion, 4 year, federal government program which provides a 1 cent per kWh incentive for up to 10 years. The objective of the program is to increase Clean Energy Supply (wind, biomass, low-impact hydro, geothermal, solar photovoltaic, and ocean energy).

The **Clean Energy Fund** is a $1 billion, 5 year, Natural Resources Canada program that focuses on reduction of greenhouse gas emissions from the production and use of energy with particular emphasis on carbon capture and storage technologies. The Research and Development (R&D) component will fund a range of activities from basic research up to and including pre-demonstration pilot projects for renewable and clean energy.

The **Innovation Demonstration Fund** is a $50 million, 4 year, Ministry of Research and Innovation program that focuses on the commercialization and initial technical demonstration of globally competitive, innovative green technologies, processes, and/or products.

Through the **Community Energy Partnerships Program**, community groups, including co-ops, non-profit groups, and local partnerships would be eligible for one-time financial assistance of up to $200,000 for project planning costs, as well as environmental and engineering studies.

The Federal Government provides a 50% **Capital Cost Allowance (CCA) for Renewable Energy** projects. Corporations can write off the capital cost of a bioenergy system against other revenue resulting in attractive tax consequences.

Participants

The **Canadian Biomass Innovation Network** is a network of federal researchers, program managers, policy makers, and expert advisors partnered with industry, academia, non-governmental organizations, other government levels, and the international community. The network's goal is to continually ensure the availability of knowledge, technology, and enabling policy required to support the development of a sustainable Canadian bio-economy.

The **Biomass Network Group in Northern Ontario** is helping to develop the biofuels and biomaterials industry within Ontario's forest and agricultural sectors by making use of local resources, primarily wood chips and pelletized wood, as a biomass with which to produce a clean, affordable, renewable, carbon-friendly fuel for heating and energy.

Locally, most biomass research is being done by the University of Guelph. The **Guelph Partnership for Innovation**, a network group, sponsors the annual Biomass conference.

OMAFRA supports a project to commercialize agricultural biomass for combustion energy. The project is led by a steering committee that represents a cross-section of agriculture, industry, academic, and government experts. The aim of the project is to examine the role agricultural biomass could have in producing renewable power and heat. Working groups have been established to explore agricultural biomass business models, technical challenges, and environmental sustainability.

Ontario growers like Don Nott of Clinton and Kurt Vanclief of Ameliasburg are involved in cultivating switchgrass as a biomass source. Processers like Ian Moncrieff of Canadian Biofuel in Springford are involved in biomass pelletization. Jamestown Pellet Stoves is the only manufacturer in Ontario located in Vermillion Bay. There are approximately 5 other manufacturers spread across Canada.

Trends

Finland and Sweden are leading the world in biomass use. Biomass supplied 19% of Finland's total primary energy supply and almost 8% of their fuel-mix in district heating. In Sweden, biomass accounts for 15% of total primary energy supply and 53% of the fuel-mix in district heating.

In Germany, Austria, and Sweden, home heating with "pellet boiler systems" is popular. These pellet systems operate like conventional central heating systems. The boilers are fed wood pellets made mainly of compressed sawdust and shavings from logs processed for lumber and other wood products.

Canadian domestic pellet consumption sits at just 5% to 7% of production. Meanwhile, thanks largely to a burgeoning northeastern market, as much as 10% of Canadian production is exported to the United States. The remainder is exported to Western Europe, a hungry, but increasingly problematic market should they be able to sort out their supply chain problems.

Growth in these European countries has been rapid and impressive. In Sweden, domestic delivery of wood pellets climbed from less than 40,000 tonnes in 1997 to almost 700,000 tonnes in 2008. Total domestic pellet consumption grew during the same period from 500,000 tonnes to almost 1.8 million tonnes. The demand for pellets in the residential heating market in Sweden is expected to grow by another 200,000 tonnes to 900,000 tonnes by 2012. In Germany, the market increased exponentially from 800 domestic pellet boilers installed nationwide in 1999 to 100,000, a 100-fold increase by 2008 which mirrored the demand for pellets.

The Canadian market is currently restricted to some small industrial users of lower-grade pellets and homeowners dragging bags of pellets home from the hardware store. Given our climate and wood supply, the domestic market for pellets could be much more.

Key Success Factors

A combination of several factors, including government incentives, public education, and investment in appliance and pellet delivery infrastructure in other countries has lead to strong growth in the biomass industry. Other factors that will impact the development of a biomass industry include:

- High oil prices, public concern over fossil fuel, more stringent greenhouse gas reduction targets, and revised boiler standards to make smaller district heating projects viable will help to drive renewable energy sources like biomass.

- Enabling the complete supply chain; from sourcing high-quality pellets, developing storage systems using local depots, creating bulk delivery systems that could deliver pellets without damaging them, pursuing a public education and marketing campaign, establishing and educating a network of dealers/installers, winning over regulators and insurance providers, and ensuring other support pieces are in place.

- Commitment by the Ontario government to convert coal plants to biomass as well as a focus on small industrial or public clients, such as greenhouses or schools, and residential heating, which will require a greater investment in time and money, but it will also create a more stable, reliable market over the long term.

- Launching a vibrant domestic market for biomass will take an aggressive and coordinated effort from federal and provincial government, private investors, pellet manufacturers, and industry advocates.

Here is a list of what is needed to add pellets to Canada's home heating mix:

Financial incentives: Residential energy incentives are common in Canada, but not yet for biomass pellets. Provincial and federal incentives of $10,000 per new home are available for geothermal systems in Ontario. A modern central heating pellet appliance with bulk storage and automated pellet infeed costs $12,000 to $16,000 installed.

Pellet and pellet appliance standards: Canadian homeowners and small businesses will want assurances that both the fuel and heating systems are reliable, safe, durable, and meet emissions standards. The US-based Pellet Fuels Institute recently created a voluntary set of quality standards and labelling for its pellet-producing members. Canadian appliances need similar guidelines and labelling systems.

Installer education and certification: Pellet systems are, for the most part, already available although some modifications are needed to meet the Canadian preference for hot air furnaces over boilers. The big hurdle is creating a network of recognized installers. This is not a new challenge. The domestic geothermal sector had to build its network from scratch, and countries like Austria have done the same for biomass. One way to drive this forward is to link government incentives to the use of certified appliances and installers.

Marketing and promotional campaigns: This will be critical to drive the demand for biomass heating. As the systems and delivery methods become modernized along European lines, the industry needs to counter the image of rural customers dragging around bags of pellets.

Government support: Government can set the example by converting public buildings from oil to biomass. A similar program in Finland saw tremendous success.

Distribution infrastructure: The creation of a modern storage and bulk delivery infrastructure in potential market areas is a key step. In northern Europe, homeowners heating with pellets face no more work than those heating with oil or gas. A delivery truck attaches a hose to an outlet in the wall, and fills a bulk storage silo in the basement or beside the house. When the thermostat kicks in, an automated infeed system delivers pellets. Governments could assist in establishing bulk storage and delivery infrastructure in areas identified as key potential markets, which would help ease concerns over shortages by creating local buffers as small appliance suppliers can't do that on their own.

Protection for the homeowner: Industry must create a delivery priority system that favours the homeowner so that, in the event of shortages, families do not go cold at the fault of the biomass sector.

Finance/insurance: Lobbying the finance and insurance sectors to accept the recent generation of biomass heating systems.

Labour Market

The biomass industry is still developing. Some jobs will require skills which are transferable from within an existing discipline while other jobs will require some additional training. Many of the current job opportunities will involve market development and planning. As the industry evolves, the following careers could experience growth:

Job Title	Institution	Program
Biomass Researcher	Confederation College (Thunder Bay)	Bio-energy Learning and Research Centre*
	Nipissing University (North Bay)	Biomass Innovation Centre**
	University of Guelph (Guelph)	Department of Plant Agriculture – Bioproducts/Biomaterials Research
Crop Advisor	University of Guelph (Kemptville	Environmental Management Diploma

	or Ridgetown)	Bachelor of Science in Agriculture
Energy Designer	Cambrian College (Sudbury)	Energy Systems Technology
Energy Systems Engineer	Mohawk College of Applied Arts and Technology (Hamilton)	Energy Systems Engineering Technology – Clean and Renewable Energy
	St. Lawrence College (Kingston)	Energy Systems Engineering Technician and Technology Program
	University of Ontario Institute of Technology (Oshawa)	Energy Systems Engineering
Energy Utility Industry Officer	McMaster University (Hamilton)	Faculty of Engineering
Forest and Resource Management	Algonquin College (Ottawa)	Forestry Technician
	Confederation College (Thunder Bay)	Forestry Technician
	Fleming College (Peterborough)	Forestry Technician
	Northern College (Timmins)	Natural Resource Technician
	Sault College (Sault Ste. Marie)	Forest Conservation and Natural Environment Technician
	Lakehead University (Thunder Bay)	Faculty of Natural Resources Management
	University of Guelph (Guelph)	Bachelor of Bio-resource Management
Manufacturing Engineer (biomass pellet production, biomass appliances)	McMaster University (Hamilton)	Faculty of Engineering
	Mohawk College of Applied Arts and Technology (Hamilton)	Energy Systems Engineering Technology – Clean and Renewable Energy
Project Engineer	Lambton College (Sarnia)	Alternative Energy Engineering Technology

* **Bio-energy Learning and Research Centre**: Confederation College will build a new biomass energy research centre to provide hands-on learning experiences for students and researchers of renewable energy technologies. The centre will include a bio-energy plant that will test the efficiency of different biomass fuels.

** **Biomass Innovation Centre**: A network of trade, commerce, education, heating/energy companies, municipalities, and institutions is developing the training infrastructure needed to grow the workforce for biofuel and biomaterial technologies. New skills and educational programs are to be developed on biomass, including courses in mechanical and civil engineering, biofuels/biomaterials for steamfitters in the Ontario Apprenticeship Program, and a certificate program for biofuels/biomaterials harvester workers. The courses and training will be developed and delivered in partnership between Nipissing, Lakehead, and Laurentian Universities.

Regulatory Considerations

Forest harvesting may require approvals from:

- Natural Resources Canada
- Local Municipalities

Approvals for grid connection are required from:

- Ontario Energy Board
- Local distribution company
- Independent Electrical System Operator
- Electrical Safety Authority

Social and Environmental Considerations

For agriculture biomass, the social and environmental considerations include:

- Maintaining a balance between food and biomass crop production
- Impacts on marginal and ecologically sensitive areas
- Chemical inputs to crops and their impacts on soil, water, and air
- Effects of large-scale monoculture farming operations

For forest harvesting, the considerations include:

- Removing trimmings that supply nutrients to the soil and sustain the forest
- Replanting and new growth rates which cannot sequester the same amount of carbon as the biomass removed from the system for burning
- Targeting carbon neutral levels of carbon dioxide when greenhouse gases are increasing worldwide
- Protecting biodiversity with old growth trees

Risks

Cost: Biomass harvesting and transportation costs are higher than coal.

Availability: It is uncertain how much wood fuel can be taken from northern Crown Land and how much biomass can be grown in southern Ontario.

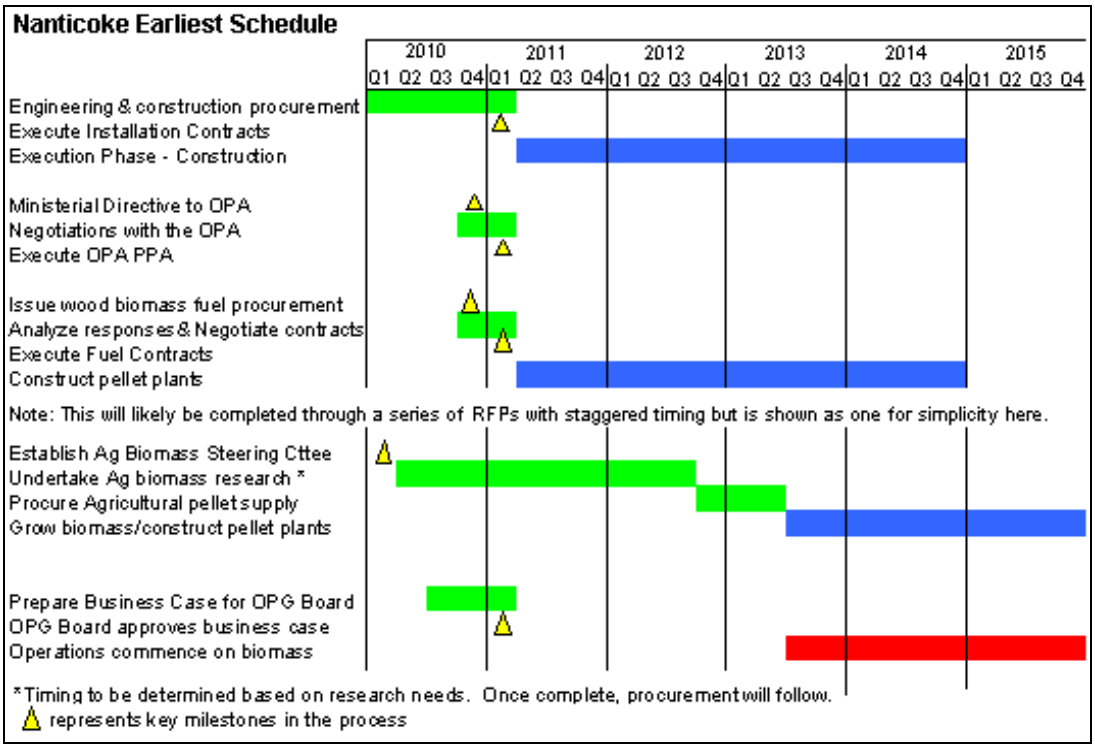
Demand: Economic conditions, unseasonable weather, and conservation have lowered electricity demand in Ontario.

Competition: Biomass can be used for many other products and power producers must compete against these other uses. There are policy issues around using farmland to grow energy crops.

Logistics: If agricultural biomass is grown in southern Ontario, the large number of pellet mills, storage units, and trucks may not be available.

Industry Outlook

OPG is targeting 2012 as the year it will begin using renewable biomass as a replacement fuel for coal in some of its electricity generating units. Biomass has the potential to play an important role in reducing net greenhouse gas emissions by replacing coal, which OPG aims to phase out by the end of 2014. Currently, OPG is conducting a number of important technical studies including a safe handling and storage analysis, combustion and ash studies, fuel specification development, as well as engineering concept studies at each of the coal-fired stations.



The above chart shows the timelines for the conversion of the Nanticoke electrical generation plant. Nanticoke is the largest plant in Ontario and is located in southern Ontario along Lake Erie. It generates

approximately half of the total coal-fired electricity in the province. In this schedule, it would appear that the intention is for Nanticoke to begin using wood pellet biomass and then making a switch to agricultural biomass in 2013.

In order to be ready to supply agricultural biomass by 2013, several areas of the supply chain will need to be addressed. At the farm level, the OPG needs to decide which crops to purchase. Once this decision is made it takes approximately three years for these crops to be established. The establishment of an aggregator is needed who will accumulate biomass from all the growers and small pellet mills. Another soft infrastructure requirement that will need to be developed is setting up the logistic flow for the large amount of product that must move into the OPG generating stations – the expected biomass tonnage of 30 million tonnes equates to 2,000 truckloads per day, 365 days of the year.

It will take at least five years to establish the residential and small commercial/industrial market assuming significant support in all areas is in place – marketing, lobbying, incentives similar to those offered for geothermal or solar energy, and the creation of an infrastructure for both appliances and bulk pellet delivery.

Sources

http://www.canadianbiomassmagazine.ca

http://bioenergy.ornl.gov/reports/misc/stakeholder.html

http://fit.powerauthority.on.ca/

http://www.omafra.gov.on.ca/english/engineer/biomass/pres_mei_jan11.htm

http://www.omafra.gov.on.ca/english/engineer/biomass/pres_opg_jan11.htm