Benefiting from biogas:

Alberta's other fuel source

energy

Community Energy Planning Mission Case Study

OVERVIEW

Alberta has invested in a wide variety of projects to reduce emissions from biogas and investigate ways to benefit from its fuel potential. Biogas, largely made up of methane, is produced by fermenting or decomposing organic material such as manure, sewage sludge, municipal solid waste (MSW), crop residues, or any other biodegradable feedstock in an oxygen-free environment. Generated in anaerobic digesters or captured at MSW landfill sites, biogas can be converted into useful fuels, electricity or heat. Using biogas as a fuel source can help to improve air quality and reduce greenhouse gas emissions, and decrease reliance on fossil fuels. Alberta's investments in biogas technology and research have yielded encouraging results that can help to expand the use of biogas in the province and in other Canadian municipalities.

BIOFUELLING ALBERTA'S FUTURE

Alberta produces 34 per cent of Canada's canola, a source crop for the production of biodiesel. Yet commercial use of biodiesel in Alberta is limited, in part due to challenges associated with blending and distribution. Through its research, testing and demonstration activities, the Olds College School of Innovation (OCSI) hopes to expand the province's capacity to use this alternative fuel.

"Biodiesel generates three and a half times more energy than it uses," explains Tanya McDonald, bioenergy research associate at OCSI. "It has a better energy output than ethanol."

- → The Olds College School of Innovation biodiesel production unit aims to produce 45,000 litres of clean, high-quality biodiesel from canola oil in its first year of operation.
- → Research conducted by the Alberta Research Council provides viable options for reducing emissions and extending the life of Alberta's small and medium-sized landfills.
- → The City of Edmonton's gasification project is anticipated to increase the city's diversion rate from 60 to 90 per cent.

Seed press and oil storage for biodiesel production at the Olds College BioFuel Technology Centre (Photo: OCSI/ Carien Vandenberg)

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From bushel to biodiesel

From seed storage to biodiesel blending, the complete production process takes place on-site at OCSI's 1,500-square-foot biodiesel production facility. The canola seed used to produce biodiesel is stored outdoors and crushed inside in a screw press, a device capable of crushing up to five tonnes of canola seed per day. About 30 per cent of the canola oil is pressed out of the seed; the remaining seed forms a press cake that is used to feed livestock. The oil is filtered, heated and dried before it is mixed with methanol and a catalyst to create the necessary chemical reaction. Heat forces out unneeded glycerin, which can be used in composting or in livestock feed. Remaining impurities are filtered out in a final dry-wash before the blending system mixes up to three different blends of clean, high-quality biodiesel.

The facility is slated to produce 45,000 litres of biodiesel in its first year of operation using virgin canola of various grades. OCSI is currently working to optimize the production process and improve quality control.

A recipe for biogas

In addition to its work on biodiesel, OCSI focuses a significant part of its research on biogas production. The school conducted a study to qualify and quantify the available feedstock in and around the town of Olds to produce biogas for generating heat and electricity. "We did an inventory of what waste could be used, and it was mostly manure," explains Carien Vandenberg, research technician at OCSI. Because it was in such significant supply, it was determined that manure would need to make up about 80 per cent of the codigester recipe. "Hog manure and offal also work well," she adds. OCSI estimates that for every litre of solids available, six litres of biogas could be produced.

The school is looking into ramping up its research into something larger. In the long term, it aims to construct a demonstration biogas plant for research, training and education. Renewable energy and compost produced from such a facility could be used on campus both to demonstrate the technology and to meet the sustainability goals of the school.

GENERATING ENERGY FROM GARBAGE

Compared to biogas production through anaerobic digestion, technologies for capturing and using gas produced at landfill sites are relatively new. The Alberta Research Council (ARC) is currently applying its strategic research, technology services and technology commercialization efforts to designing, developing and demonstrating new and innovative technologies in this growing area.

While large cities like Edmonton and Calgary are already using landfill gas technologies to reduce emissions and extend the life of their landfills, most of Alberta's landfills are small and medium-sized, notes Dr. Christian Felske, research scientist at ARC. With landfills across the province reaching their capacity and the waste stream continuing to grow, the need to consider better ways of dealing with waste is paramount.

Researching possibilities

Fort McMurray's booming growth rate and the resulting increases in its waste stream prompted the city to investigate ways to reduce the environmental impact of its landfill. The Fort McMurray landfill receives approximately 81,000 tonnes of MSW per year, and a new regional landfill is slated to open in 2008. Supported by the Federation of Canadian Municipalities' Green Municipal Fund™ (GMF), ARC and other project partners recently began a project to assess the amount of landfill gas produced at the Fort McMurray site using modelling and real-time measurement. "It all starts with an assessment," says Dr. Felske. "What you can do with a landfill site depends on the size of the landfill, its feedstock over time, and other factors." Once the assessment is complete, the project team will determine the potential to implement landfill gas technologies to generate energy, reduce greenhouse gas emissions, or both.

A longer life for landfills

In partnership with other project participants, ARC is providing technical advice to an innovative bioreactor project underway at the Aquatera landfill in Grand Prairie, Alberta. This medium-sized landfill receives more than 50,000 tonnes of MSW per year. To stabilize and degrade organic waste more quickly, liquid and air are added to the waste through a piping system under a liner or cover. "Bioreactor technology converts a landfill to a waste treatment system," explains Dr. Felske. The leachate, to be treated at the wastewater treatment plant, creates the moisture content needed to generate landfill gas.

Bioreactor technology offers several benefits, notes Dr. Felske. It significantly reduces the time needed to decompose waste from decades to years. The decomposition process increases the density of the waste mass, which can gain between 15 and 30 per cent of landfill space.

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Aerobic and anaerobic decomposition also combine to make the waste less toxic. Depending on the size of the landfill and the amount of waste available, the technology can significantly increase the amount of landfill gas generated at the site. When this gas is captured, it can be used to generate energy at the site or sold. Aquatera Utilities Inc., the regional utility corporation that operates the site, intends to implement co-generation to heat its office building.

Aquatera landfill in Grand Prairie, Alberta (Photo: Aquatera Utilities)

The oxidation option

The Leduc regional landfill east of the city of Leduc receives 35,000 tonnes of MSW per year. Supported in part by GMF, ARC and other project partners designed, constructed and monitored a full-scale test field and test bed to investigate methane oxidation as a way to mitigate gases released from smaller landfills. To conduct the test, a 10 by 10-metre area of MSW was covered with a synthetic membrane often used to line landfills. Two biofilters made of compost were installed on top of an opening in the membrane. The landfill gas was vented through the biofilters and measured, with promising results: the oxidation process removed an average of 63 per cent of the methane produced at the site.

Dr. Felske notes that this technology works well to reduce methane emissions in a cold climate, although it has not yet been tested in areas of continued permafrost. He anticipates that oxidation could be used in most small to medium-sized landfills to reduce emissions without a landfill gas collection and treatment system.

THE FOURTH "R"

Through its established recycling and composting programs, the City of Edmonton has maximized the three Rs — reduce, reuse and recycle — to achieve its impressive 60 per cent diversion rate. But with its landfill set to close in 2009 and a drive to increase its diversion rate even further, the city is turning to gasification technology. "The fourth 'R' is recovery," points out Jim Shubert, project manager in the city's waste management branch. The energy in the waste remaining in landfill can be recovered and converted into useful fuels, electricity or heat. While it does not replace the need for a landfill, recovering the energy makes use of the waste that remains despite best efforts to divert it.

En route to 90 per cent diversion

Supported by GMF, the city screened over 150 leading-edge gasification technologies and identified the process conducted by Enerkem Technologies in Sherbrooke, Quebec, as the most promising. A sample of the city's waste was shredded into refuse-derived fuel (RDF) in the form of fluff and pellets to create a uniform feedstock, which was then used to generate synthetic gas, or syngas.

RDF fine fluff (Photo: City of Edmonton)

Producing a uniform feedstock proved to be quite complex, notes Shubert. He anticipates that this step, along with the high cost of the process, will be key challenges for municipalities interested in adopting this technology.

Based on the results of the initiative, the city has decided to build an $87 million MSW gasification demonstration facility at the Edmonton Waste Management Centre. The facility will integrate a research and development facility to further its research into the technology, including its potential to produce higher value products such as ethanol and hydrogen, as well as uses for syngas. The facility will initially be capable of producing 30 million litres of methanol and two to three megawatts each of electricity and useable heat energy per year. The city anticipates that the energy generated by the facility could be used in municipal operations in place of conventional fossil fuels. It also predicts a net reduction in overall greenhouse gas emissions and lower energy costs.

WASTE AS A RESOURCE

Using waste as a resource is starting to gain ground in Alberta, as research organizations, private industry and municipal governments explore viable ways to reduce the environmental impacts of manure, crop residues, MSW and other waste products and exploit their potential as a fuel source. The province's investments in research and new technology have yielded encouraging and transferable results that can help Canadian municipalities take advantage of the opportunities presented by waste now and in the future.

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ADDITIONAL RESOURCES

This case study highlights sites visited by delegates on the 2007 FCM Community Energy Planning Mission. For additional information on the Mission, including more Mission case studies, presentations and the 2007 Mission Report, visit the FCM Centre for Sustainable Community Development Website at <www.sustainablecommunities.fcm.ca/Community_Energy_Mission>.