



ENERKEM ALBERTA BIOFUELS

CLEAN ENERGY FROM NON-RECYCLABLE WASTE

CANADIAN CONSULTING ENGINEERING AWARDS – 2016
Natural Resources, Mining, Industry & Energy Category

Engineering
for a changing world

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Summary

Summary

Enerkem Alberta Biofuels is the world's first commercial biorefinery that converts non-recyclable household garbage into clean, renewable energy. BBA was chosen by Enerkem for its industry expertise to provide detailed engineering for the successful development of its game-changing plant.

Sound engineering and innovations were key to transition from research and development to full-scale application, all within budget. Calculated greenhouse gas emissions are reduced by 110,000 tons of CO₂ per year through less landfilling.



Waste challenge



Main site components

- A. Feedstock preparation
- B. Biomass building
- C. Waste water treatment plant
- D. Feeding system
- E. Gasification
- F. Methanol
- G. Ethanol
- H. Biofuels storage and building

Context

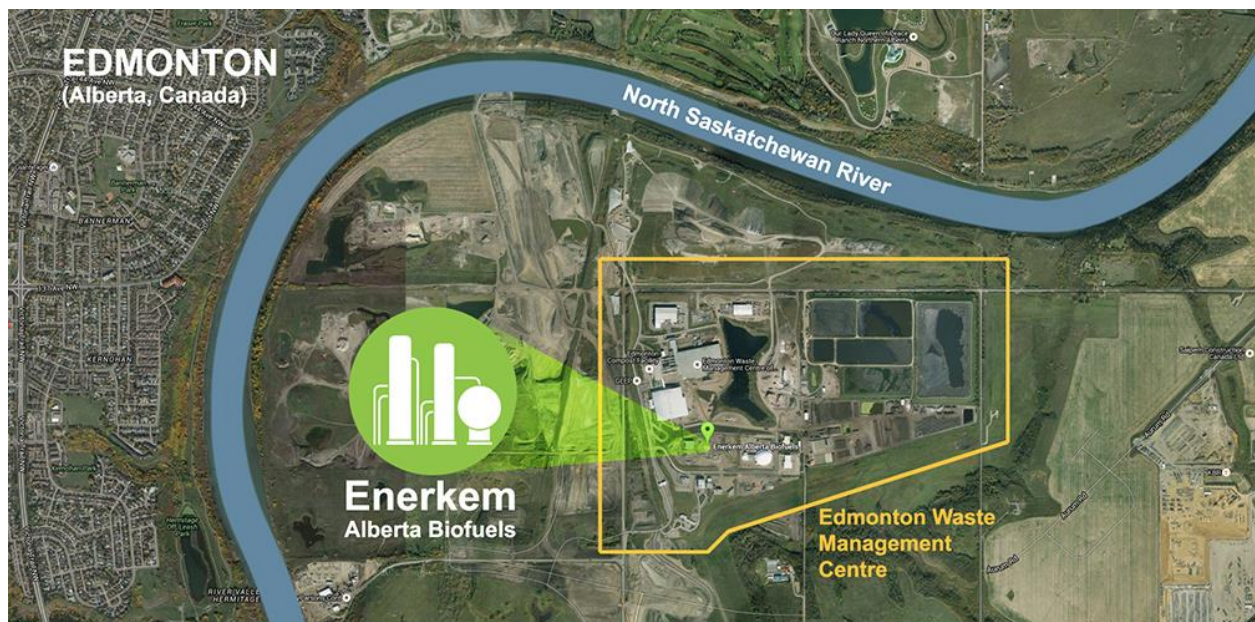
Context

Canadians generate an average of 1,031 kilograms of solid waste per year. From this, an average of 25% is recycled (Statistics Canada, catalogue 16-201-X: Human Activity and the Environment, Waste Management in Canada).

Products that are extracted from waste and recycled are mostly organic, like foods, cardboard and newspapers. Other products in smaller amounts are also recycled, such as glass and certain plastics. The rest is classified as non-recyclable waste and mostly dumped in landfills. Some regions incinerate the waste. When garbage is dumped in landfills, it decomposes over the years and creates greenhouse gases, such as methane, along with other soil contaminants.

The Enerkem Alberta Biofuels Project is a global game-changing facility because it provides a sustainable alternative and produces biofuels by recovering carbon molecules contained in non-recyclable waste.

The Enerkem Alberta Biofuels plant initiated the commercial production of biomethanol in the summer of 2015. This product is sold as a chemical building block to produce secondary chemicals, which can then be used for thousands of everyday products. In Edmonton, a plant expansion is underway to produce cellulosic ethanol, a renewable fuel that is blended with traditional gasoline. In Canada, the mandated renewable fuel content in gasoline is 5%, on average.



Enerkem Alberta Biofuels site location

Energkem Alberta Biofuels benefits Canadians in many ways:

- **By reducing the production of greenhouse gases:** Before the project, the City of Edmonton was diverting municipal waste from landfill primarily through recycling and composting. This project will increase the diversion capacity rate to 90%.
- **By generating biofuels used as an alternative to fossil fuels:** Fossil fuel reserves are finite and unevenly distributed on earth. Canada holds large reserves that secure our short-term energy needs. However, this does not lessen the need to develop alternative fuel sources in order to reduce our short-term dependency, extend the life of fossil fuel reserves and provide energy security for future generations.
- **By building a sustainable bio-economy**

Context



Edmonton Waste Management Centre – Aerial view

Innovation

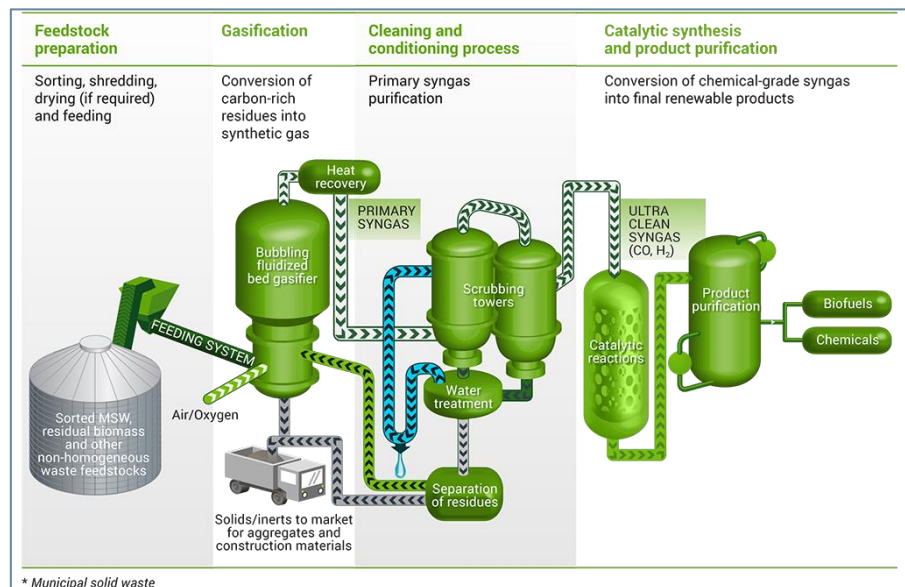
Surpassing limits with engineering creativity

Innovation

As a technology provider in the environmental sector, Enkernem deems it critical that its engineering consultants provide environmentally driven solutions that mitigate inherent risks, enhance performance and minimize the environmental footprint of projects—each day brought on a new challenge when it came to optimizing the overall budget for this critical and unique project.

BBA's mandate was to perform modular detailed engineering for methanol purification and ethanol production process units.

Enkernem wanted the plant to be designed in modules and to use the least surface area. Also, the plant had to be designed to include enough space between equipment to provide operators with safe access in the course of normal operations and emergencies. With these parameters, BBA used its cutting-edge design expertise to solve these engineering challenges.



Enkernem technology

Innovative construction strategy

Going beyond its engineering mandate, BBA proposed a construction strategy and changes to the project schedule to improve project value: the main idea was to design and fabricate modules to align with the construction plan, instead of following the standard development sequence.

The goal was to optimize on-site time of large cranes that perform heavy lifting, to gain significant savings in the construction phase.

Diminishing the plant footprint

BBA's engineering team led the modules design. The team made significant achievements by optimizing the weight and volume of modules to minimize overall costs. It involved developing a comprehensive layout to minimize the structural steel weight and efficiently integrate the piping routing into the structure. Innovatively, a vertical layout was developed instead of using surface area, which provided further savings in foundation costs.

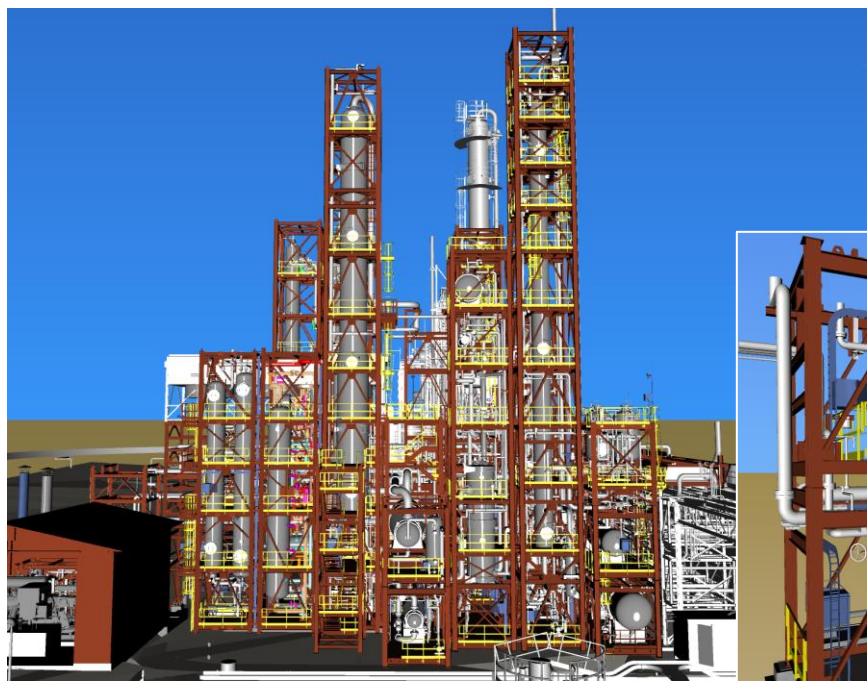
Innovation

Expertise for design challenges

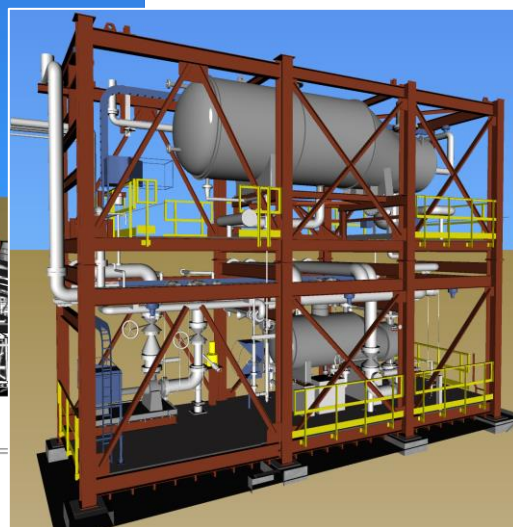
The piping between equipment was sized from 1 inch to 60 inches in diameter. One of the largest conduits operates at extreme temperatures with a flow of wide-ranging components from garbage. BBA's Mechanical Engineering experts designed this customized line and its mechanical supports to prevent the installation of costly expansion joints. The constraints analysis was performed with rigour, ensuring reliability in various operating conditions. The solution brought to this challenge is unique considering that the conduit is made of various material liners.

Technology to enhance recycling

The entire design was modelled in 3D so the Enerkem Alberta Biofuels plant could become a company standard and the chosen modular approach could be adapted and reproduced for future projects.



Innovative vertical layout design



Module design

Complexity

When it has never been done before

Complexity

Equipment and material selection research

Since the plant is unique worldwide, the selection of mechanical equipment, piping, valves and instruments was a first and had to be defined. The project had to be engineered with a solid understanding of the extensive technical challenges: fluid velocities, product composition, pressure, temperature, expected plant life, reliability and space limitations.

A team composed of process, mechanical and instrumentation experts researched and analyzed suitable materials that could be selected. Since the combination of process conditions and product composition had never been seen in a project, this work could only be carried out in cooperation with BBA design experts, the Enerkem technology team and suppliers, thus developing the solution that would comply with project design criteria and the project procurement schedule.

From research and development to a commercial application

At the start of this project, Enerkem's research was demonstrated through a smaller-scale facility located in Westbury, Québec. The capacity of the Enerkem Alberta Biofuels plant is 7 times greater than the demonstration plant and is supplied with a different feedstock. As the Enerkem technology team tested the impact of various waste compositions, BBA's team was working on the project's detailed engineering. The engineering team worked jointly with the Enerkem technology team to anticipate condition changes by integrating evolutionary research into the project, thereby ensuring safe continuity and robust design. BBA worked through this complexity by using its high-level engineering expertise and focusing on the client goal.



Enerkem Alberta Biofuels

Social and/or economic benefits

Shaping the Canadian industry mindset

Social
and/or
economic
benefits

The plant is located on the site of the Edmonton Waste Management Centre. Incoming products are sorted and non-recyclable materials are shredded and transported by conveyor to the Enerkem Alberta Biofuels waste-to-biofuels facility for conversion into biofuels and renewable chemicals. Adding the Enerkem Alberta Biofuels plant to the Edmonton Waste Management Centre will enhance recovery to 90%, which translates to less than 10% of materials dumped in landfill sites once the plant is operating at full capacity.

Thanks to the Enerkem Alberta Biofuels plant, Edmontonians are working hard to develop a better city. The main benefit is that garbage is now seen as an opportunity to create something useful. This inspiring mindset, which could not have been anticipated by previous generations, will thrive with future generations. It's a major change... for the better!

From an economic standpoint, one of the project's key benefits is that the production of biofuel will contribute to the province's commitment to introduce at least 5% of biofuels into the gasoline offered on the market.

The plant construction creates 610 direct and indirect jobs with a net total economic impact of \$199 million across Canada, while plant operations creates 152 high-quality direct and indirect jobs along with an increase of \$64.5 million in local spending.

The project is a significant step toward a sustainable economy where items that are no longer useful are being decomposed to the molecular level and recomposed into a valuable product.



City of Edmonton

Environmental benefits

Reducing landfilling and dependence on fossil fuels

Environmental
benefits



The Enerkem Alberta Biofuels project is the world's first biorefinery to convert municipal solid waste (MSW) (or household garbage) into biofuels and renewable chemicals, with a yearly capacity to process 100,000 dry tons of MSW generated by those living in the City of Edmonton.

The calculated reduction in greenhouse gas emissions (GHG) is equivalent to 110,000 tons of CO₂ per year.

The plant is fed with waste materials, such as textiles, non-recyclable plastics, wood residues and packaging waste normally destined for landfill. To date, this material cannot be recycled in any other way. Therefore, the project is reducing GHG emissions and landfilling.

In addition to reducing landfill, using municipal solid waste as feedstock for the production of advanced biofuels offers the advantage of reducing dependence on oil. Plant output produces 38 million litres of biofuel annually. The equivalent amount of fossil fuel no longer has to be extracted, which means more crude oil can remain in the ground for future use. The amount of crude oil that does not have to be extracted and refined is calculated at 400,000 barrels per year at a refinery gasoline conversion rate of 60%. The reduction in crude oil extraction and refining activities also contributes to reducing GHG emissions.

Using garbage to make biofuels means:

- less land used for garbage disposal
- fewer greenhouse gases from decomposing garbage are released into the air
- less crude oil is extracted for the same amount of human activity



Enerkem's technology: A lower-cost option for waste management than incineration or landfilling

Meeting client's needs

Meeting
client's needs

The Enerkem goal was to successfully develop the first commercial biorefinery in Edmonton, Alberta, that would produce clean energy from waste. BBA and Enerkem define project success as financially viable and efficient technological solutions that meet Enerkem social and environmental commitments.

BBA involved a highly experienced engineering team that immediately integrated the Enerkem technology team, undertook a comprehensive review of the project, and proposed innovative solutions adapted to multifaceted objectives:

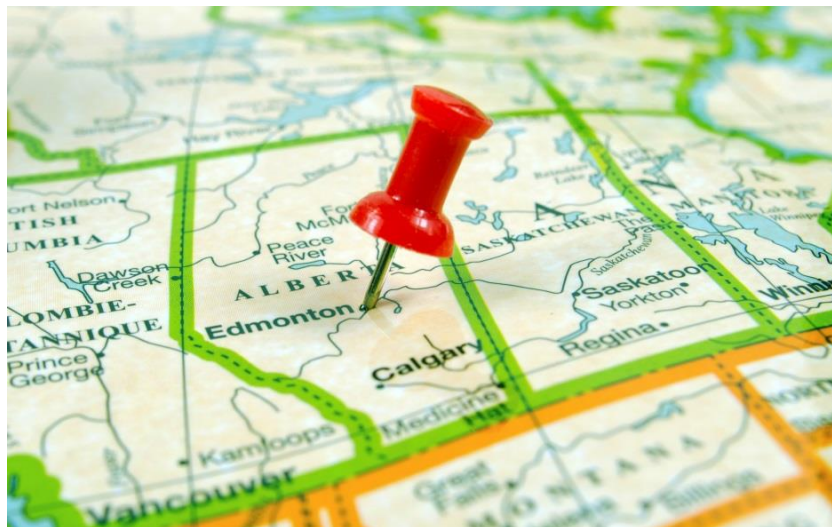
- **Safety in design:** BBA brought experience from other industries, notably safe spacing around equipment and emergency access
- **Sticking to the budget:** Each idea proposed by BBA and integrated by the Enerkem technological team was appreciated and resulted in improved efficiency
- **Enerkem long-term strategy for reusable modules:** BBA supported the strategy and used 3D design modeling
- **Minimizing surface area:** Thinking outside the box for vertical plant layout and construction strategy
- **Supporting Enerkem research:** Selecting the appropriate equipment and materials for a combination of process conditions that had never been done before

Enerkem recognized how valuable it was for both teams to unite, as they quickly adapted engineering development to project complexity, which was an essential part of the project. For example, certain process data were integrated and optimized during the detailed engineering, significantly reducing project costs.

This confirmed that the partnership between Enerkem and BBA was extremely valuable.

In September 2015, initial production of biomethanol was made and in December, BBA completed the design of the ethanol plant.

Milestones reached!





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About BBA

For over 35 years, BBA has been offering a wide range of consulting engineering and project management services, from project definition to commissioning. The firm's expertise is recognized in the fields of energy, mining and metals, and oil, gas and biofuels. BBA relies on a team of seasoned experts to transform complex problems into practical, innovative and sustainable solutions.

BBA is supported by a network of offices across Canada to better serve its clients and carry out mandates at the local, national and international levels.

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