Enerkem biorefineries: setting a new global standard in biofuels, chemicals and waste management
Enerkem at a glance

- Biofuels and renewable chemicals from garbage
- Proprietary clean technology developed in-house
- Private company founded in 2000; 200 employees
- First full-scale commercial biorefinery beginning operations in Edmonton
  - 2 facilities in Québec (pilot and demonstration)
- Developing similar facilities in North America and abroad
  - Several MOUs in China and EU
Enerkem at a glance

- MSW-based biofuels and renewable chemicals producer
- World’s first full-scale commercial MSW biorefinery beginning operations in Edmonton, Alberta
- $400M invested to date to move from R&D to commercial stage
- 200 employees
- New alternative to landfilling and incineration
Cost-competitive and sustainable solution

Municipality:
- Supplies between 100,000 to 400,000 tons of MSW per year (as available)
- Long-term contract
- Pays tipping fee – attractive compared to status quo
- Suggests sites

Enerkem:
- Technology provider and joint venture partner in $100 - $225 M project
- Converts RDF into biofuels and renewable chemicals up to 4x scale of Edmonton
- Works with the waste and municipal partners to optimize MSW sorting into commodities and for site selection
- Manages business risks incl. sale of final product
- Creates high-quality jobs
- Generates $C65 M/year in net economic benefits in the region (for 1 X standard Enerkem system of 100,000 tons / year)
ENERKEM ALBERTA BIOFUELS

Capacity: 38 million litres per year (i.e. 1 X standard Enerkem system)
Feedstock: 25-year agreement with City of Edmonton for 100,000 dry tonnes of MSW per year
Products: Biomethanol, cellulosic ethanol
Unique partnership with the City of Edmonton

- Leader in waste management practices
- Edmonton Waste Management Centre
  - North America’s largest collection of modern, sustainable waste processing and research facilities
  - 233-hectare site
- Enerkem selected as part of a thorough selection process involving over 100 technology providers
Benefits of the Enerkem Alberta Biofuels facility

**Economic**

- An investment of >$100M
- High-quality jobs: 150 direct and indirect permanent jobs\(^1\)
- 610 direct and indirect jobs\(^2\) during construction
- Increases annual net economic spending in the local area by $65 million
- Helps diversify Alberta economy

\(^1\) Based on an independent economic impact analysis conducted by Doyletech using their EconWin model
Benefits of the Enerkem Alberta Biofuels facility

Energy

- Diversifies energy basket
- Contributes to meeting provincial Renewable Fuel Standard
  - Enerkem’s production will represent ~10% of required ethanol production
- Positions Alberta at the forefront of clean technology and advanced biofuels
- Creates synergies with petrochemical sector and research institutions
Benefits of the Enerkem Alberta Biofuels facility

Environmental/Social

- Solves a waste problem and avoids methane emissions
- Reduces GHG emissions by 60% when compared to gasoline
- Can become a model for municipalities around the world
Solving the waste problem

Enerkem’s technology can help municipalities divert up to 60-90% of waste that would have to be landfilled.
Benefits of using waste as feedstock

ENVIRONMENTAL

• Reduces GHG emissions
• No land use impact
• Sustainable alternative to landfilling
• Complementary to recycling
• Fuel produced close to point of consumption/feedstock (limited transportation)

ECONOMIC

• Most inexpensive feedstock (typically no cost)
• Abundant resource
• Readily available and collected
• Available in all regions (urban and rural)
Key market drivers for waste as feedstock

- Increased scarcity of urban landfill airspace and societal desire for waste diversion
- Circular economy or “cradle-to-cradle” approach
- Low cost unconventional feedstocks
- Renewable fuels mandates around the world
- Consumer pull for renewable and biobased products
- Focus on carbon footprint and GHG emissions reduction
Alternative to landfilling and traditional WTE

Helping increase waste diversion to 90%
Large market potential

**MSW in North America**

- **To Landfill:** 529 million metric tons of MSW generated per year
- **168 million metric tons of MSW suitable for Enerkem’s technology platform**
- **The potential:** 63 billion litres/16 billion gallons using Enerkem


We’re building the bioeconomy. | © Enerkem, 2015
Large market potential

**MSW IN THE WORLD**

- Recycled/Composted
- To Landfill
- 1.3 Billion metric tons of MSW generated per year
- 420 Million metric tons of MSW suitable for Enerkem’s technology platform

The potential: 160 Billion litres/42 B gallons using Enerkem

Bringing the model to reality

Rigorous path to commercialization

We’re building the bioeconomy. | © Enerkem, 2015
An efficient “carbon-recycling” process

<table>
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<tr>
<th>Feedstock preparation</th>
<th>Gasification</th>
<th>Cleaning and conditioning process</th>
<th>Catalytic synthesis and product purification</th>
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<tr>
<td>Sorting, shredding, drying (if required) and feeding</td>
<td>Conversion of carbon-rich residues into synthetic gas</td>
<td>Primary syngas purification</td>
<td>Conversion of chemical-grade syngas into final renewable products</td>
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</tbody>
</table>

100k MT of RDF

- Bubbling fluidized bed gasifier
- Heat recovery
- PRIMARY SYNGAS
- Scrubbing towers
- Water treatment
- Separation of residues
- Solids/inerts to market for aggregates and construction materials

43k MT per year of methanol
10mm gpy of ethanol

* Municipal solid waste
Best available solid feedstock bolt-on to existing oil and gas infrastructure

**Single feedstock**
- Oil and gas

**Multi-feedstock**
- MSW
- Biomass
- Coal/petcoke
- Tire Derived Fuel (TDF)
- Refinery chemical residues

**Unconventional feedstocks**

**Traditional refinery**

**Enerkem biorefinery**

**Final refined fuels and chemicals**
- Syngas
- Electricity
- Heat
- Methanol
- Ethanol
- Renewable chemicals
Modular approach

- Modular manufacturing approach enabling global expansion
- 43 pre-fabricated modules for standard facility (e.g. Edmonton):
  - 15 process-driven modules
  - 28 structural modules
Demonstration facility in Westbury
Ethanol production in Westbury
VANERCO
First advanced biofuels facility in Canada to be co-located with a conventional biofuels production facility

Capacity: 38 million litres
Feedstock: Urban waste (industrial, commercial, institutional, construction, etc.)
Status: Pre-construction work started
Using waste as feedstock for the chemical industry

Fourteen partners have joined forces to assess the use of waste for the production of chemicals in the Netherlands. The public-private partnership will study the options for setting up Europe’s first plant, either in Rotterdam or Delfzijl.

Other partners involved in the initiative:
Target growth areas for global partnerships

- Strategic partnerships with leading industrial groups
- Selection based on market attractiveness:
  - public policies
  - tipping fees
  - proximity to petrochemical infrastructure
  - population
Renewable chemicals from waste help transition to a circular economy
Renewable chemicals for everyday products

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<th>Chemical building blocks in our syngas</th>
<th>Product Family</th>
<th>Applications</th>
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<td>CO</td>
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<td>- Transportation fuels</td>
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<td>Acrylates</td>
<td>- Solvents for pesticides and coatings</td>
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The Canadian firm transforming your sofa into biofuels

Enerkem’s waste-to-energy technology is giving old clothes and sofas a new lease of life as a source of renewable energy.

Read more at: http://enerkem.com/newsroom/medias-4/
Thank you

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