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

- Canadian-based company producing biofuels and renewable chemicals from non-recyclable and non-compostable household garbage (MSW or RDF) as an alternative to landfilling and incineration
- Proprietary clean technology developed in-house
- Private company founded in 2000; 200 employees
- First full-scale commercial biorefinery beginning operations in Edmonton (CND) in 2015
  - Pilot and demonstration facilities in Québec
- Developing similar facilities in North America and abroad
  - MOUs in China and EU
The Enerkem solution

**Feedstock**
- Municipal Solid Waste
- Approximately 1.3B MT\(^{(1)}\) of trash generated per year at global scale

**Process**
- Proprietary Thermochemical Technology
- Syngas
- 10 year history – Largest operating demo plant in cellulosic ethanol

**Products**
- Ethanol / Methanol
- Renewable Chemicals
- Power Generation
- Product cost competitive with those derived from fossil-based feedstocks

**Markets**
- Transportation Fuels
- Solvents, Polymers, Coatings, Plastics, Adhesives
- End Products Flexibility
Alternative to landfilling and traditional WTE

Helping increase waste diversion to 90%

Source Reduction and Reuse
Recycling / Composting

Biorefinery (liquid fuels, chemicals)

Waste-to-Energy (heat, electricity)

Landfill
Sustainable waste management solution

Complementary to recycling and composting

100,000 DRY METRIC TONS NON-RECYCLABLE WASTE PER YEAR

OR

BIOFUELS

38 M LITRES or 10 MMGPY RENEWABLE CHEMICALS

EVERYDAY PRODUCTS

TRANSPORTATION FUELS

Biogenic portion

We’re building the bioeconomy. | © Enerkem, 2016
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
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)
Large market potential globally …..

**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

but also in Europe

MSW IN THE EU

254 MILLION METRIC TONS OF MSW GENERATED PER YEAR

RECYCLING / COMPOSTING

LANDFILL / INCINERATION AND OTHERS

75 MILLION METRIC TONS OF MSW SUITABLE FOR ENERKEM’S TECHNOLOGY PLATFORM

THE POTENTIAL: 28.3 BILLION LITRES USING ENERKEM’S TARGET YIELD¹

¹ 375 litres of cellulosic ethanol per metric ton
Source: Eurostat (European Commission), 2011
MSW treatment in EU MS in 2013

Source: Eurostat 2016
MSW treatment in EU MS in 2013 (in tons)

Source: Eurostat 2016
Large Global Market with Regulatory Upside

- Ethanol and biomethanol are used as a transportation fuel blend in some EU states (RED) and China
- Unique opportunity in EU and China for blending methanol in fuels (instead of selling as chemical intermediate)
An efficient “carbon-recycling” process

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100k MT of RDF

100k MT of RDF

43k MT per year of methanol
38m lpy of ethanol

* Municipal solid waste
Bringing the model to reality

Rigorous path to commercialization

UNIVERSITY OF SHERBROOKE PILOT
SHERBROOKE

Laboratory  →  Pilot  →  Syngas Demo  →  Methanol Demo  →  Ethanol Demo  →  Full-scale commercial production

WESTBURY FACILITY

MODULAR COMMERCIAL BIOREFINERIES
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 project
- Converts MSW 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)
Modular approach

- Modular manufacturing approach enabling global expansion
- Pre-fabricated modules assembled on site
World’s first commercial MSW-to-biofuels and chemicals facility

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
City of Edmonton’s Integrated Waste Management Centre

1. Integrated Processing and Transfer Facility
2. Recycling center
3. Composting center
4. ENERKEM biorefinery

Recycled \( \rightarrow \) 20%
Composted \( \rightarrow \) 40%
Biofuels \( \rightarrow \) 30%
Landfill \( \rightarrow \) 10%

Waste diversion = 90%
Edmonton Waste-to-Biofuels Initiative

Integrated Processing and Transfer Facility
- Funded by City of Edmonton
- Owned / operated by City of Edmonton
- Prepares waste materials for composting and biofuels facilities

Enerkem Alberta Biofuels Waste to Biofuels Facility
- Funded by Enerkem Inc.
- Supported by:
  - AI-EES ($20M – this grant is administered by the City of Edmonton)
  - Alberta Energy ($3.35M)
- Owned / operated by Enerkem

Advanced Energy Research Facility
- Funded by AI-EES
- Owned / operated by City of Edmonton
- Powered by Enerkem technology
- Hosts a laboratory and other technologies
Delivering new technology (1)

Key challenges Enerkem has overcome

• Scaling-up from pilot to demonstration to commercial plants
  • Iterative design improvements based on operational performance
  • Move from ‘custom’ to modular delivery

• Funding / financing demonstration facility and 1st commercial plant
  • 15 year development programme
  • Capital scarcity during economic downturn

• Project deliver challenges
  • Modularisation and transport of modules to site
  • Building a reliable and costs effective supply chain
  • Construction in the Albertan winter!
Delivering new technology (2)

Ongoing challenges…

• EU market – policy variability and uncertainty
  • 28 sets of member states’ biofuels policies – RED vs FQD?
  • Approach to 0.5% advanced sub-target?
  • Lack of clarity over policy post 2020 – all set to change?
  • Where are the highest value markets?
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
Next projects

- Biomethanol facilities in Europe
- Projects under development in Canada and the U.S.
- MOUs in China and other regions of the world
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:

- Air Liquide
- BioMCN
- CleanTech Delta
- DNV-GL
- EEW
- Enerkem
- Port of Rotterdam
- Visser & Smit Hanab
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Read more at: http://enerkem.com/newsroom/medias-4/
Thank you

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