



October 2016

Biocleantech Forum, Ottawa

Deployment of large-scale biorefineries: the case of Enerkem



Building a global cleantech company

SHERBROOKE
LAB & PILOT



WESTBURY DEMO



Pre-commercial phase

EDMONTON – 1ST FULL SCALE FACILITY



Beginning commercial phase
(modular manufacturing)

COMMERCIAL GROWTH



VARENNES (QC) +
INTERNATIONAL

GREENFIELD

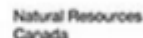
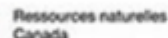
AkzoNobel

WM

上海城投
SHANGHAI CHENGTOU

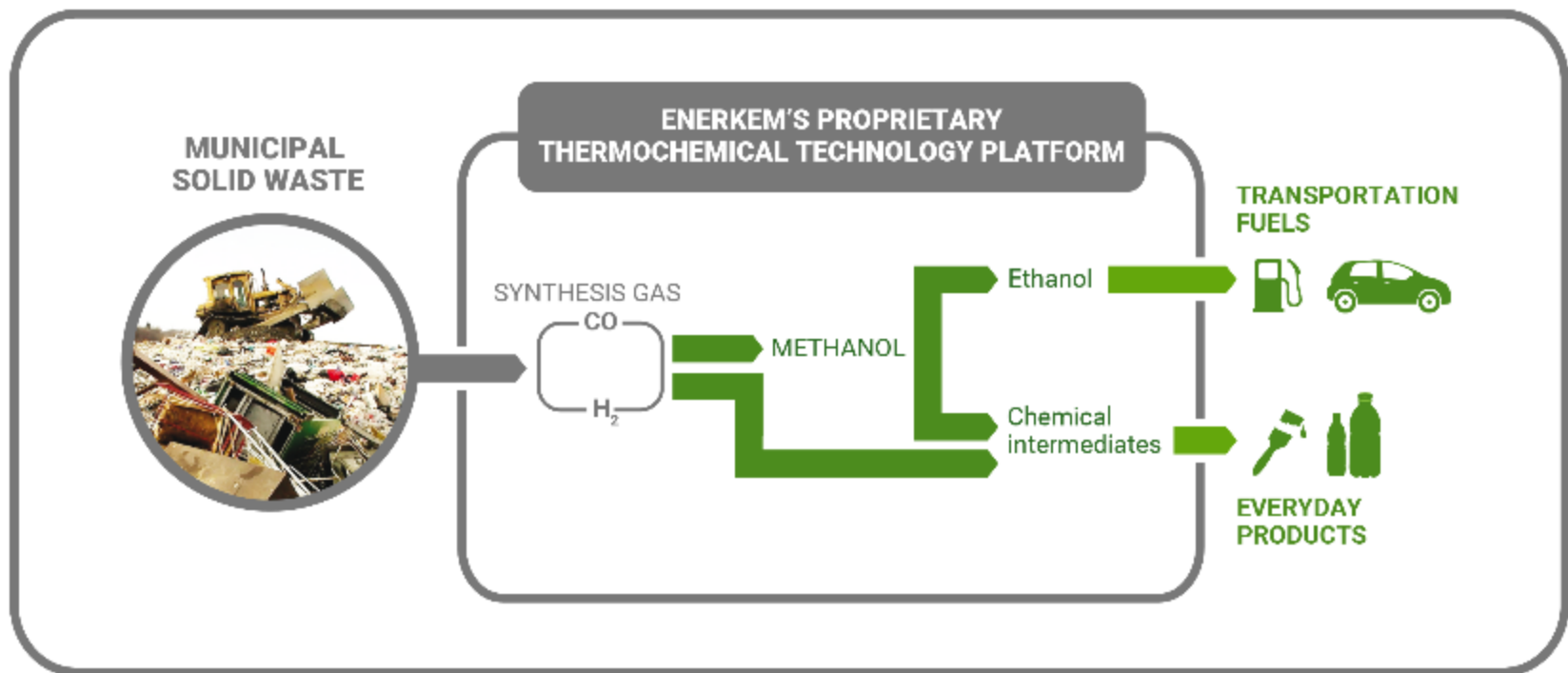
- Founded in 2000
- Headquartered in Montreal
- Employs 194 people
- Raised over \$400M in financing from lab to commercial stage
- Operates first full-scale facility in Edmonton (production ramp-up)
- Preparing for construction launch in Varennes in 2017
- Developing projects abroad with key industrial partners
- Operates innovation centers in Sherbrooke and in Edmonton for new product development

Investors and Partners



Enerkem's biorefinery process

Replacing the use of petroleum for transportation fuels and chemicals production



Abundant Supply of Waste Biomass

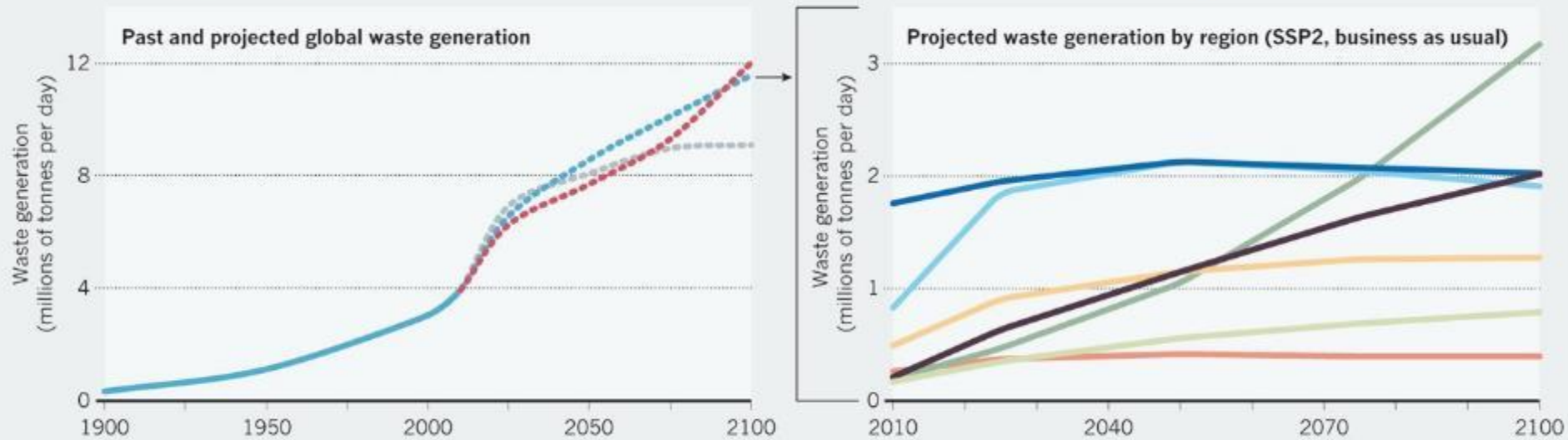
WHEN WILL WASTE PEAK?

Three projections to 2100 for waste generation spell very different futures. In the first Shared Socioeconomic Pathway⁹ scenario (SSP1), the 7-billion population is 90% urbanized, development goals are achieved, fossil-fuel consumption is reduced and populations are more environmentally conscious. SSP2 is the 'business-as-usual' forecast, with an estimated population of 9.5 billion and 80% urbanization. In SSP3, 70% of the world's 13.5 billion live in cities and there are pockets of extreme poverty and moderate wealth, and many countries with rapidly growing populations.

-- SSP1 -- SSP2 -- SSP3

*Organisation for Economic Co-operation and Development

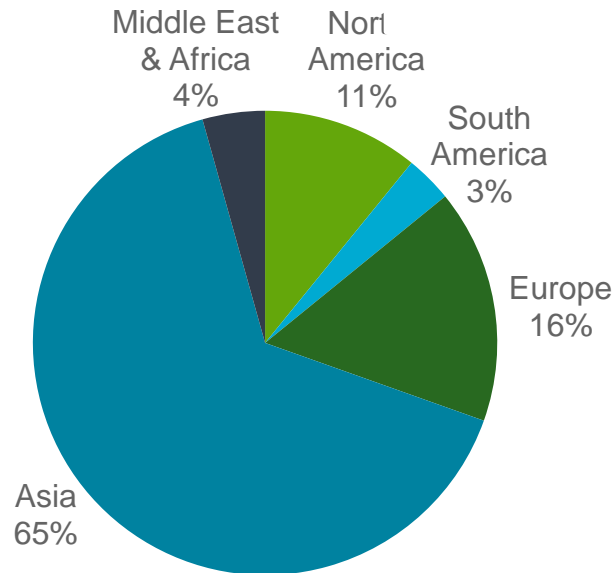
— Sub-Saharan Africa
— East Asia and Pacific
— Europe and central Asia
— South Asia
— Latin America and the Caribbean
— Middle East and North Africa
— High-income and OECD* countries



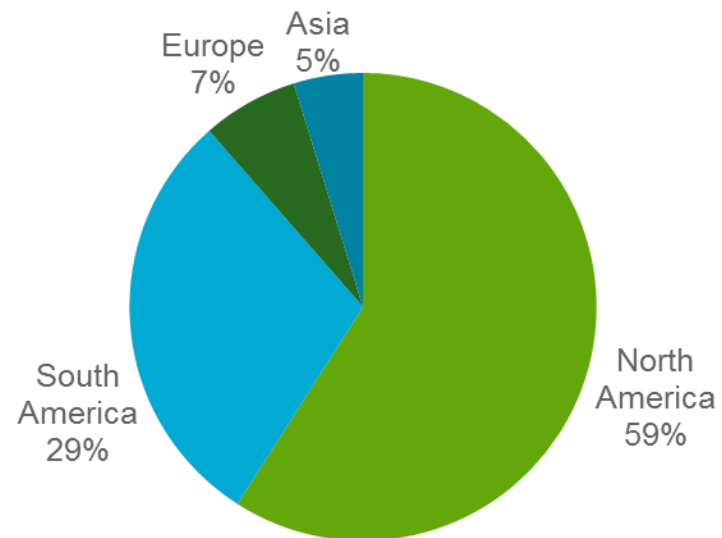
Source: 'Environment: Waste production must peak this century', Nature Magazine, [Daniel Hoorweg](#), [Perinaz Bhada-Tata](#) & [Chris Kennedy](#), 30 October 2013

Large Global Market for End-Products

**2014 Global Methanol Demand
(22B gallons)**



**2014 Global Ethanol Demand
(27B gallons)**



- Over 60 countries have mandated the blend of a minimum content of renewable fuels in gasoline and diesel pools
- Increased demand for renewable chemicals (circular economy)



Background on Enerkem Alberta Biofuels

- 2002: City conducted global review of thermal waste conversion technologies to address non-recyclable and non-compostable garbage. Enerkem's thermochemical conversion technology was chosen.
- 2008: Transportation and Public Works Committee authorized that the City execute a long-term operating agreement with Enerkem.
- 2012: Plant construction start.
- 2014: Inauguration event (Phase 1).
- 2015: Initial production of biomethanol began. Followed by installation of additional equipment to bring to full capacity.
- 2016: First sales of biomethanol (ISCC certification for European biofuels market).
- 2017: Expansion and first sales of ethanol.



City of Edmonton's Integrated Waste Management Centre


Edmonton

Recycled	↻	20%
Composted	↻	40%
Biofuels	↻	30%
Landfill	↻	10%

Waste diversion = 90%



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



World's first commercial
MSW-to-biofuels and
chemicals facility

ENERKEM ALBERTA BIOFUELS

- Capacity:** 42 million liters/year (1 train Enerkem plant). Biomethanol production in 2016. Ethanol expansion in 2017.
- Feedstock:** 25-yr agreement with City of Edmonton for 100,000 dry tons of posted-sorted residential waste per year – CAD\$50/MT tipping fee indexed annually
- Location:** Edmonton Waste Management Center in Edmonton, Alberta
- Products:** Alcohols : Biomethanol (IMPCA, ISCC); Ethanol (ASTM)

Methanol sale and delivery



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-ESS (\$29.6M – grant administered by the City of Edmonton)
 - ✓ Alberta Energy (\$3.35M grant)
 - ✓ SDTC (\$63M loan)
- 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





Benefits of Enerkem facilities

ENERGY

- Reduces use of gasoline and provides oxygenate (high-octane)
- Contributes to meeting the federal and provincial RFS with advanced biofuels
- Provides a locally-produced low-carbon transportation solution

ECONOMIC

- Contributes to diversifying and greening economy
- Each plant:
 - Generates net annual economic impact of \$65 CAN million locally*
 - Generates high-quality jobs: 150 direct and indirect permanent jobs*
- Helps stimulate manufacturing sector
- Provides cost-effective waste diversion solution for municipalities
- Opens door to new export opportunities
- Positions Canada at the forefront of clean technology and advanced biofuels

ENVIRONMENT

- Solves a waste problem and contributes to circular economy
- Avoids methane from landfills / air pollution associated with incineration
- Reduces GHG emissions by >60% (ISCC-certified)
- Uses feedstock already collected and available in urban and rural areas

* Based on an independent economic impact analysis for Edmonton plant conducted by Doyletech using their EconWin model

Building the facility through modular manufacturing generates economic benefits in Canada



Edmonton example for standard facility:

- 93 pre-fabricated modules
- 83% of suppliers located in Canada
- \$125M in contracts to Canadian suppliers to date
- Opportunity to revitalize and green manufacturing sector in Canada

Next Facility: VANERCO

First advanced biofuels facility in Canada to be co-located with a conventional biofuels production facility (GreenField)

Location: Varennes (South Shore Montreal)
Capacity: 60 million litres of biomethanol / 42 million litres of ethanol
(1 standard Enerkem system → possibility to add more systems)
Feedstock: Non-recyclable/non-compostable urban waste
(industrial, commercial, institutional, construction, etc.)



Using waste for the production of greener chemicals

Waste-to-Chemicals public-private partnership in Europe



JV with AkzoNobel

In Port of Rotterdam



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Key Success Factors

- Rigorous technology scale-up with continuous IP protection strategy
- Strong partners and investors
- Sound business model with :
 - large and growing markets
 - use of sustainable feedstock
 - low cost approach
- High barriers of entry for competition



Thank you

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