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Enerkem



**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



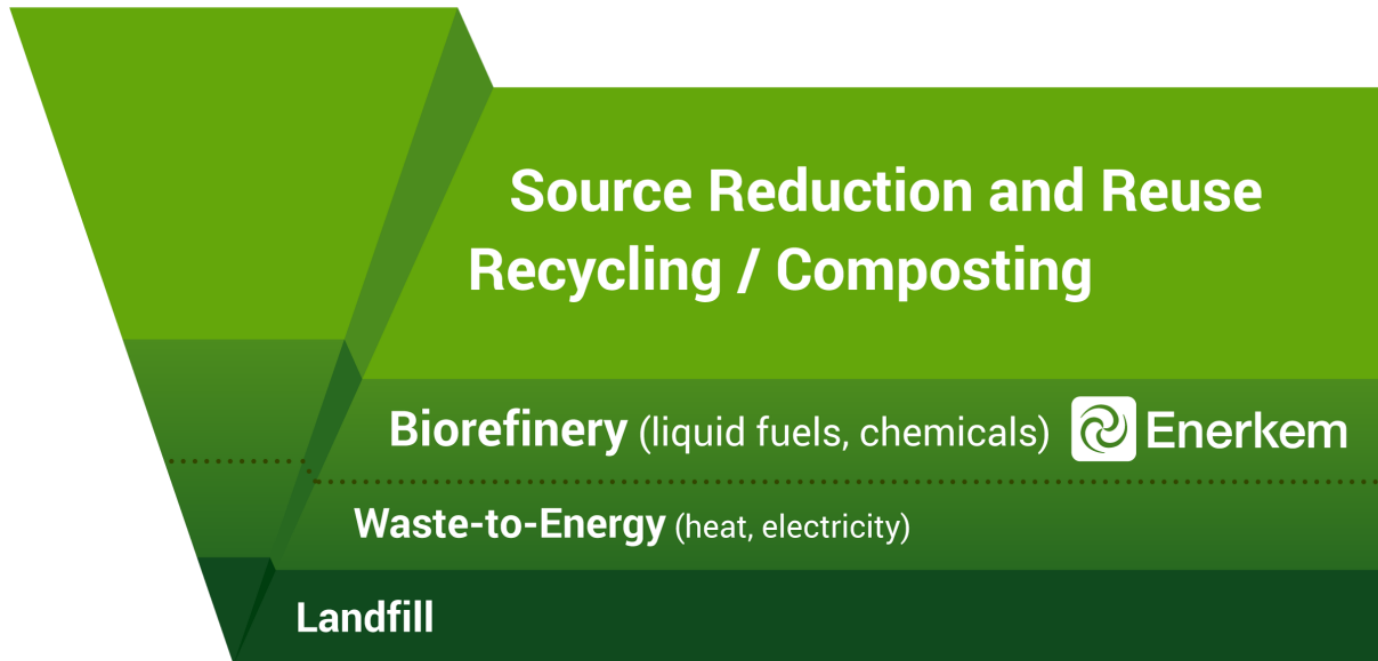
Solvents, Polymers,
Coatings, Plastics,
Adhesives



End Products
Flexibility

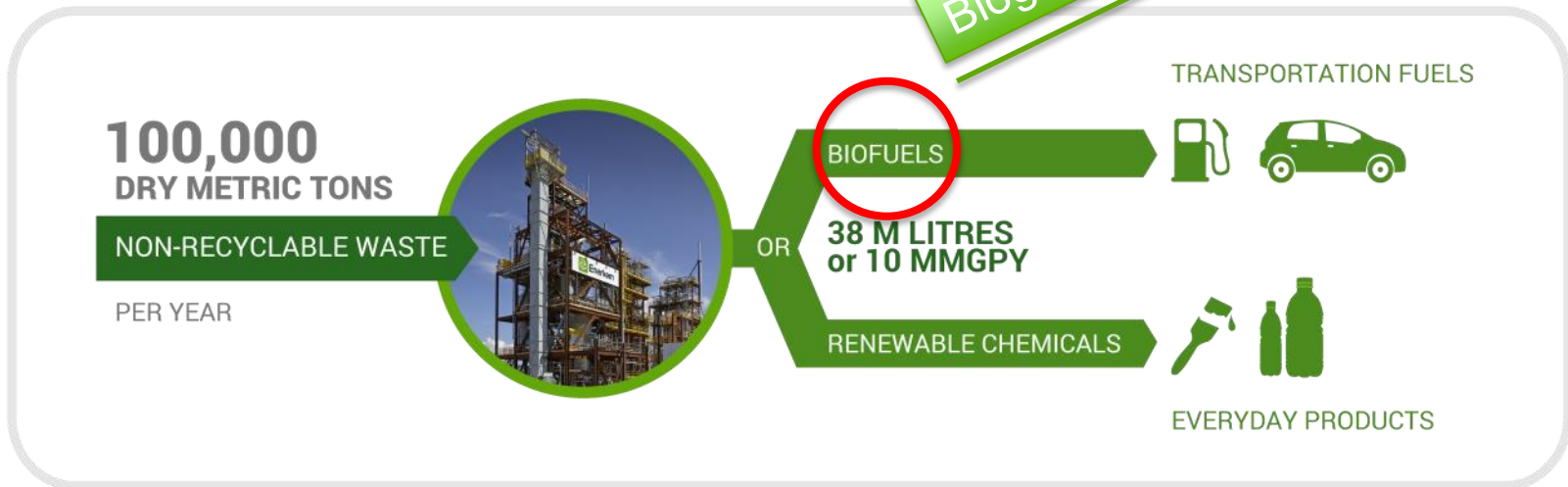
Alternative to landfilling and traditional WTE

Helping increase waste diversion to 90%



Sustainable waste management solution

Complementary to recycling and composting



A yellow bulldozer is shown in the middle ground, pushing a large pile of waste. The waste consists of various types of trash, including plastic, paper, and metal. In the background, there are trees and a clear sky. The bulldozer is positioned on a raised area of the landfill, and its front loader is tilted upwards. The overall scene depicts a large-scale waste management operation.

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



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

Source: World Bank, 2012

..... but also in Europe

MSW IN THE EU



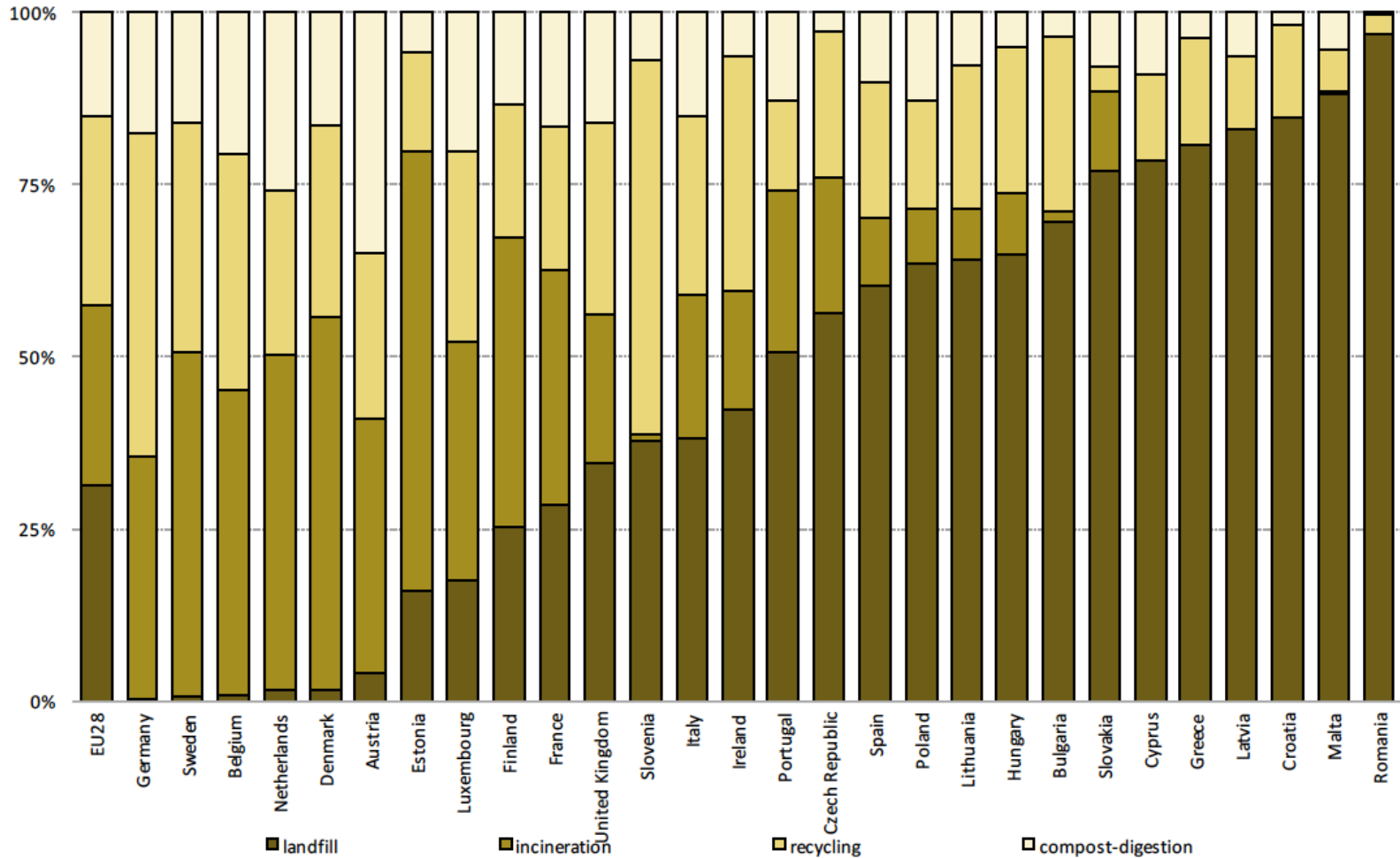
254 MILLION
METRIC TONS OF MSW
GENERATED PER YEAR

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

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

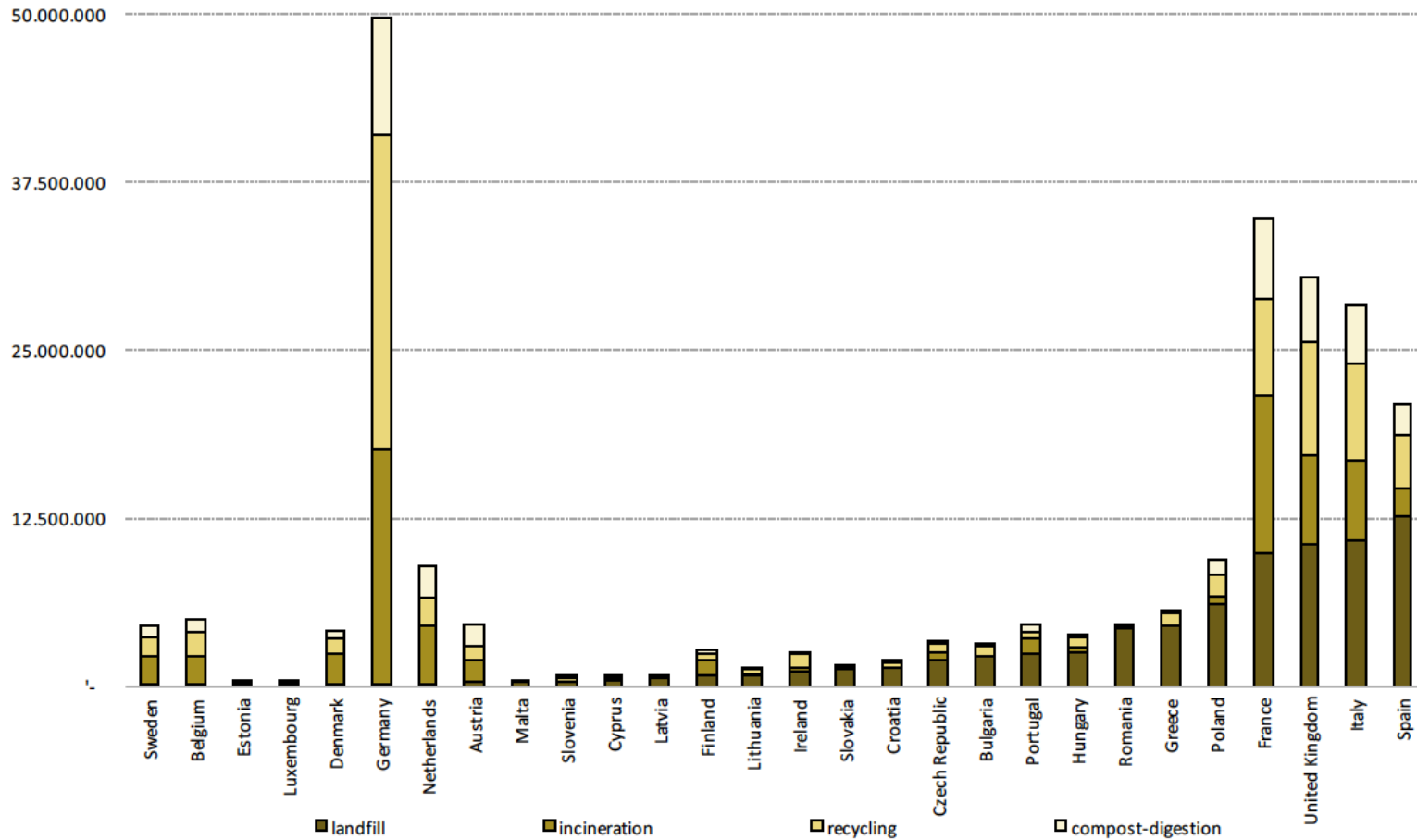
¹ 375 litres of cellulosic ethanol per metric ton
Source: Eurostat (European Commission), 2011

MSW treatment in EU MS in 2013



Source: Eurostat 2016

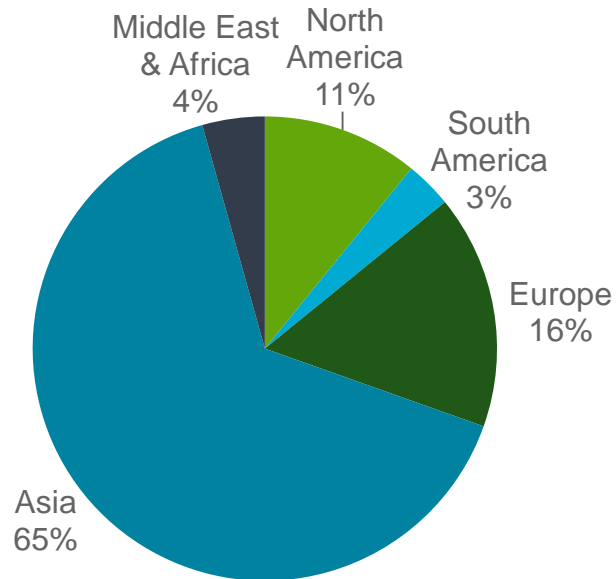
MSW treatment in EU MS in 2013 (in tons)



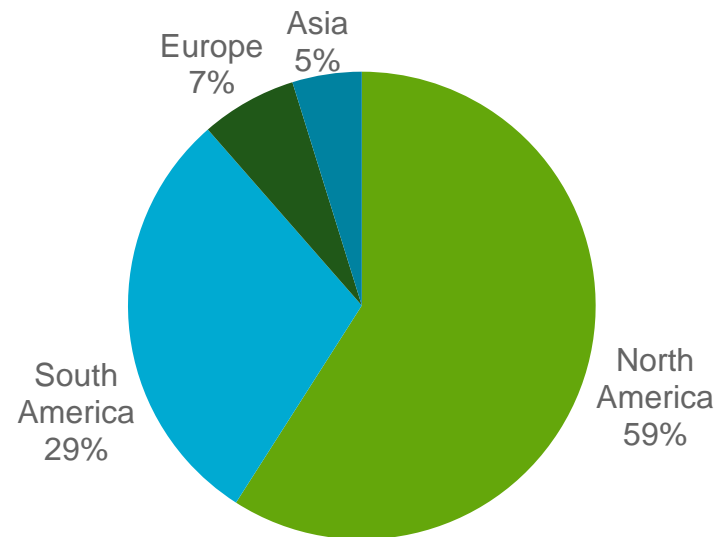
Source: Eurostat 2016

Large Global Market with Regulatory Upside

2014 Global Methanol Demand
(84 Bn L)

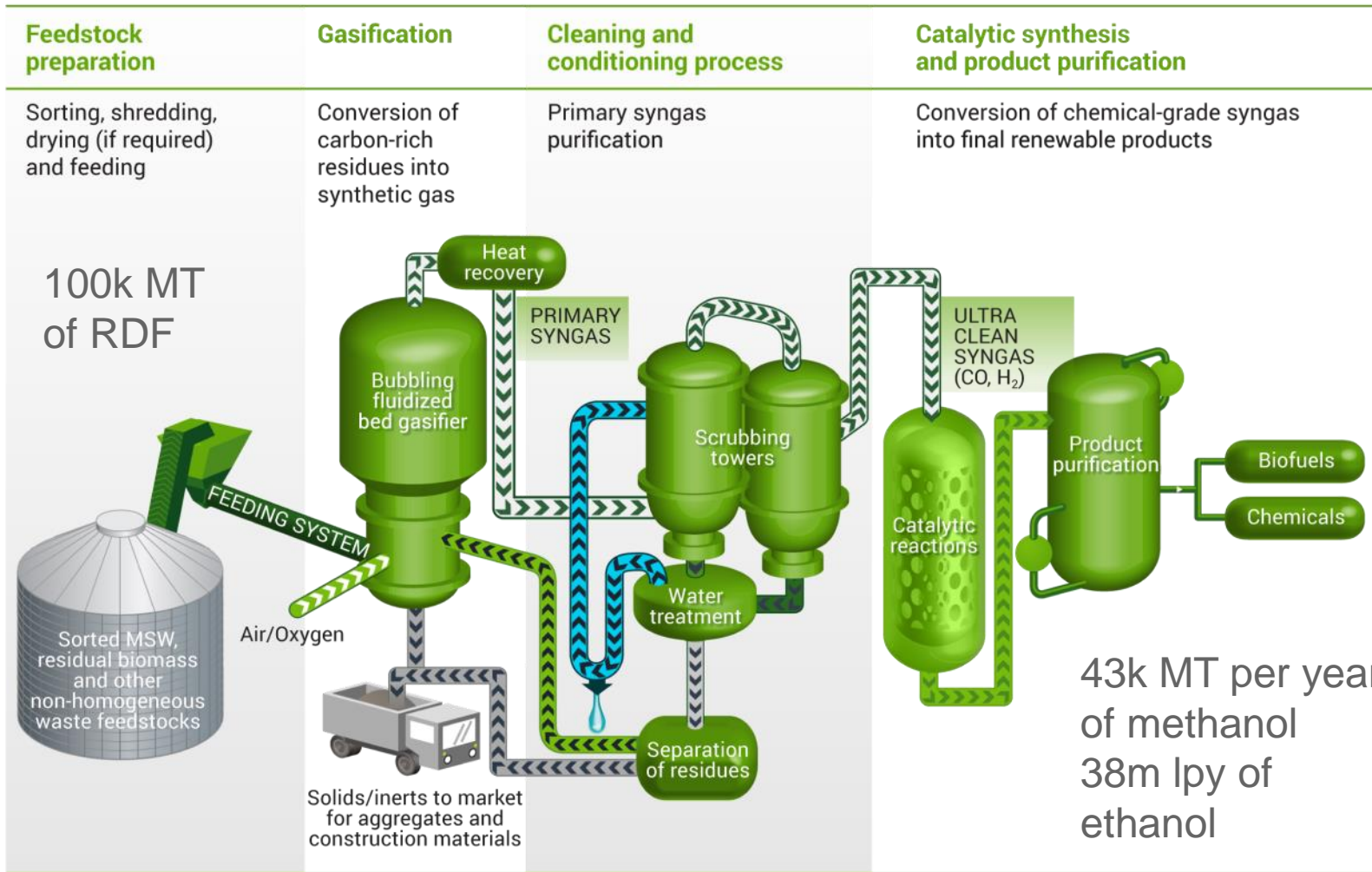


2014 Global Ethanol Demand
(102 Bn L)



- North American ethanol market highly incentivized by Canadian and US Renewable Fuel Standard mandates.
- 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



* Municipal solid waste

Bringing the model to reality

Rigorous path to commercialization

UNIVERSITY OF
SHERBROOKE
PILOT



SHERBROOKE



WESTBURY FACILITY



MODULAR COMMERCIAL BIOREFINERIES



Laboratory

Pilot

Syngas
Demo

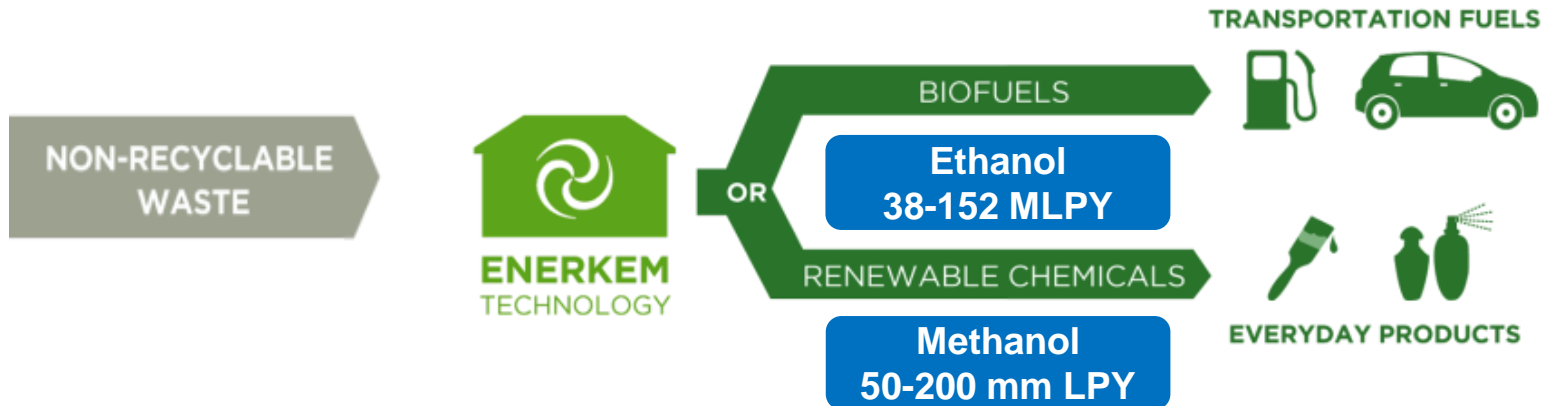
Methanol
Demo

Ethanol
Demo

Full-scale commercial
production



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



© Papillon et Fils



© Papillon et Fils



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

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

 Alberta
Innovates
Energy and
Environment Solutions

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



A photograph of a large industrial facility, likely a research plant, featuring complex machinery, pipes, and yellow safety railings. The scene is set in a large, well-lit industrial building with a high ceiling and structural beams. The equipment includes large cylindrical tanks, a central vertical vessel, and various piping systems. A green semi-transparent banner is overlaid on the top left of the image.

Advanced Energy Research Facility

Edmonton

 Alberta
Innovates
Energy and
Environment Solutions

CYCLONE



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!

A background image showing industrial machinery, including pipes and structural beams, in a warm, golden-brown color palette.

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



VANERCO

GREENFIELD



Enerkem

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.

www.akzonobel.com

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:



INSIDE:

- Bio gas continues to blossom p. 30
- Mixed waste processing examined p. 34
- Q&A with Covanta's new CEO p. 41
- Engine selection expert advice p. 44

SERVING FUEL AND ENERGY PRODUCERS // www.REWmag.com // SEPTEMBER-OCTOBER 2015

HISTORY IN THE MAKING

Enerkem's innovative, commercial-scale biomethane facility in Edmonton, Alberta, has the potential to transform the global waste industry.

the **guardian**
Winner of the Pulitzer prize

The Canadian firm transforming your sofa into biofuels

Enerkem's waste-to-energy development is set to give old chairs and sofas a new lease of life as a source of renewable energy

THE GLOBE AND MAIL*



Enerkem raises funds for expansion, begins biofuel production in Edmonton

BERTRAND MAROTTE

MONTREAL — The Globe and Mail
Published Wednesday, Sep. 09, 2015 11:12AM EDT
Last updated Wednesday, Sep. 09, 2015 12:59PM EDT

Forbes / Entrepreneurs

2/16/15, 2015 @ 05:58 PM 1,443 views

Waste-To-Fuel: How To Make A Challenge An Opportunity

An entrepreneurial company is planning to take a new approach to the old adage 'making money from old rope'.

Instead of splitting used hemp to re-sell, Enerkem – the company in question – is taking solid municipal waste and turning it into fuels and chemicals through a proprietary process that involves further sorting of waste feed material and then chemistry conversion of the remaining feedstock through a gasifier as well as a fluidised bed.

Freddie Dawson
CONTRIBUTOR

ALBERTA OIL
The Business of Energy

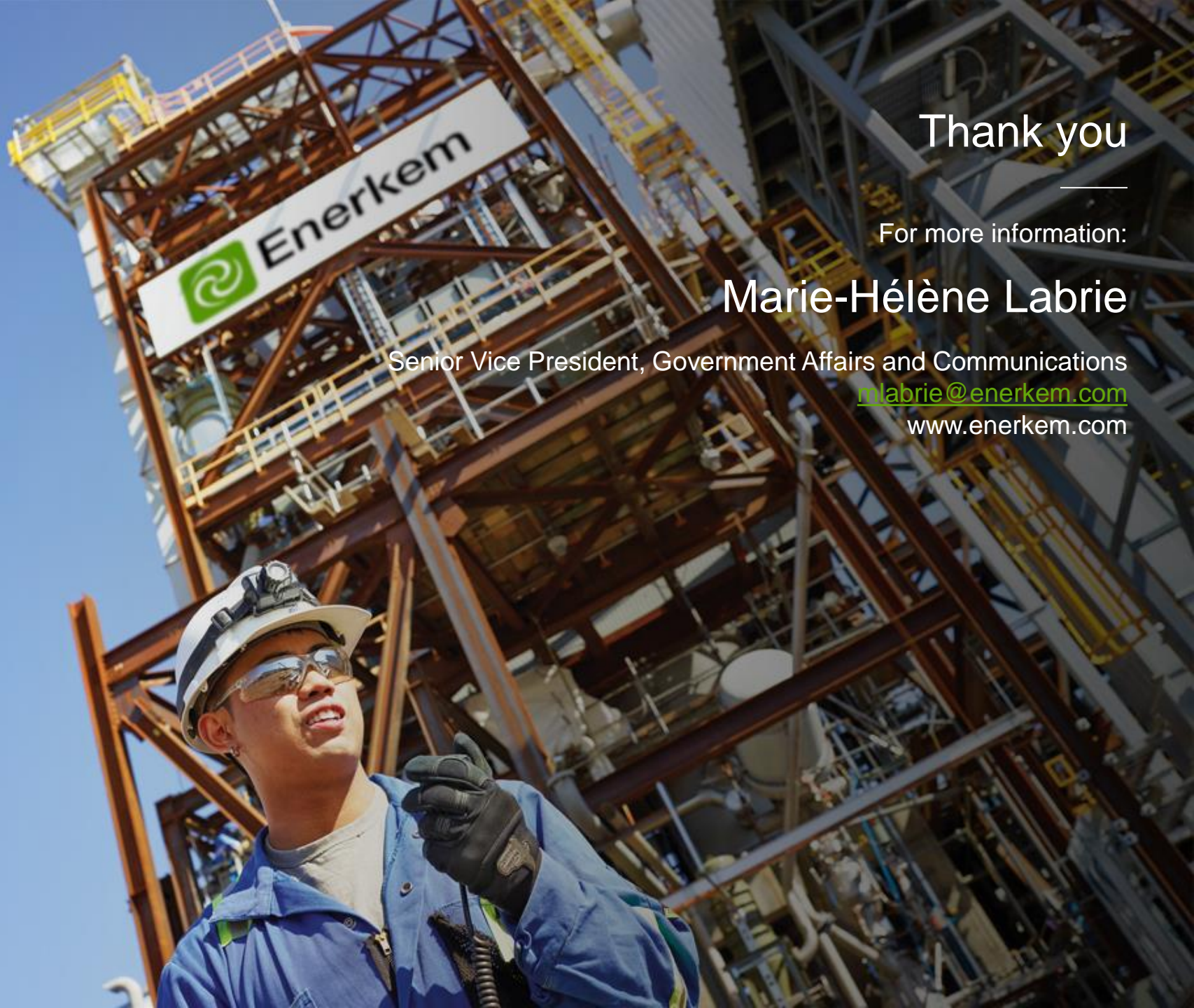
Canada's Top Energy Innovators 2015

From environmental reclamation to operational excellence, Canada's Top Energy Innovators are pushing hard on their industry's leading edges

BY ALBERTA OIL STAFF

March 02, 2015

Read more at: <http://enerkem.com/newsroom/medias-4/>



Thank you

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