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Marketable bioproducts and biomaterials from research to commercial manufacture for sustainability, greenhouse gas emission reductions and a circular economy

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Enerkem : Marketable bioproducts and biomaterials from research to commercial manufacture for sustainability, GHG emission reductions and a circular economy

Enerkem at a glance

- Biofuels and renewable chemicals from non-recyclable household garbage
- Proprietary clean technology developed in-house
- Private company founded in 2000; 200 employees
- First full-scale commercial biorefinery beginning operations in Edmonton
    - 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 globally

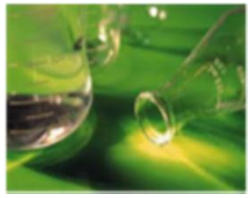
Process

Syngas

Proprietary Thermochemical Technology

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

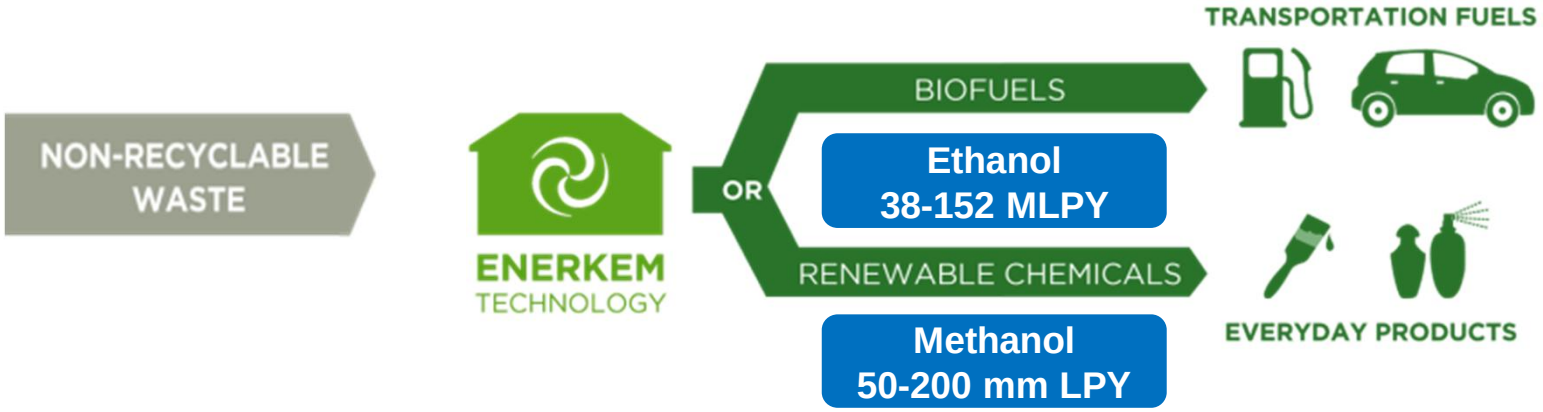
Markets

Transportation Fuels

Solvents, Polymers, Coatings, Plastics, Adhesives

End Products Flexibility

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)

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

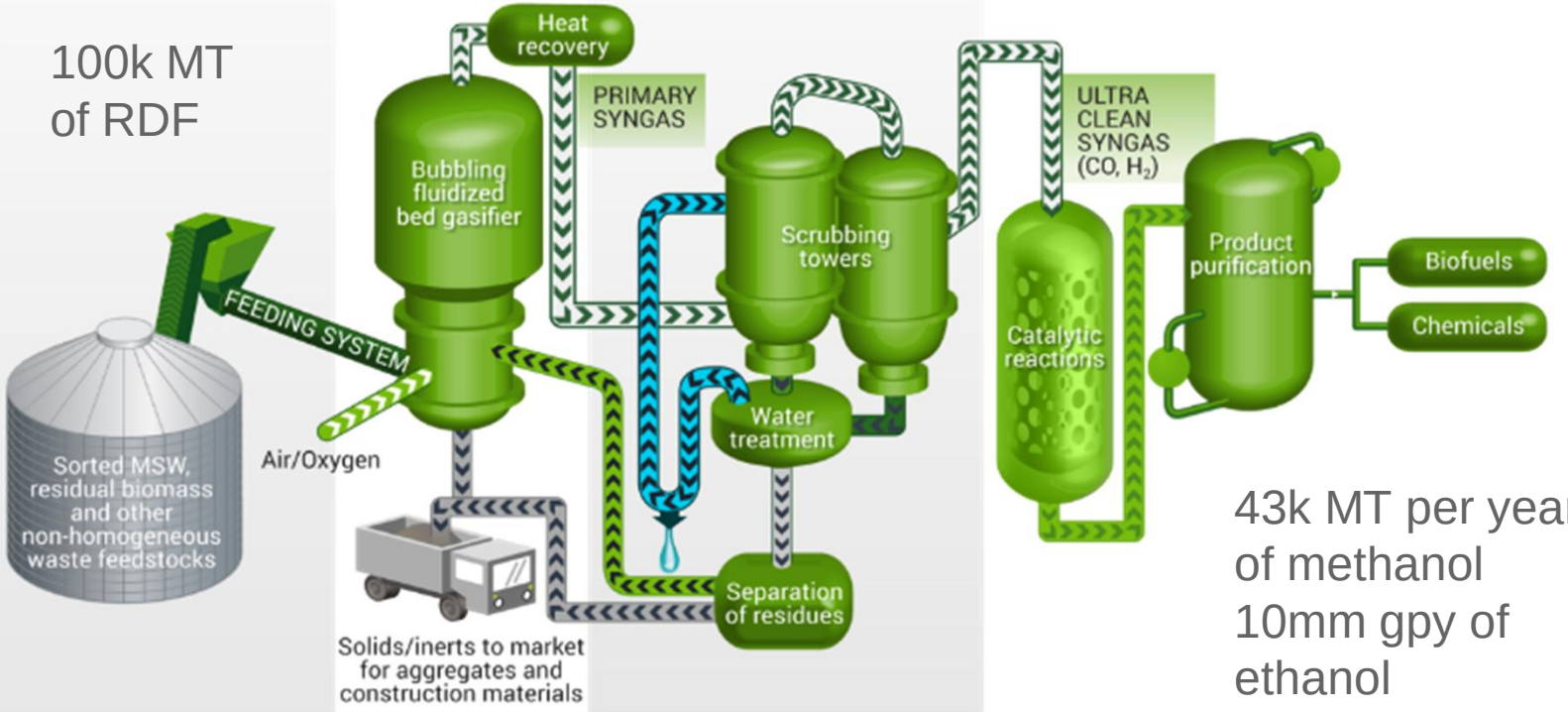
ENERKEM ALBERTA BIOFUELS

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

An efficient “carbon-recycling” process

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

100k MT of RDF



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

* *Municipal solid waste*

Enerkem

How did Enerkem get here?

- The concept
  - Individuals dreams
  - Seeing potential
  - Selling the idea to others
- The vision
  - Taking the idea
- Numerous Laboratory experiments.
  - Contribution of many researchers
- Pilot testing
  - Numerous researchers and experiments
  - Re-evaluation, innovation and change.
- Realisation

Enerkem

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**

Pilot to commercial plant

Plant Rollout – A disciplined approach to all stages

- Early concept designs
- Process engineering designs and specification
- Process validation and testing
- Partner identification and sign-up
- Sourcing and materials purchasing
- Permitting and regulations
- Installation site services and support infrastructure
- Funding requirements identified and sourced
- Plant engineering designs
- Detailed engineering designs
- Identification of fabricators and suppliers
- Purchasing and contracts
- Fabrication of plant and equipment
- Construction and installation
- Commissioning
- Production/plant handover

Enerkem facilities

Demonstration facility in Westbury


Ethanol production in Westbury


Advanced Energy Research Facility
Edmonton
Alberta
Innovates
Energy and
Environment Solutions
CYCLONE

Key relationships provide meaningful support

Government and municipalities

Natural Resources Canada / Ressources naturelles Canada

Canada

Sustainable Development Technology Canada

Government of Alberta

Énergie et Ressources naturelles Québec

Alberta Innovates Energy and Environment Solutions

Edmonton

IQ Investissement Québec

Key strategic partnerships

WM Waste Management

GreenField Specialty Alcohols Inc.

Strong financial backing

rho

Braemar Energy Ventures

Cycle Capital Management

The Westly Group

Fonds de solidarité FTQ

FONDACTION CSN pour la coopération et l'emploi

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

Edmonton

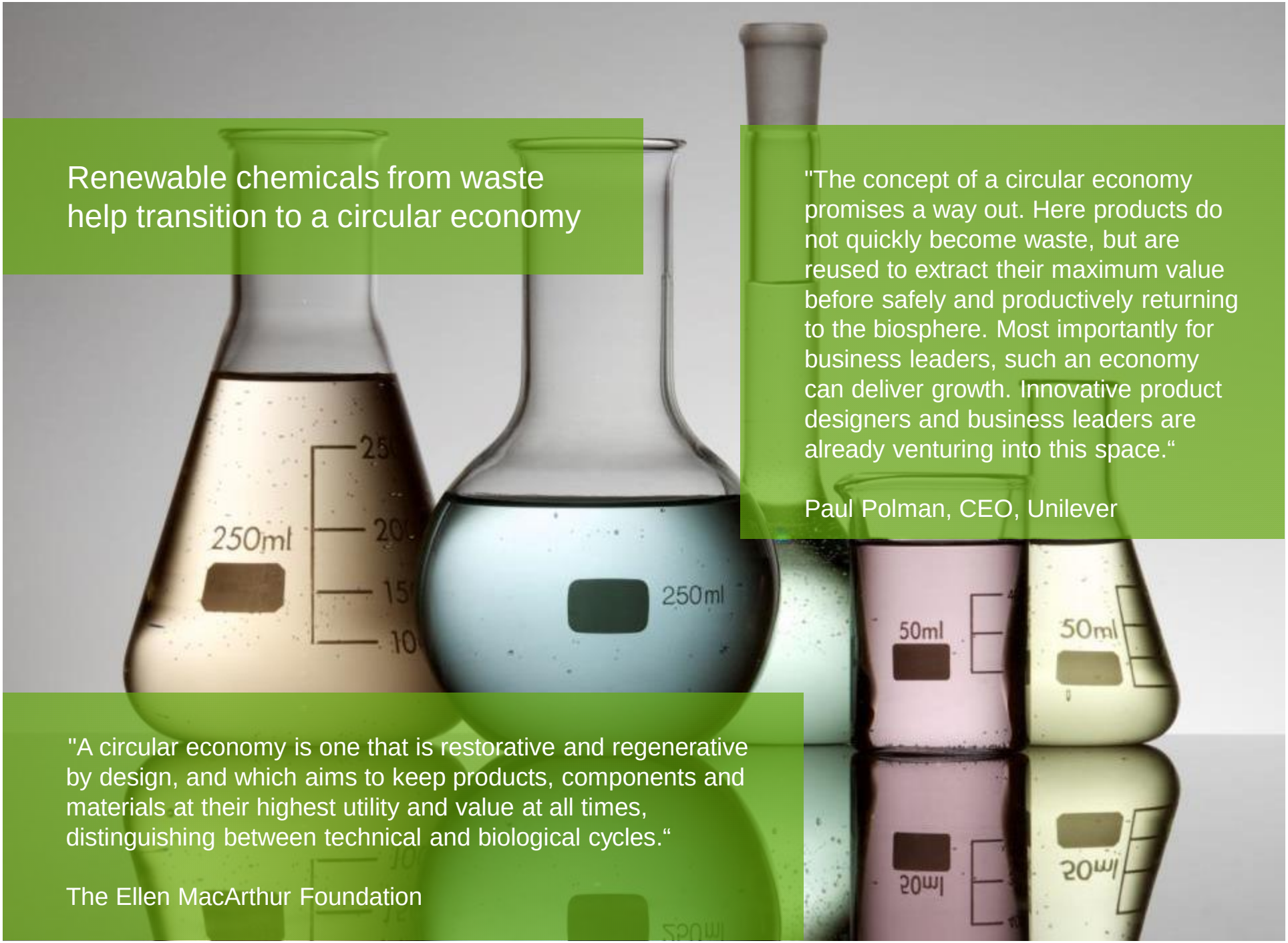
Alberta Innovates Energy and Environment Solutions


City of Edmonton's Integrated
Waste Management Centre
Edmonton
Recycled ➲ 20%
Composted ➲ 40%
Biofuels ➲ 30%
Landfill ➲ 10%
Waste diversion = 90%
Alberta Innovates
Energy and Environment Solutions

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



Renewable chemicals from waste help transition to a circular economy

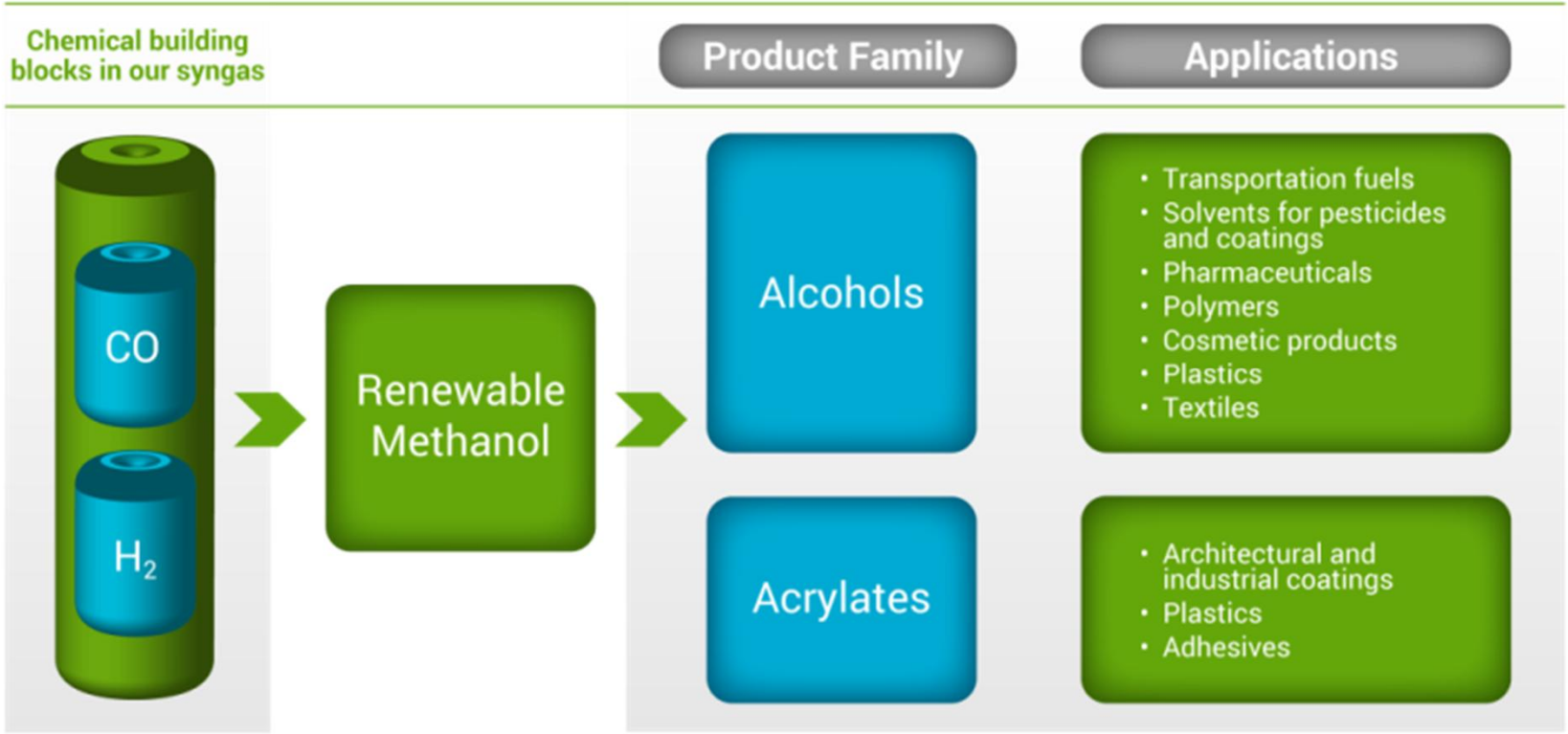
"The concept of a circular economy promises a way out. Here products do not quickly become waste, but are reused to extract their maximum value before safely and productively returning to the biosphere. Most importantly for business leaders, such an economy can deliver growth. Innovative product designers and business leaders are already venturing into this space.“

Paul Polman, CEO, Unilever

"A circular economy is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.“

The Ellen MacArthur Foundation

Renewable chemicals for everyday products

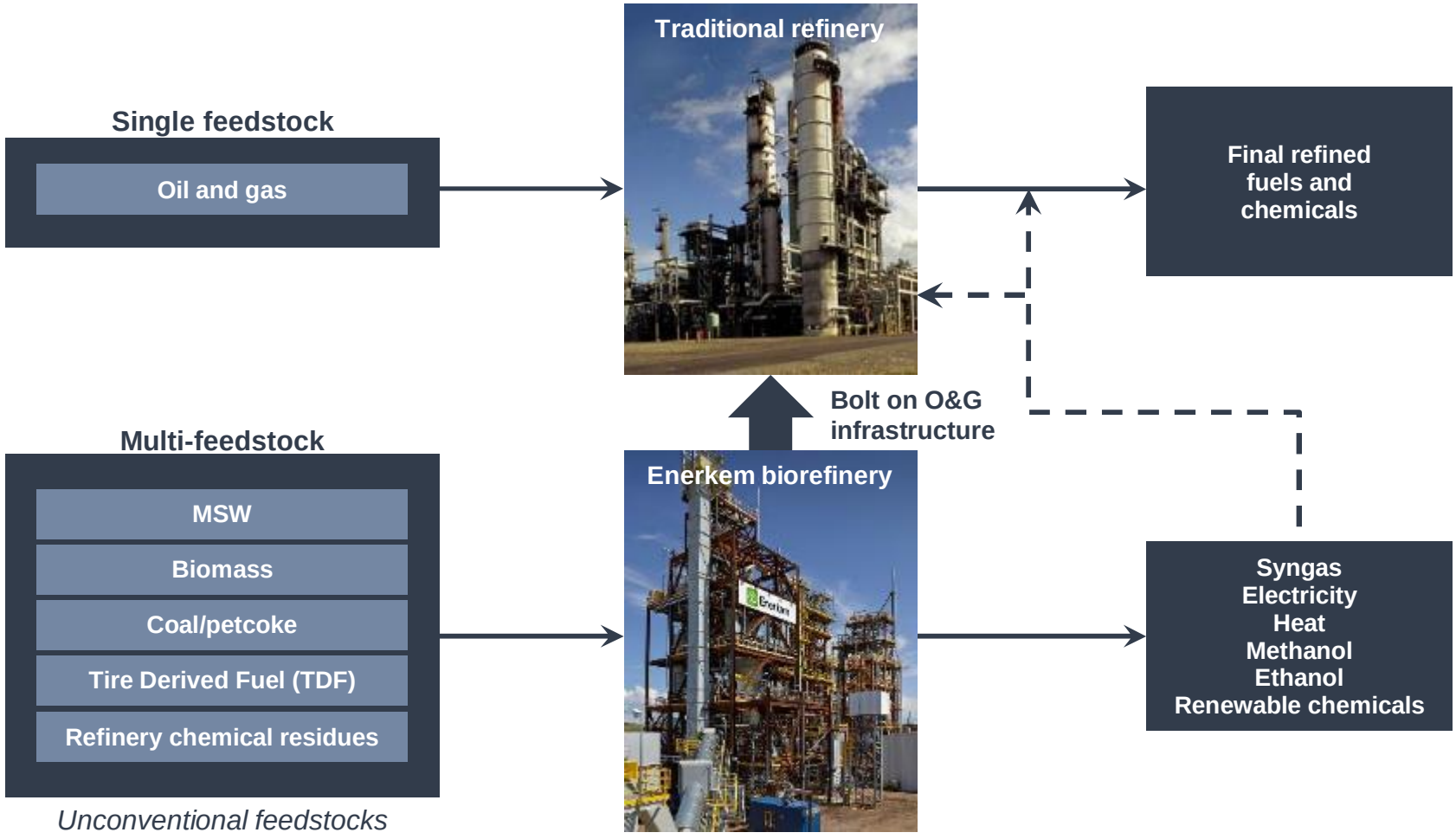


Enerkem

Using waste as a feedstock for the chemical industry

Public-private partnership with AkzoNobel in Europe

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



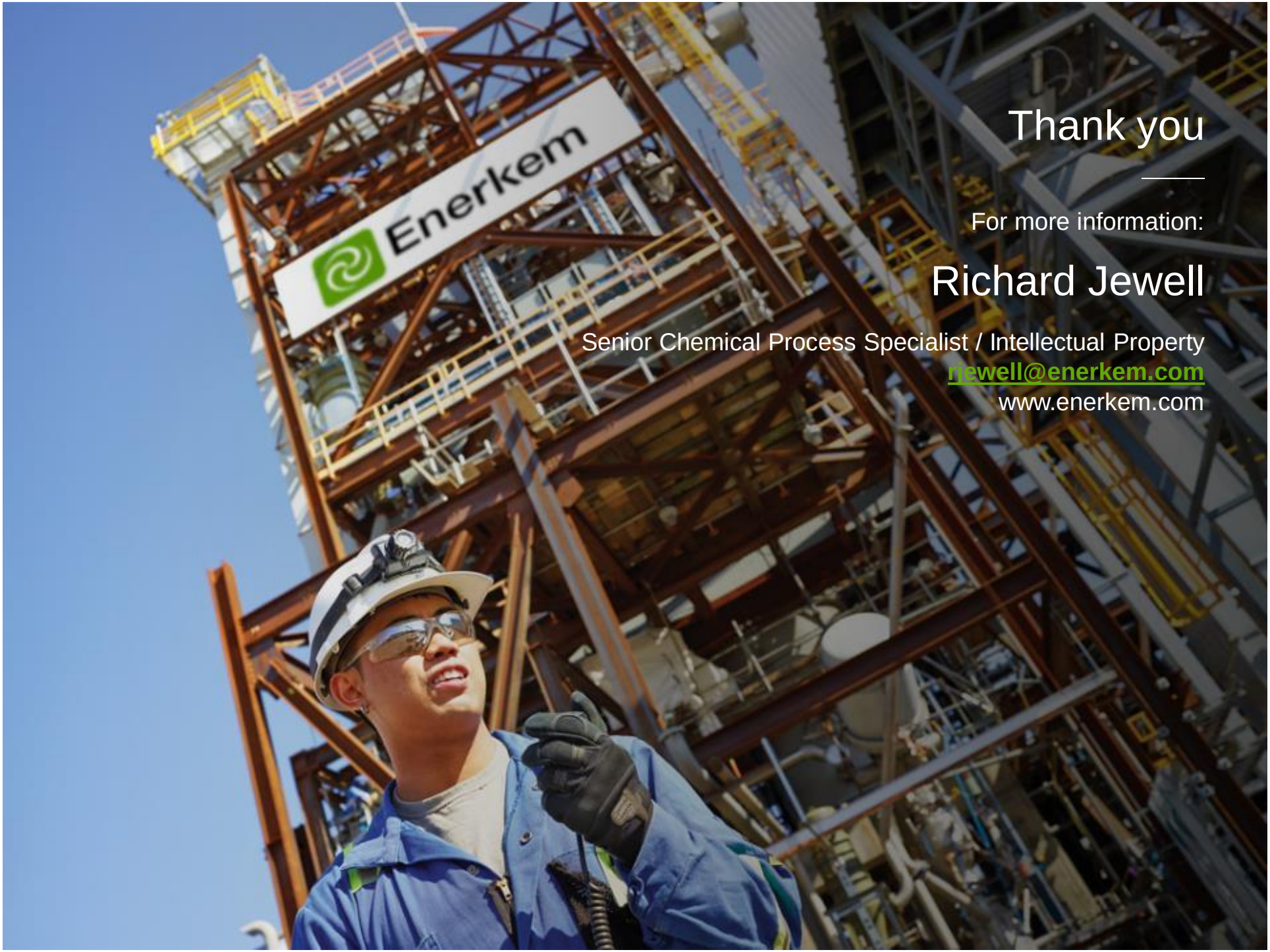
Enerkem

Next facility: VANERCO

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

Capacity: 38 million litres
(1 standard Enerkem system → possibility to add more systems)

Feedstock: Non-recyclable/non-compostable urban waste
(industrial, commercial, institutional, construction, etc.)



Thank you

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