# THERMAL TREATMENT SUMMIT:
# Technology for Resource Recovery Renew NS

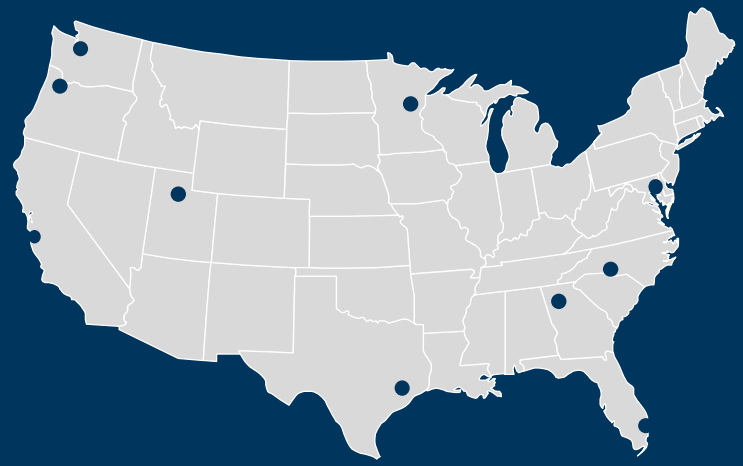
14 May, 2019

MORRISON HERSHFIELD

# Introduction: Konrad Fichtner, P. Eng.

- Senior professional with over 30 years' solid waste experience.
- Leads Global Waste Practice at Morrison Hershfield.
- Experience across Canada and internationally.
- Specializations:
  - Waste-to-energy.
  - Organics management, composting, anaerobic digestion.
  - Waste processing, recycling.
  - Integrated systems and planning.

Canadian Office Locations



USA Office Locations

India Office Location

# ABOUT MORRISON HERSHFIELD

- Employee-owned firm with 1000+ staff and annual revenues over $150M.
- Focused on our people, culture and capabilities to provide highly specialized multidisciplinary engineering solutions.
- North America based with international reach.
- Over 70 years of success as a market-orientated, client-focused firm.
- With 90% of our revenue from repeat business, we focus on relationships.
- **Mission:** To be the first call for engineering solutions that make a difference.

# What We Will Talk About Today

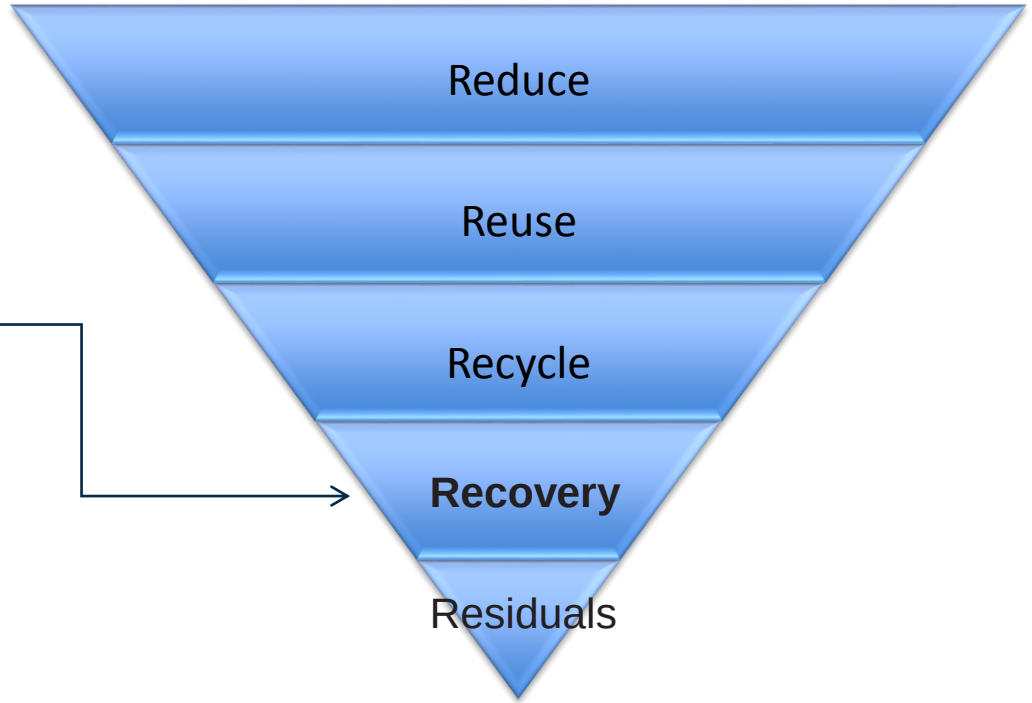
- The role of waste-to-energy (WTE).
- How WTE works.
- What does it cost?
- Environmental and health impacts.
- Issues to be aware of.
- Common myths.
- Questions and discussion.

# Objective: Waste-to-Energy Overview

- **Thermal Systems**
  - Thermal treatment or conditioning.
  - Conversion technologies.
  - Mass burn combustion.
  - Gasification; pyrolysis.
- **Biological Systems**
  - Anaerobic digestion.
  - Landfill gas recovery.
- **Waste to Fuels**
  - Refuse-derived fuel.
  - Bio-drying.
  - Hydrothermal carbonization (HTC).

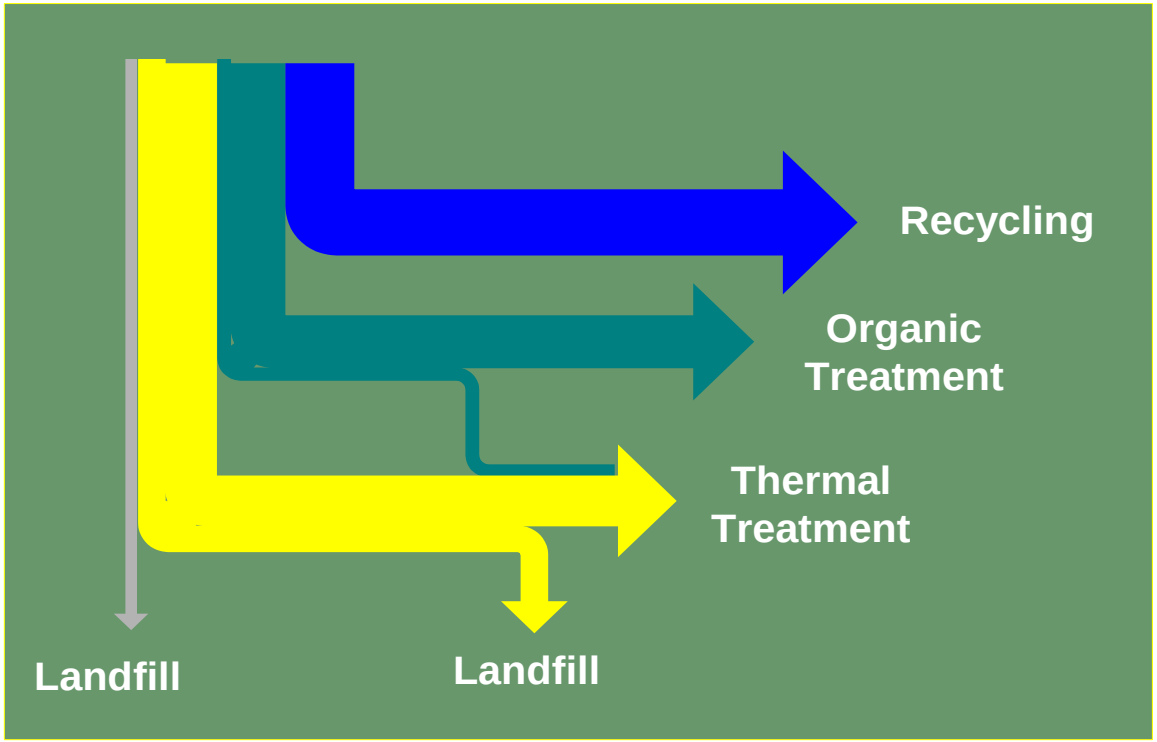
# Where Does WTE Fit In?

- **4th R** - Recovery of energy and materials after the first 3Rs, prior to disposal

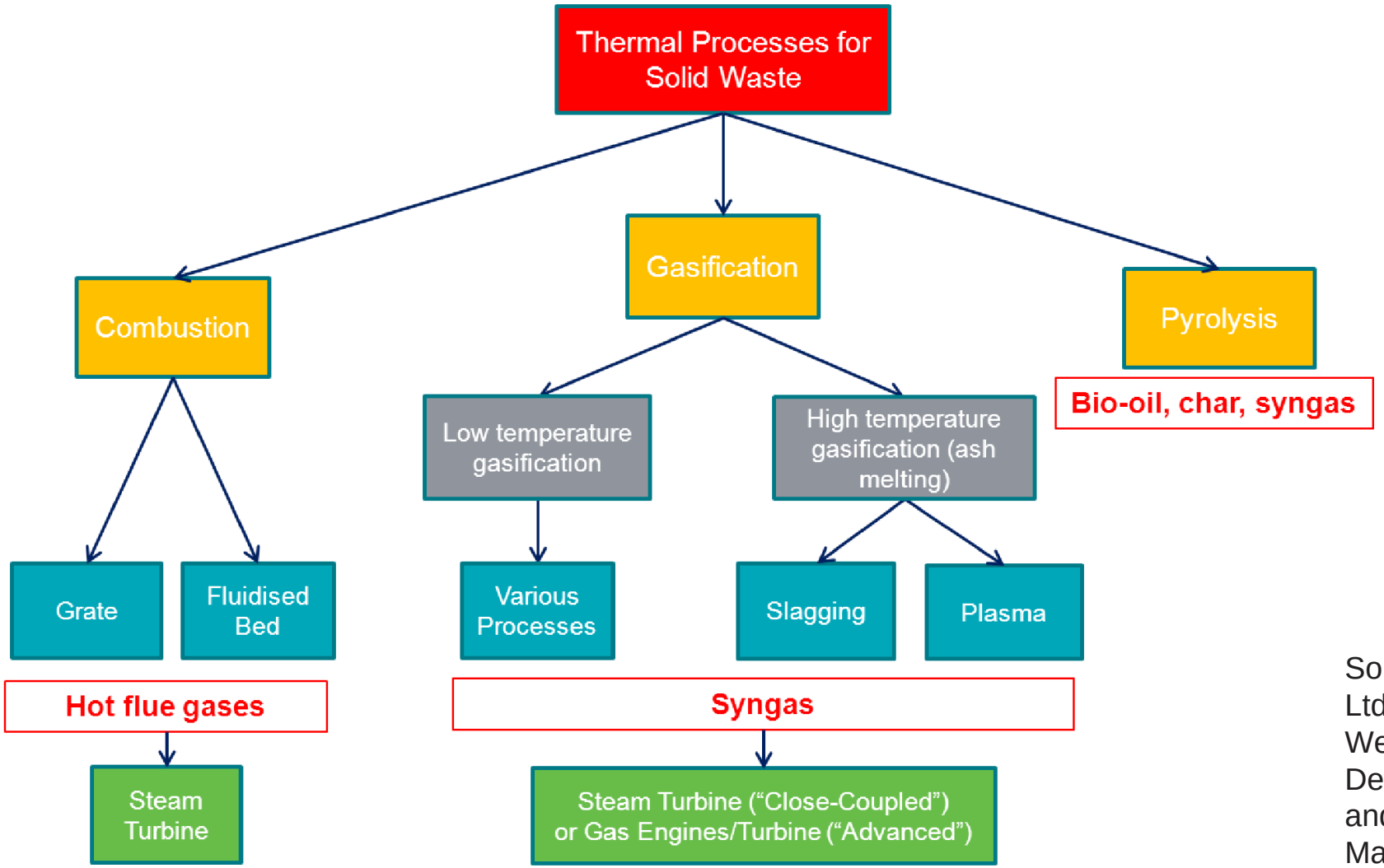


# The Role of WTE in an Integrated System

- With recycling and organics treatment:



# Thermal WTE Technologies




Source: WSP Environmental Ltd for the Government of Western Australia, Department of Environment and Conservation
May 2013

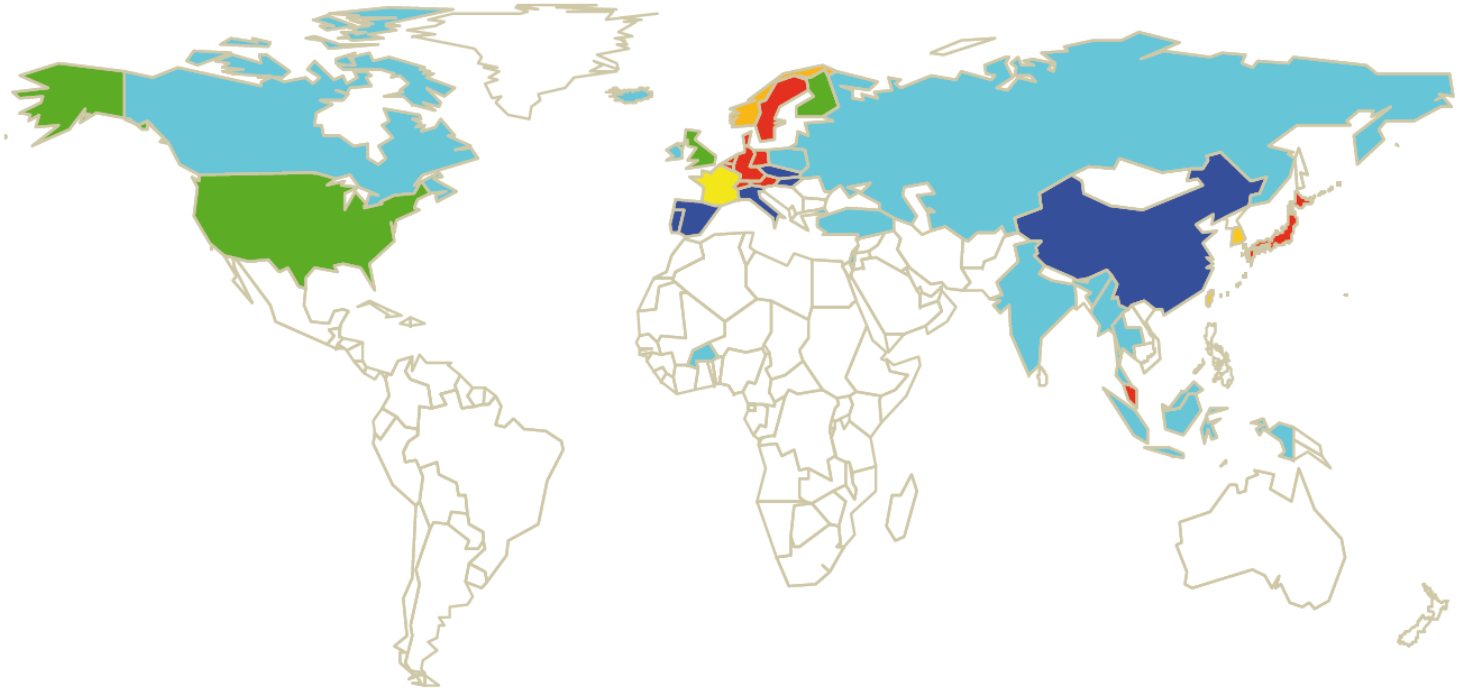
# How Thermal WTE Works

- Technologies offer different ways of releasing the energy in the waste.
- Conventional WTE systems are essentially power plants that use waste as fuel instead of natural gas, coal or wood.
- Advanced WTE systems use heat to convert the energy in the waste into a gas that can be burned for power or converted to fuel (for burning).

# Waste-to-Energy Facilities

- In Canada, 5 major facilities.
- In USA, 75.
- In Europe, 492.

Source:IEA Bioenergy https://www.ieabioenergy.com/wp-content/uploads/2014/03/ExCo71-Waste-to-Energy-Summary-and-Conclusions-28.03.14.pdf



Distribution of waste incineration in percentage of residual waste after recycling

# Burnaby, BC, Mass Burn Facility

- Operational since 1988.
- 280,000 tonnes per year.
- Numerous environmental upgrades.
- Meets all air emission standards.
- Recent operational issues with fly ash (resolved).

# York Durham WTE

- Newest WTE plant in Canada - started operations in 2016.
- Mass burn technology.
- Capacity: 140,000 tonnes per year, upgrading to 160,000.
- Ultimate Capacity: 400,000 tonnes per year.

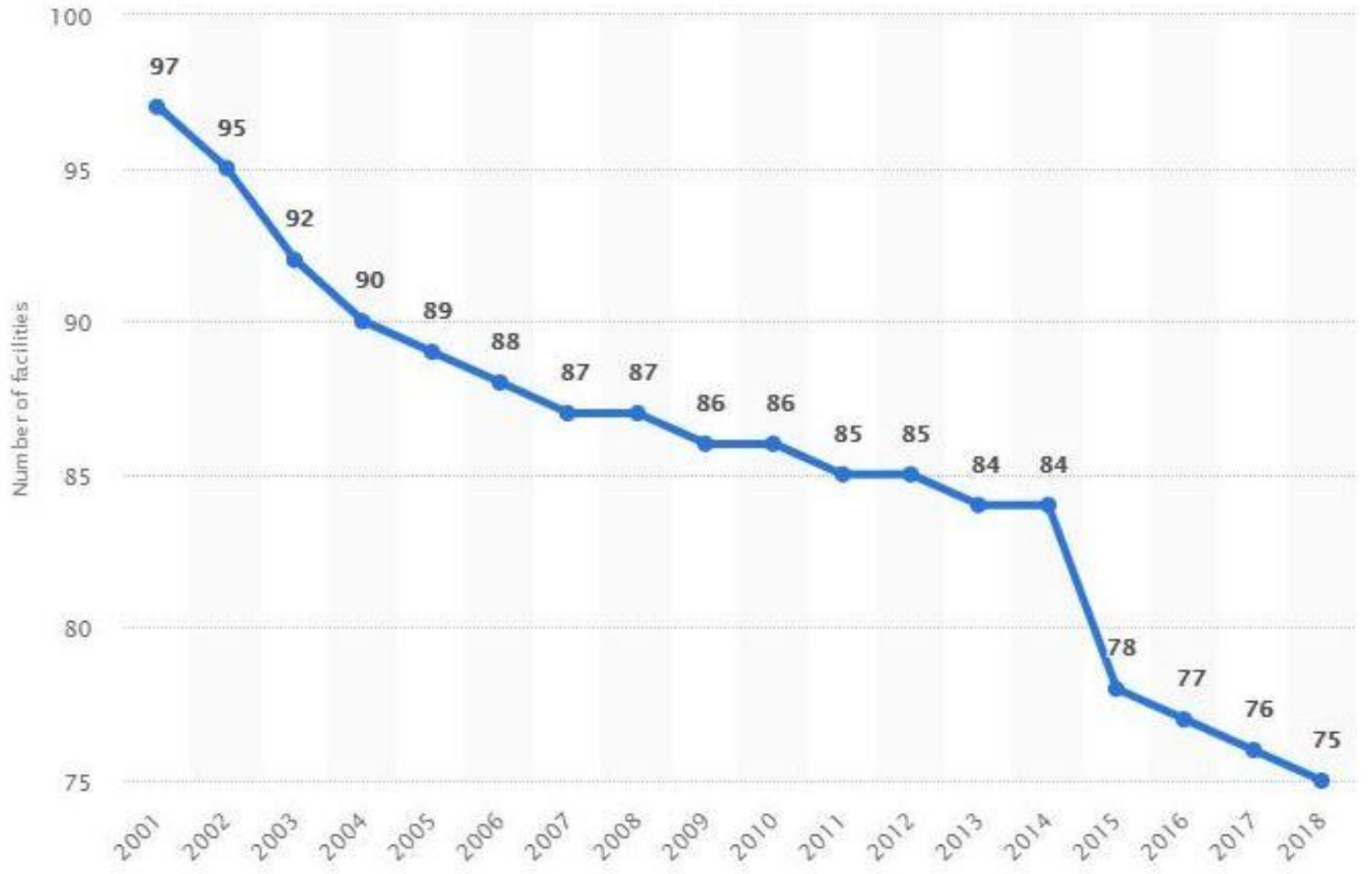
# Wainwright, AB, WTE

- Built as demonstration facility in 1995.
- 10,000 Tonnes per year.
- Energy recovery steam for nearby canola plant.
- Burns MSW and medical waste.
- Recently shut down.

# Other WTE Facilities in Canada

- **Region of Peel**: privately owned and operated facility; 180,000 tonnes per year (electricity).
- **Quebec City (Ville de Quebec):** 300,000 tonnes per year (steam for industrial uses, district energy being considered).
- **PEI:** operations began in 1983; currently 25,000 tonnes per year MSW and wood (steam and hot water for district heating), being expanded to about 50,000 tonnes per year plus improvements to air pollution control system.

# Facilities in USA



# Facilities in Europe

## Waste-to-Energy in Europe in 2017

- WtE Plants operating in Europe (not including hazardous waste incineration plants) : **492**
- Waste thermally treated in WtE plants (in million tonnes): **96**

Data supplied by CEWEP members and national sources

* Includes plant in Andorra and SAICA plant

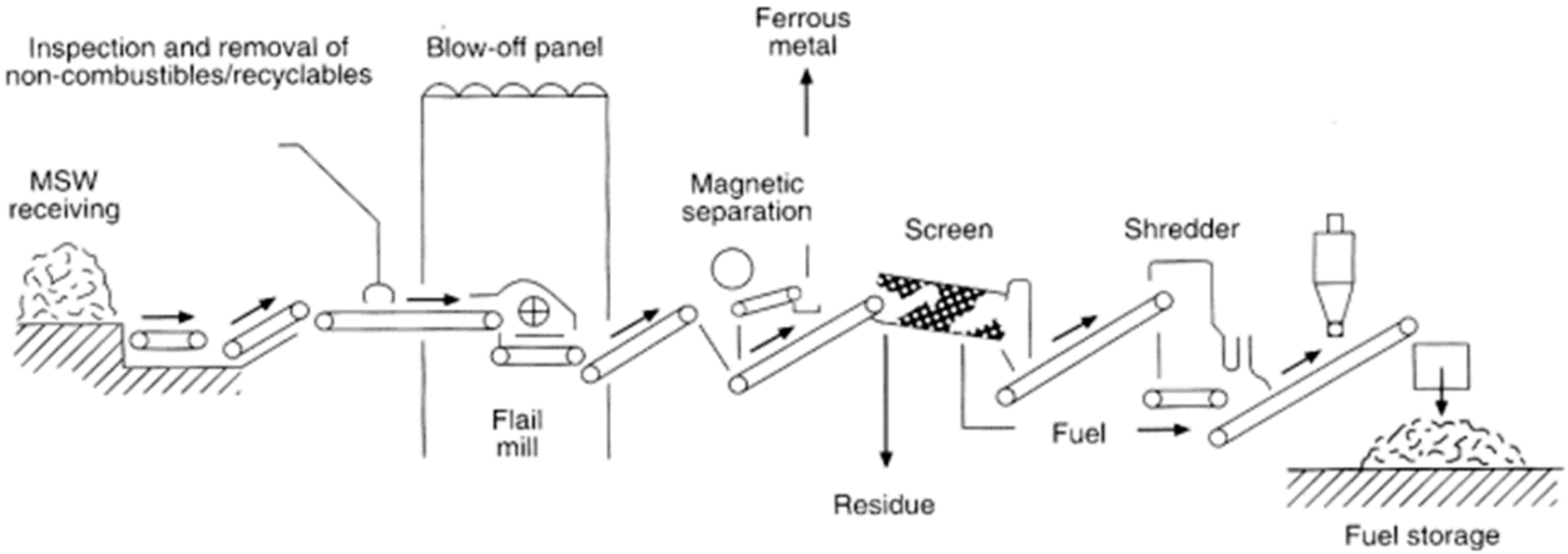
CEWEP Confederation of European Waste-to-Energy Plants

# Gasification

- Plant in Edmonton.
- Compost residuals to Methanol.
- 100,000 tonnes per year.
- Operation intermittent.
- Commissioning since 2012.
- Final product ethanol.

# Refuse-Derived Fuel (RDF)

- Mechanical process to prepare waste for burning by third party.
- Dry RDF can be fluff or pellets; can be stored and transported.



# Bio-Drying

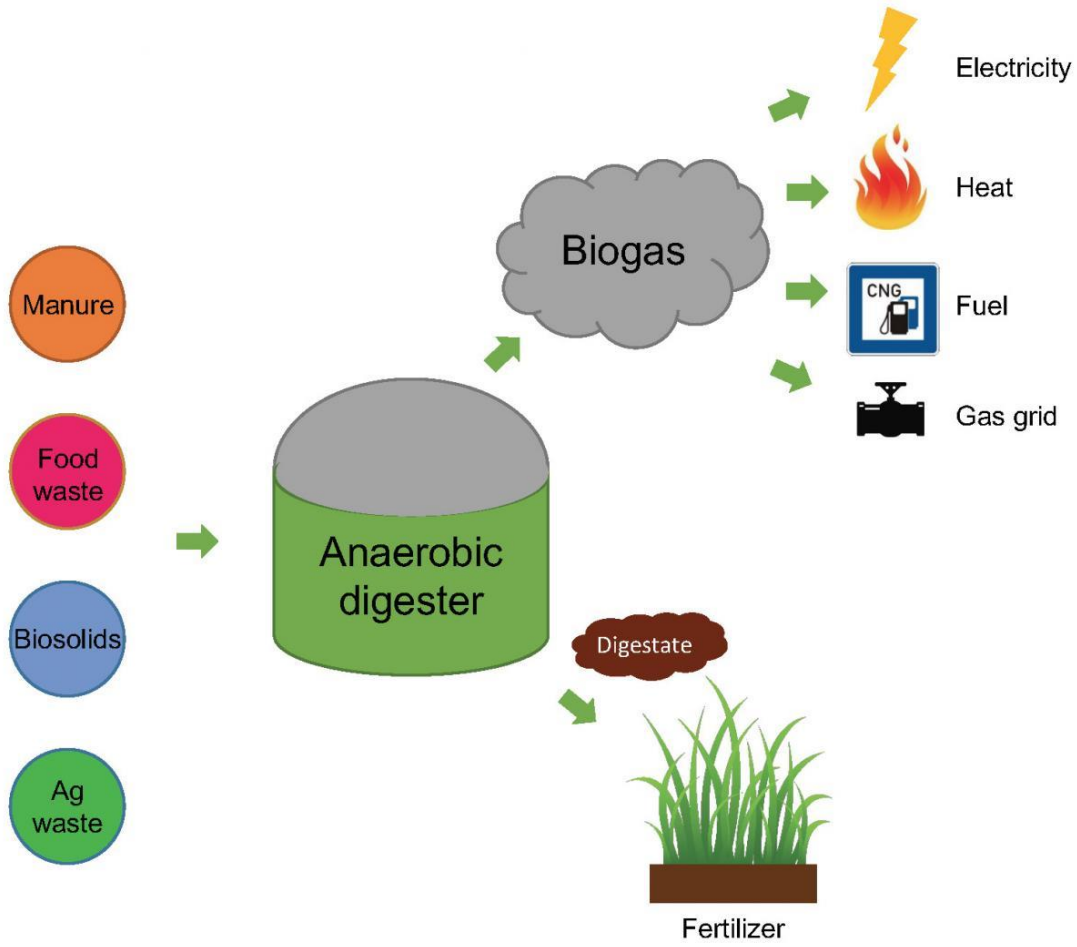
- Applicable for organic materials only.
- Naturally occurring heat during aerobic decomposition is used for drying (similar to composting).
- Makes a dry biogenic alternate solid fuel (can displace wood or coal in industrial facilities).

# Hydrothermal Carbonization (HTC)

- Mimics natural process of coal formation.
- Suitable for all forms of organic materials, including plastics, yard waste, food, biosolids, waste wood, non-recyclable paper, etc.
- Bio-coal has high heating value, high energy density, and can be stored and transported.
- First demonstration plants being built.
- Technology to watch.

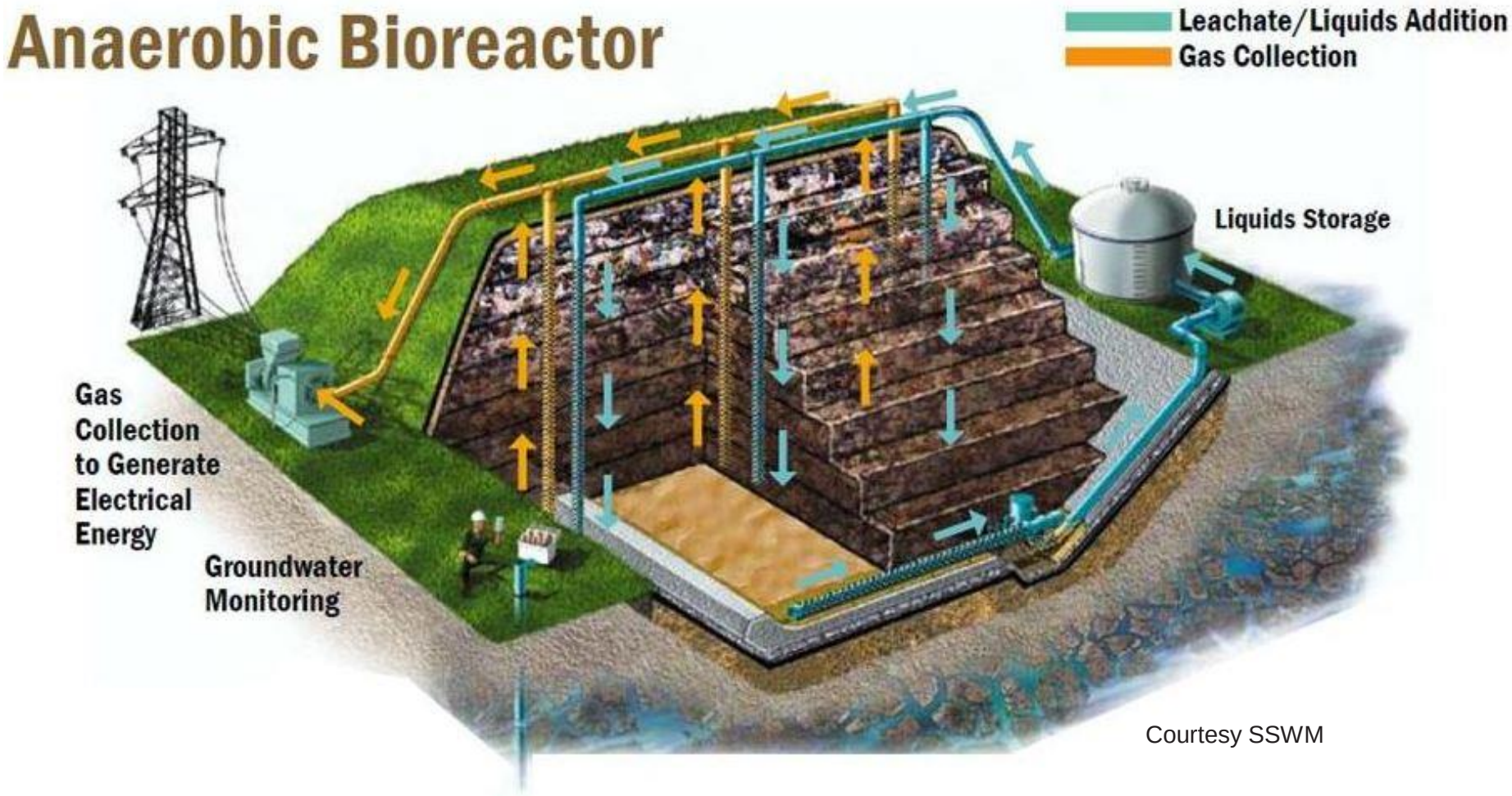
# Biological WTE

- Anaerobic Digestion (AD)
  - Bacteria degrade organics and form methane.
  - Methane is captured and cleaned.
  - Can be burned as fuel or
  - Upgraded to natural gas quality (to be used as fuel).



# Anaerobic Digestion Pictures

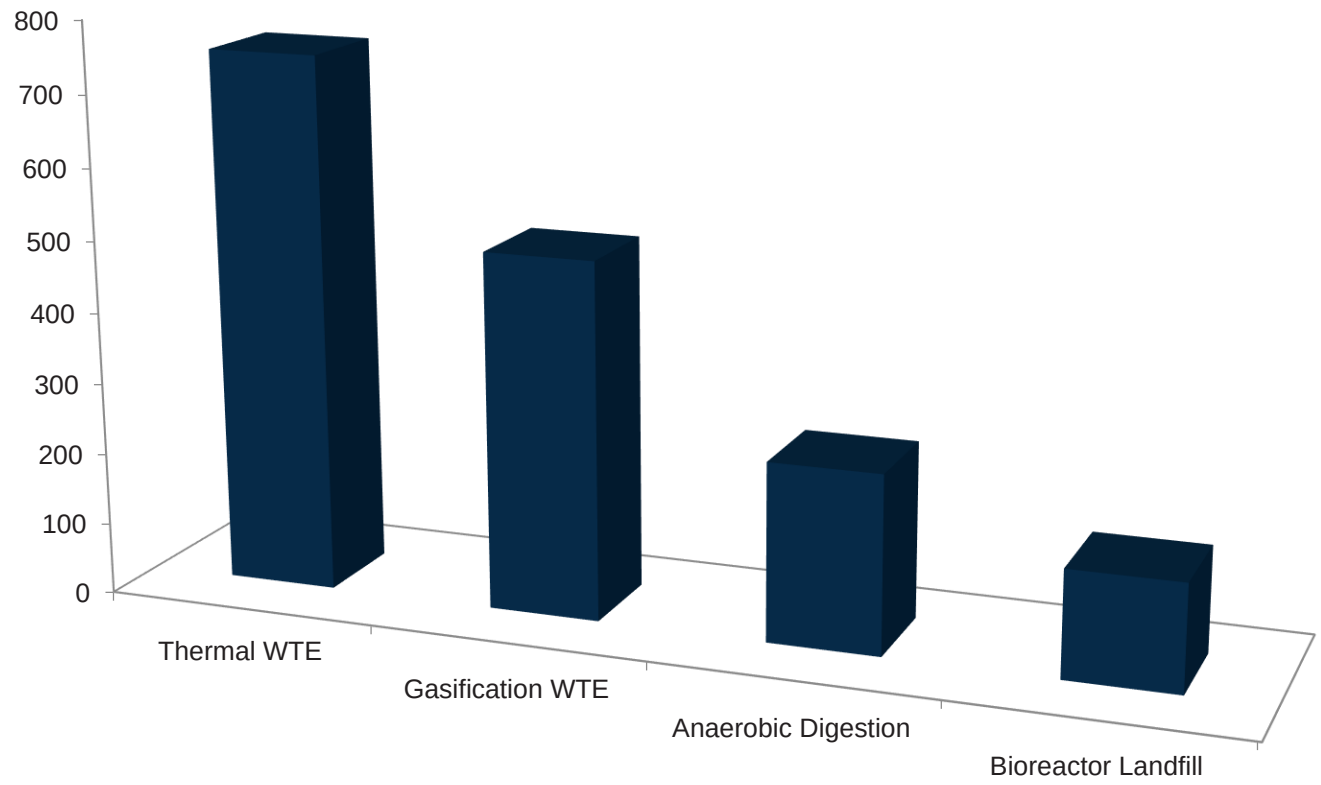
# Bioreactor Landfill




Courtesy SSWM

# Energy Comparison

Potential kWh per tonne of waste

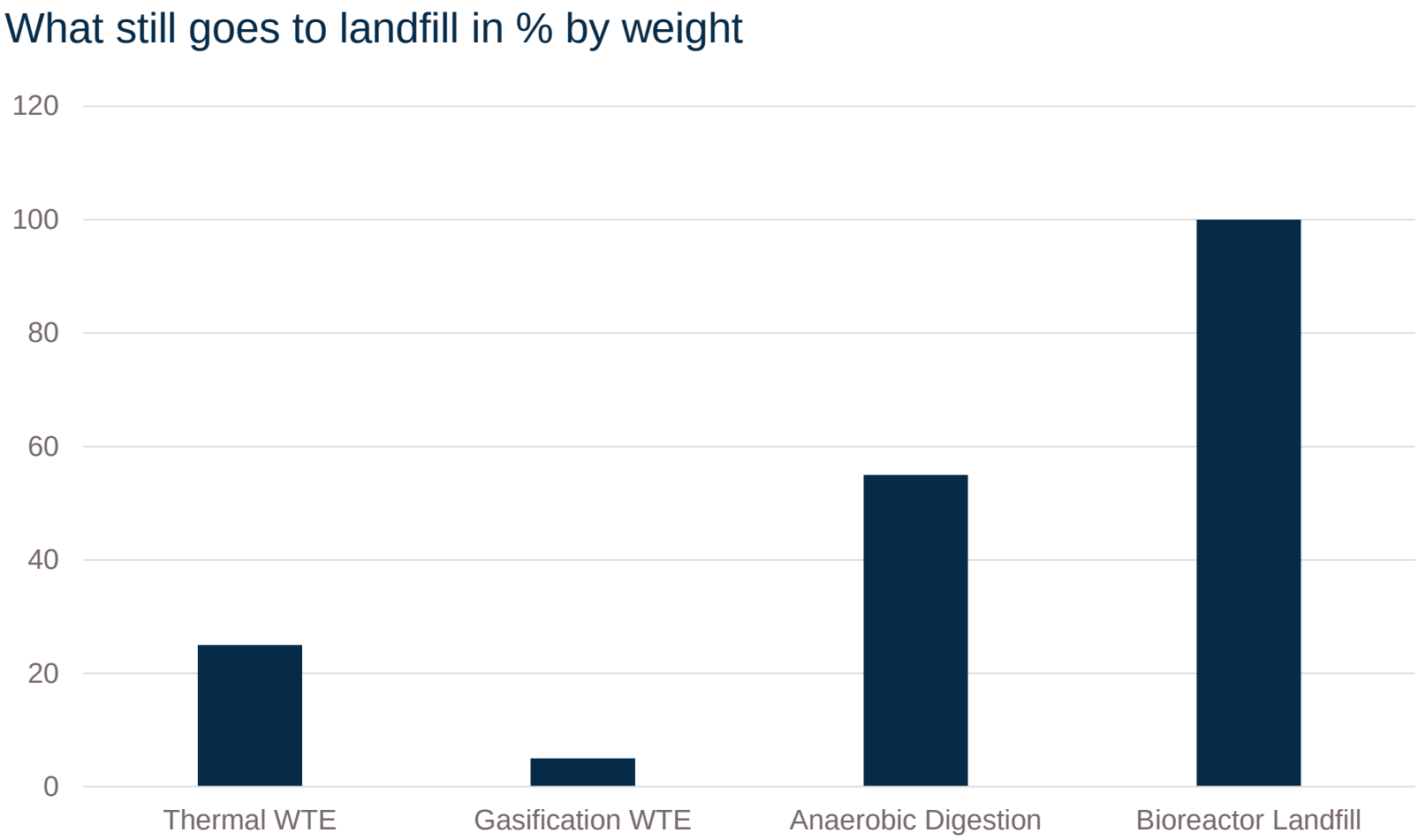


# Waste Diversion Potential

- **Thermal WTE**
- Takes 100% of residual waste after recycling.
  - 75% converted to energy.
  - 25% to landfill as ash by weight (10% to landfill by volume).

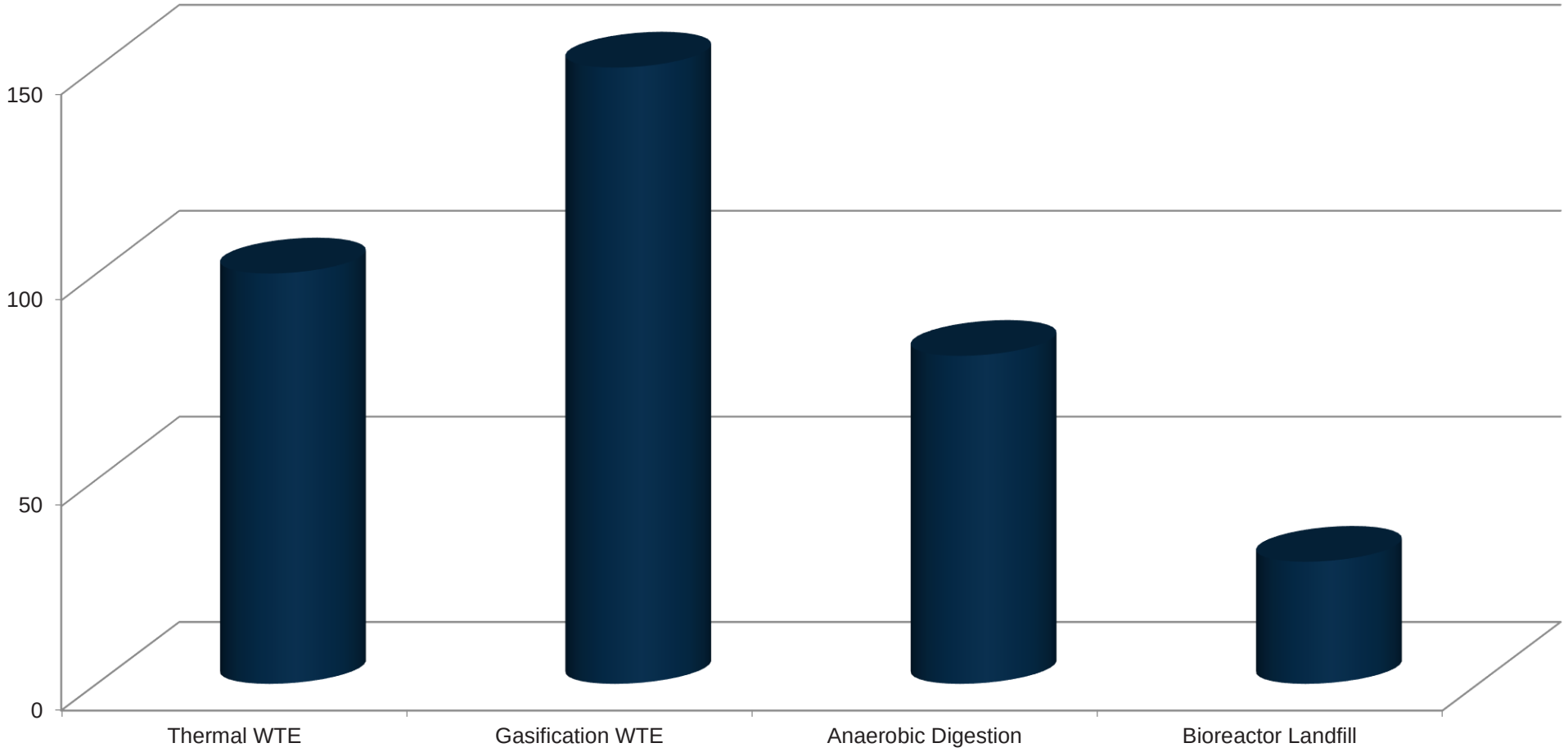
- **Biological WTE**
- Takes 35 – 40% of waste (organic portion).
  - 60% to 65% still goes to landfill.
  - About half of the diverted organics become compost.
  - The rest goes towards making energy.

# Landfill Reduction

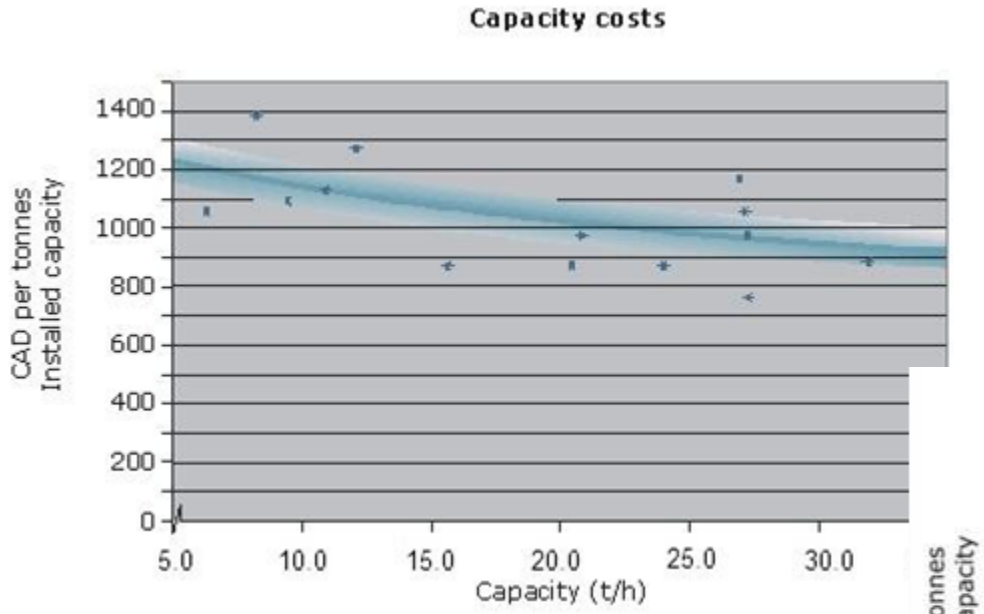


# Cost Comparison, Capital and Operating

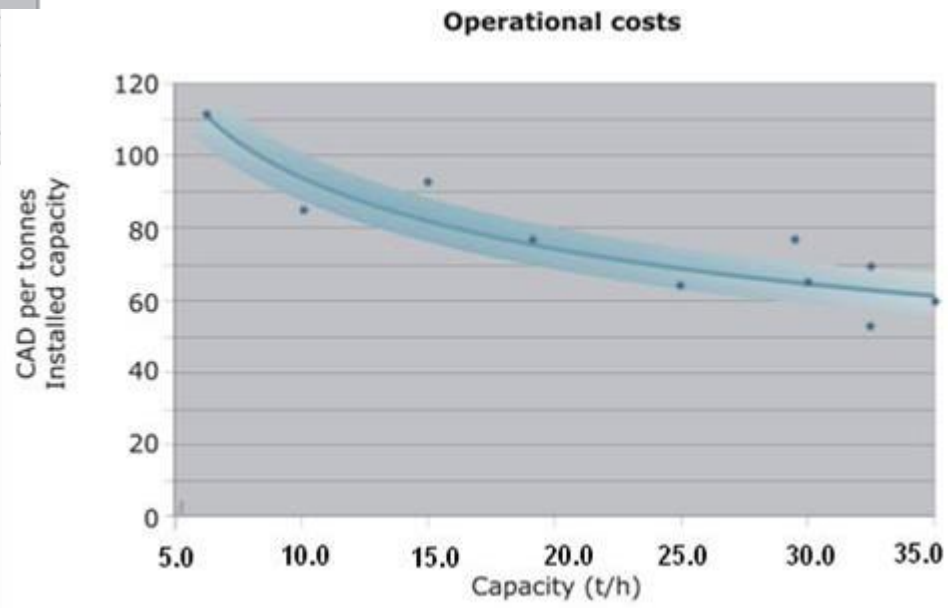
$ per tonne comparative estimates, including capital repayment and revenues from the sale of energy



# Economies of Scale for Thermal WTE




Courtesy Ramboll (developed for York – Durham)



# Environmental Issues

- Air Emissions
  - Emission standards more stringent than for most wood-fired power plants or industrial boilers.
  - In Europe, air emissions from WTE considered irrelevant compared to industry and transportation.
- Residues from Thermal Systems
  - Bottom ash generally safe to dispose in landfill or use as cover.
  - Fly ash (5%) needs to be stabilized before landfilling.
- AD residue is compost, which can be land-applied.

# Recent Health Risk Study Durham/York, ON

- Conclusion from Durham's Extensive Human Health and Ecological Risk Assessments. (Paper Published in 2013)

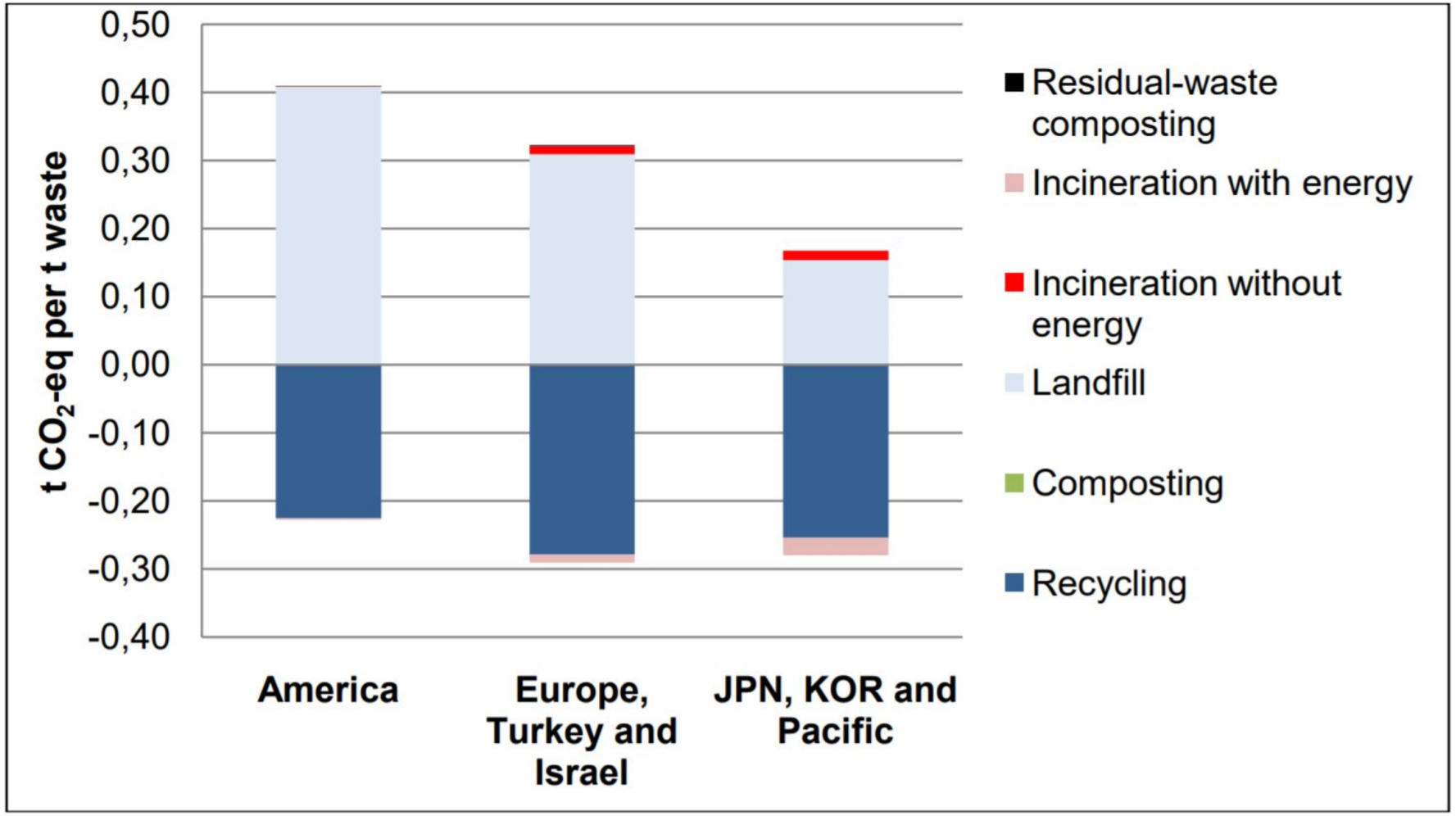
  http://www.sciencedirect.com/science/article/pii/S0048969713007869

- Extensive human health and ecological risk assessments (HHRA and ERA, respectively) were undertaken. Overall, results of the ERA indicated that chemical emissions from the proposed EFW facility would not lead to any unacceptable risks to ecological receptors in the local risk assessment study area under either the initial operating design capacity of 140,000 tonnes per year or the maximum design capacity of 400,000 tonnes per year.

# Studies (UK and Spain)

- Brief Summary of Imperial College (UK) study (2013) Main conclusion: Most importantly, the authors conclude that the modeled PM10 impacts of both facilities were “extremely low”, in fact, so low that it would not be possible to validate the modeling because the concentrations are below the limit of detection for ambient air measurements. *The authors focused on two WTE plants in the UK .*
- Long-term monitoring of dioxins and furans near a municipal solid waste incinerator: human health risks (Tarragona, Spain). http://wmr.sagepub.com/content/30/9/908.full.pdf showed that the facility “… does not produce additional health risks for the population living nearby.

# Technology Contribution to GHG




Source: The Climate Change Mitigation Potential of the Waste Sector, German Federal Environmental Agency, 2015

# Issues When Considering WTE

- Feedstock Supply
  - How much feedstock can be guaranteed for 20 years?
  - What quality of feedstock (composition of waste) is expected?
- Maturity of Technology
  - Full-scale (same as proposed) commercial operating plants?
  - Can these plants be visited?
- Risk
  - If new technology, appetite for risk?
  - Work with qualified specialists to assess and quantify risk.
- Financing
  - Is the business case solid for bank financing?
  - Other financing and costs?

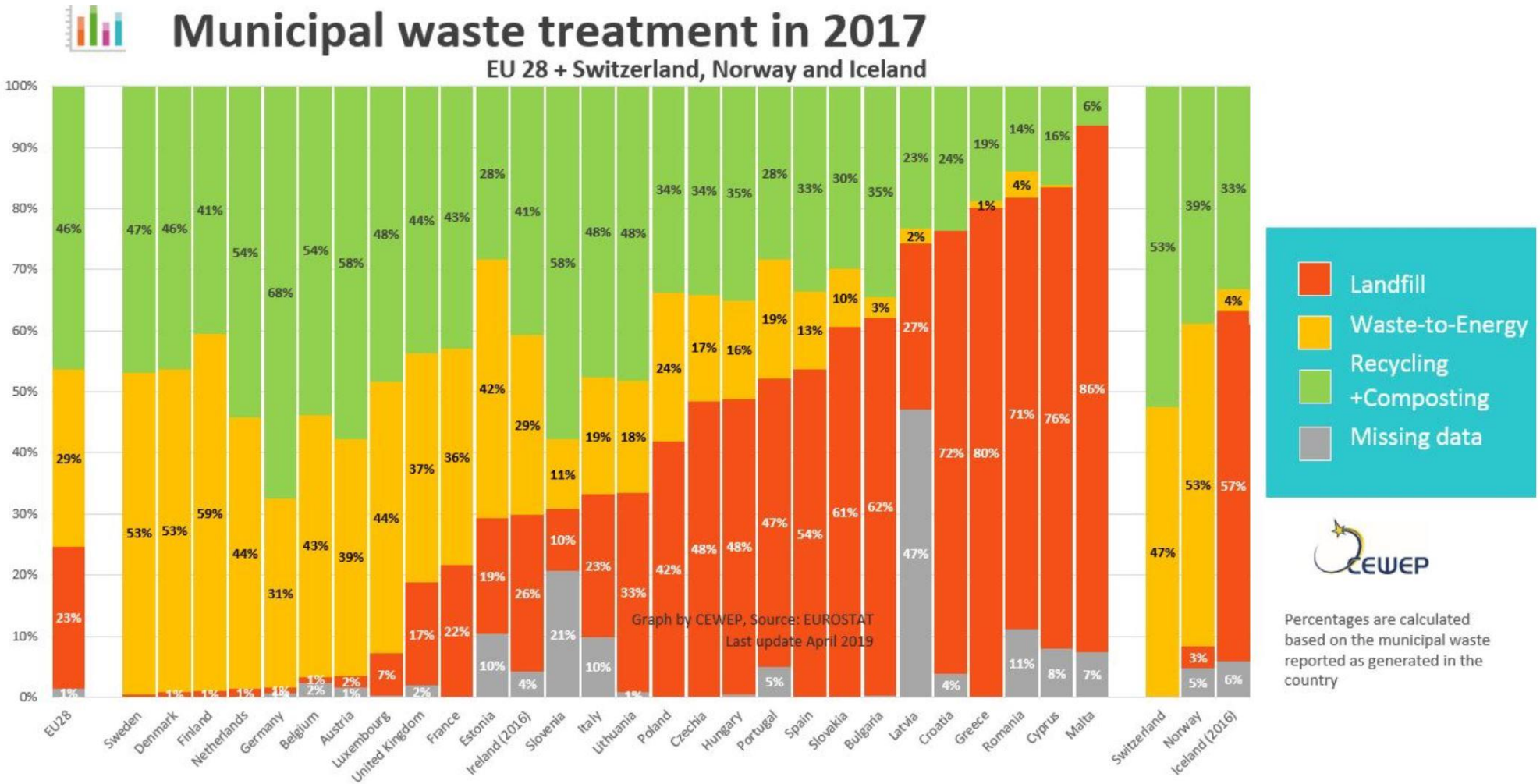
# More Issues When Considering WTE

- Site
  - Has a suitable site been selected?
  - Is it strategically located (utilities, roads, etc.)?
- Permits
  - Will the facility likely be permitted?
  - Will the chosen technology meet all environmental requirements?
  - Identify barriers.
- Public Acceptance
  - How will a WTE facility be received locally?
- Offtake Agreements
  - Can the power and heat be sold with long term agreements?

# Myths – True or False

- Thermal WTE has no future.
  - **False**: there are 800 plants worldwide and over 400 in Europe, with many new ones on the way.
  - But: newer more specialized technologies in the future.
- WTE will eliminate the need for landfills.
  - **False**: landfills will be needed for ash, for downtime, and to handle growth.
- Thermal WTE will reduce recycling.
  - **False**: those countries with the highest WTE also have the highest recycling.

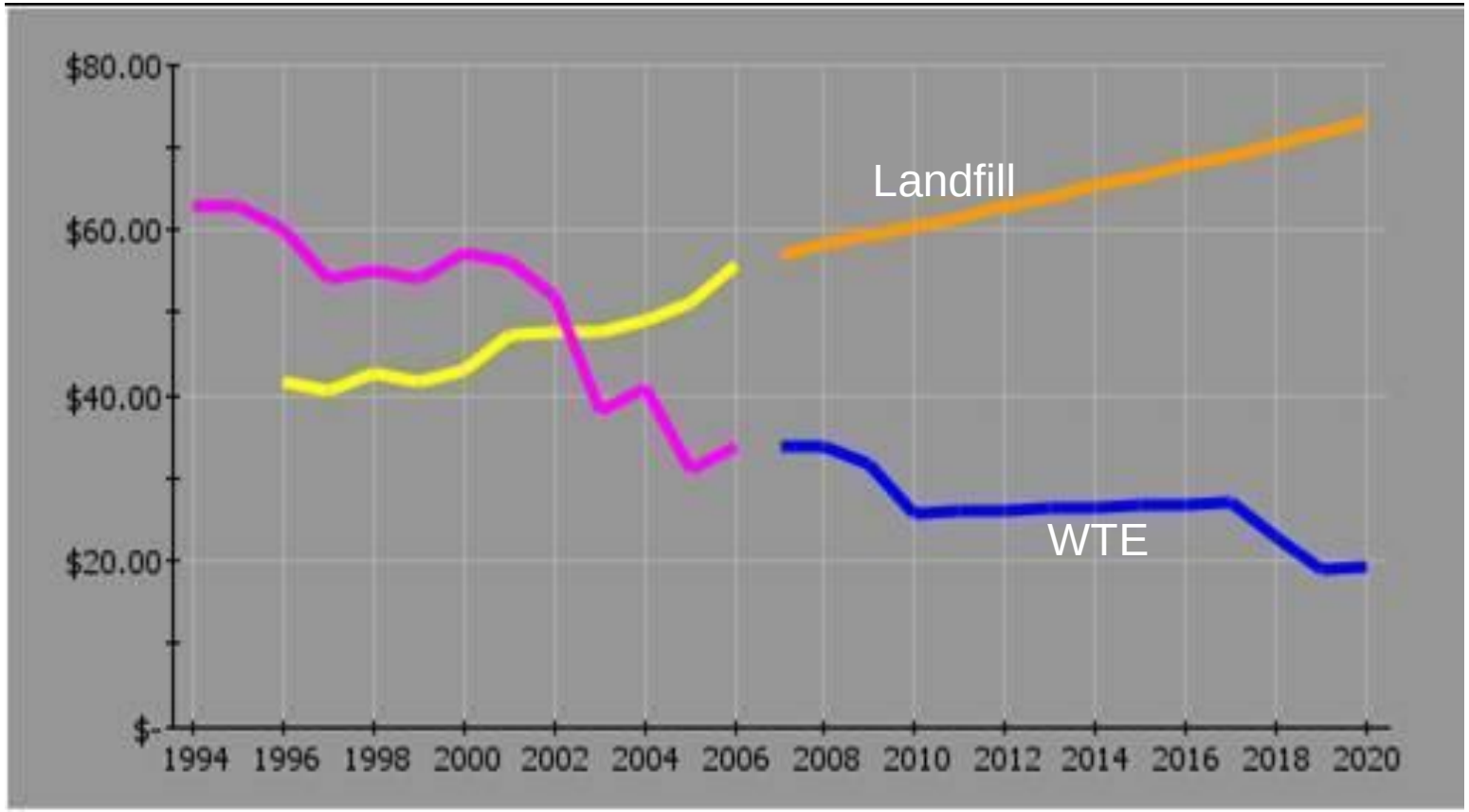
# Does WTE Reduce Recycling?



# Myths (continued 2)

- Revenues from WTE can pay for everything and put money back into the community.
  - **False**: Capital and operating costs are too high to be fully offset by energy revenues.
- WTE systems always cost more than landfills.
  - **False**: While often true where landfill costs are low, there are cases where it can make financial sense (see graph in next slide).

# Long-term WTE Costs Versus Landfill



# Myths (continued 3)

- Emerging technologies carry a high risk.
  - **True**: Many promises are made, but most cannot deliver.
- Burning waste can cause health issues.
  - **False**: Modern MACT (Maximum Available Control Technology) systems have not been linked to health issues.

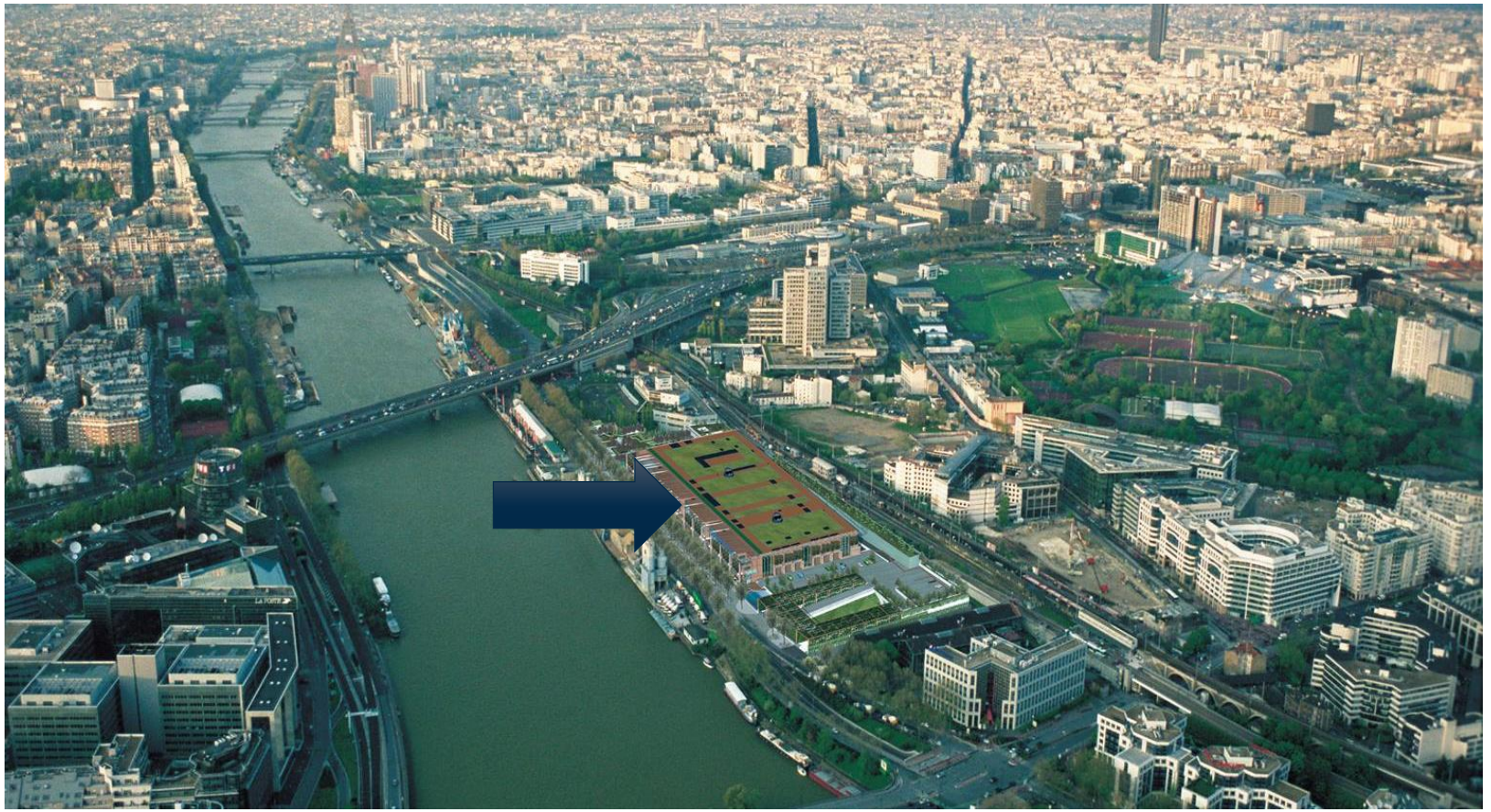
***Note:*** Older facilities that do not meet MACT or facilities not properly operated and monitored may need to be upgraded to protect environment and public health.

# Myths (continued 4)

- WTE is too expensive for smaller communities:
  - **True**: In most cases, maximized recycling and landfill will be less costly (if landfill capacity is available).
- AD is growing worldwide and pays for itself:
  - **False**: AD plant construction in Germany has slowed dramatically because subsidies have been reduced.
- Low energy prices hurt WTE projects.
  - **True**: Even large-scale plants need good energy revenues to keep tipping fees reasonable.

# Myths (continued 5)

- WTE facilities will never be sited anywhere close to anyone.
  - **False**: see location of WTE plant in downtown Paris.



# THANK YOU!


Konrad Fichtner, P. Eng.

604 617 6727

kfichtner@morrisonhershfield.com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