New York State Association for Solid Waste Management

NYSASWM 2023 Fall Conference

Advances in Waste Conversion Technologies and Regulatory Updates

HDR

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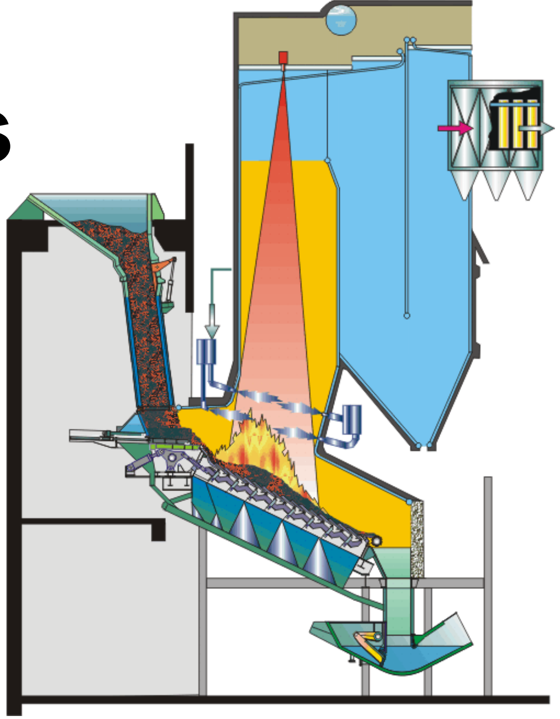
Technology Overview

- Thermal Conversion
- Biological Conversion
- Mechanical Processing
- Chemical Conversion

Thermal Conversion Technologies

- **Definition:** A process that uses high temperatures and/or pressure to convert biomass or carbonaceous materials into a gas and other solid/liquid by-products.
- **Technology Classes:**
  - Combustion/Incineration
  - Gasification
  - Pyrolysis
- **Technology Types:**
  - Mass burn combustion
  - Modular combustion
  - Fluidized bed gasification
  - Plasma arc gasification



Mass Burn Combustion Stoker Grate

Plasma Arc Gasifier


Aerobic Windrow Composting


Anaerobic Digestor Vessel (Toronto)

Biological Conversion Technologies

Definition: A process that convert the biogenic (derived from plants or animals) fraction of the waste stream through decomposition through the use of microbes.

Technology Classes:

- Aerobic
- Anaerobic

Technology Types:

- Composting
- Anaerobic Digestors (dry, wet, co-digestion)
- Aerobic Digestion

Mixed Waste Processing/"Dirty" MRF (Western Placer, CA)

Solid Recovered Fuel Facility (Sweden)

Mechanical Processing Technologies

Definition: A process that mechanically separate various products (e.g. metals, plastics, etc.) from the waste stream while reducing (shreds) the size of the remaining waste materials.

Technology Classes:

- Mixed Waste Processing
- Refuse Derived & Solid Recovered Fuel (RDF/SRF)
- Steam Classification

Technology Types:

- Duel and Single-Stream MRFs
- "Dirty" MRFs
- Mechanical Biological Treatment
- Autoclave

Fiberight Hydrolysis Facility, Hampden, Maine

Agilyx Waste-to-Fuel Facility (Oregon, USA)

Chemical Conversion Technologies

- **Definition:** A process that uses one or a series of chemical reactions to convert the organic fraction of waste into reusable by-products or chemicals.

Technology Class(es):

- Acid and Thermal Hydrolysis
- Catalytic Depolymerization

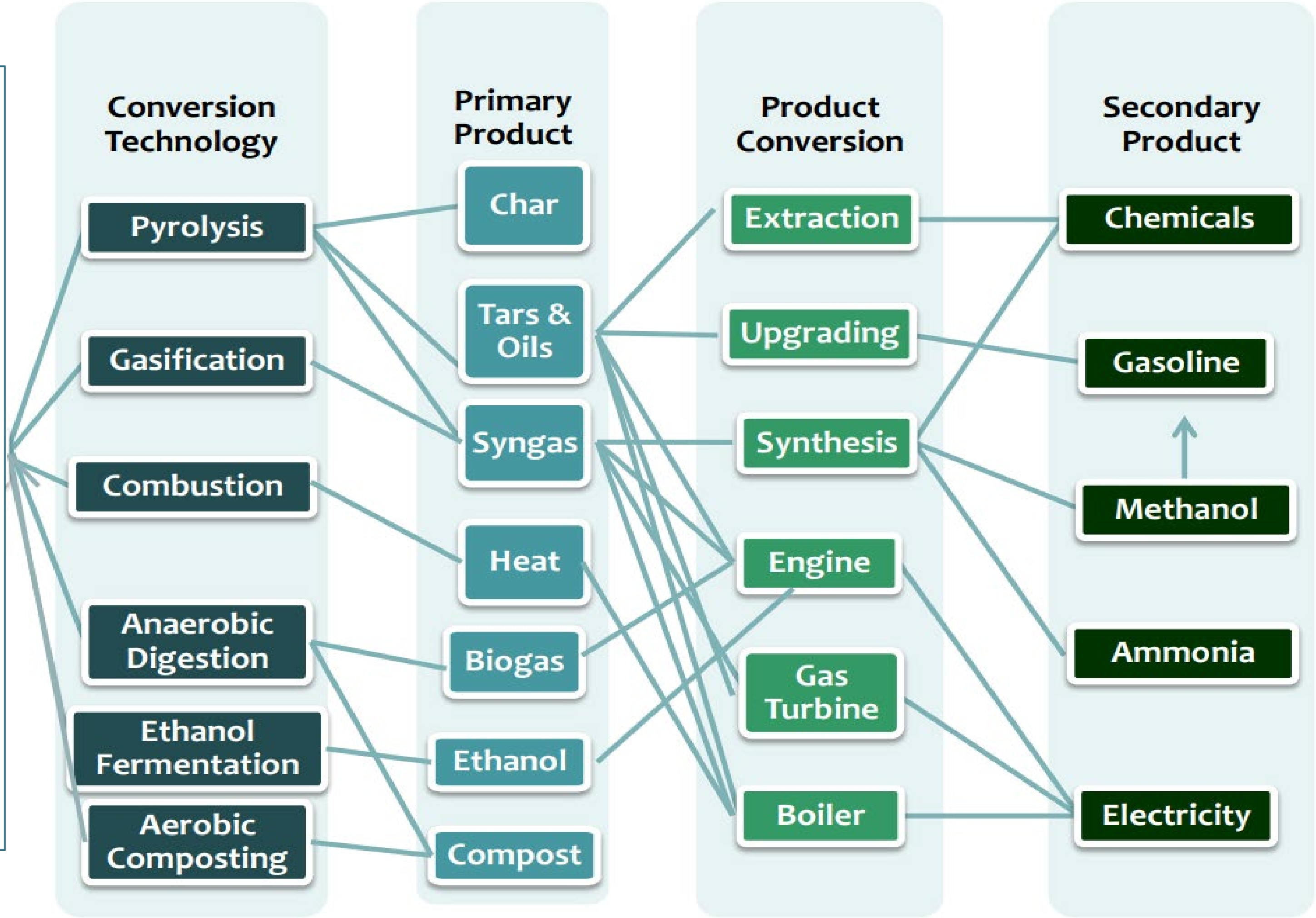
Technology Types:

- Waste-to-Fuel
- Plastics-to-Fuel

Waste Conversion Technologies & Outputs

FEEDSTOCKS

- Residual MSW
- Biosolids
- Biomass (woody wastes
- Plastics
- Food Waste



Technology Class	Technology Types	Pros/Cons
Thermal Technologies	• Combustion/Incineration • Gasification • Pyrolysis	• Pro: Flexible with most types of waste streams • Pro: Proven (particularly combustion) • Con: High CapEx and OpEx • Con: Low public acceptance
Biological Technologies	• Aerobic composting • Aerobic Digestion • Anaerobic Digestion	• Pro: Proven on biosolids and SSO • Pro: Wider public acceptance • Con: Only treats fraction of waste stream • Con: High CapEx and OpEx for AD – needs to be combined with other technologies
Mechanical Technologies	• Mixed Waste Processing • Refuse Derived & Solid Recovered Fuel (RDF/SRF) • Steam Classification	• Pro: Commercially proven technology • Pro: Wider public acceptance • Con: High CapEx and OpEx • Con: Only treats part of waste stream – needs to be combined with other technologies
Chemical Technologies	• Acid and Thermal Hydrolysis • Catalytic Depolmerization	• Pro: Proven on select organic wastes • Con: Limited commercial success • High CapEx and OpEx • Con: Only treats part of waste stream – needs to be combined with other technologies

State of U.S. Waste Conversion Industry

Thermal Technologies:

- 70 remaining operating conventional WTE Facilities in U.S.
- Several emerging technology pilot & commercial projects in development
- Increased regulatory and financial pressure causing closures & limiting new facilities

Biological Technologies:

- Composting is widespread
- Anaerobic Digestion facilities for food waste & co-digestion with biosolids

Mechanical Technologies

- MWP and RDF facilities have been developed with mixed success due to end market fluctuations

Chemical Technologies:

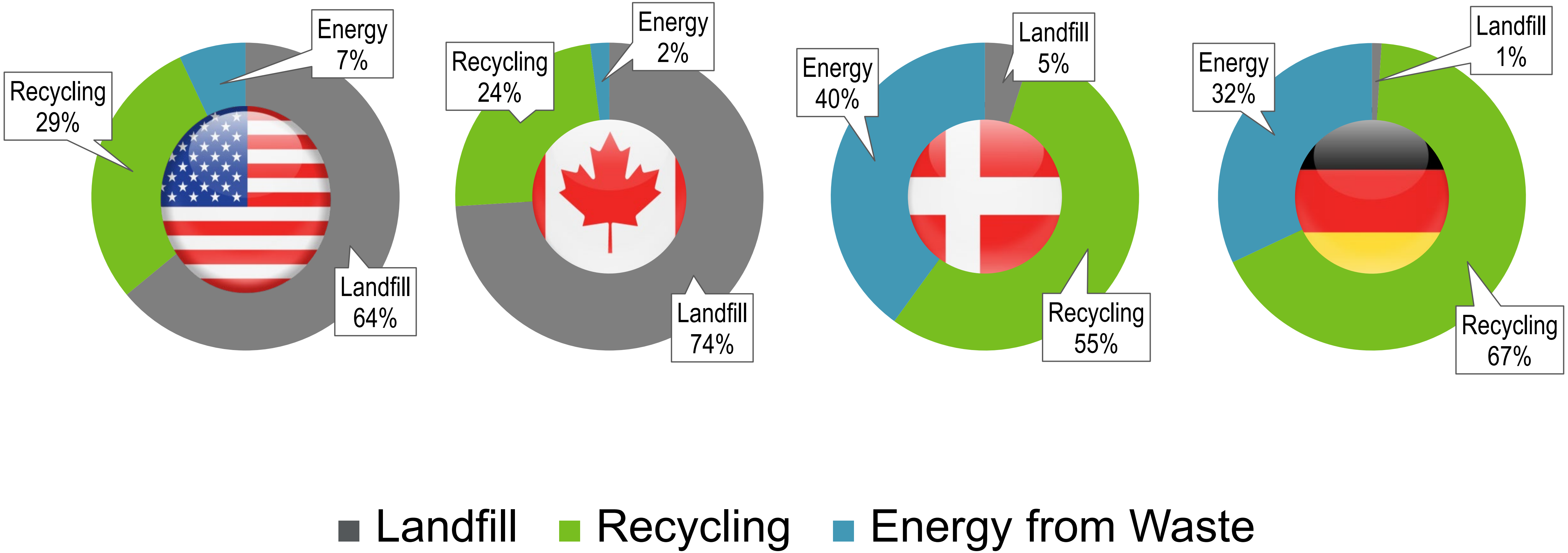
- Commercial facility development limited – Fiberight Facility shutdown with new buyer

Fulcrum Waste-to-Fuel, Sierra Biofuels Facility, Reno, Nevada

Challenges in US Market

- Drive for diversion from landfill but still a lot of available and relatively cheap capacity outside the Northeast
- High capital and operating costs for new waste technology development
- Lower pricing for recovered energy products – particularly for electricity
- Regulatory uncertainty and pressure on existing and new facility development – particularly in Northeastern U.S.
- Public acceptance is not favorable toward existing and any new waste technology capacity – particularly thermal technologies

The WTE Industry:
How the U.S. compares



State of Waste Technologies in Europe

- High energy pricing, government incentives, and landfill levees or bans
- 500 plus thermal conversion facilities EU-wide but there is also a lot of excess capacity – mostly mass burn
- Strict environmental and energy efficiency standards for WTE
- Post Brexit has increased new thermal facility development in the UK

Poolpeg Power Station, Dublin, Ireland

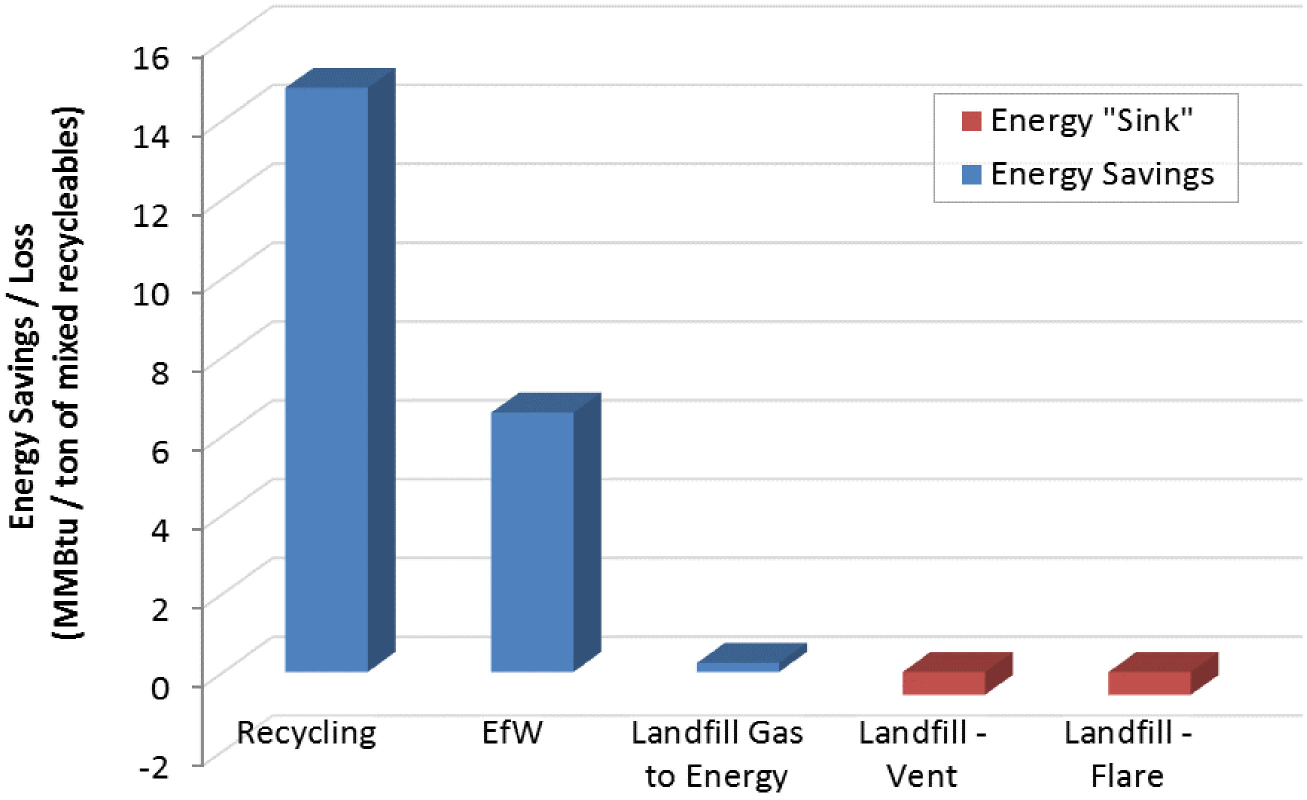
State of Waste Technologies in Asia

- Drivers include limited landfill capacity in Japan and Korea, plus increasing population density in Chinese cities
- Diversity in thermal technologies used in Asia – particularly in Japan, China, and Korea
- Reuse of all WTE by-products, including ash or slag, as construction aggregate
- Southeast Asia and the Pacific Rim are fast-growing markets for new waste conversion technologies

Groundbreaking Vietstar WTE Plant, Vietnam

Energy Recovery Improvements

- Higher efficiency boilers and improvements to steam cycle efficiency
- Reductions in in-plant (or "parasitic") loads
- Implementation of micro-grids and co-gen at some facilities



Source: U.S. EPA (2016) Waste Reduction Model, Version 14

Emission Reduction Improvements

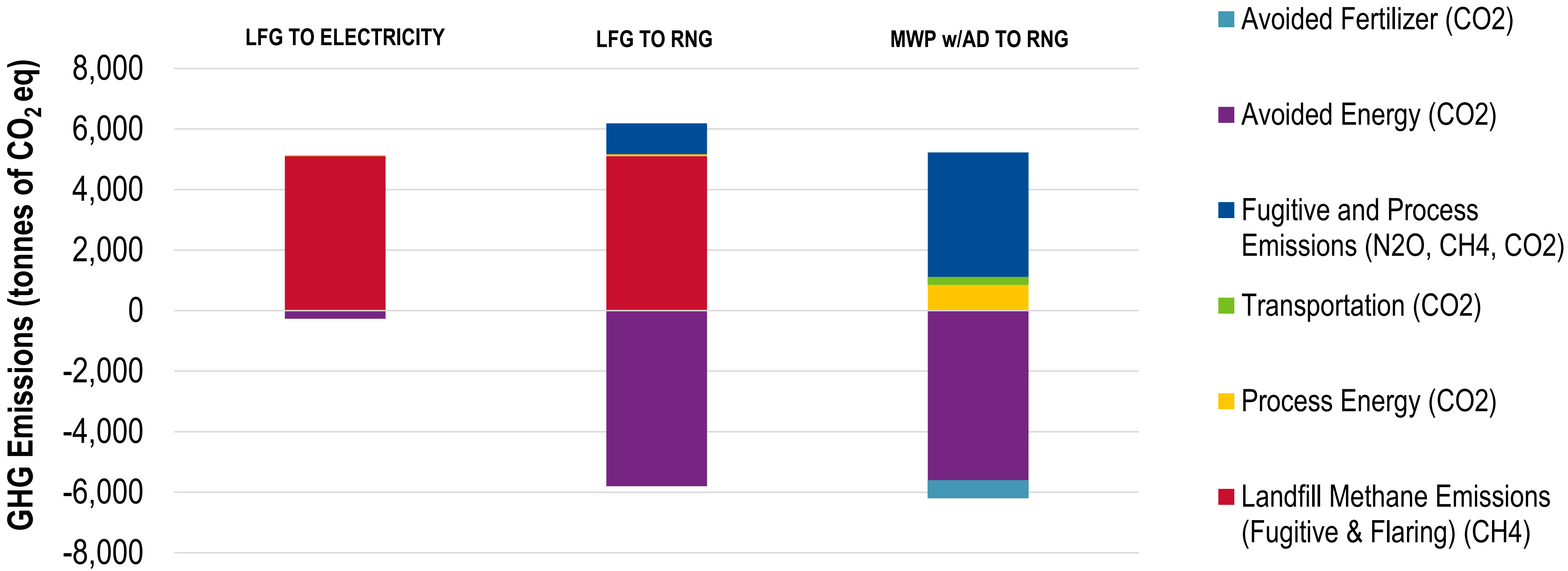
- Significant reductions in emissions since 1990
- Technology improvements for reducing criteria pollutants – particularly Nitric Oxides (NOx)
- Improvements and advancements in emission monitoring devices

Dioxin/Furans	Mercury	Cadmium	Lead
↓ 99+%	↓ 95.1%	↓ 93.0%	↓ 90.9%

PM	HCl	SO_2	NO_X
↓ 89.8%	↓ 94.3%	↓ 86.7%	↓ 17.6%

Source: USEPA (2023)

Greenhouse Gas Impacts of Waste Conversion



Annual GHG Emissions (tonnes CO2 eq), by source (2050)

Note: Quantities above "0" are direct GHG emissions and quantities below "0" are emissions that are avoided.

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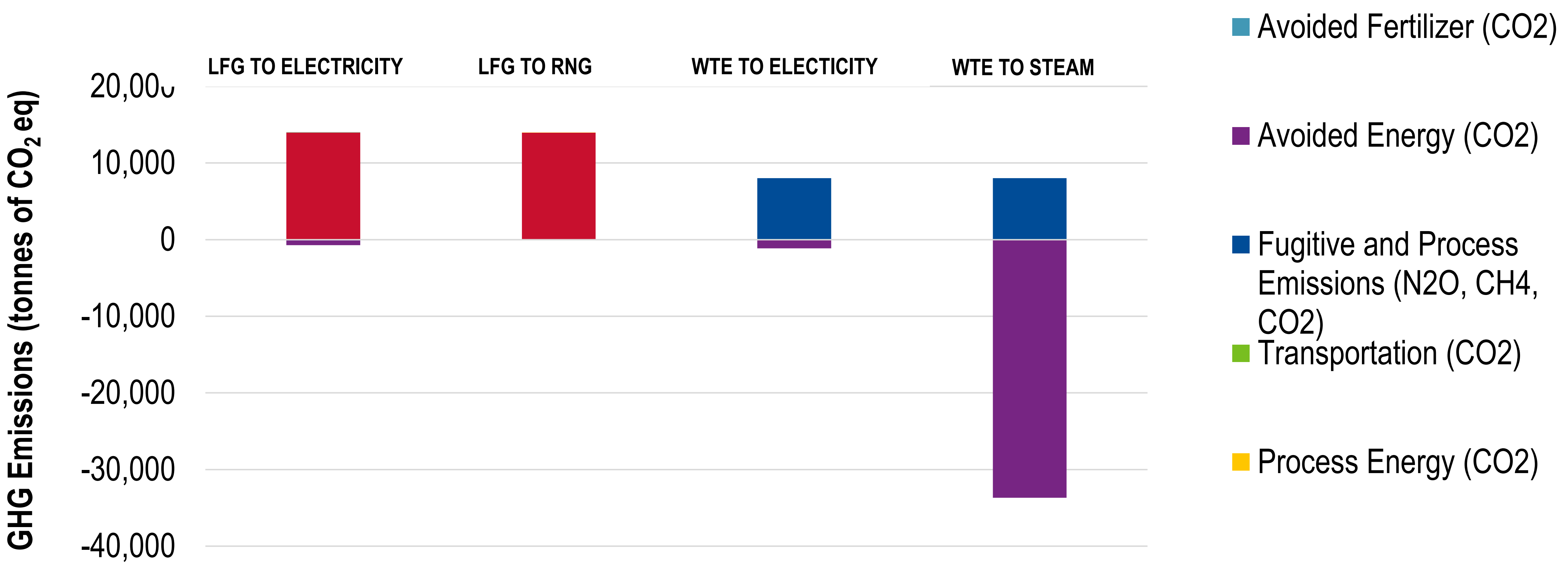

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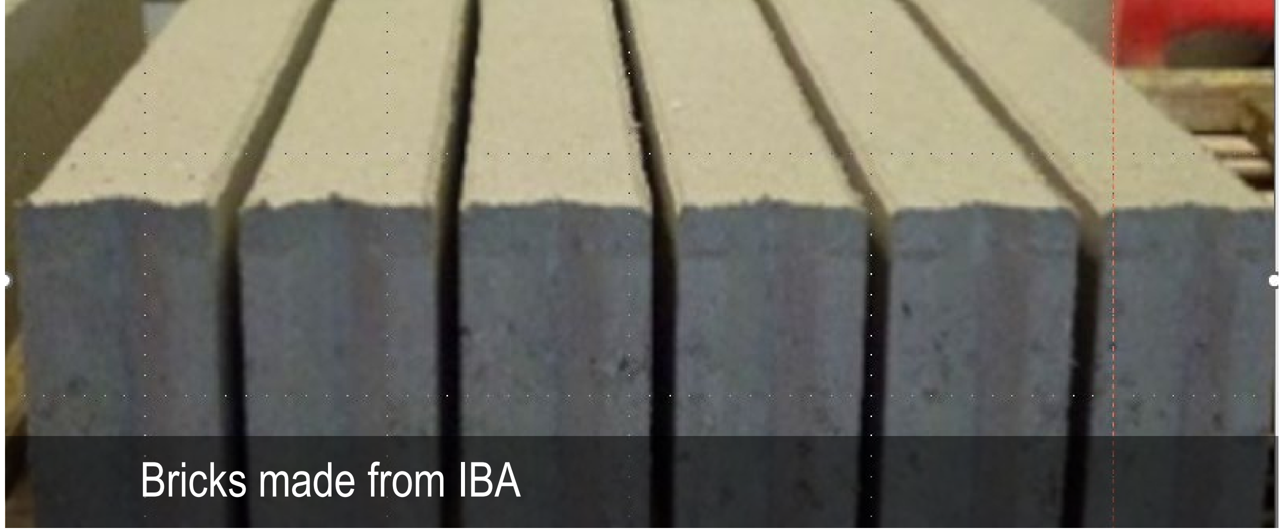


Enhanced Metals Recovery & Residue Reuse

- A combination of wet and dry processing of incinerator bottom ash (IBA) to recover additional ferrous and non-ferrous metals and a aggregate material
- Dry Processing – multi-step screening and size classification of IBA to recover additional metals through magnets and eddy current systems
- Wet Processing – multi-step cleaning and refining of IBA remaining after Dry Processing step:
  - IBA is washed to remove salts, fines, and organic material to produce a uniform aggregate that can pass a TCLP test and can be used in construction industry

Waste-to-Aviation Fuel

Hybrid Technology that combines:

- Mechanical pretreatment of waste feedstock
- Thermal conversion (typ. Gasification) to create a syngas
- Chemical/catalytic conversion process to convert syngas to fuels

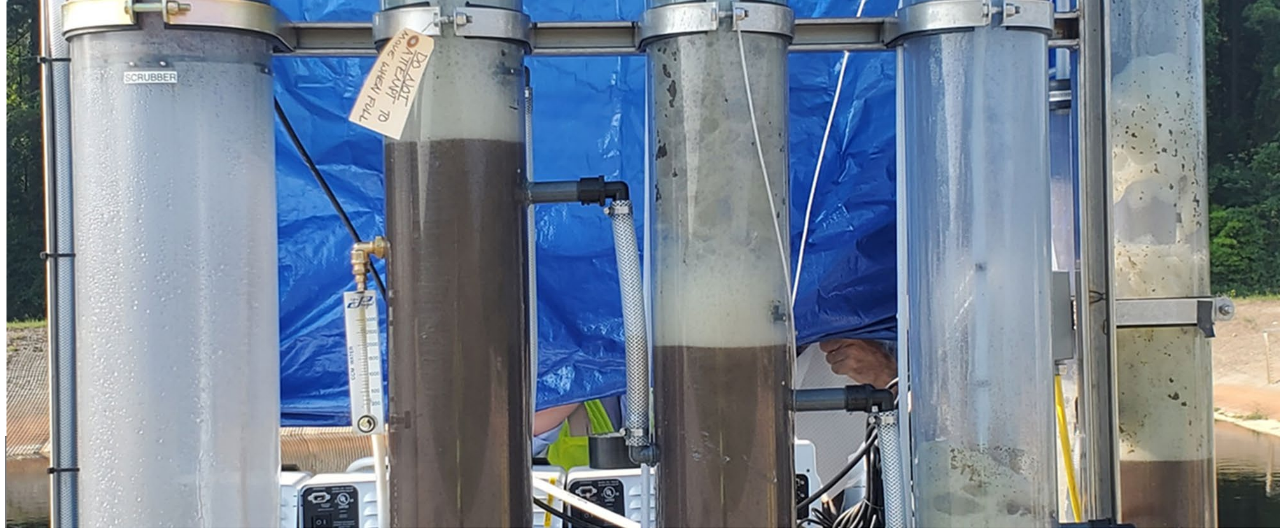
Interest is Sustainable Aviation Fuel (or “SAF”) is not yet commercially widespread but is gaining interest

Some commercial & demonstration plants in development:

- Fulcrum Sierra Biofuels Plant (Nevada)
- Alberta Biofuels Plant (Canada)

Waste-to-Hydrogen

- High temperature thermo-chemical process that generates a syngas containing hydrogen and methane
- In the development phase – no large-scale or commercial facilities in operation
- Several U.S.-based companies in the process of developing projects:
  - Ways2H (Kern, California)
  - H Cycle/OMNI Conversion Technologies (California)



Other Advances with WCTs

- **Renewable Natural Gas (RNG)**:
  - Advances in biogas treatment to pipeline quality RNG
  - Increasing in interest from gas utilities and private developers to take RNG from wastewater plants and landfills
- **PFAS Destruction:**
  - Development of thermal technologies that can destroy PFAS in MSW and biosolids
  - Some interest in co-incineration in parts of North America

Regulatory Updates - Federal

Federal

- USEPA Clean Air Section 129 sets emission standards for new and existing sources burning nonhazardous solid waste
- Title V operating permits are for all sources/units
- EPA must review and revise standards every 5 years (last update was 2006) - currently reviewing MACT floors, technology review, and “other” issues
- Emission guidelines are set based on average emissions from top best performing 12% of operating units
- Other issues will include evaluating Startup, Shutdown, and Malfunction

Regulatory Updates

New York State

- **Climate Leadership and Community Protection Act, Chapter 106 of the Laws of 2019 (CLCPA)** directs NYSDEC to adopt regulations establishing statewide emission limits

- NYSDEC issued a new regulation, **6 NYCRR Part 496, Statewide Greenhouse Gas Emission Limits**, which establishes the two statewide greenhouse gas (GHG) emission limits called for in the CLCPA:
  - a limit for 2030 that is equal to 60% of 1990 greenhouse gas emission levels
  - a limit for 2050 that is equal to 15% of 1990 emission levels

- **Draft State Solid Waste Master Plan (2023):**
  - Aims to increase total waste stream recycling to 50% by 2050
  - Requiring a per-ton disposal disincentive surcharge on all waste landfilled or combusted in New York State and all waste generated in New York State being sent for landfilling or combustion out-of-state, to provide financial support for recycling programs

Final Thoughts

- Need for education at all levels on the real impacts and benefits of Waste Conversion technologies
- Recognition of recovery as the 4th "R" in the waste hierarchy and waste diversion efforts
- Continue to monitor advancements in new and emerging technologies
- Cooperation amongst all levels of government (yeah...I can dream anyway)
- We can't wait any longer – these projects take a long time to implement (7-10 years from start to finish)

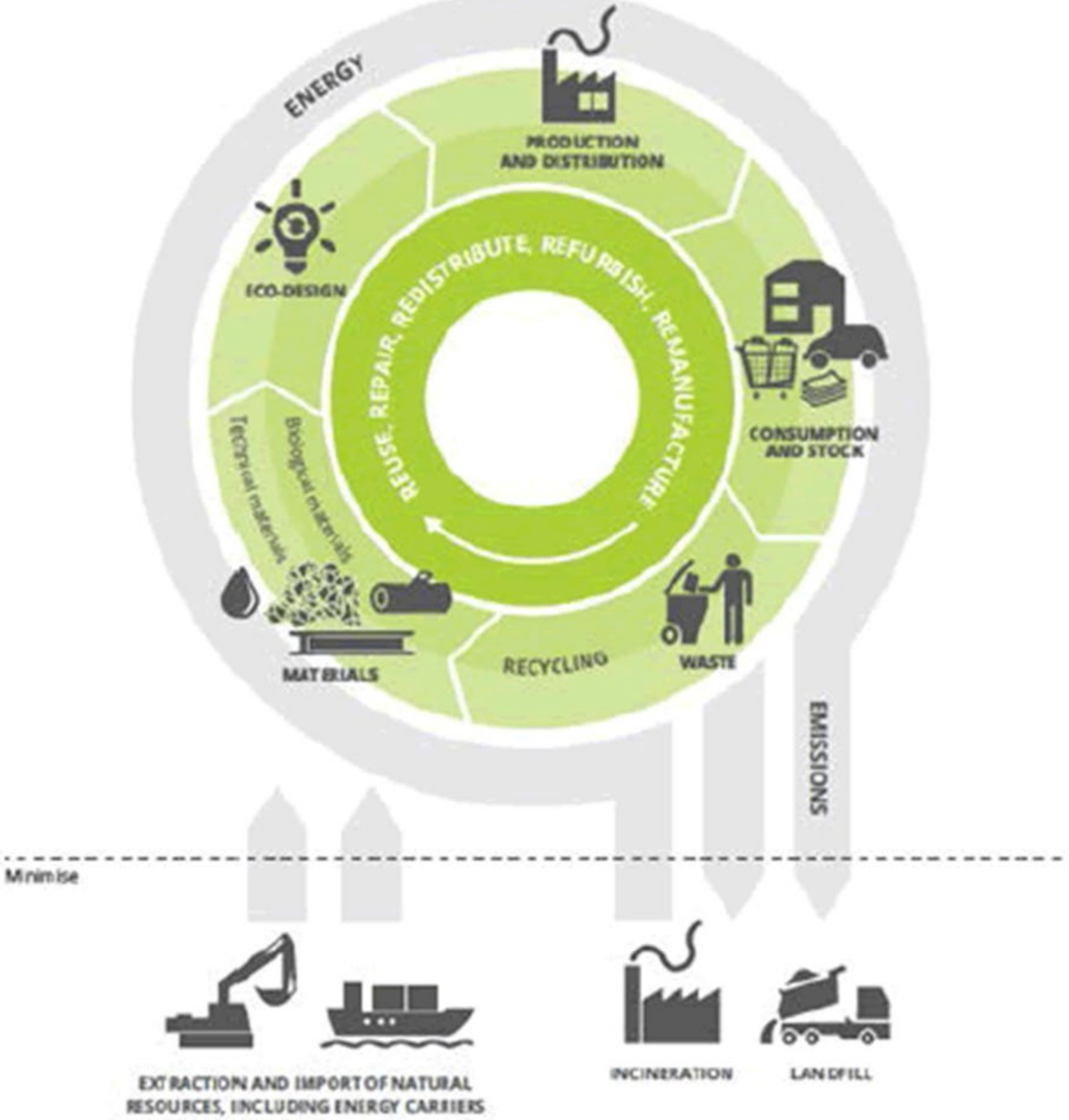


Figure 1: The concept of circular economy [11].

Questions

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