Is Municipal Waste to Energy Conversion Still any Good Today?

American Institute of Chemical Engineers
Dallas Section

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Agenda

- Some History
- Municipal Solid Waste
- Garbage Dumps vs. Landfills
- Waste to Energy Facilities in the United States
- Types of Waste to Energy Technologies
- What's Next
- Questions and (maybe) Some Answers

Some History

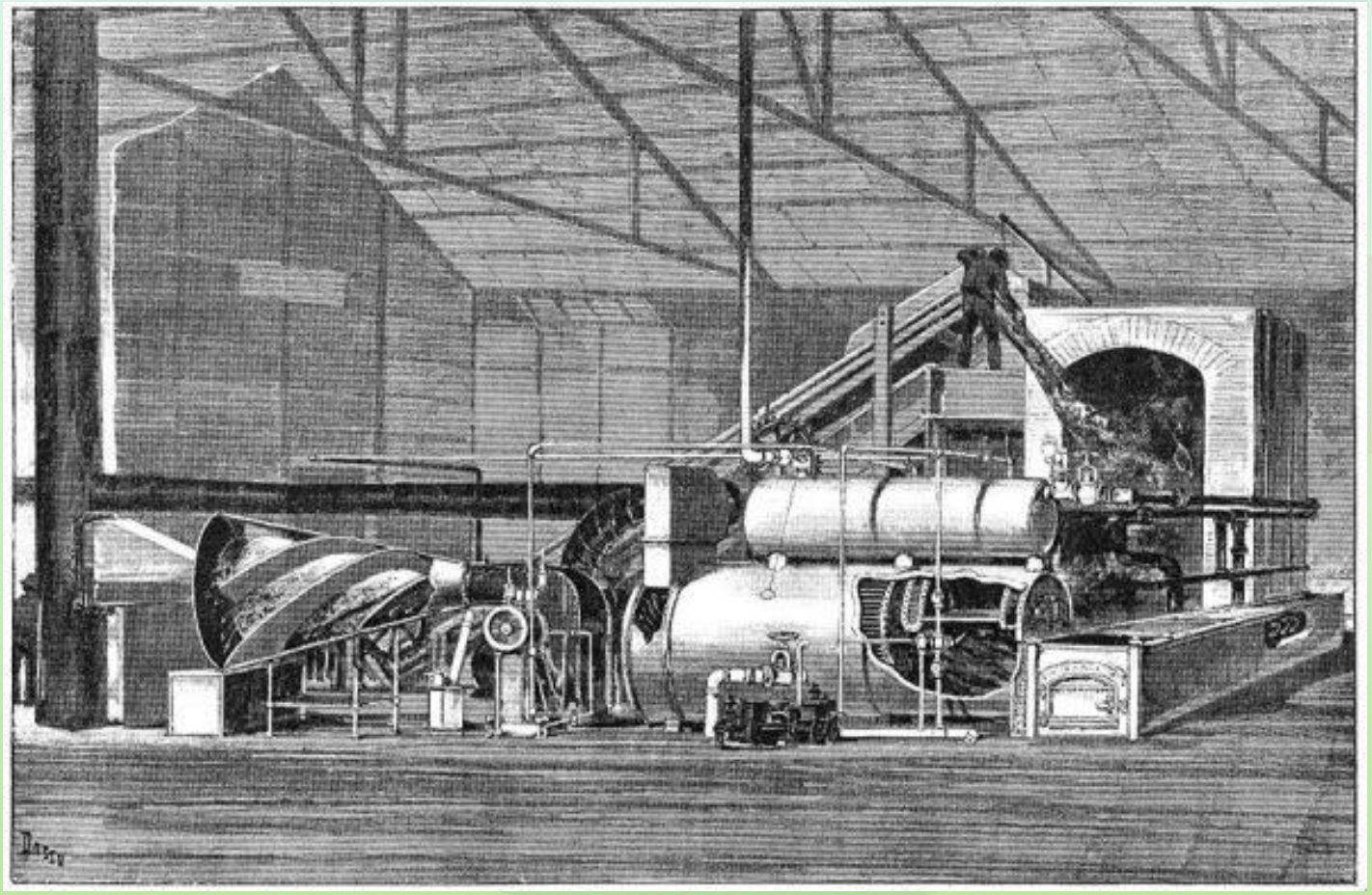
- Initially trash was simply tossed, piled and just left to be scavenged, rot, breed disease vectors, cause water contamination…
- During the middle ages this practice had disastrous results
  - The bubonic plague or Black Death, that killed more than half of the population of Europe during the 14th century;
  - Contaminated water transmitted contagious diseases like:
    - Cholera
    - Dysentery
    - Typhoid fever
    - Skin parasites

Some History

- Some jurisdictions burned their garbage to reduce its volume and some contaminating characteristics
- Garbage burning helped reduce its volume, but it could be dangerous and produce noxious fumes such as H_2S, CO, volatile organics, even dioxins and furans
- In 1885 the first incinerator was built in Governor's Island, New York
- By mid 20th century there were hundreds of large scale incinerators operating in the United States as well as thousands of smaller units in apartment buildings
- In the 1960s awareness of air and water contamination started growing

Some History

- The Governor's Island incinerator



Some History

- Calls for awareness
  - Silent Spring, by Rachel Carson – 1962
  - Spaceship Earth, by Buckminster Fuller – 1968
- The Clean Air Act:
  42 U.S.C. §7401 et seq. (1970)
- Evolution of incinerators – Units that could not be retrofitted under the developing and ever stricter regulations were gradually shutdown
- 1980's MSW burning with energy recovery started to take on

Garbage Dumps vs Modern Landfills

- Garbage dumps were unregulated open piles of refuse accumulated just outside of where people lived.
  - They are referred to in history, even in the Bible (and not very favorably).
  - They attracted scavengers (human and otherwise),
  - Were a haven for disease vectors such as rats, mosquitoes, flies, etc.
  - Had a propensity for fires, sometimes set, sometimes spontaneous
  - Emitted all kinds of contaminants into the atmosphere
  - Contaminated under- and above-ground water sources

Garbage Dumps vs Modern Landfills

- Modern Landfills are strictly regulated facilities designed to store refuse in a safe and environmentally friendly manner
  - Have liners to prevent contaminants to enter water sources
  - Are covered to
    - Reduce air emissions
    - Keep scavengers away
    - Keep rainwater from entering and leaching contaminants into the soil
  - Are monitored scientifically
    - For air emissions
    - For underground contamination, by the use of wells to sample underground water
  - Some have systems that collect combustible gases to keep them from the atmosphere and for use as fuel
  - They still can have occasional spontaneous fires

Landfills in the United States

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Municipal Solid Waste – EPA Data

Generation, Materials Recovery, Composting, Combustion With Energy Recovery, and Discards of MSW, 1960 to 2012 (in millions of tons)

Activity	1960	1970	1980	1990	2000	2005	2008	2010	2011	2012
Generation	88.1	121.1	151.6	208.3	243.5	253.7	252.5	250.4	250.4	250.9
Recovery for recycling	5.6	8.0	14.5	29.0	53.0	59.2	61.9	65.0	66.3	65.3
Recovery for composting*	Negl	Negl	Negl	4.2	16.5	20.6	22.1	20.2	20.6	21.3
Total materials recovery	5.6	8.0	14.5	33.2	69.5	79.8	84.0	85.2	86.9	86.6
Discards after recovery	82.5	113.0	137.1	175.0	174.0	173.9	168.5	165.3	163.5	164.3
Combustion with energy recovery†	0.0	0.4	2.7	29.7	33.7	31.6	31.6	29.3	29.3	29.3
Discards to landfill, other disposal‡	82.5	112.6	134.4	145.3	140.3	142.3	136.9	136.0	134.2	135.0

* Composting of yard trimmings, food waste, and other MSW organic material. Does not include backyard composting.

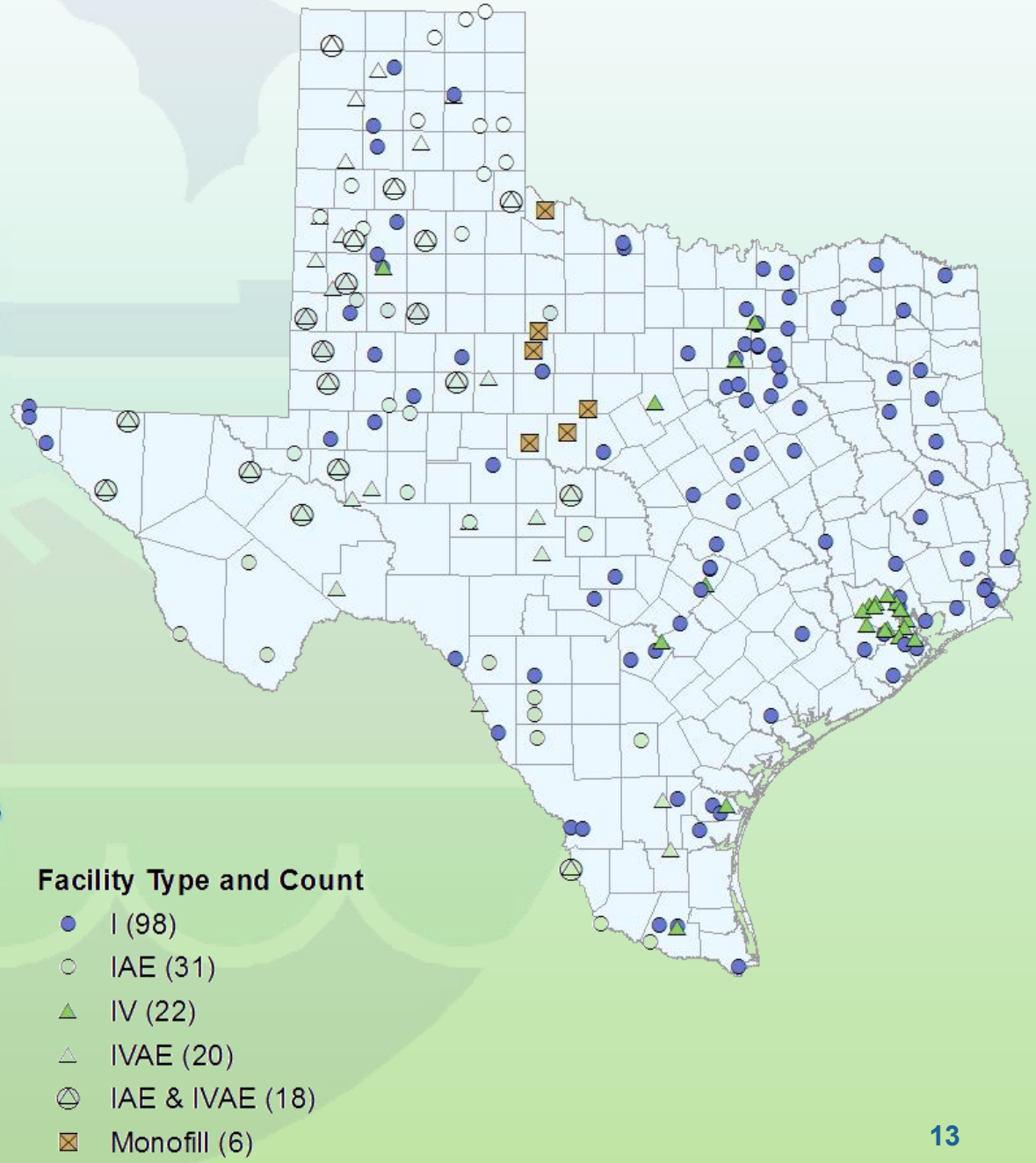
† Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets, tire-derived fuel).

‡ Discards after recovery minus combustion with energy recovery. Discards include combustion without energy recovery. (Details might not add to totals due to rounding)

Source: EPA publication: Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012

Landfills in Texas

- Type I – Standard Landfill
  - 50% of active landfills
  - 89 % of waste disposed
- Type IV – Only accepts brush, construction & demolition waste, nonputrescible waste
  - 11% of active landfills
  - 10% of total waste
- AE – Arid Exempt Landfill – exempt from liner and groundwater monitoring
  - 36% of active landfills
  - 1% of waste disposed
- Monofill – dispose of demolition waste in counties of fewer than 12,000 people



Hierarchy of Waste Management

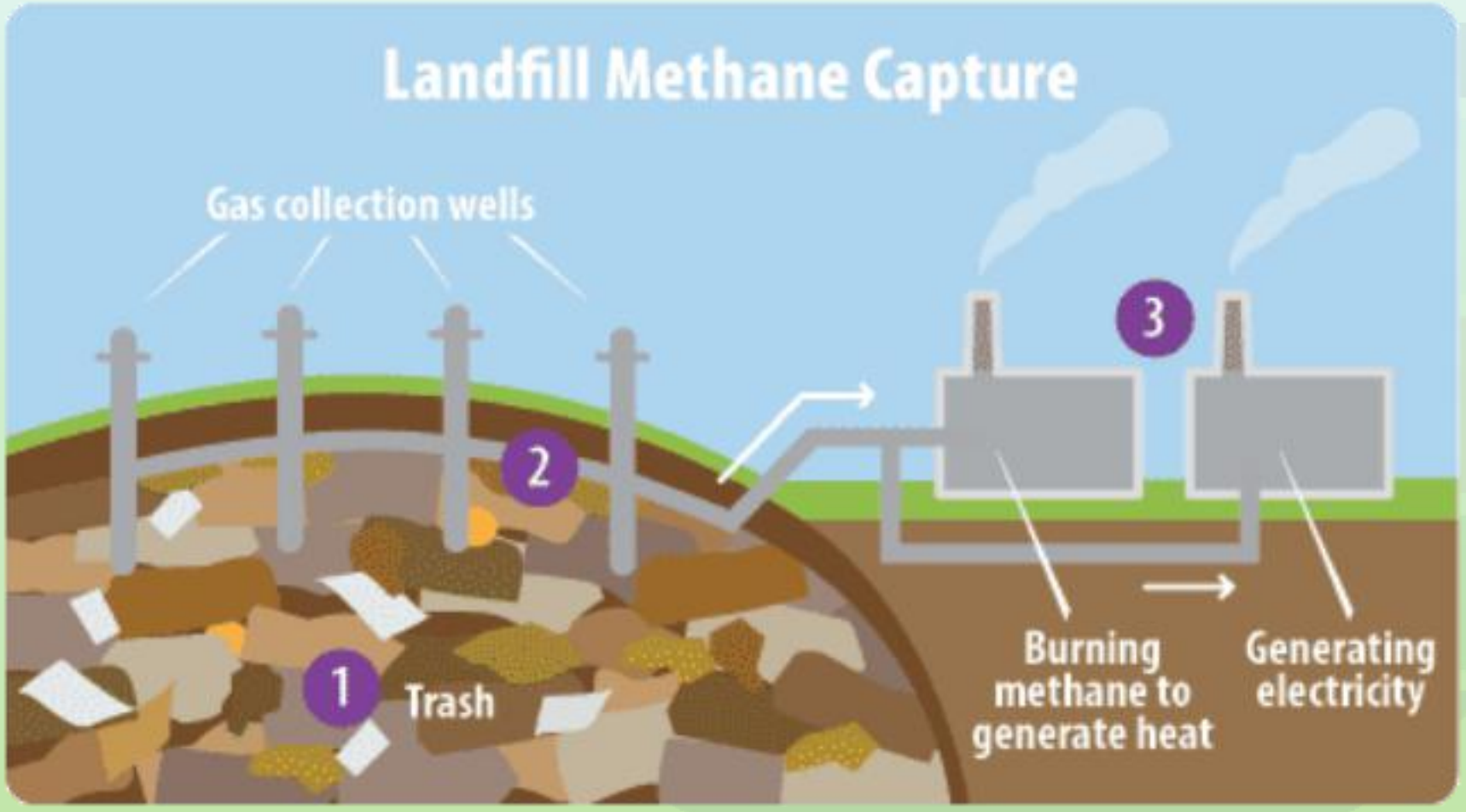
- Reduction at the source
- Recycling and reuse
  - Separation
  - Markets
- Conversion
  - Compost
  - Chemical recycling (plastics)
  - Energy recovery (various methods – some to be discussed)
- Landfill

Heating Values of Selected Fuels

Types of Fuel	Btu/cf	Btu/lb
Bunker C (no 6 Fuel oil		15200 – 18800
Coal		13000 – 14000
Methane – CH_4	1011	23811
MSW		4000 – 4500
Natural Gas (typical)	950-1150	19500 – 22500
RDF		5000 – 6000
Water Gas	261	4881

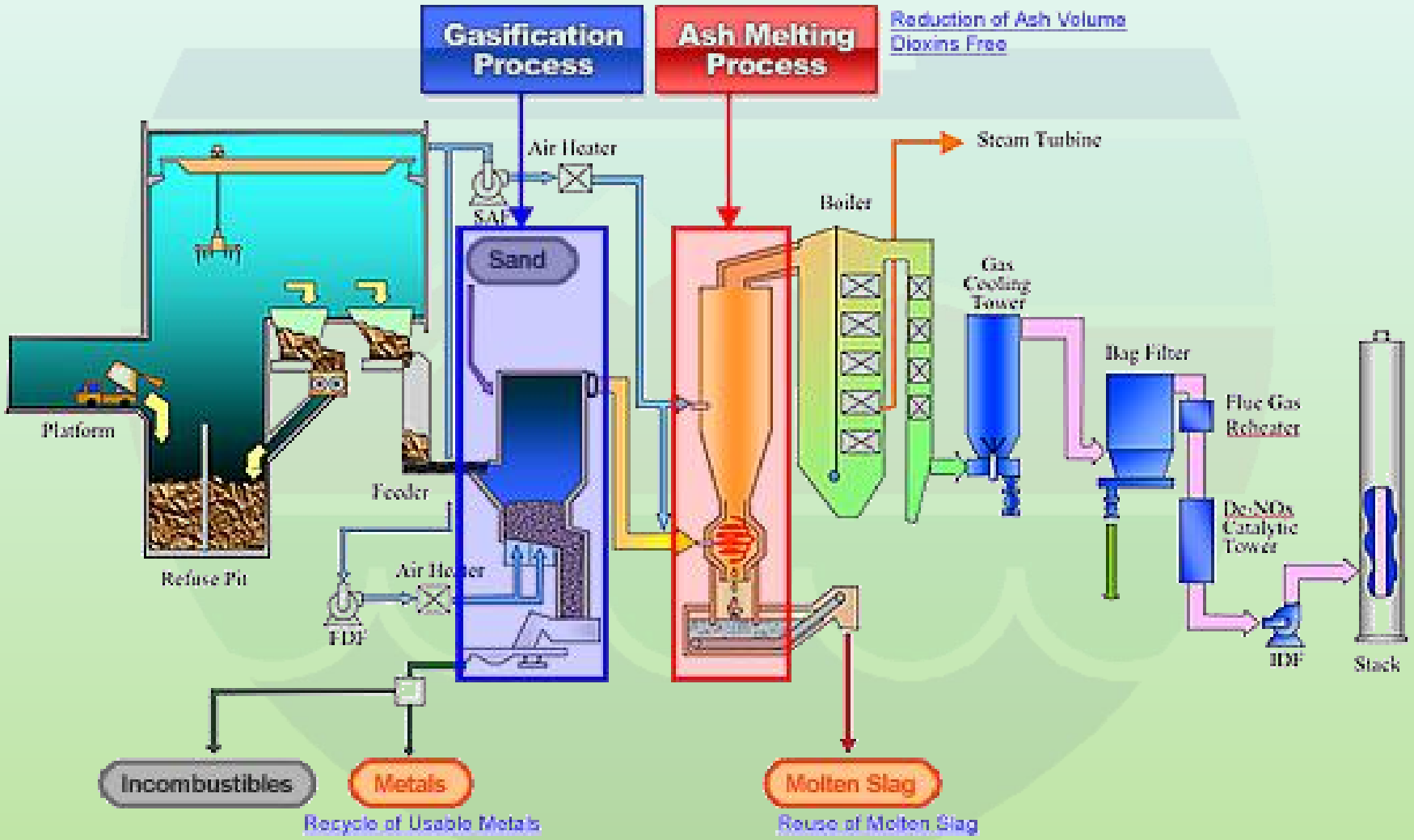
Some Energy Recovery Technologies

Landfill Gas Collection and Burning (EPA Illustration)



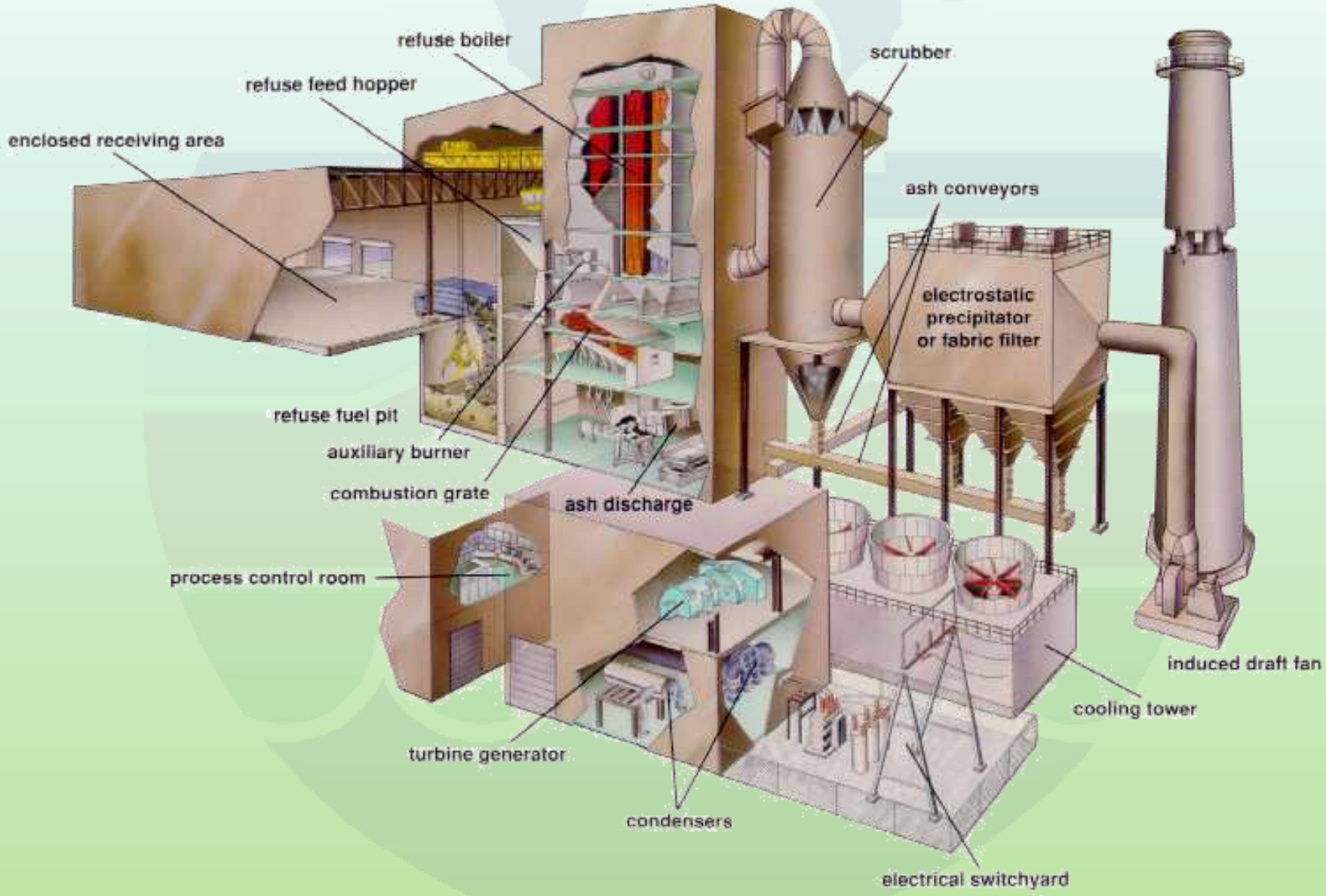
1. Trash decomposes (or rots) in landfills, creating methane gas.
2. Methane rises to the top of the landfill and is collected in pipes.
3. The methane is burned to produce heat or generate electricity.

Gasification (Mitsubishi process)

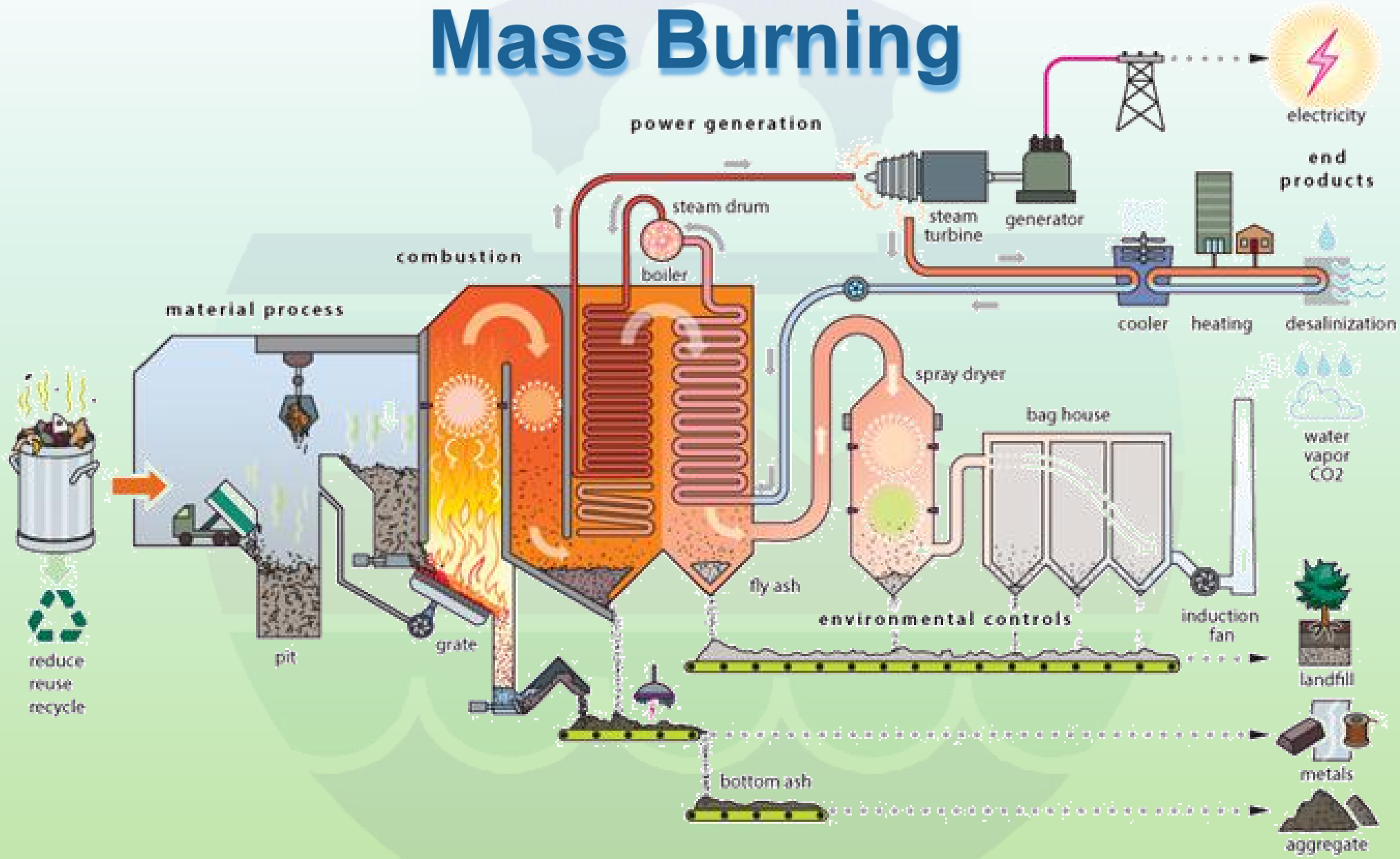


Mass Burning

Mass Burning



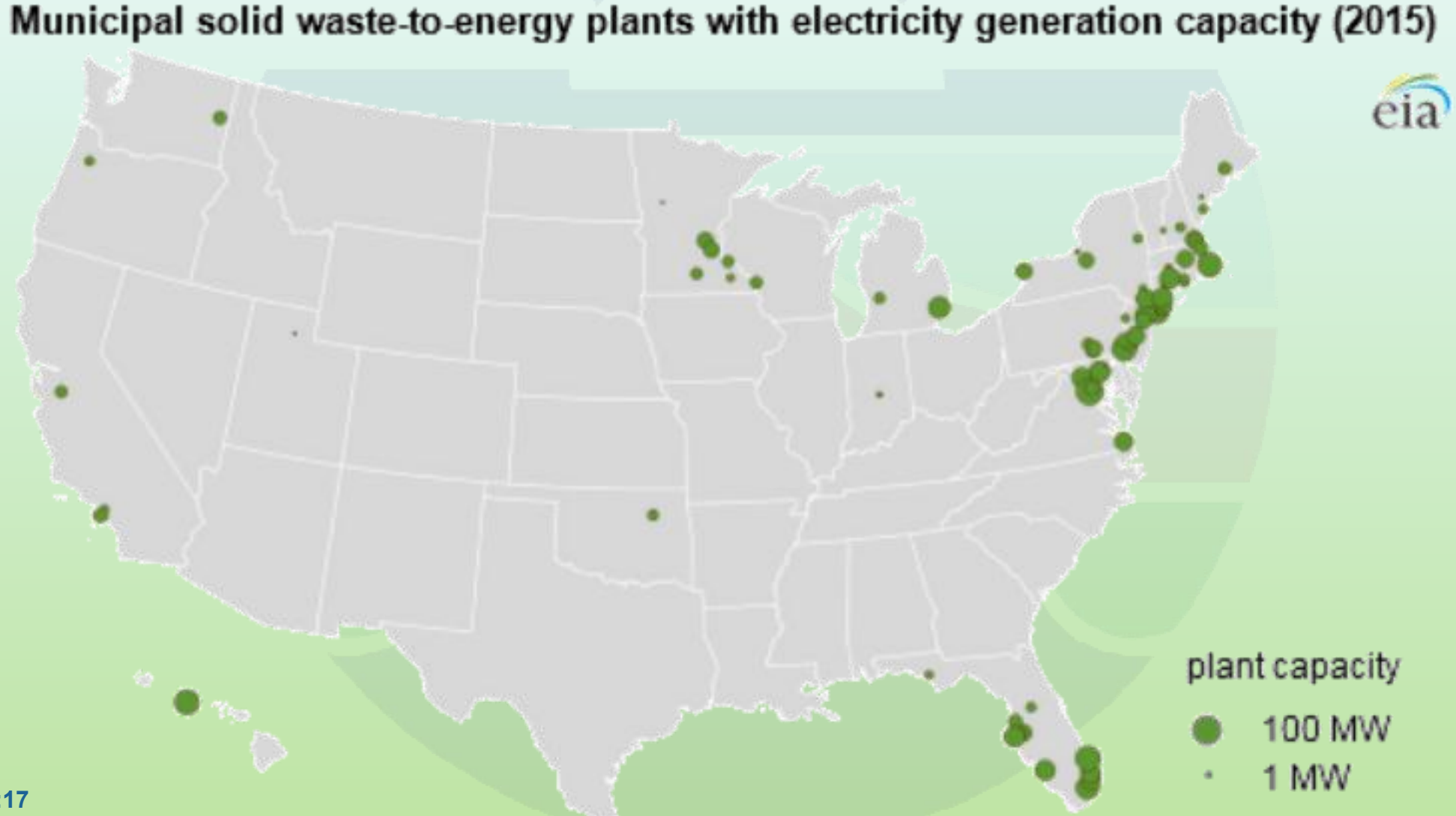
Mass Burning



Refuse Derived Fuel – RDF

- This adds a treatment process to the MSW to make it a cleaner fuel.

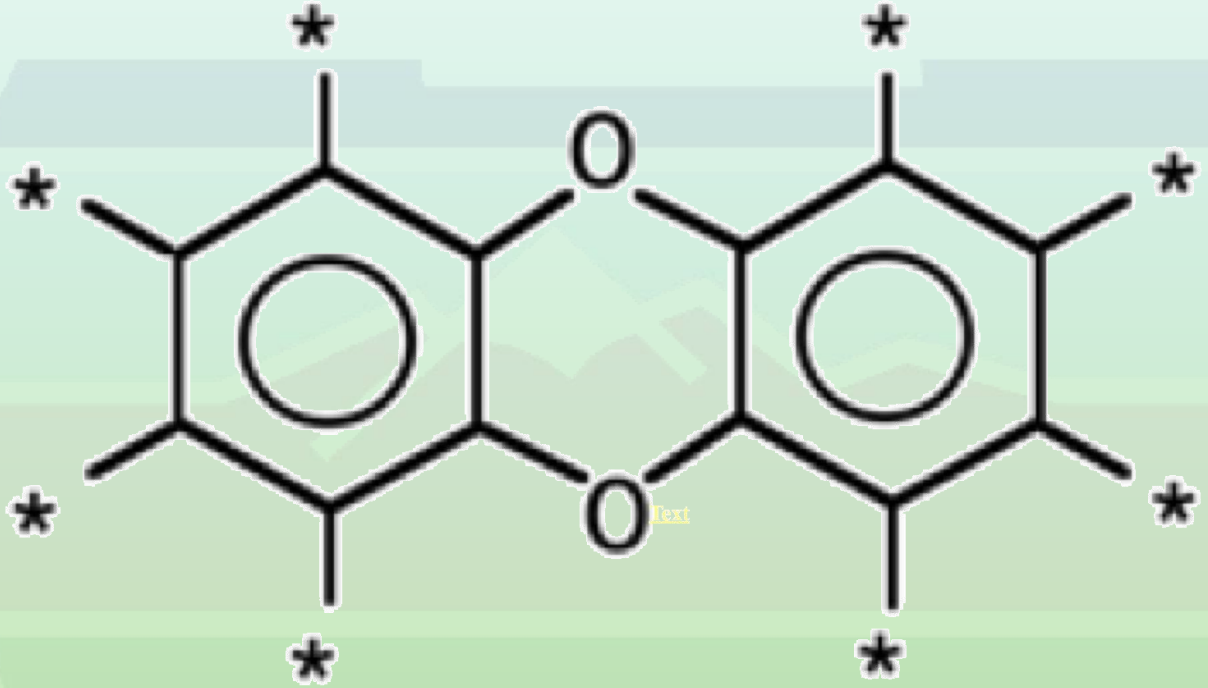
Today's picture



Characteristics of Mass Burn Plants

- Reduce the volume of waste significantly (up to 90%)
- Recovers energy in the form of electricity
- There are proven technologies operating today with hundreds of plants around the world, about 90 in the US
- They require recycling upstream
  - Removal of plastics
  - Removal of metals
- Ashes require periodic TCLP (toxicity characteristic leaching procedure)
- Operation must be reliable
  - Temperature control is critical
  - Removal of ash and acid gases is essential (and mandatory)

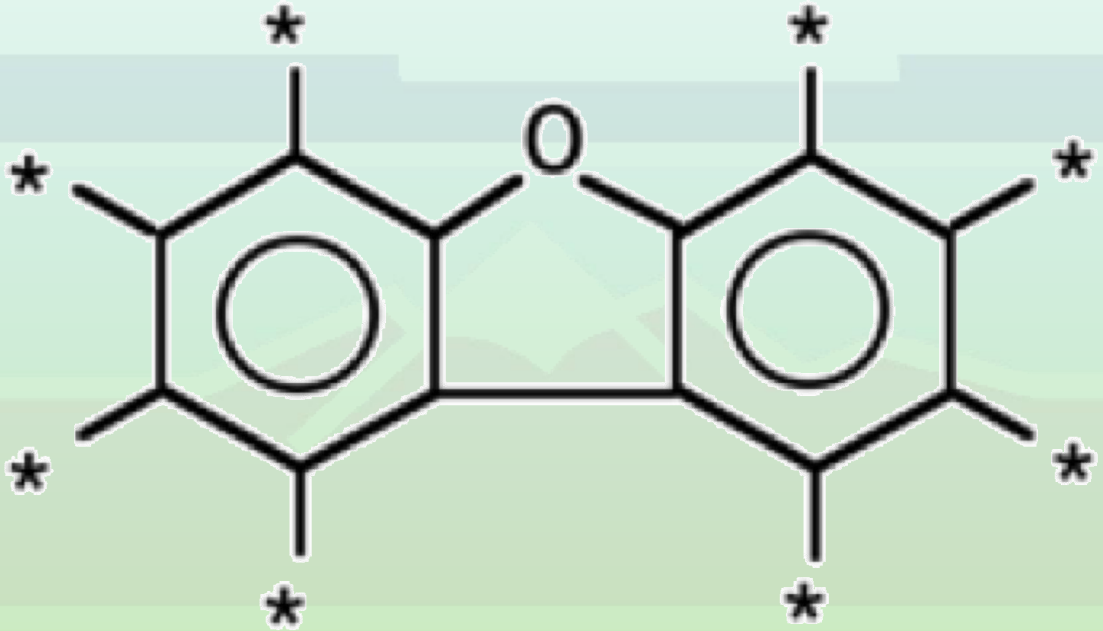
The “Scary” Chemicals



*** Denotes a position that may be occupied by a chlorine or hydrogen atom**

GENERAL STRUCTURE OF DIOXINS

The “Scary” Chemicals



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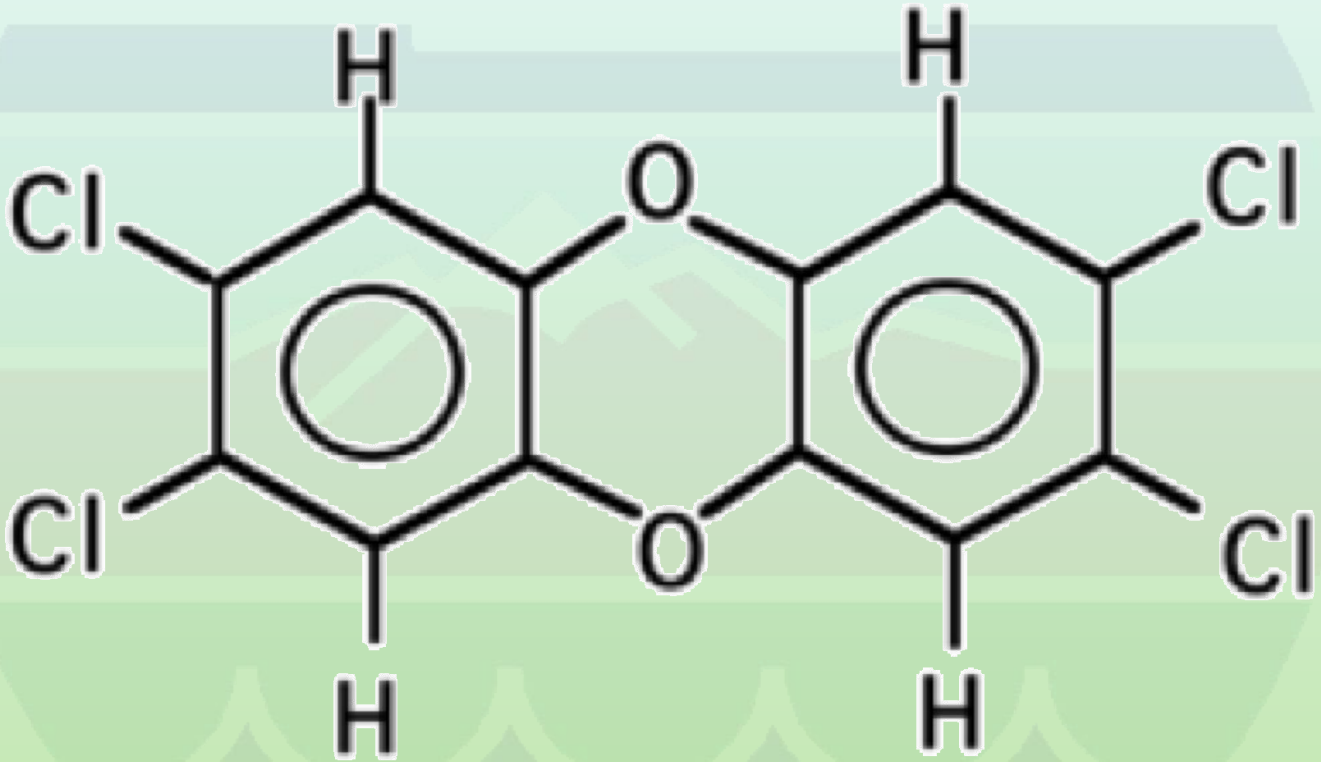
GENERAL STRUCTURE OF BENZOFURANS

A Toxic Dioxin



2, 3, 7, 8-Tetrachlorodibenzo -p-dioxin

Dioxins and Benzofurans

- They may be generated in the combustion chamber
- Their generation can be reduced by removing chlorinated organic compounds from the feedstock and with good temperature control
  (Grzegorz Wielgosiński (2011) The Reduction of Dioxin Emissions from the Processes of Heat and Power Generation, Journal of the Air & Waste Management Association, 61:5, 511-526, DOI: 10.3155/1047-3289.61.5.511)
- They are solids at ambient temperatures so they would come out in the fly ash
- Current systems would intercept them before being released into the air

Environmental Impact Statement

- Air Emissions
- Water emissions
- Ash disposal
- Land use
- Historical impact
- Flood propensity
- Traffic patterns
- Social justice
- Insurance considerations
- Involvement of the communities affected
- Consultation
  - Tens of local regulatory agencies
  - Scores of federal regulatory agencies
- Dawn to sunset analysis
- No action alternative
- ”Long and Winding Road”
- Other pertinent considerations

The Long and Winding Road

- Permitting Process
  - Seeking the common good
  - Ethically responsible
  - Guaranteeing citizens participation
  - Opposers treated with respect
  - Be prepared
    - Analyze what might happen unexpectedly
    - Plan for avoidance of unexpected situations
    - Plan for if it happens anyway

Questions?

Thank you for your attention

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