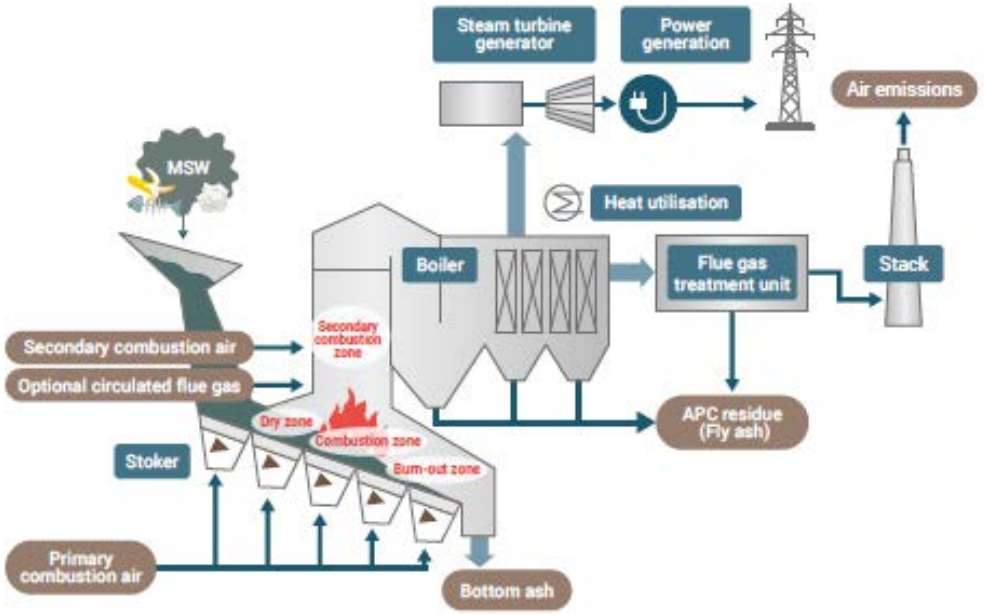
# Waste-to-Energy Incineration Technology

**2.6 Technological aspects**

Mandatory key criteria

**3 Main Technology and Discussion Points with Plant Manufacturers**

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# Focus of the presentation

1. **Waste composition**

   Waste composition and LCV (at least 6,000 kJ/kg for WtE incineration) should be investigated. ✔

2. **Basic of WtE incineration technology**

   Plant manufacturers have an appropriate level of expertise and suitable incinerators. ✔

3. **Environmental protection**

   An environmental monitoring system is in place. ✔

   Bottom ash and APC residue (fly ash) can be safely treated. ✔

4. **Answers for questions**

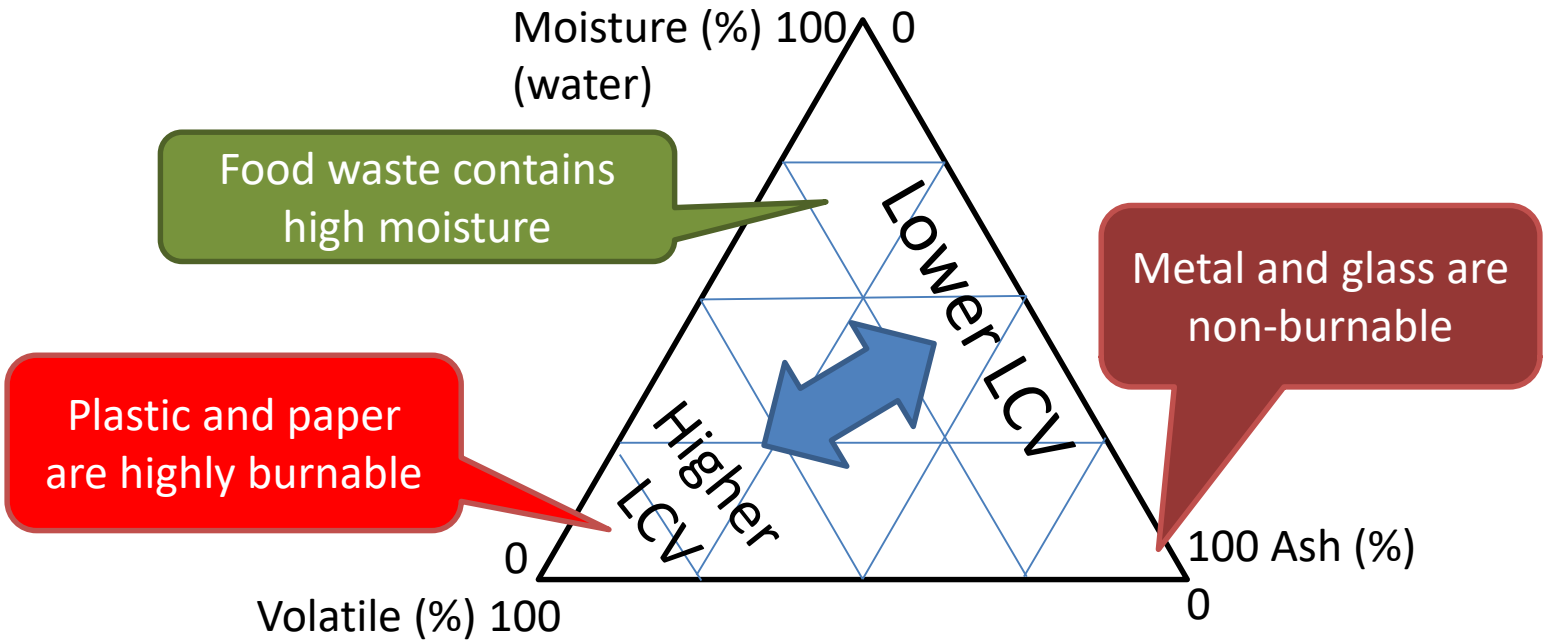
# 1. Waste composition

**Waste composition and LCV (at least 6,000 kJ/kg for WtE incineration) should be investigated.** ✔

# Waste composition and LCV

**LCV (lower calorific value)** of waste is the most important indicator for waste incineration.

(unit of LCV = kJ/kg)




Relation of proximate composition and LCV of waste

# Waste composition differs among cities

## Portion of food waste is especially important

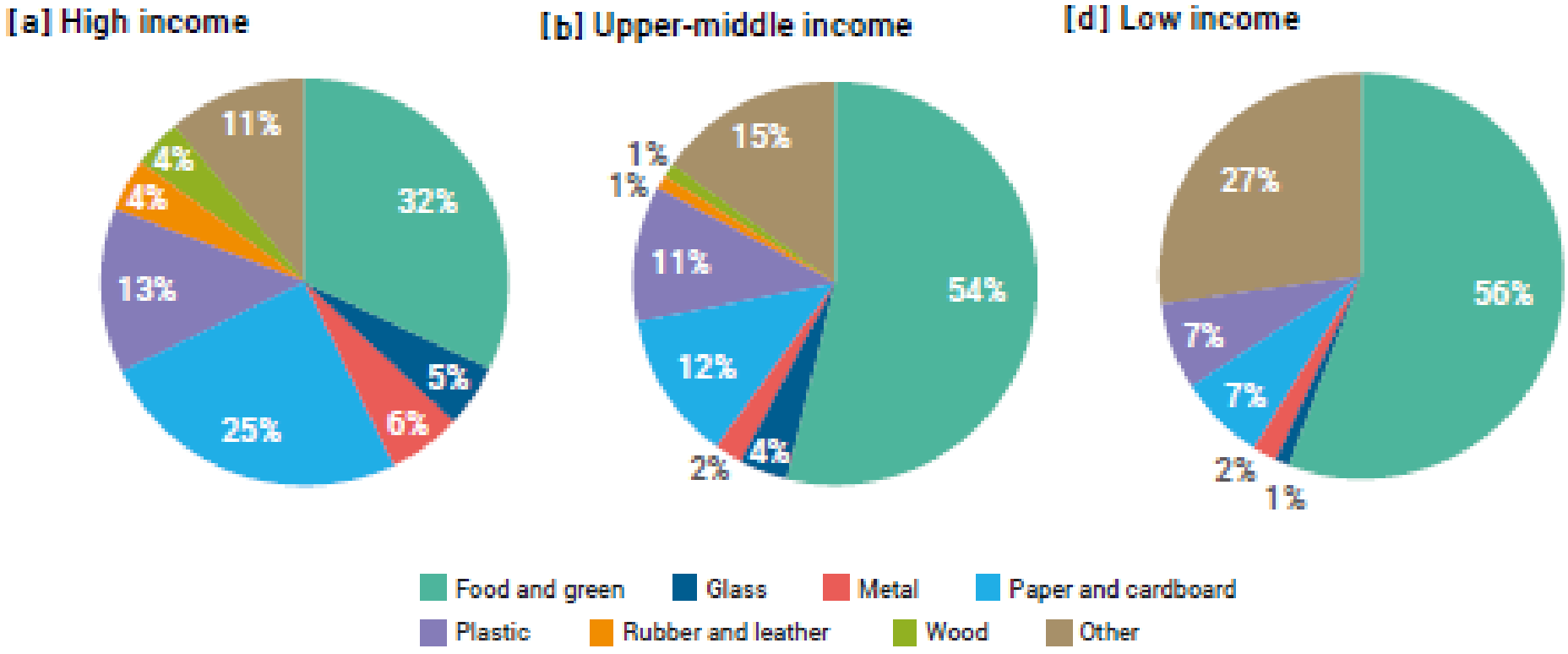



Fig. 5 Country income levels and waste composition

(Source: revised by author based on World Bank (2018))

# Requirements of waste composition and LCV for WtE incineration

- For WtE incineration, **LCV>6000 kJ/kg** is required.
- This could be achieved when the portion of **food waste is <50%**.

Incineration is still possible for waste containing >50% food waste, however, energy recovery is not efficient.

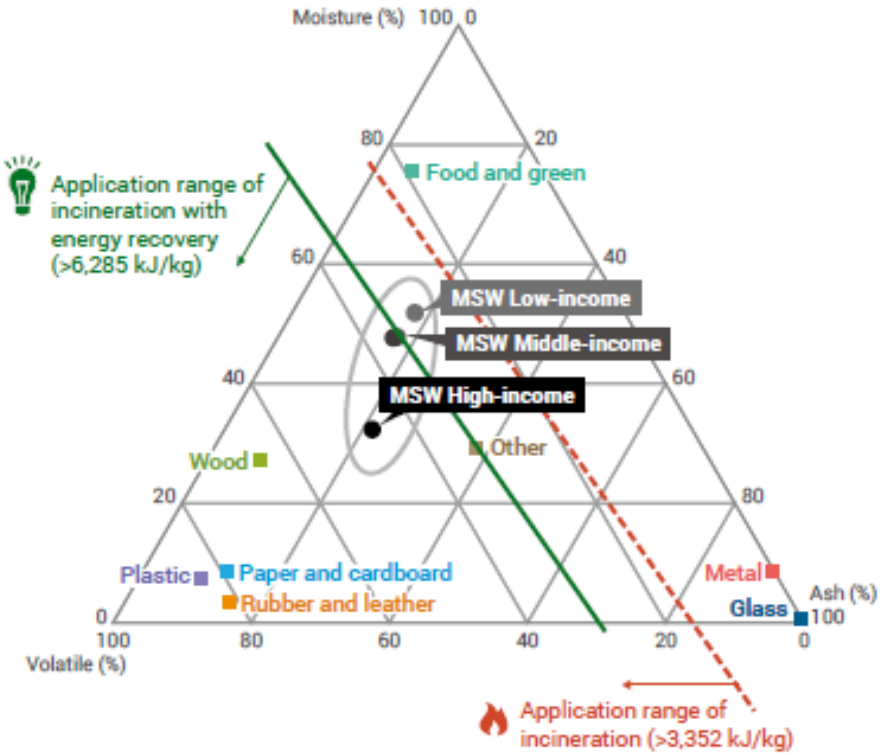


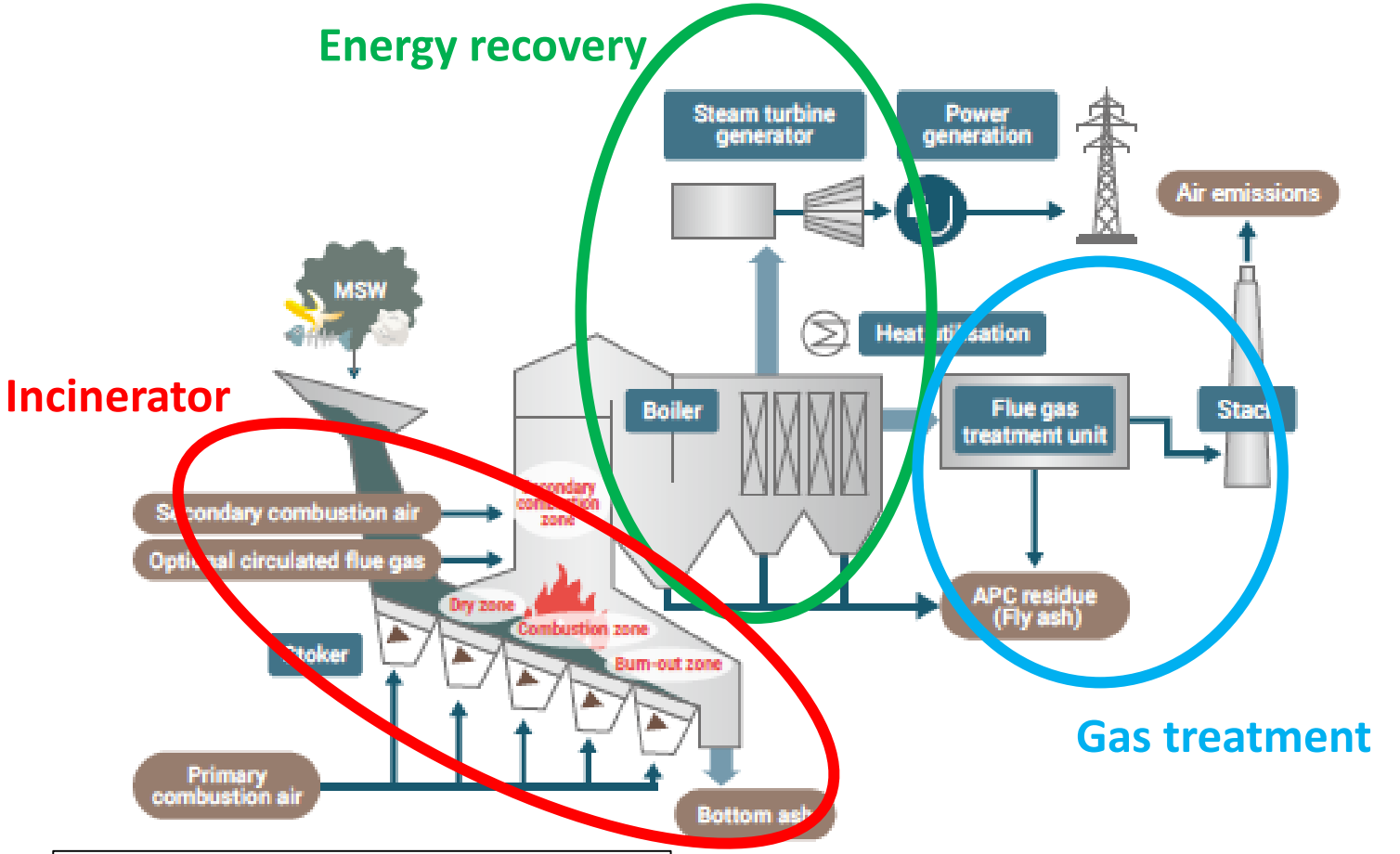

Fig. 6 Proximate composition of different country groups and application range of incineration and WtE incineration

(Source: prepared by author based on Kawai (2016) and World Bank (2018))

# 2. Basic WtE incineration technology

**Plant manufacturers have an appropriate level of expertise and suitable incinerators.** ✔

# Basic structure of WtE incineration plant




Stoker-type incinerator

(Source: revised by author based on facility pamphlets)

# Different types of incinerator

- Stoker-type incinerator is most widely used for municipal solid waste.

Stoker-type incinerator

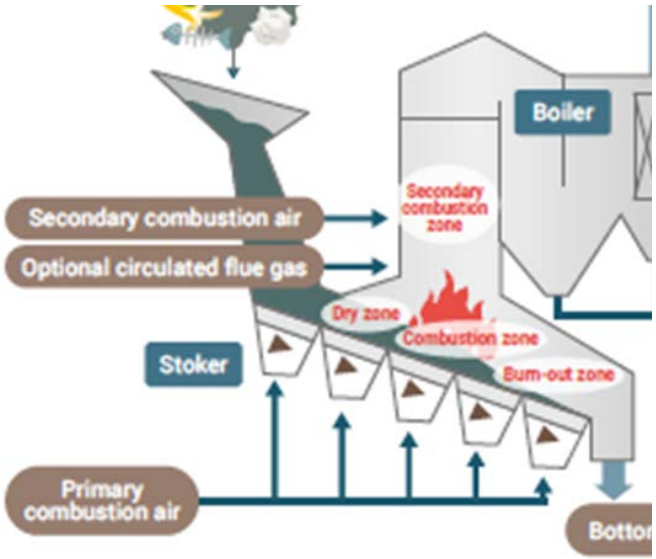



Fig. 8 Example of a stoker-type incinerator

fluidised bed-type incinerator

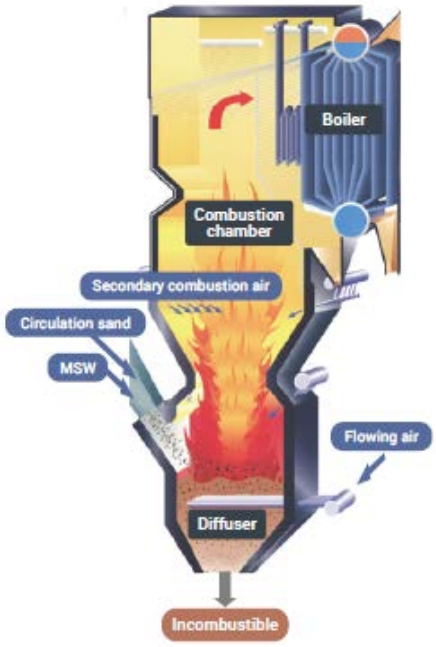



Fig. 9 Example of a fluidised bed-type incinerator

gasification-melting furnace

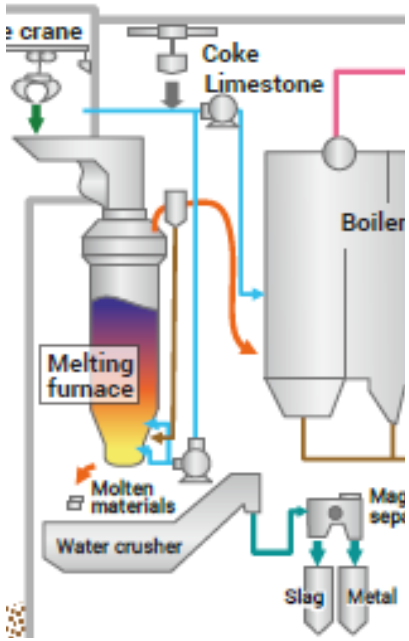



Fig. 10 Examples of gasification melting furnaces

# Discussion points with plant manufacturers

- Type of incinerator

  If a manufacturer proposed a type other than stoker, ask if the manufacturer had successful experiences with that type of incinerator.

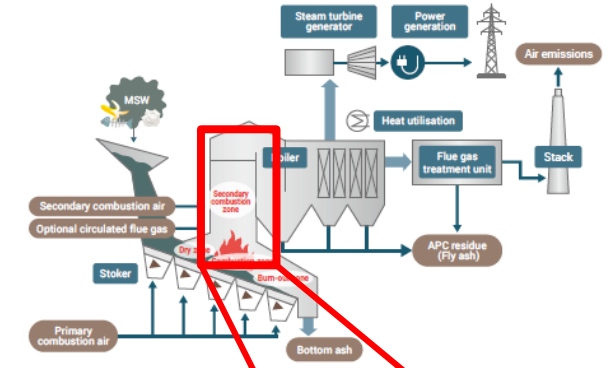
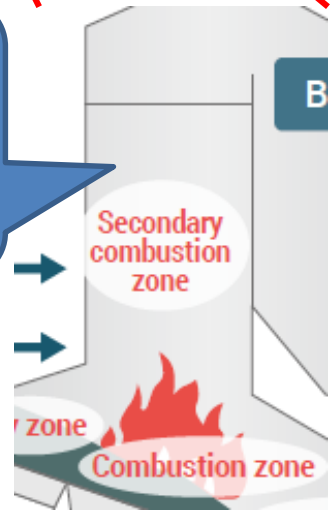



Fig. 8 Example of a stoker-type incinerator (Source: Devised by author based on facility pamphlets)

- Operational parameters for combustion

  - Air ratio
  - 3T in secondary combustion zone (temperature, retention time, turbulence)
  - Target CO concentration

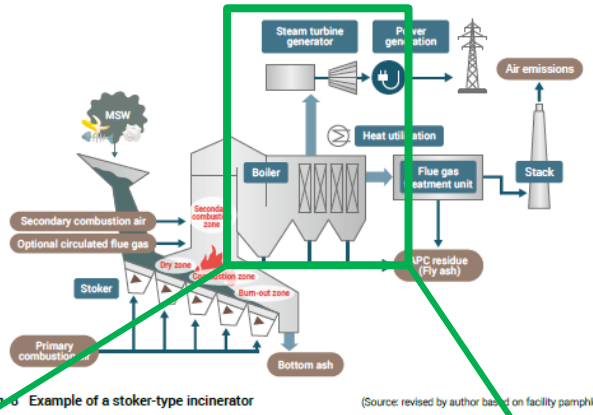
Important to prevent dioxins




**Compare multiple manufacturers!**

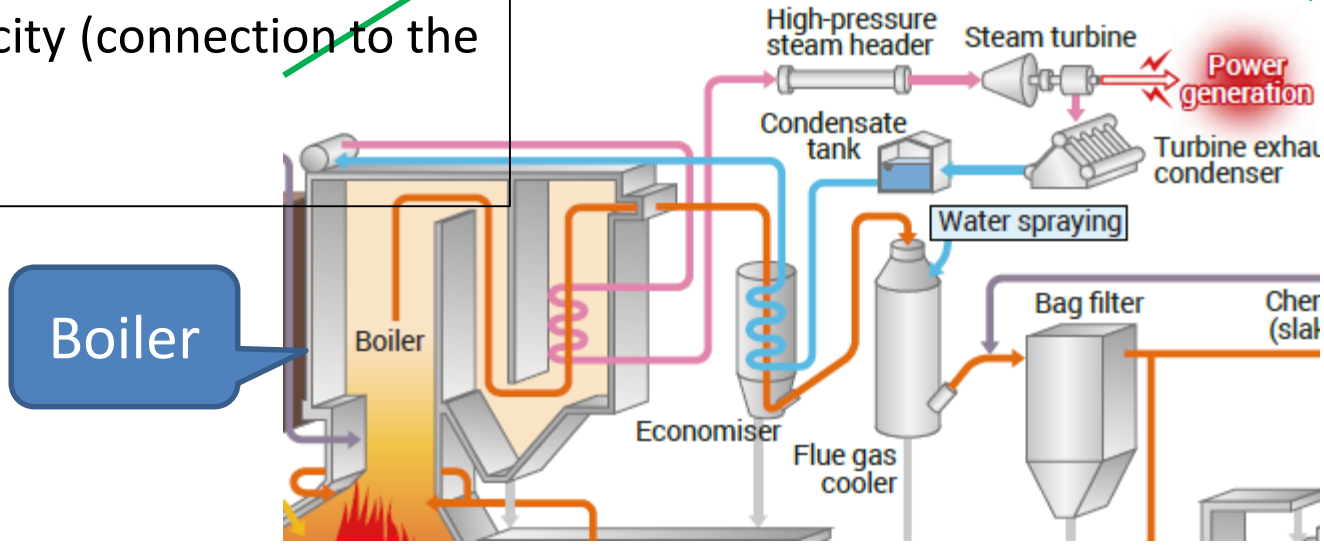
# Heat recovery and power generation

- Key parameters
  - Temperature (℃) and pressure (MPa) of steam
  - Power generation (kw)




Example of a stoker-type incinerator (Source: revised by author based on facility pamphlets)

- Consideration points
  - Sales of electricity (connection to the power grid)
  - Heat utilisation



# 3. Environmental protection

An environmental monitoring system is in place. ✔

Bottom ash and APC residue (fly ash) can be safely treated. ✔

# Air pollution and wastewater control

Air emission and wastewater discharge should meet local standards.

Water

**Closed system** is often used to prevent discharge of **wastewater**.

Air

**Bag filter** is the key process equipment for **air pollution control** (dust, HCl, SOx, Hg, and dioxins).

- NOx reduction requires other control systems.
- Continuous monitoring units (except dioxins) and periodical measurement (including dioxins) are required.

# Bag filter

Neutralise HCl and SOx

**Alkali** and

**Activated carbon**

Absorb Hg and dioxins

Flue gas (<200℃)

Cleaned gas

Filter to capture dust, reacted alkali and activated carbon

**APC residue (fly ash)**

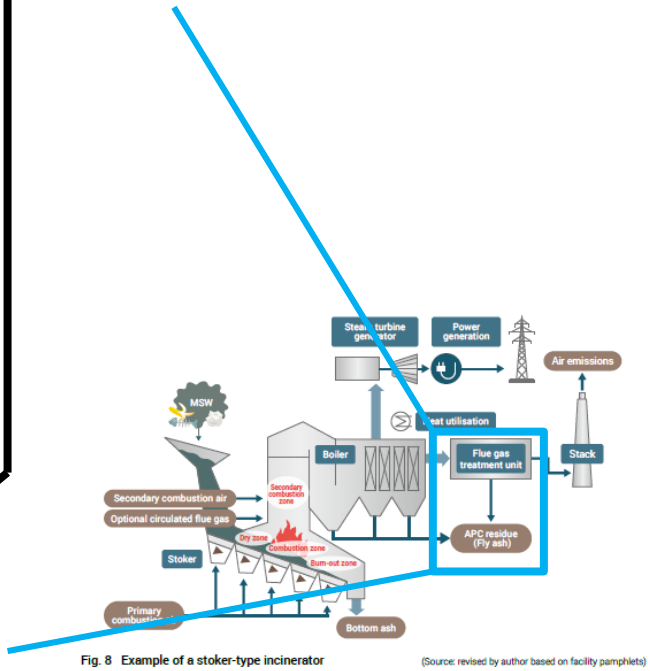


Fig. 8 Example of a stoker-type incinerator (Source: revised by author based on facility pamphlets)

# Dioxins and NOx reduction

- Dioxins
  - Complete combustion in incinerator (low CO)
  - Temperature control of bag filter around 200℃ (prevent *De Novo* synthesis)
  - Collection using bag filter and activated carbon
  - (Optional: denitrification catalyst (see below) also decompose dioxins)
- NOx
  - Combustion control (low air ratio)
  - Non-catalytic denitrification
  - Catalytic denitrification (highest efficiency and cost)

Depending on required emission standard

# Bottom ash and APC residue (fly ash)

**Controlled landfill** is necessary for disposal of bottom ash and APC residue (fly ash).

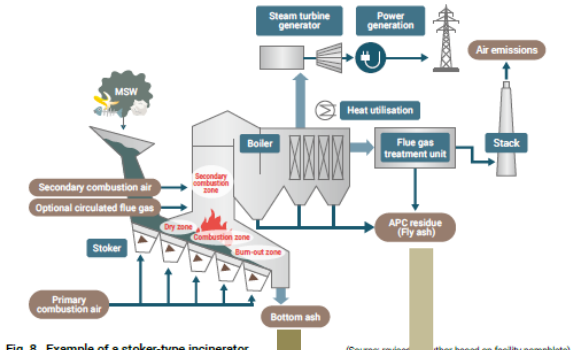
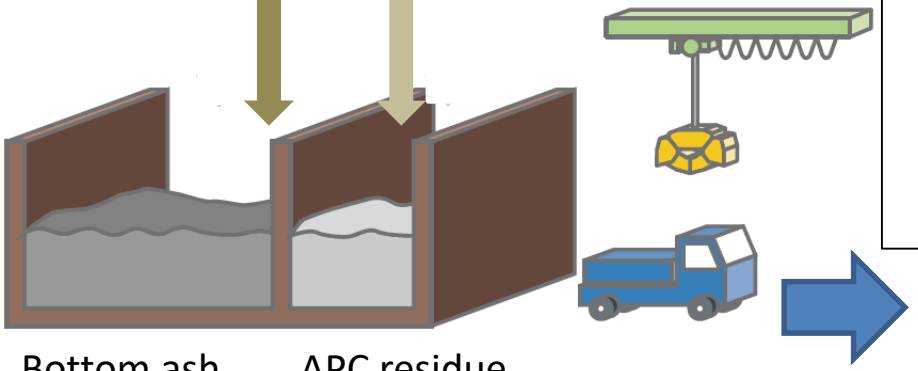



Fig. 8 Example of a stoker-type incinerator (Source: revised [author] based on facility pamphlets)

- For **bottom ash,** "loss of ignition" should be checked. Though recycling methods are available, they are limited because of cost and capacity.

- **APC residue (fly ash)** usually contains harmful substances such as heavy metals. Appropriate quality check and treatment is required.



Bottom ash

APC residue (fly ash)

**Reclaim to controlled landfill**

# 4. Answers for questions

# Small scale WtE incinerator

- 40 t/day X 2 = 80 t/day (24 hours continuous) seems the smallest WtE incinerator for municipal solid waste in Japan.
- Smaller size incinerator is not recommended for waste because it is;
  - difficult for stable combustion
  - difficult for appropriate air pollution control
  - not efficient for energy recovery.

(Small size boiler (generator) can be operated with homogenous fuel, not waste.)

# Comparison with other renewable energies

- A typical WtE incineration plant

  - 1000 t/day (target population: 1,000,000 people)
  - Power generation capacity: 30 MW
    (Output 100 GWh/year: cover 100,000 people)

**Stable generation (24h/day)**

- 100 GWh/year electricity could be generated approximately by;

  - 1 km X 1 km (or more) of solar panel
  - 20 units of wind power generator

**Unstable generation**

Photo from Agency for Natural Resources and Energy, Japan

# Thank you very much!