Current Status of Waste to Energy in Japan

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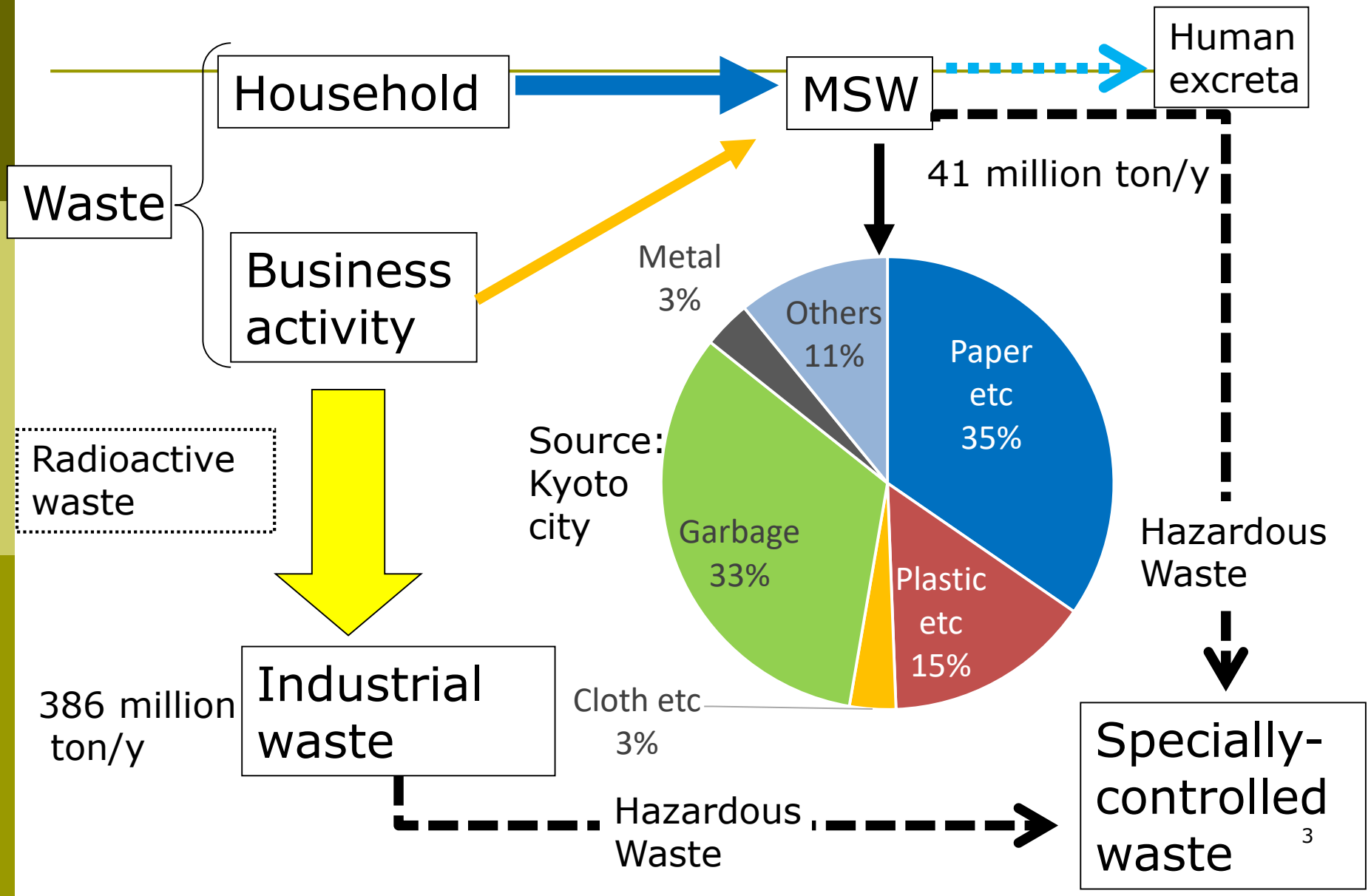
Content

- Waste treatment in Japan
- The Conventional Role of Thermal treatment (merit and demerit)
- GHG reduction and Waste to power generation
- Latest WtE technologies
- Conclusions & Future Challenges

Classification of Waste in Japan



Position and Function of WtE in Sound Material Cycle Society

Order in Priority of MSW Treatment

- Reduce
- Reuse
- Material Recycle
- **Waste to Energy**
- Proper Treatment

Biogas

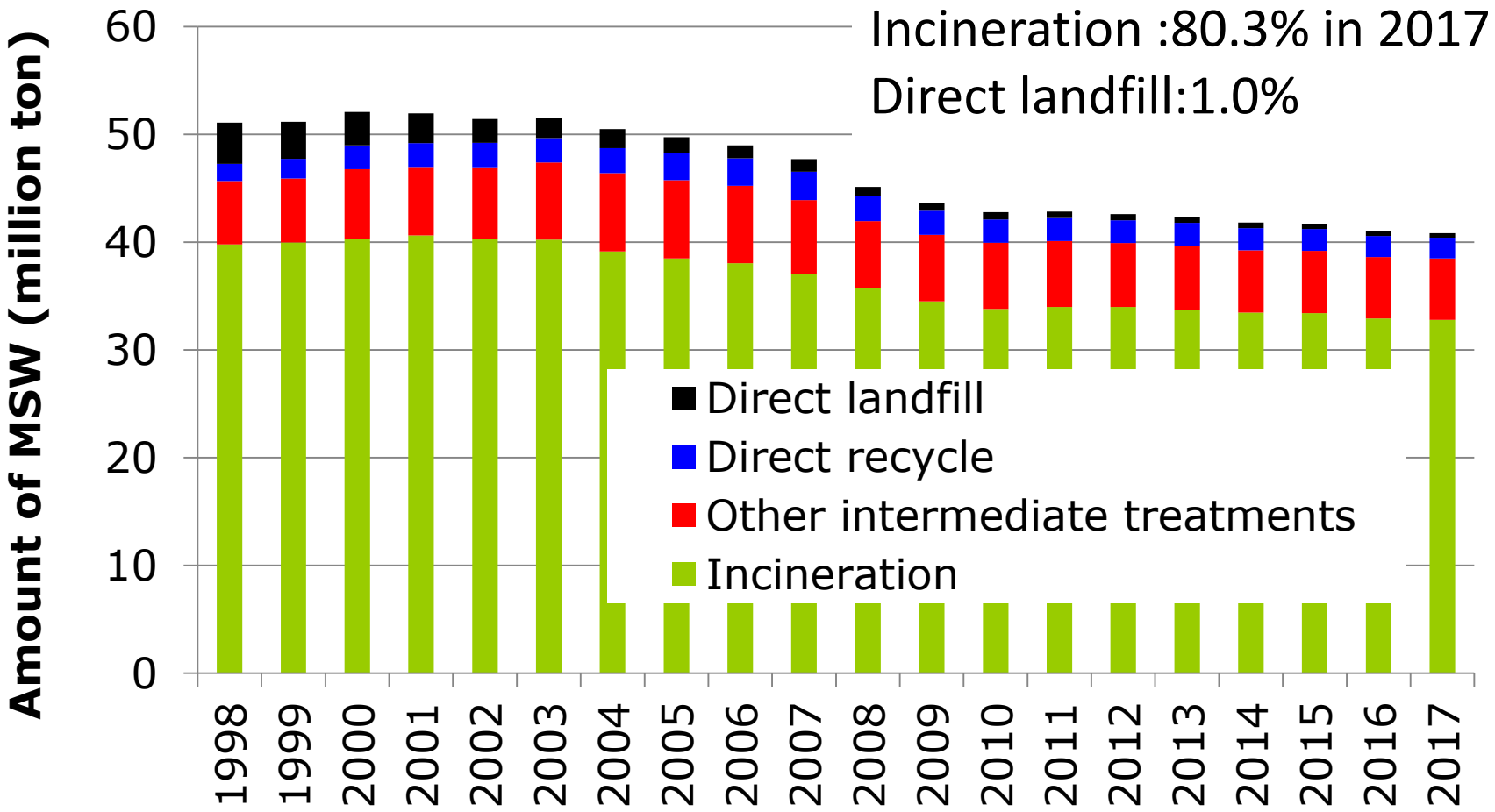
- Energy recovery
- But, sludge residue still remains.

Thermal Recovery

- Hygienic waste treatment
- Drastic volume and weight reduction
- Energy recovery

- But,
- Concern for emitting hazardous compounds
- Major source for CO_2 emission

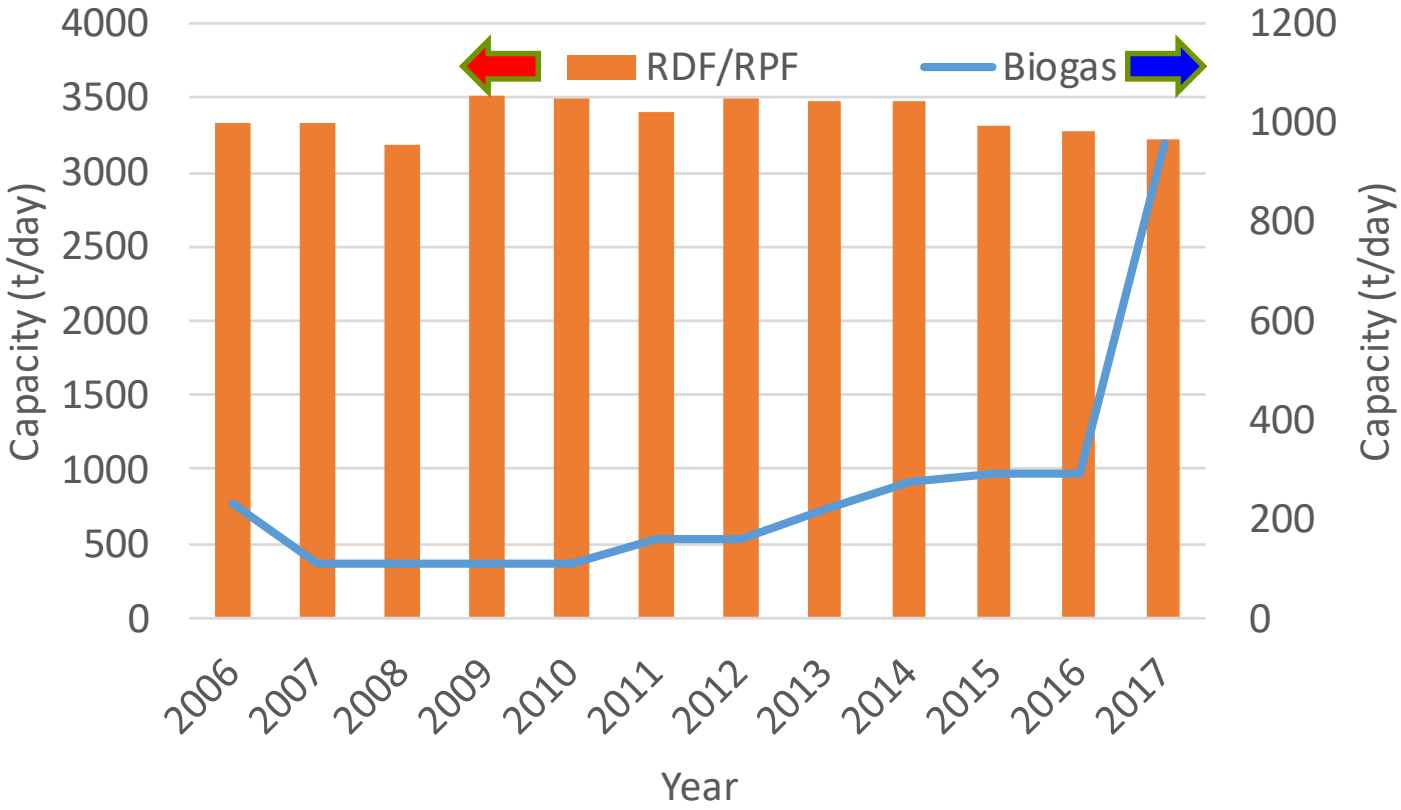
Trend of Treatment Type in MSW



Source: MOE

Other WtE technologies for MSW

- Incineration:180,471 t/day

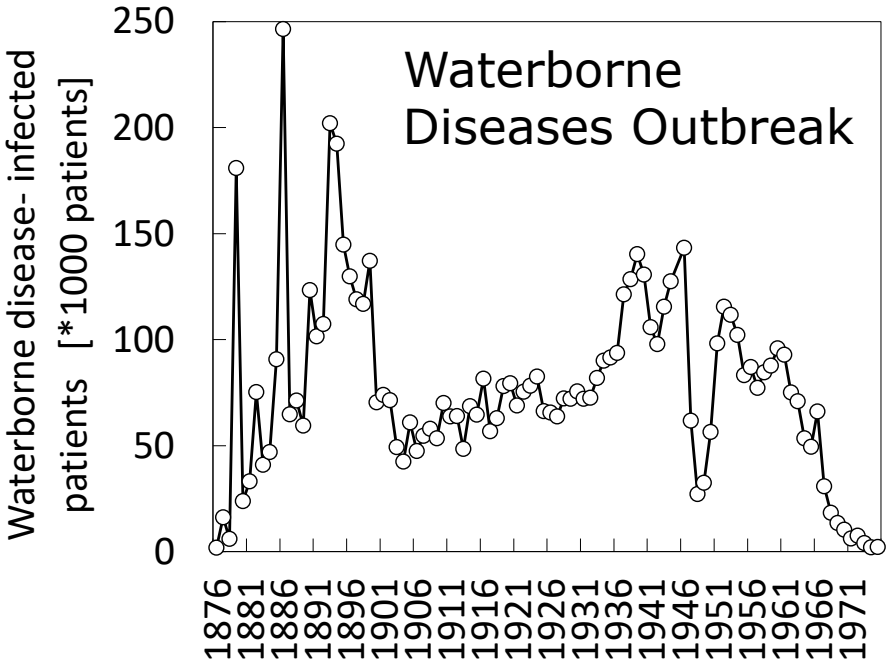


RPF from IW (JRPF)
Production: 1.3 million ton @2017
Demand: 2.0 million ton @2020

Biogas from Sewage Sludge (MLIT)

- 218,000 ton-DS
- 150GWh/y

Hygienic Treatment



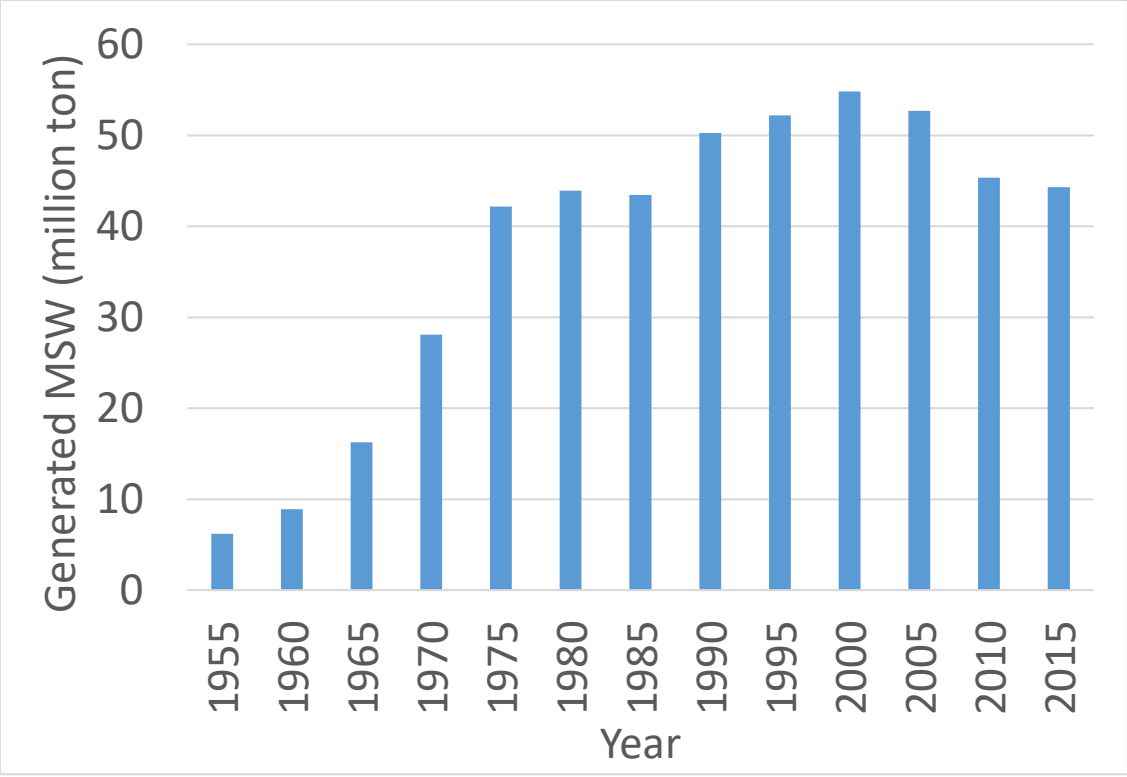
Source: Statics Japan

- Stop national isolation policy 150 years ago
- Gas light, Steam train, Telegram, Western Medicine,,,
- Out break : > 0.1 million deaths before 1879
- In 1890, "Garbage should be **incinerated** in the outbreak of cholera ."
- In 1897, Infectious Diseases Prevention Act issued
- In 1900, Unsanitary Substance Cleaning Law established
- Municipality is responsible for cleaning of waste (garbage, human excreta)

Waste management as a public health measure

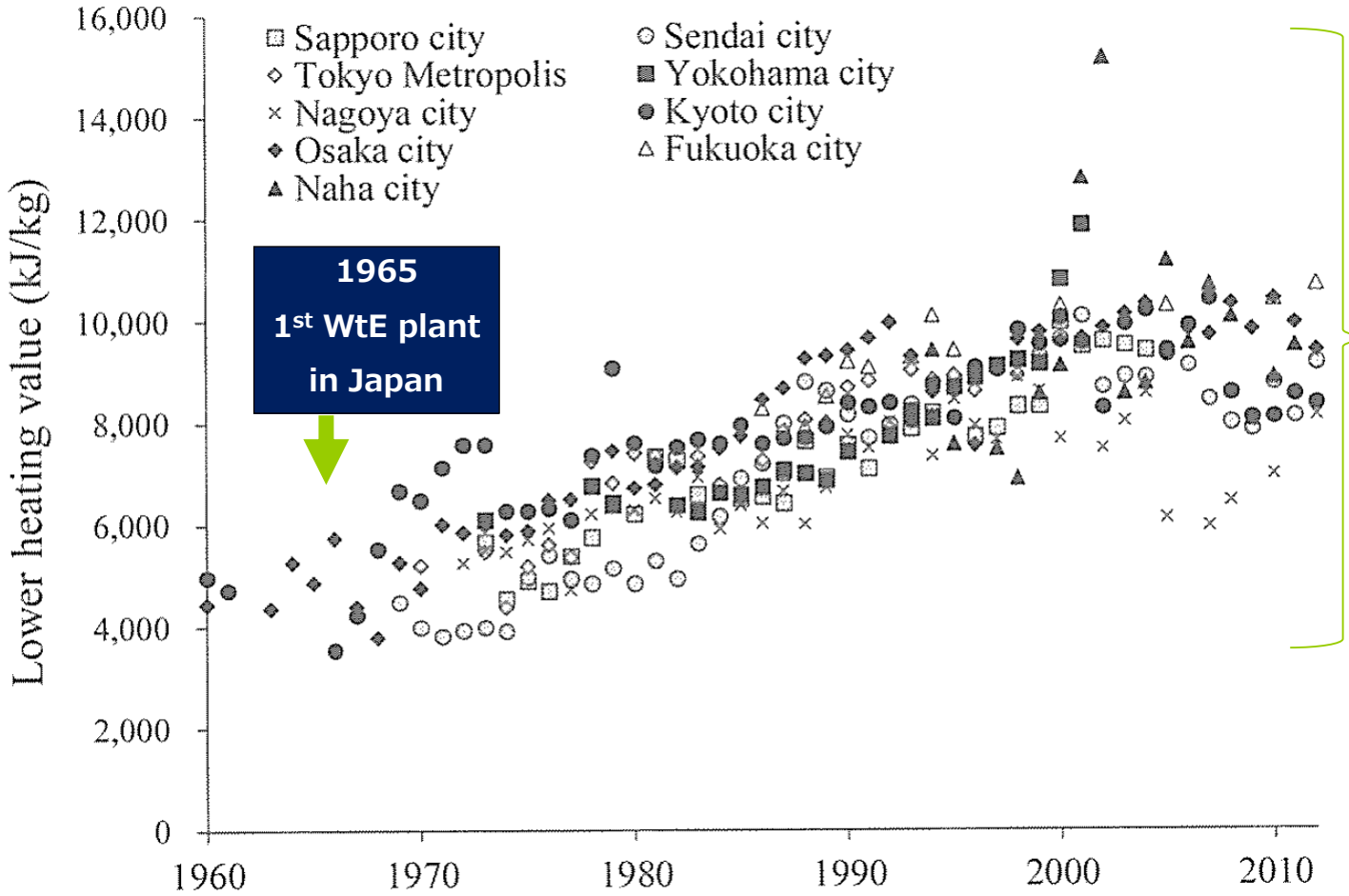
Volume reduction was urgent.

- At the beginning of the 1960s, **the high economic growth** resulted in **a large increase** in **the amount of waste generated**.
- Drastic reduction of MSW(1/10 in gravity) is possible and good for limited landfilling.



Source: MOE Japan

Change of Lower heating value



Incineration technology can handle a wide range of waste calorific values

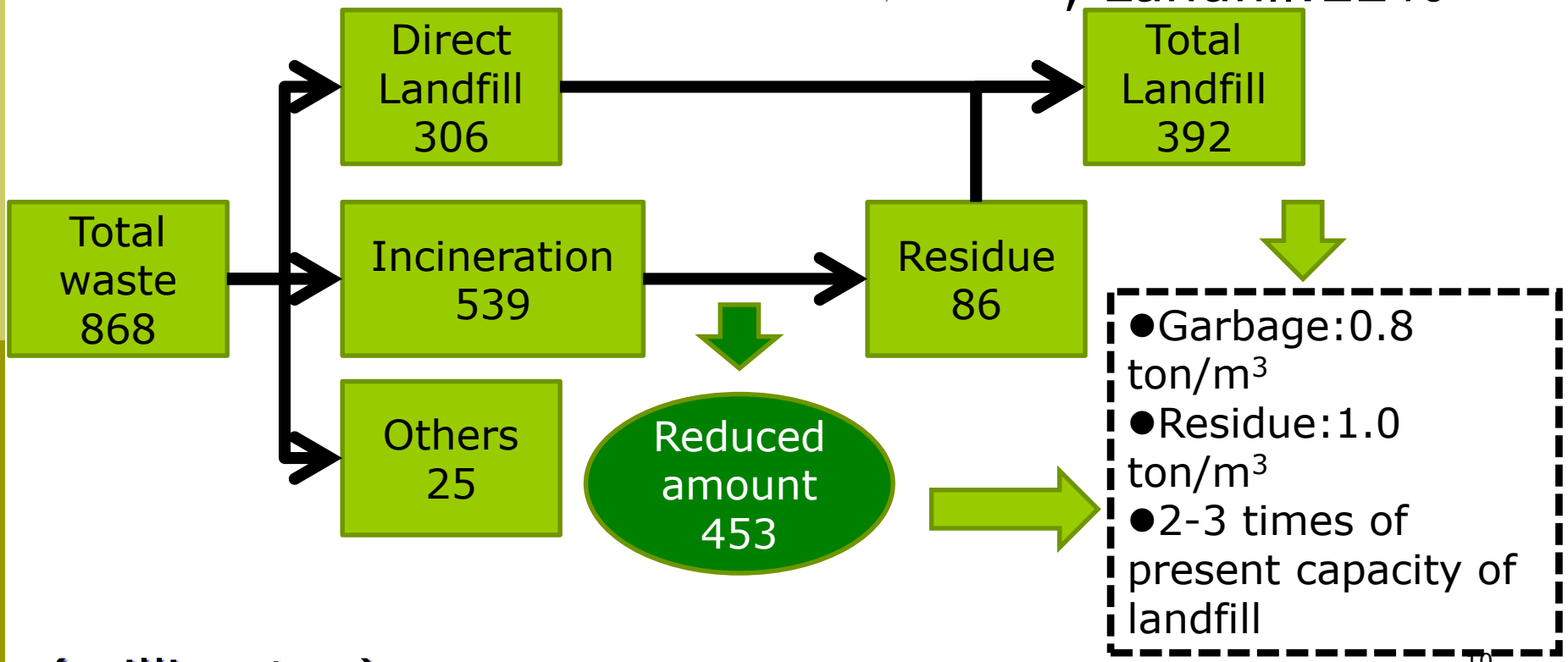
Source: Kawai and Tasaki, 2019

Volume Reduction

- 1965
- Incineration:46%, Landfill:48%

25 years

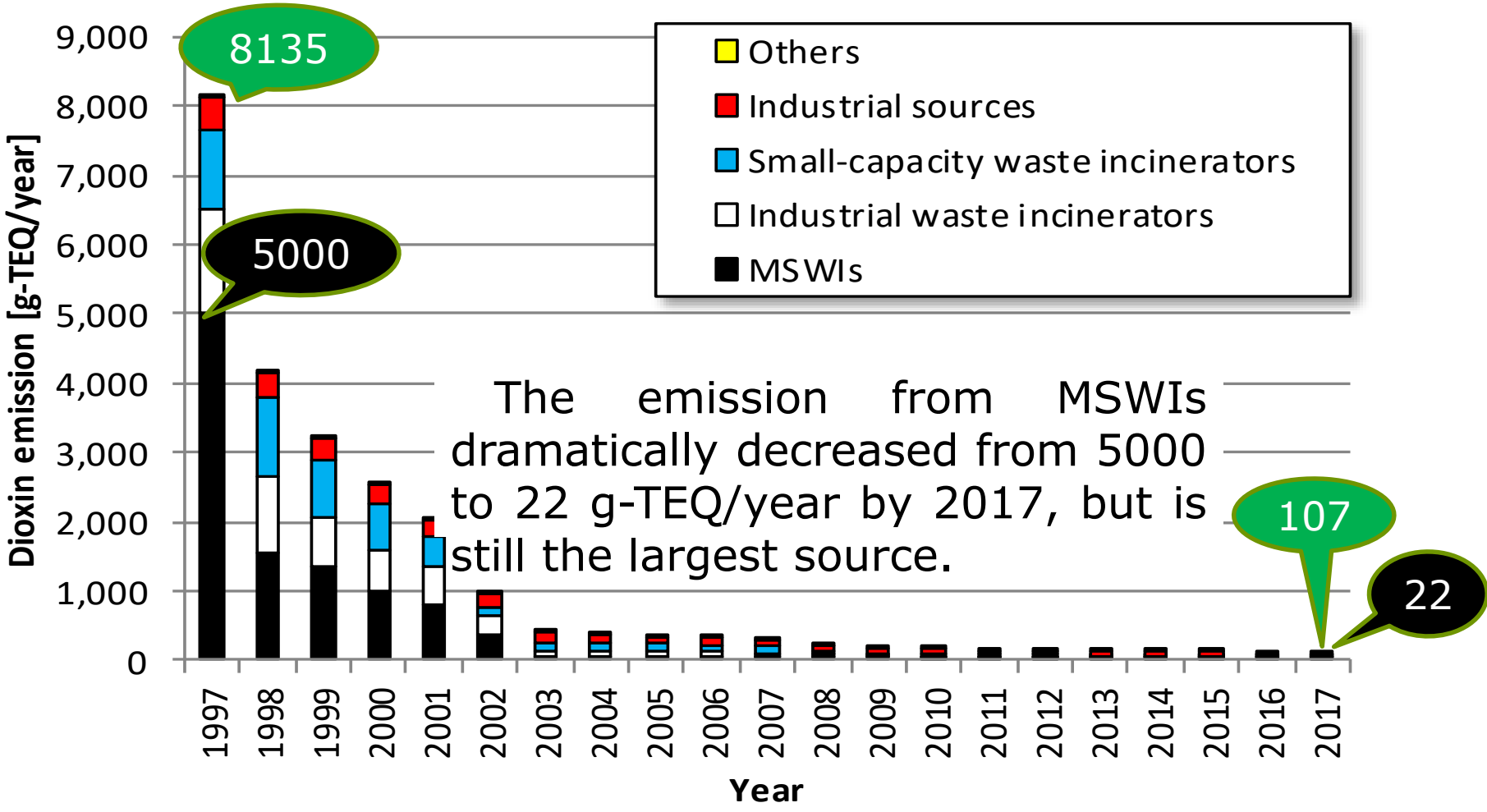
- 1989
- Incineration:74%, Landfill:22%



(million ton)

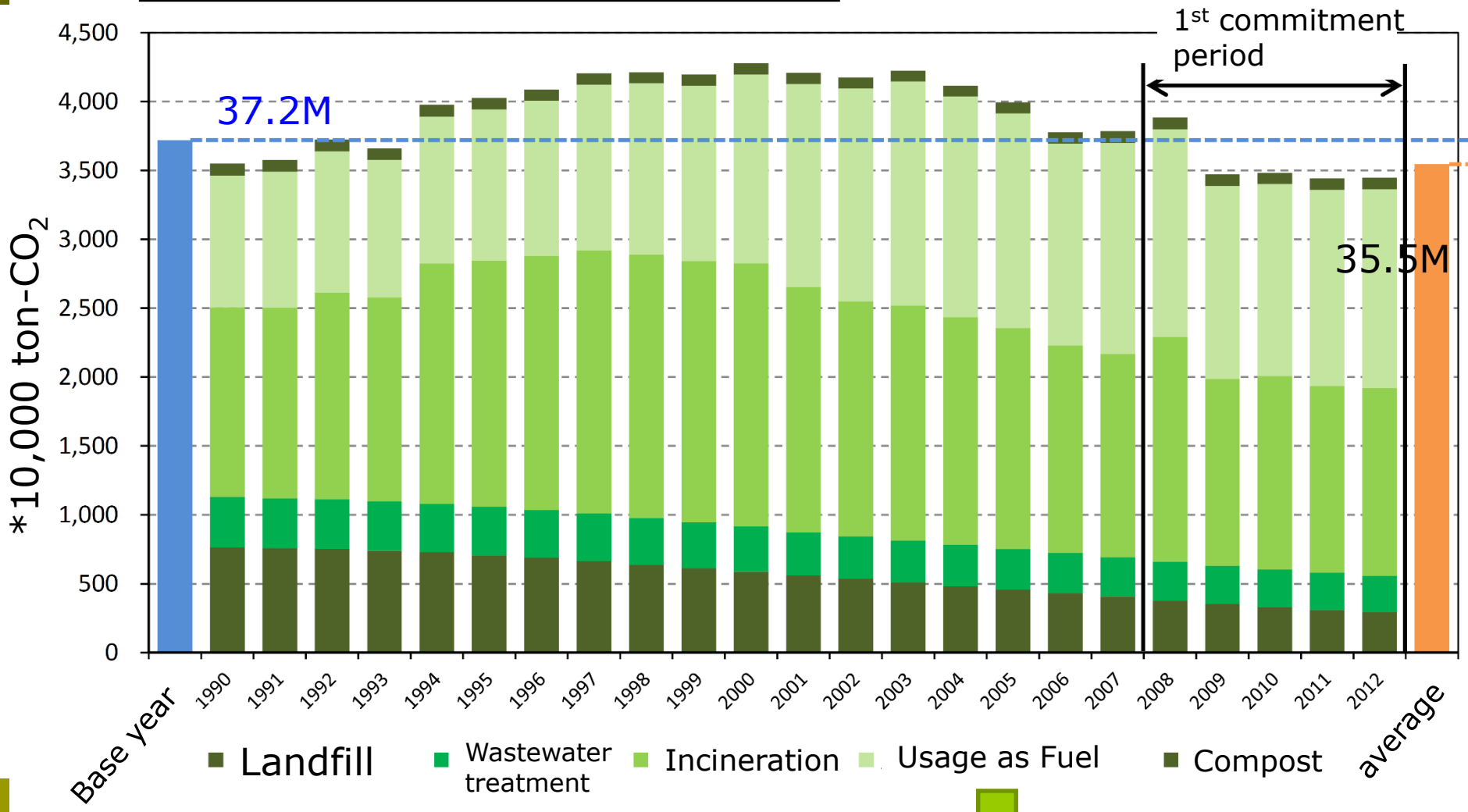
Source: MSWI division, JMCWM 1996

Trend in total dioxin emissions to the atmosphere



Source: MOE, 2019 and Takaoka etal., 2019

Emission of Green House Gas from Waste Sector



Waste to Energy

Source: MOE

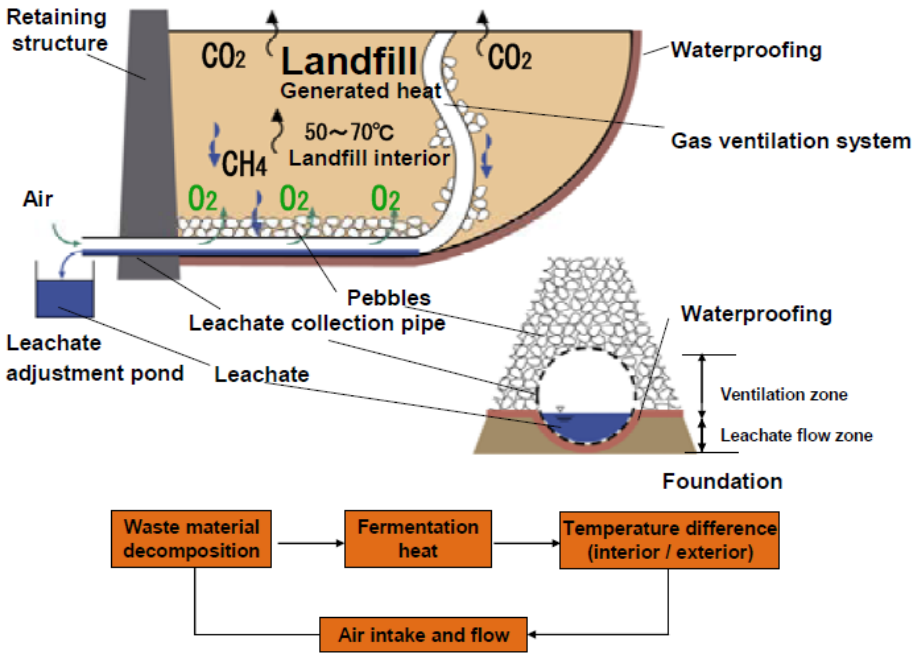
When all of the MSW were directly landfilled…

- Water content of MSW:50%
- 70% of the weight in dried condition: biodegradable organic waste
- The original source unit of CH_4 by **semi-aerobic** landfill: 70kg-CH_4/t-DB

●943 thousand tons（×21）as CH_4

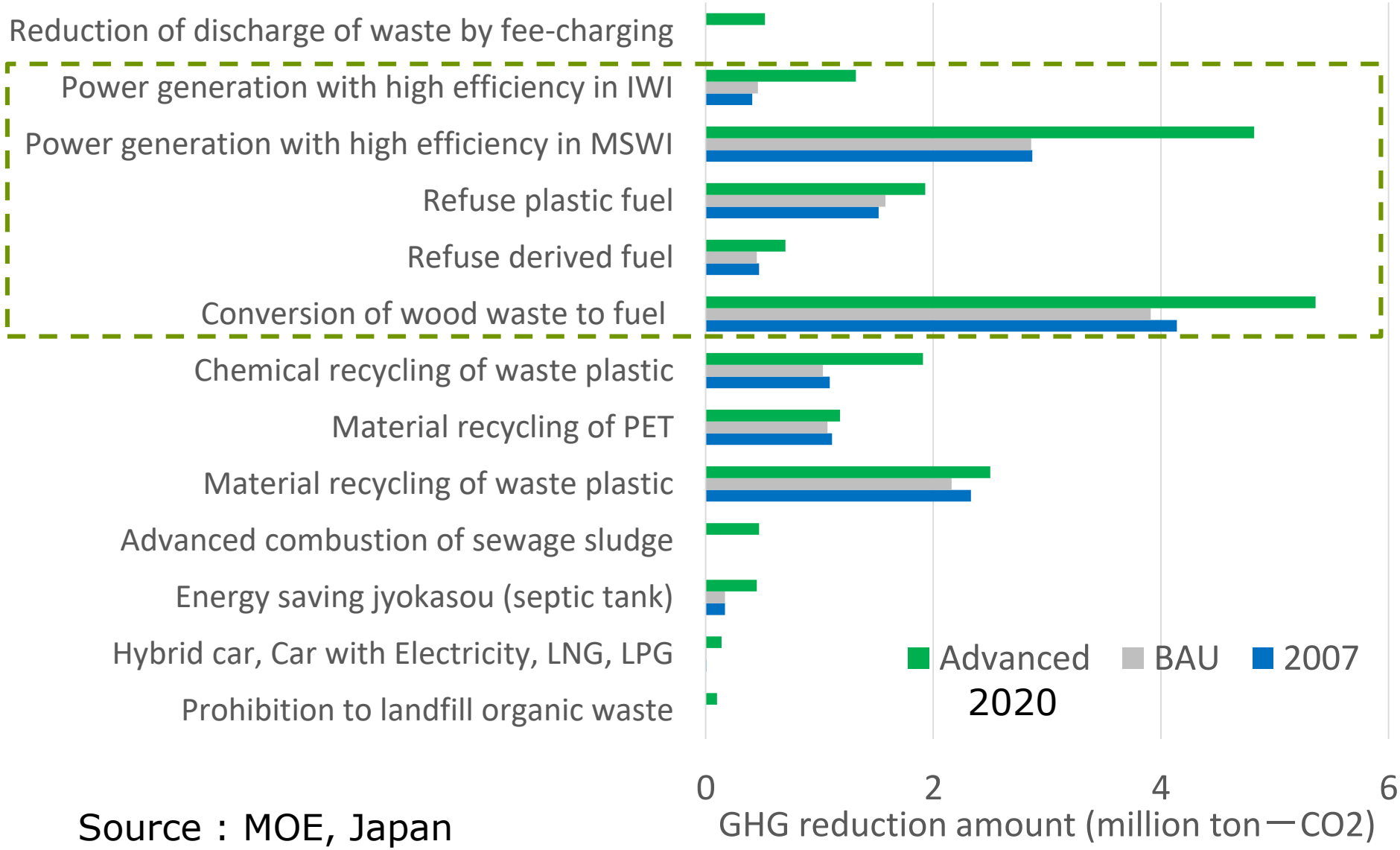
●19.8 million tons of CO_2 are emitted from **Landfill**＞15.4 million tons from **MSWI**

@2005



Matsufuji, 2011

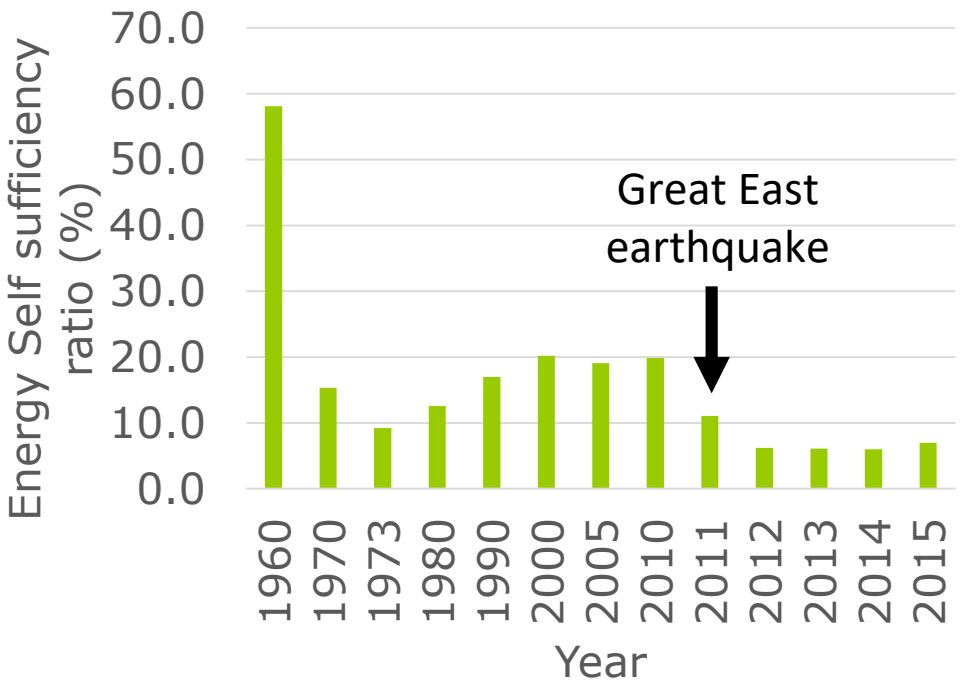
Estimated GHG Reduction by Various Countermeasures in Waste Sector



Source：MOE, Japan

Waste is an Energy Source

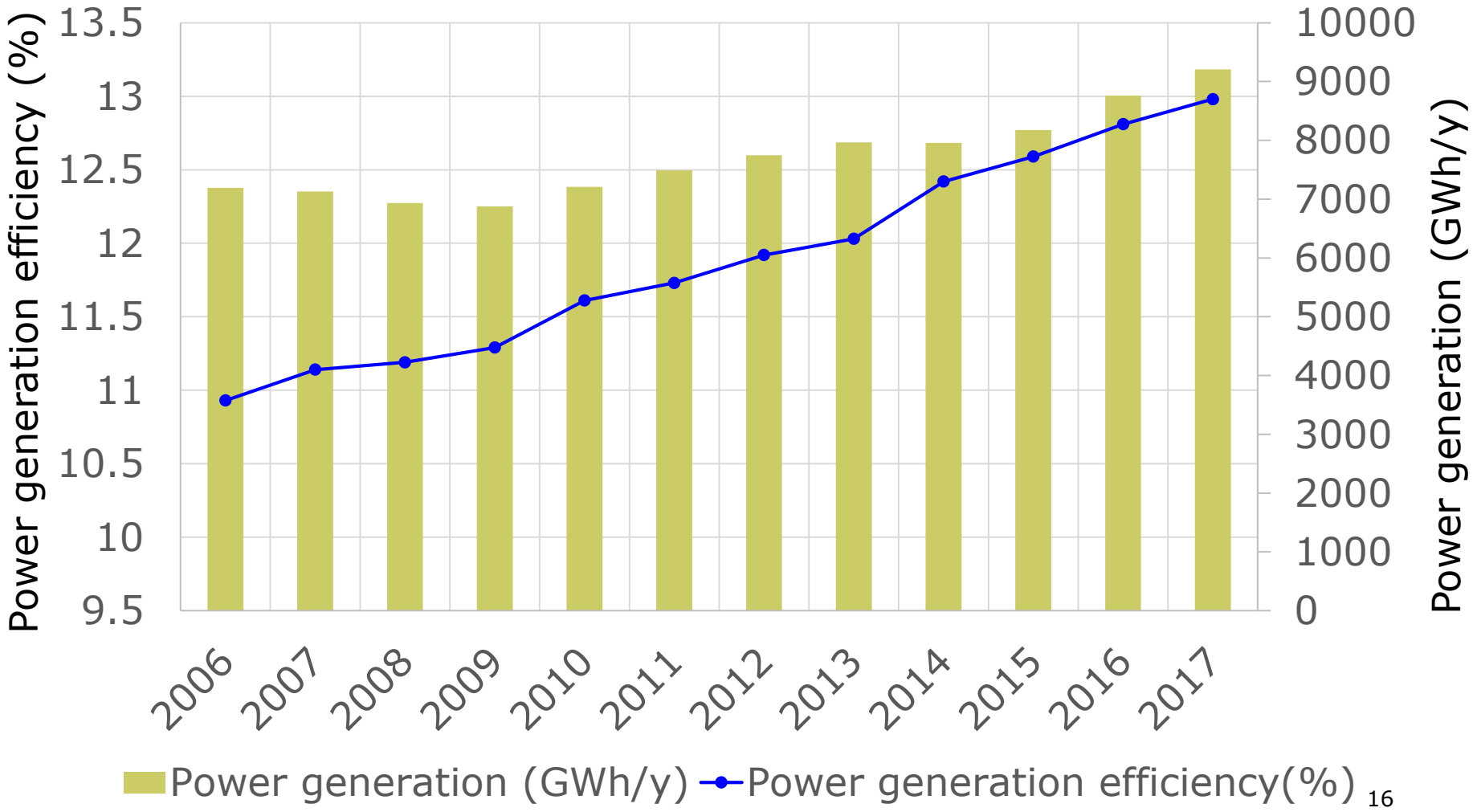
Recovered energy from wastes will **become an alternative energy for fossil fuels.** Around **165-206**L of crude oil are collectable per **1 ton of waste** considering the boiler efficiency of 80% and calorific value from crude oil of 10 thousand MJ per 258 L.



- **Local production for local consumption** : Both waste generation and electricity consumption are in same area.
- Energy from waste: more stable than wind and solar PG.

Source: Agency for Natural Resources and Energy

Waste to Power generation



Source: MOE

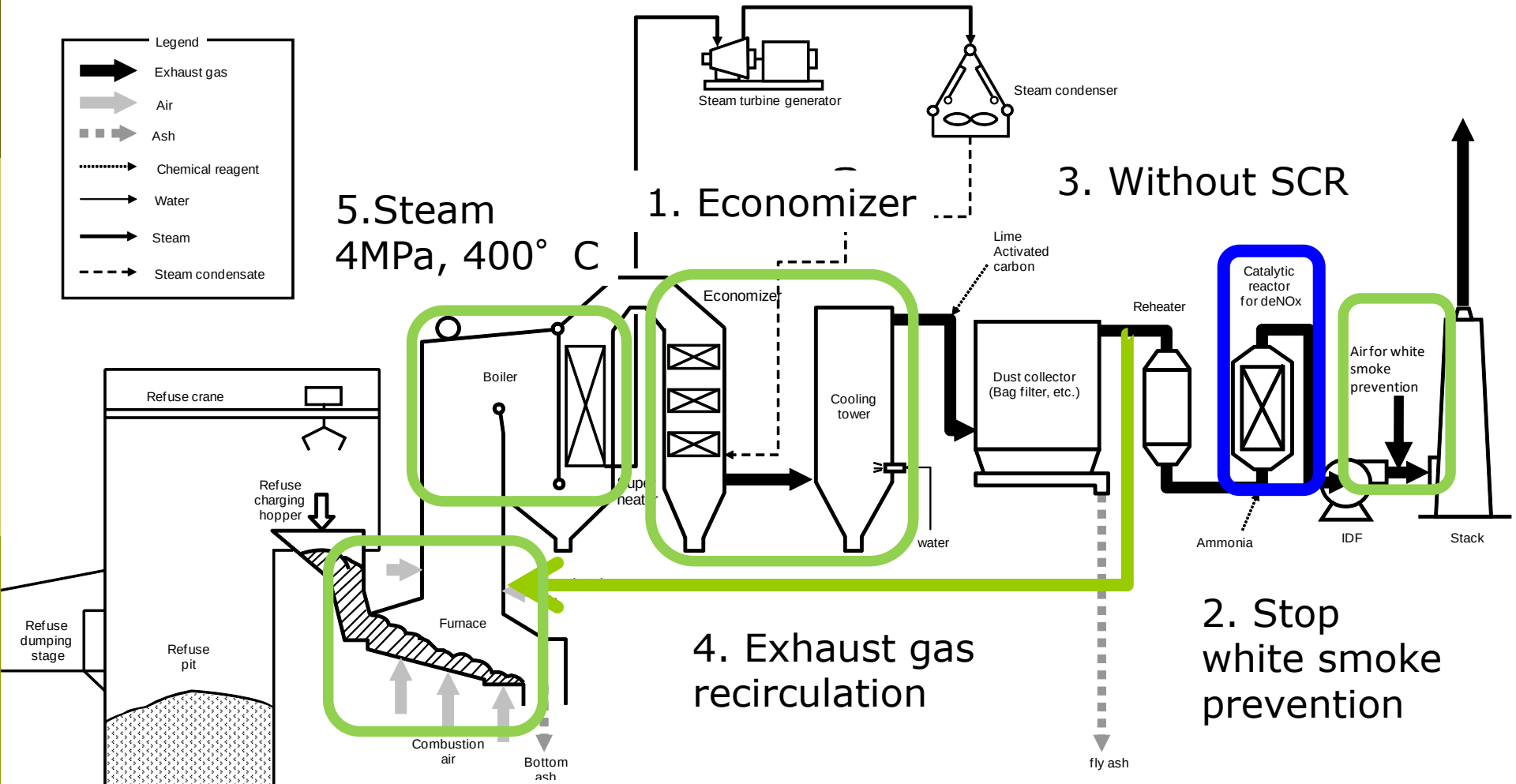
Promotion of Waste to Power Generation

- In Japan, Ministry of the Environment made **a subsidy system** and **a guide book** to promote construction of MSWI with high power generation efficiency in 2009.
- In the guide book, various existing **technological options and combinations** were recommended to achieve **more than 20%** of power generation efficiency in MSWI with capacity of 500 ton/day-level.

Recommended Technological Options

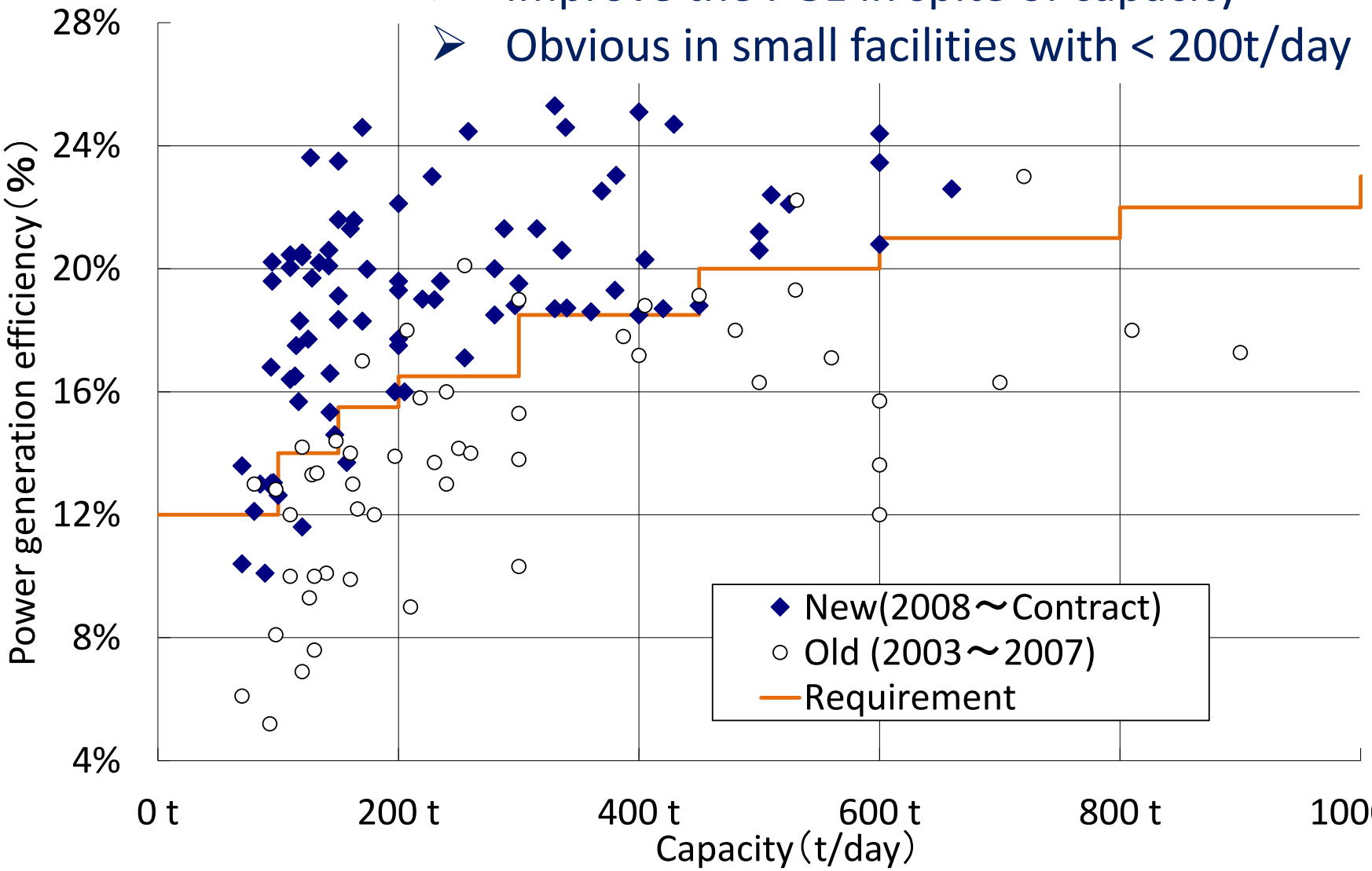
- Air ratio: 1.2-1.4
- High tem. and pressure steam conditions: 4 MPa*400 degree C
- Low temperature economizer: 160 -180 degree C
- Dry type APCDs
- Without SCR (SNCR)+EGR : <30-50 ppm NOx

Application of Various Options



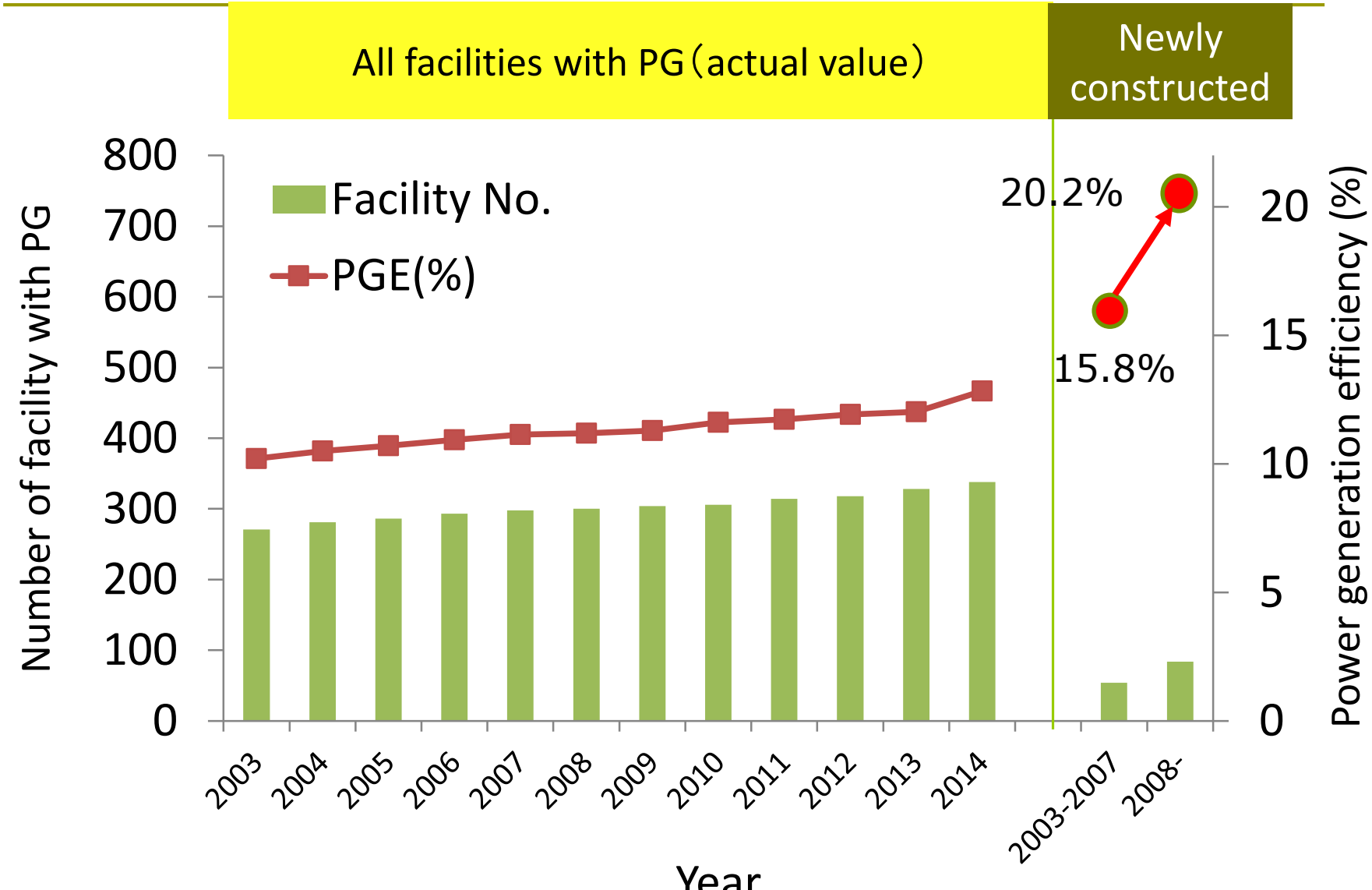
Change of PGE Before and After Promotion

- Improve the PGE in spite of capacity
- Obvious in small facilities with < 200t/day



PGE（Weighted Mean）

- 15.8 ⇒20.2% in newly constructed MSWI

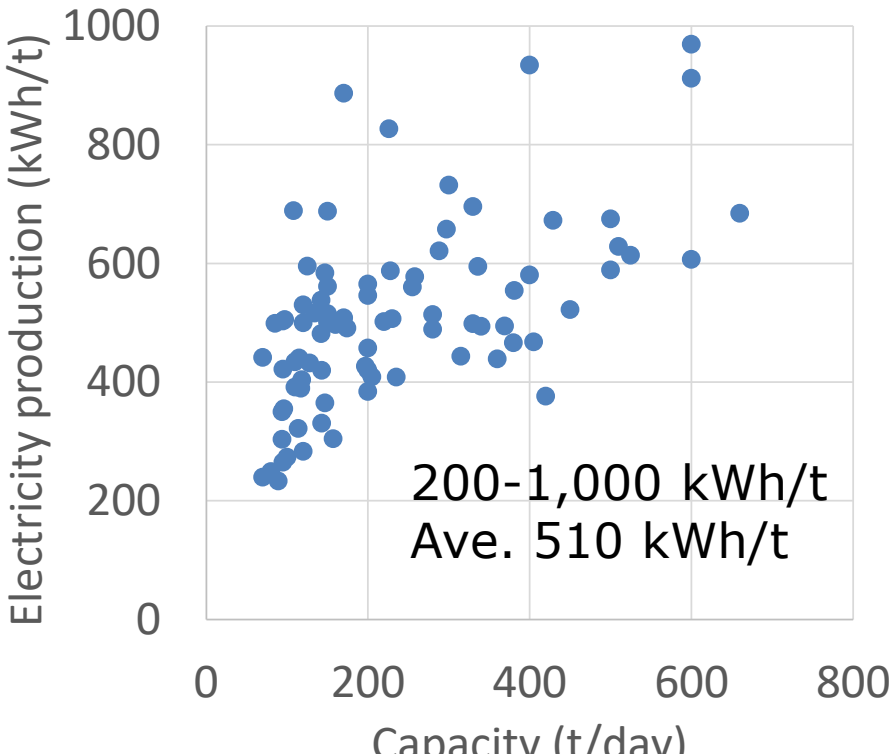


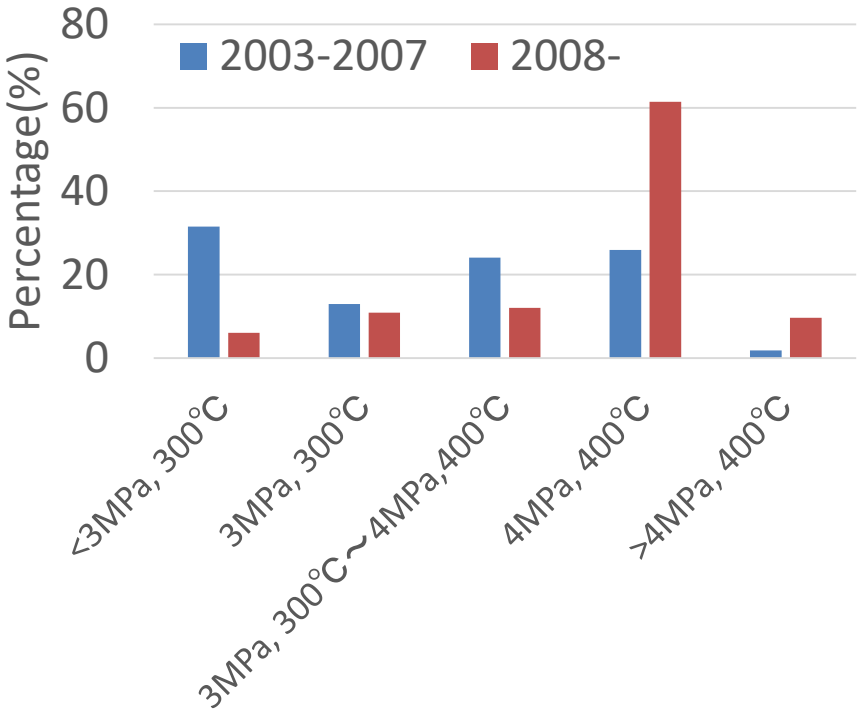
Electricity Production

Heating value	L (kJ/kg)	M (kJ/kg)	H (kJ/kg)
Average	5,850	9,035	12,216
Min.	4,100	6,700	8,710
Max	9,200	13,820	16,750

Change of Steam Condition

Anti-corrosion material
Sprayed coating
Design of Boiler etc.



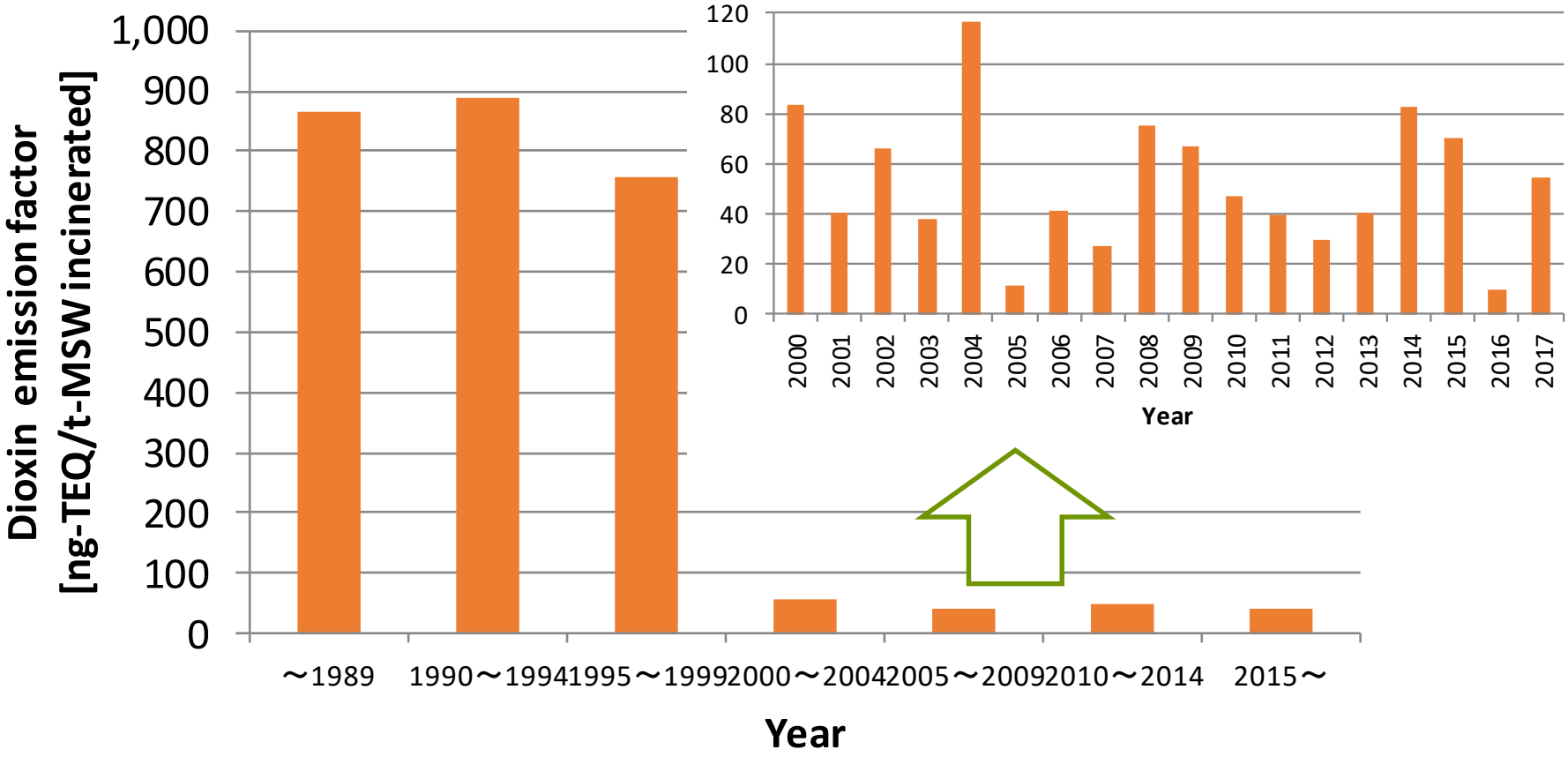


Estimation of PG & CO_2 Reduction

- When MSW for incineration is treated at facilities with **20.2% of PGE,**

Item	Unit	2012	Potential	Remark
PGE	%	11.9	20.2	
Incinerated waste	1,000t/y	33,991	33,470	
Lower Heating Value	kJ/kg	—	9,035	Average
Power generation	GWh/y	7,718	16,968	
Increase in PG	GWh/y	base	9,250	Eq. to 1.52 NPP with 1million kW
CO_2 emission coefficient	t-CO_2/MWh	0.555	0.555	
CO_2 reduction	1,000t-CO_2/y	base	5,134	51% of CO_2 accompanying MSWI can be offset

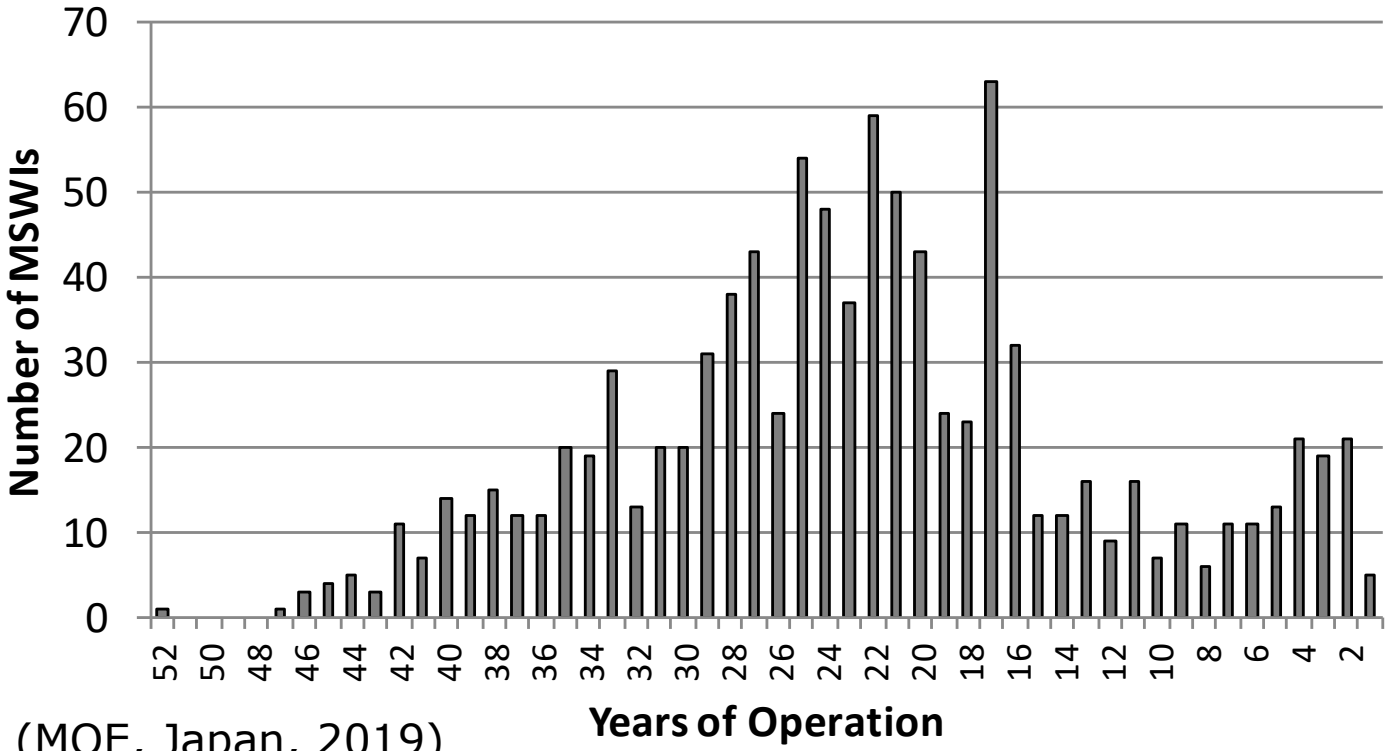
Dioxin emission factors by construction year of the MSWIs



- The average emission factor from facilities constructed after 2000 was **50** ng-TEQ/ton of MSW incinerated. 1/10 of the lowest PCDD/PCDF emission factor in the Stockholm Convention

Source: Takaoka etal., 2019

Number of MSWIs by years of operation



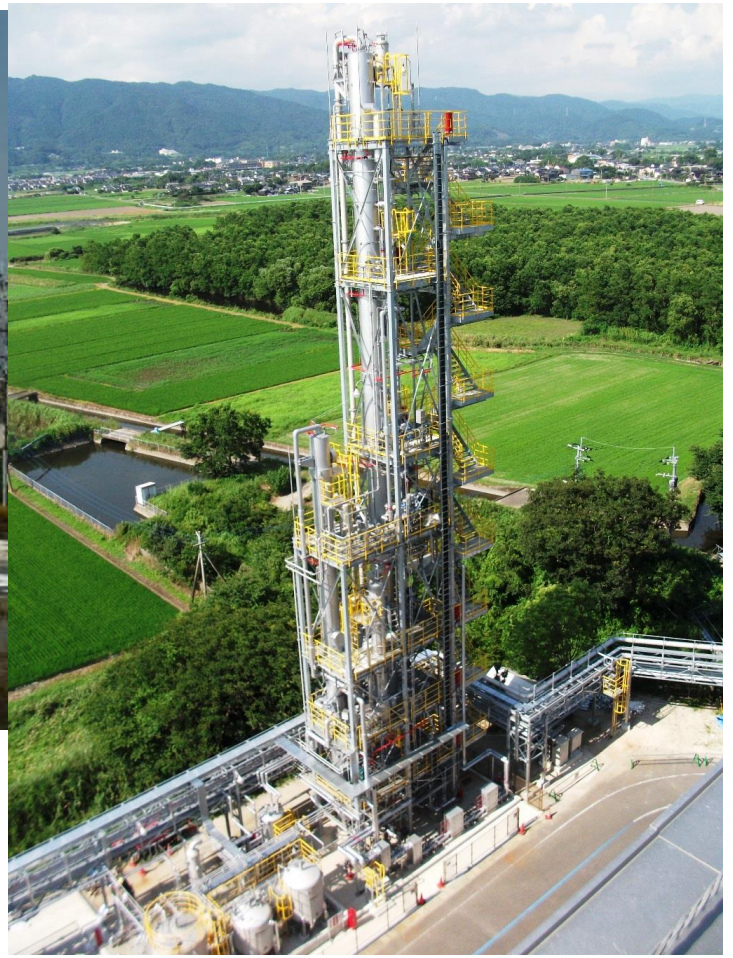
(MOE, Japan, 2019)

- The typical service lifetime of an MSWI is considered to be 40-50 years.
- **More consolidation and integration** with other social infrastructures should be promoted.

Combined System

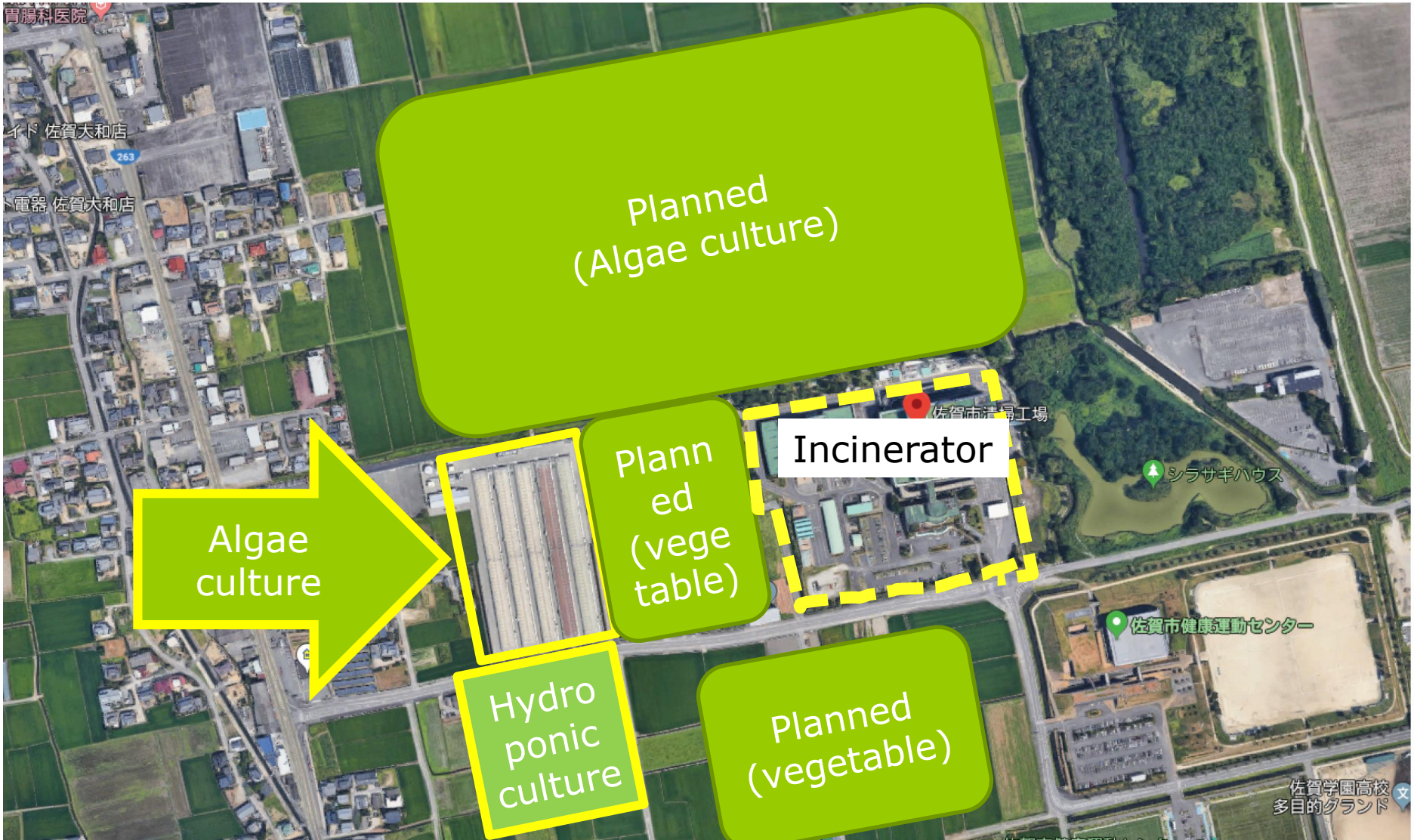
Kyoto City (Operation just start from 1st Oct., 2019)
MSWI 500 ton/day+ Recycling 180 ton/day+ Biogas(Dry) 60 ton/day

Waste to Energy + CCU



- Saga City in 2016
- 300t/day stoker type
- 10t/day CO_2 recovery

Agricultural use
= No longer NIMBY



Conclusions & Future challenges

- Thermal treatment still has an important role as appropriate treatment of waste.
- Waste to Energy is an promising option for preventing global warming in waste sector.
- Technological development should be encouraged. Policy support is also necessary for growth in the world.
- Other WtE technologies such as biogas plant, RDF/RPF, etc. should be encouraged. The combination of processes has several benefits.
- Principle of disposal waste within the boundaries of each ward should be relaxed. More consolidation and integration with other social infrastructures should be promoted.

Acknowledgement

- Invitation for Symposium Organizing Committee
- Useful discussions and supports for members in the research group for waste incineration in Japan Society of Material Cycles and Waste Management.

Thank you for your kind attention!