International Workshop - Session 1

Promoting low carbon industries through urban symbiosis

Promoting low carbon industries through urban symbiosis

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In recent years, major cities in Asian countries have realized dramatic economic growth, which has provided products that sustain people's affluent lifestyles throughout the world. However, the environmental pollution generated as a consequence of this growth jeopardizes the lifestyles of people and resource- and energy-intensive industrial structures are also placing a huge burden on the overall global environment due to the emission of greenhouse gasses and mass consumption of resources, etc. Shifting to a sound material-cycle society with a low carbon emission is therefore an important issue for people in Asia.

As an alternative to promote a low carbon industry, the author and his group recently proposed a concept of "hybrid industry" which is a technological and institutional system to utilize waste, waste heat and renewable resources in industries as much as possible and acts as an innovative waste management system to reduce carbon dioxide emissions and cost (Fig. 1). This concept was partly based on "urban symbiosis" (Geng et al., 2010; van Berkel et al., 2009), which spatially expands the concept of "industrial symbiosis" (Chertow, 2000). Urban symbiosis can be defined as "the use of byproducts (waste) from cities (or urban areas) as alternative raw materials or energy sources for industrial operations.

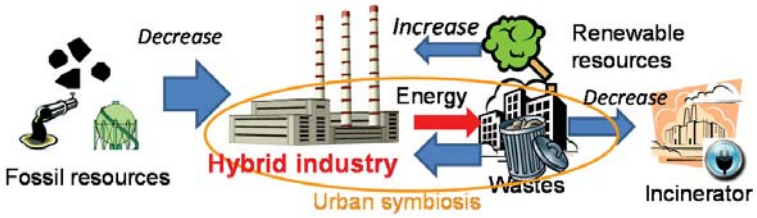

Fig. 1 Conceptual diagram of a hybrid industry

The recycling to use existing facilities in indsutries such as steel, cement, chemical, paper and so on has advantages in recycling efficiency as well as in saving a cost for constructing waste treatment facilities such as an incinerator. Figure 2 shows the efficiencies of several recycling methods of waste plastic containers and packaging (and paper in some methods) which utilize existing facilities in industries, with the efficieny of theoretical maximum efficieny of plastic recycling and the efficiency of waste power generation by a kind of state-of-the-art incinerator (Fujii et al., 2011). The maximum efficiency in terms of energy efficiency is achieved when 1 kg of waste can substitute for 1 kg of the virgin form of the same material with no additional energy input. Since the plastic containers and packaging consist of various kinds of plastics and even contain foreing matters, it is difficult to achieve maximum efficiency. In light of such a situation, hybrid industries have sufficiently high efficiencies. In particular, they are better than the efficiency of waste power generation of the most-advanced incinerator.

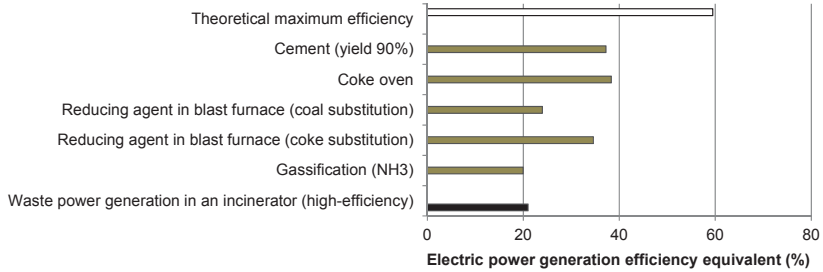

Fig. 2 Efficiencies of recycling utilizing existing industrial facilities and waste power generation.
The graph appeared in Fujii et al., 2011 was modified.

To promote hybrid industries, a system to broaden the kind of wastes to be accepted by industries are required. For that purpose, a filtering function to purify wastes is necessary to make the wastes an acceptable form for industries. Two patterns for the filtering function are supposed: the separation and pre-treatment of waste (filtering function A) and the conversion of mixed wastes to cleaner forms of energy (filtering function B). In the filtering function A, after source ceparation of wastes, wastes with high quality are separately collected and pre-treated before using them as industrial inputs. In this case, incinerators can be reduced but wastes with low quality still need to be treated by incinerators. In the filtering function B, wasts are combustied altogether in an incinerator and the steam recoverd by a boiler is supplied to industries. Such a system is more efficient than conventional waste power generation. However, in this case, incinerators are not reduced and an incinerator and industries should be located within several kilometers to transport the steam within acceptable level of energy loss. Because both patterns have advantages and disadvantages, either one can be used depending on the situation.

Cities in Asian countries are in the middle course of the shift to incineration of wastes from dumping. However, in view of the low carbon effect through recycling as well as the cost for recycling and appropriate treatment of wastes, the potential for utilizing existing or newly built industrisl fscilities around those cities should be considered. Important factors which will affect the cost-effectiveness of hybrid indstries are spatial density of wastes generation, composition of wastes, relative labor cost for collection and pre-treatment of wastes compared with construction cost of an incinerator and avoided cost through fissile fuel substitution, proximity from population center of a city to neighboring industries, composition of industry, attitude of citizen to the separation of wastes and so on. In the presentation, the results that these factors are examined in major cities in Japan, China, Korea and potential of carbon dioxide reduction and cost for the hybrid industries in those cities will be reported. Then key drives in order to promote hybrid industries in Asian cities will be discussed.

References:

Chertow, M. R. (2000) Industrial symbiosis: Literature and taxonomy. Annual Review of Energy and the Environment, 25, 313-337.

Fujii, M., Fujita, T., Chen, X., Ohnishi, S., Osako, M., Moriguchi, Y., Yamaguchi, N. (2011) Study on the recycling system of waste plastics and mixed paper from a long-term perspective. Journal of Japan Society of Civil Engineers, Ser. G (Environmental Research), 67 (6), II_439-II_447. (in Japanese)

Geng, Y., Fujita, T., Chen, X.D. (2010) Evaluation of innovative municipal solid waste management through urban symbiosis: a case study of Kawasaki. Journal of Cleaner Production, 18, 993-1000.

van Berkel, R., Fujita, T., Hashimoto, S., Fujii, M. (2009) Quantitative assessment of urban and industrial symbiosis in Kawasaki, Japan. Environmental Science & Technology, 43 (5), 1271-1281.

Promoting low carbon industries through urban symbiosis

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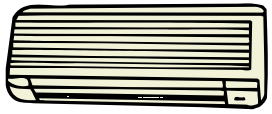
Background

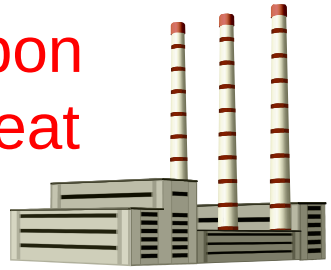
Low-carbon in business operations and civilian sectors is relatively easily achieved to substantial extent by introducing currently available technologies such as PV, battery, FC, heat pump, super insulation, supply and demand control etc.



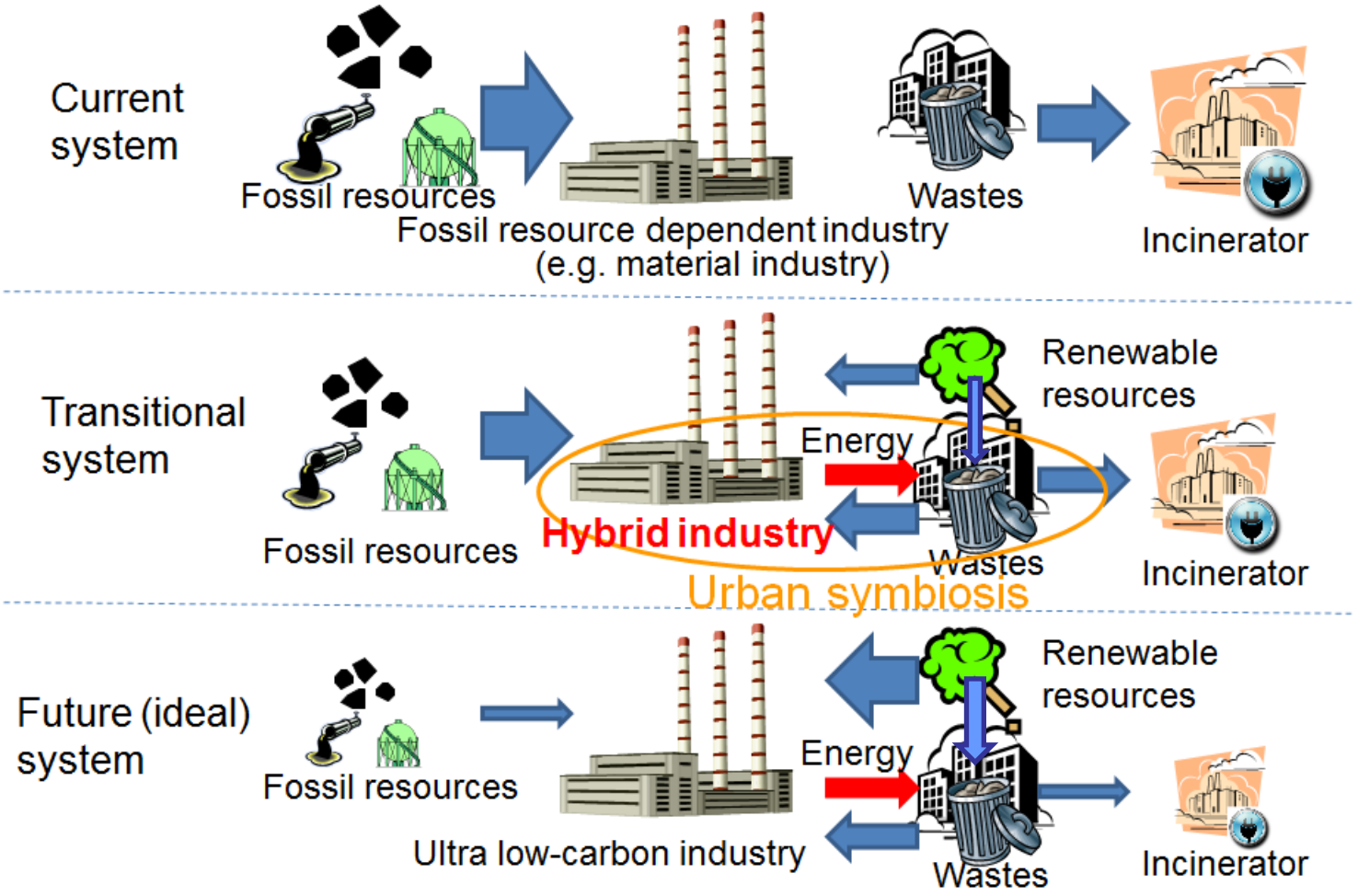


While low-carbon in industries is relatively difficult, especially in Japan where advanced energy saving technologies have been already installed in each factory.

To reduce the CO_2 emission from industries, shift of raw material and fuel from fossil resources to low-carbon resources such as wastes, biomass and waste heat will be required.



Toward low carbon industry



A hybrid type industry which uses not only fossil resources but also utilizes wastes and renewable resources (co-processing) as much as possible will be effective to gradually promote the transition to the low carbon industry.

Hybrid system for promoting green innovation

<Typical existing example>

Gas station

Current system

Petrol-driven vehicle

Transitional system

Hybrid vehicle

Future (ideal) system

Electric vehicle

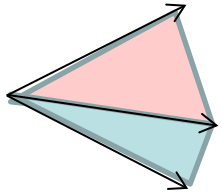
Plug-in station

A plug-in hybrid vehicle can ease drastic investment for building plug-in stations and make it possible to transit gradually from a petrol-driven vehicle to an electric vehicle which is one of the ideal transportations.

Advantages of apparent upgrade

- Highly-efficient use of wastes/biomass/waste heat and resulting greater CO_2 reduction effect

- Expansion of potential demand

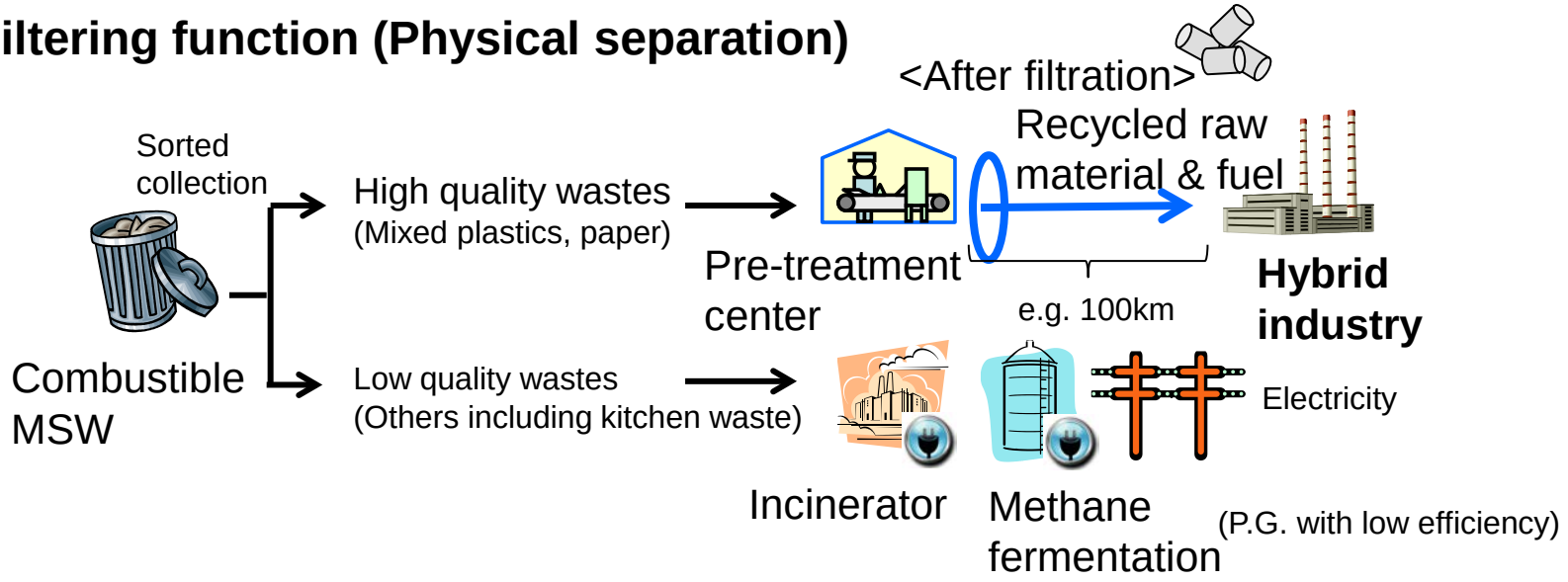


(In general, the demand side of upgraded use has large and stable demand)

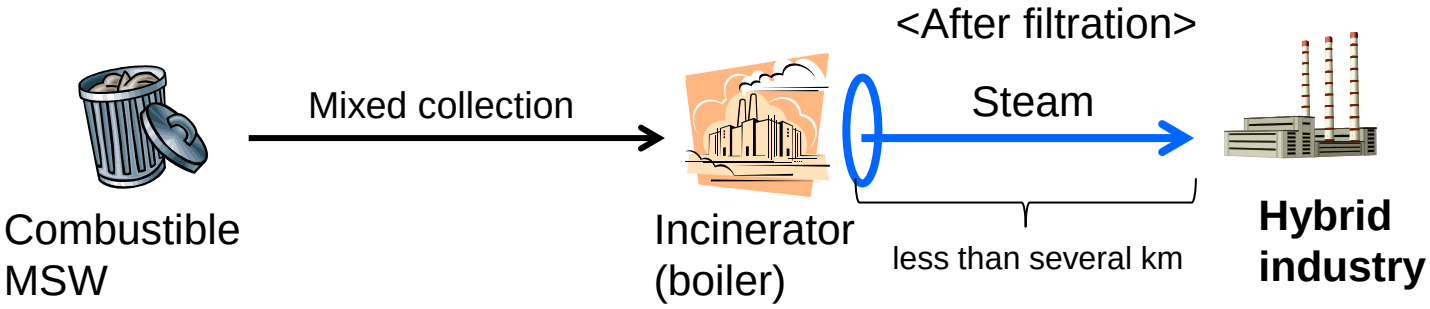
- Flexible supply-demand control can be achieved by the co-processing with fossil fuels

Filtering function to use various energy sources

Filtering function (Physical separation)



Filtering function (Energy conversion)



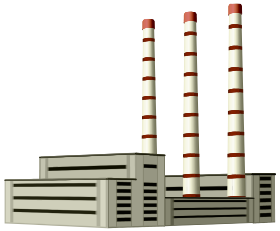
Example of apparent upgrade use-1

Co-combustion of woody biomass in a coal fire power plant

Apparent upgrade use

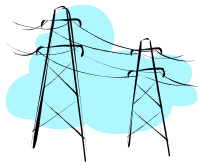
Coal

Wood



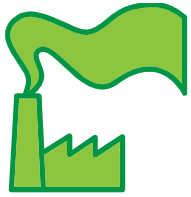
Coal-fired power plant

G.E. > 40%



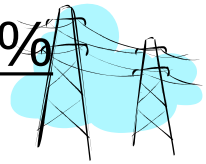
Reference case (biomass boiler)

Wood



Biomass boiler and generator

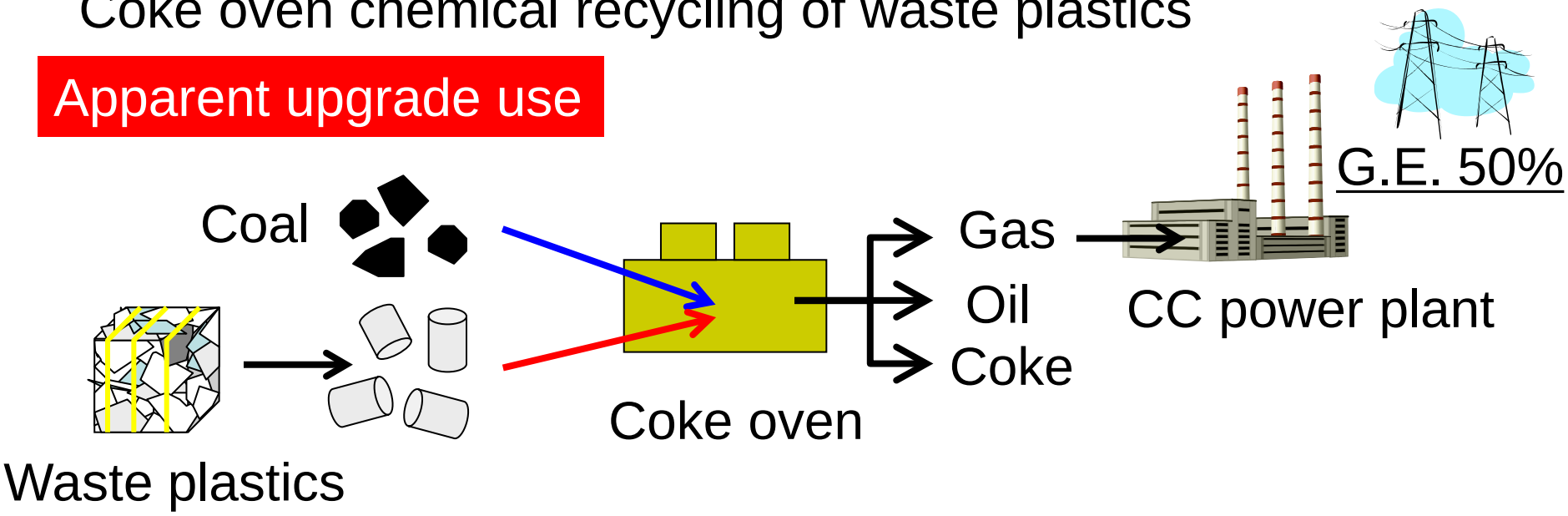
G.E. 15 - 20%



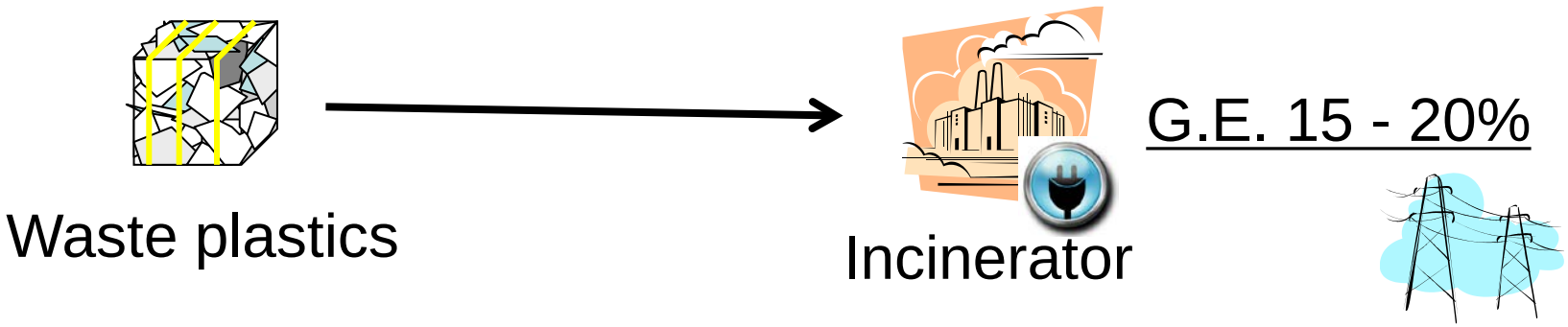
Example of apparent upgrade use-2

Coke oven chemical recycling of waste plastics

Apparent upgrade use



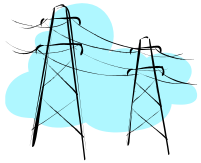
Reference case (Incinerator)

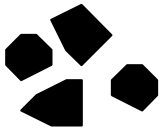
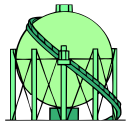


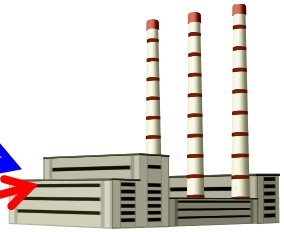
Example of apparent upgrade use-3

Steam supply from incinerator to thermal power plant

Apparent upgrade use



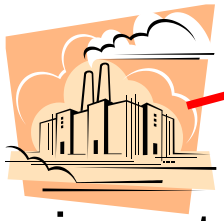
Fossil fuel  



Net G.E. 30%

(Ogawa et al., 2014)

Garbage



Incinerator

Steam (300ºC)

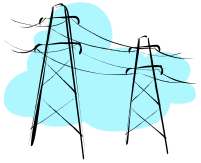
Thermal power plant

Reference case (Incinerator)

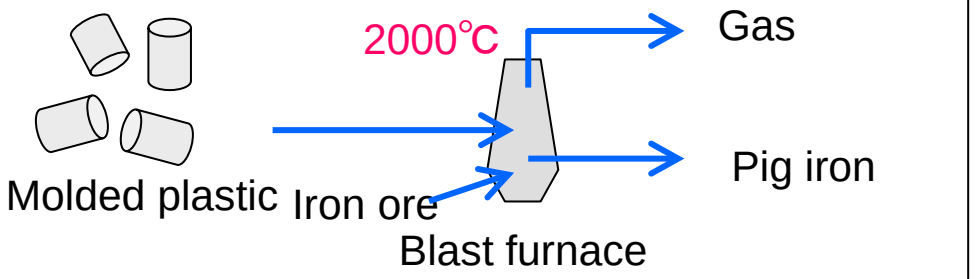
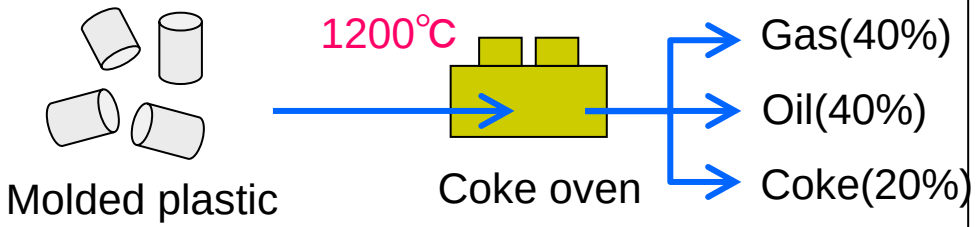
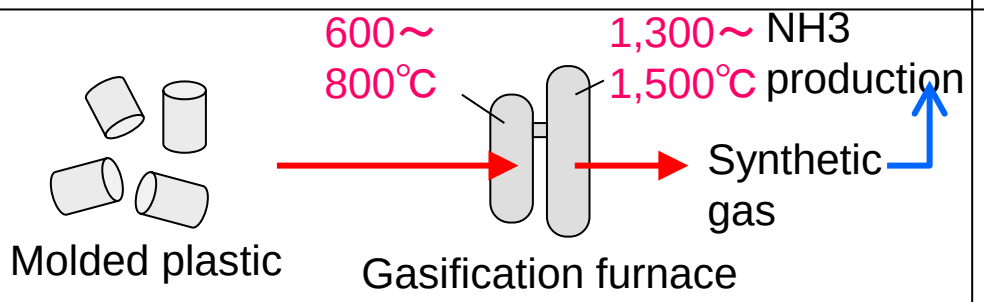
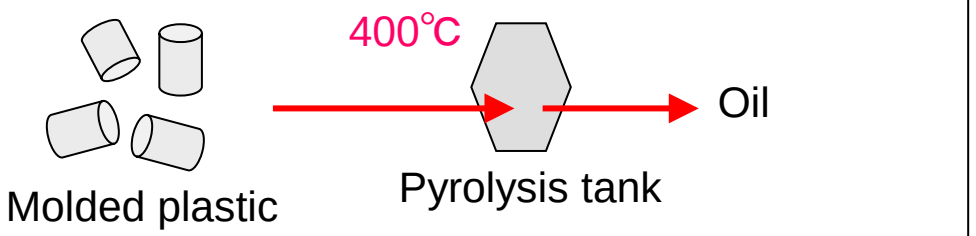
Garbage

Incinerator

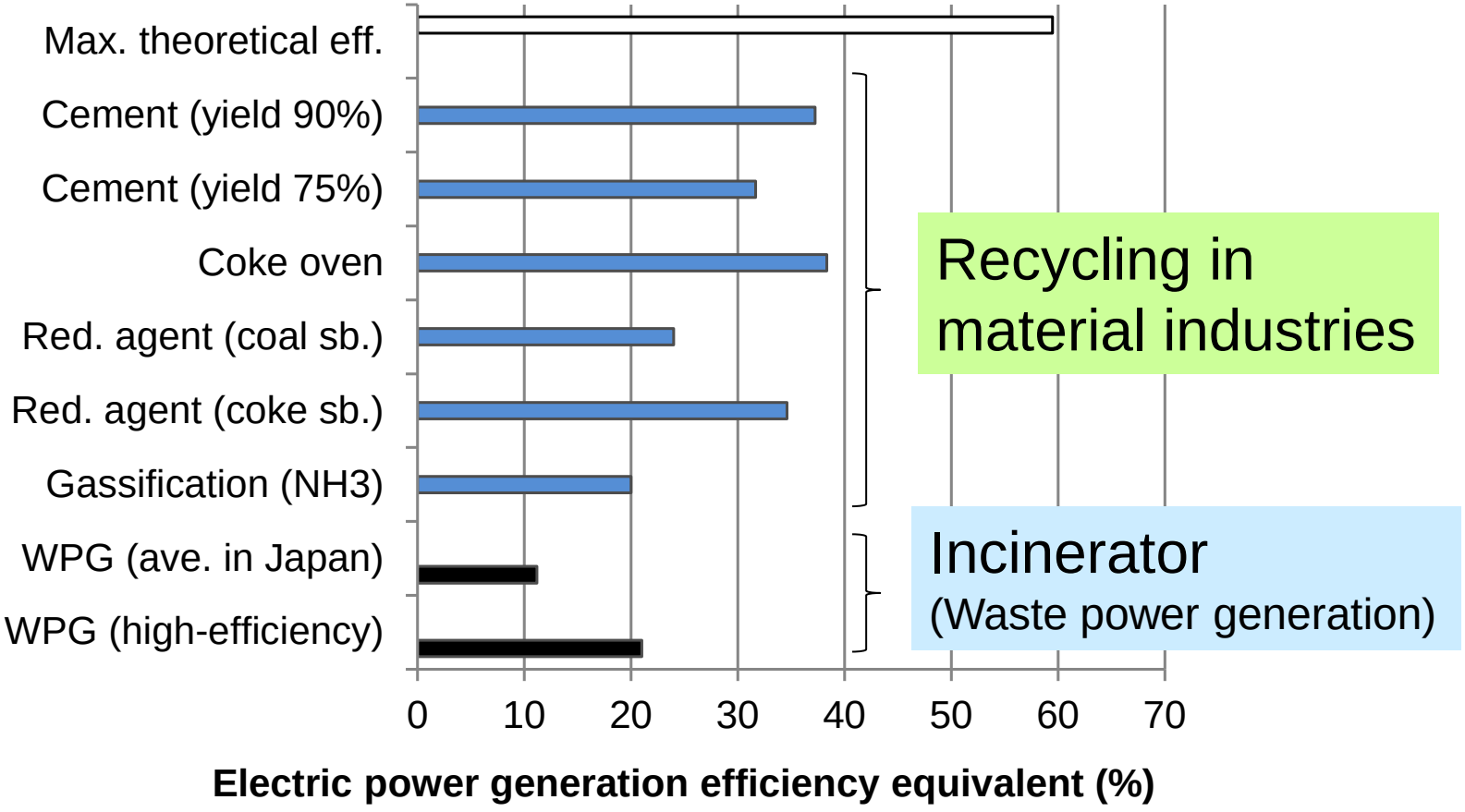
G.E. 15%



Chemical recycling technologies

Blast furnace feedstock recycling		Coke and pulverized coal are substituted
Coke oven chemical recycling		Coke, heavy oil and naphtha are substituted
Gasification (NH_3)		City gas (natural gas) is substituted
Liquefaction		Naphtha or heavy oil is substituted

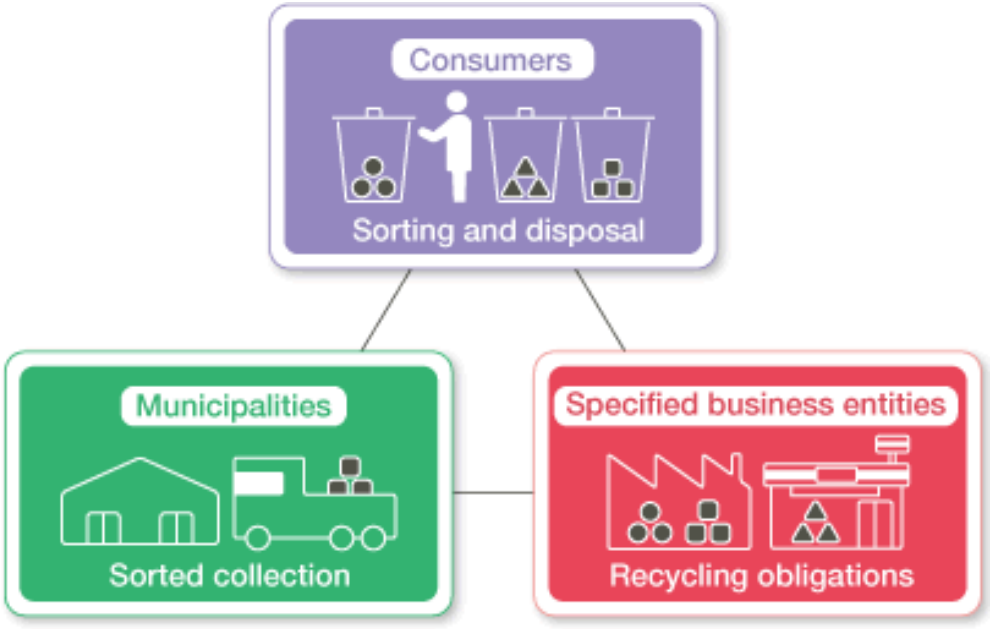
Efficiency of hybrid industry



The efficiencies of recycling in material industries are compared with those of waste power generation (converted to power generation efficiency).

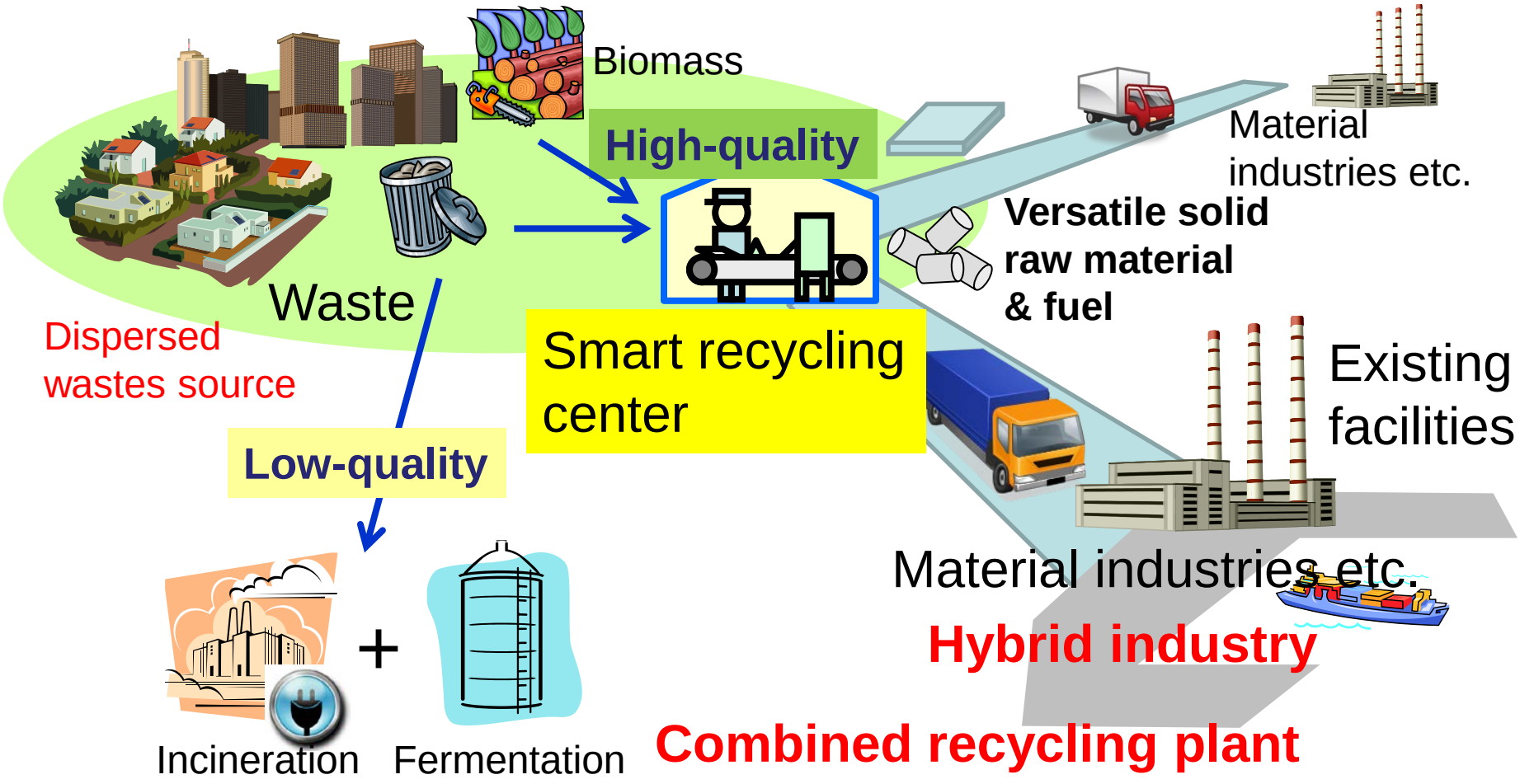
Social system for hybrid industries

The Containers and Packaging Recycling Act was established in Japan in1995



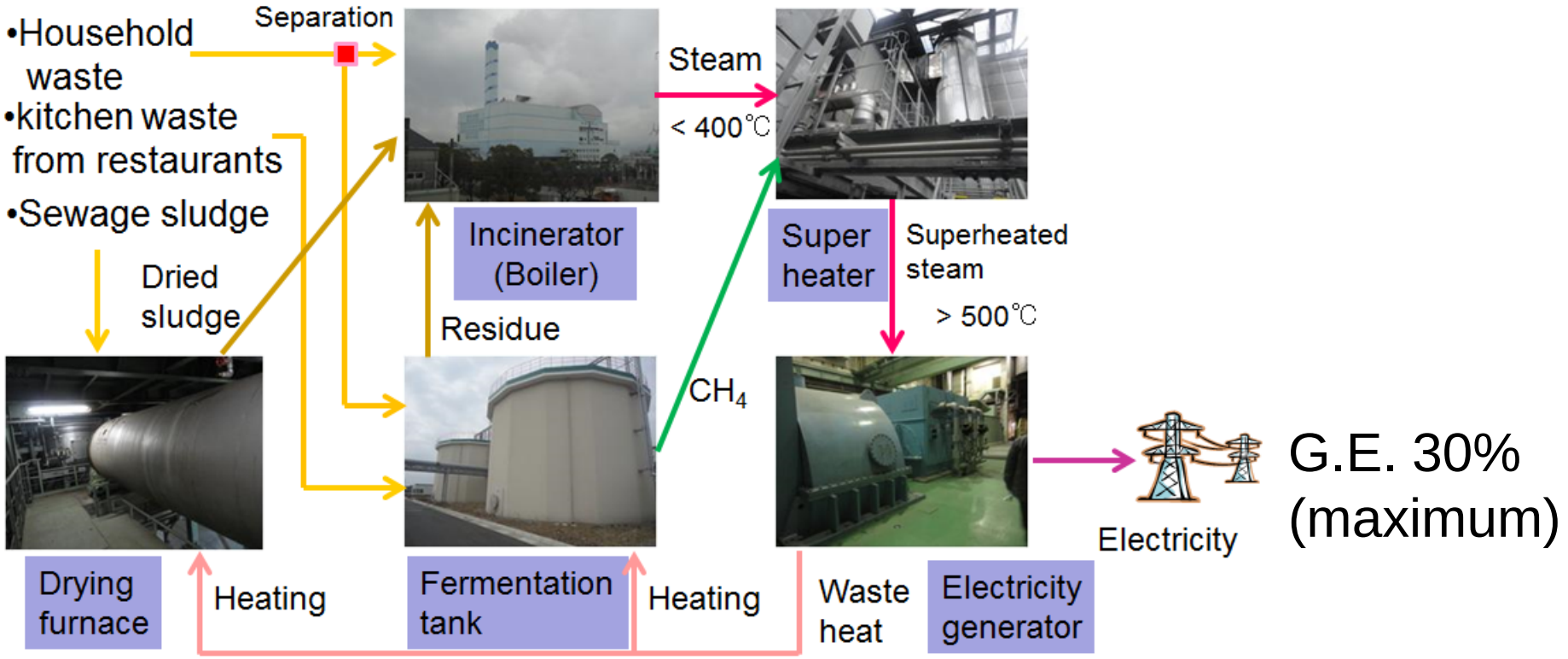
860kt of plastics out of 4500kt of municipal waste plastic was collected under this act in FY 2013 and rest of plastics was incinerated in incinerators. Still there is considerable room for the promotion of hybrid industries.

To realize hybrid industry



We propose a recycling system which enables sorted collection of wastes from the dispersed wastes generation points and produces versatile recycled law material for the best use of each waste with high efficiency owing to the scale merits of industries.

Combined energy recovery system



Hofu City Clean Center (Combined plant) started the operation in 2014

Source: Kawasaki Heavy Industries, Ltd.

Summery

- To promote green innovation in industries, a hybrid industry which utilizes fossil resources as well as wastes and renewable resources actively would be effective.

- For the improvement of overall efficiency of whole energy supply and demand system, apparent upgrade use of wastes, biomass and waste heat will play an important role.

Thank you for your attention!