

MSW Management and Waste-to-Energy in the Republic of Korea



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❖ **Starting in the early 1990s, securing landfills in South Korea became very difficult:** Population density is very high, 50% greater than in India (50 million people in 99,700 km²)

❖ **National waste management plan concentrated on waste reduction, recycling, and waste energy by implementing several regulations and policies:**

- “Waste Deposit Refund System (1991)”
- “Act on the Promotion of Saving and Recycling of Resources (1992)”
- **“Volume-Based Waste Fee (VBWF) system (1995)”**
- “Extended Producer Responsibility initiatives (2003)”
- “Mandatory Food Waste Separation act (2005)”

❖ **By 2009, the Republic of Korea had reduced MSW landfilling from 12.6 million tons (72% of the total), in 1995, to 3.5 million tons (19% of total MSW) in 2009.**

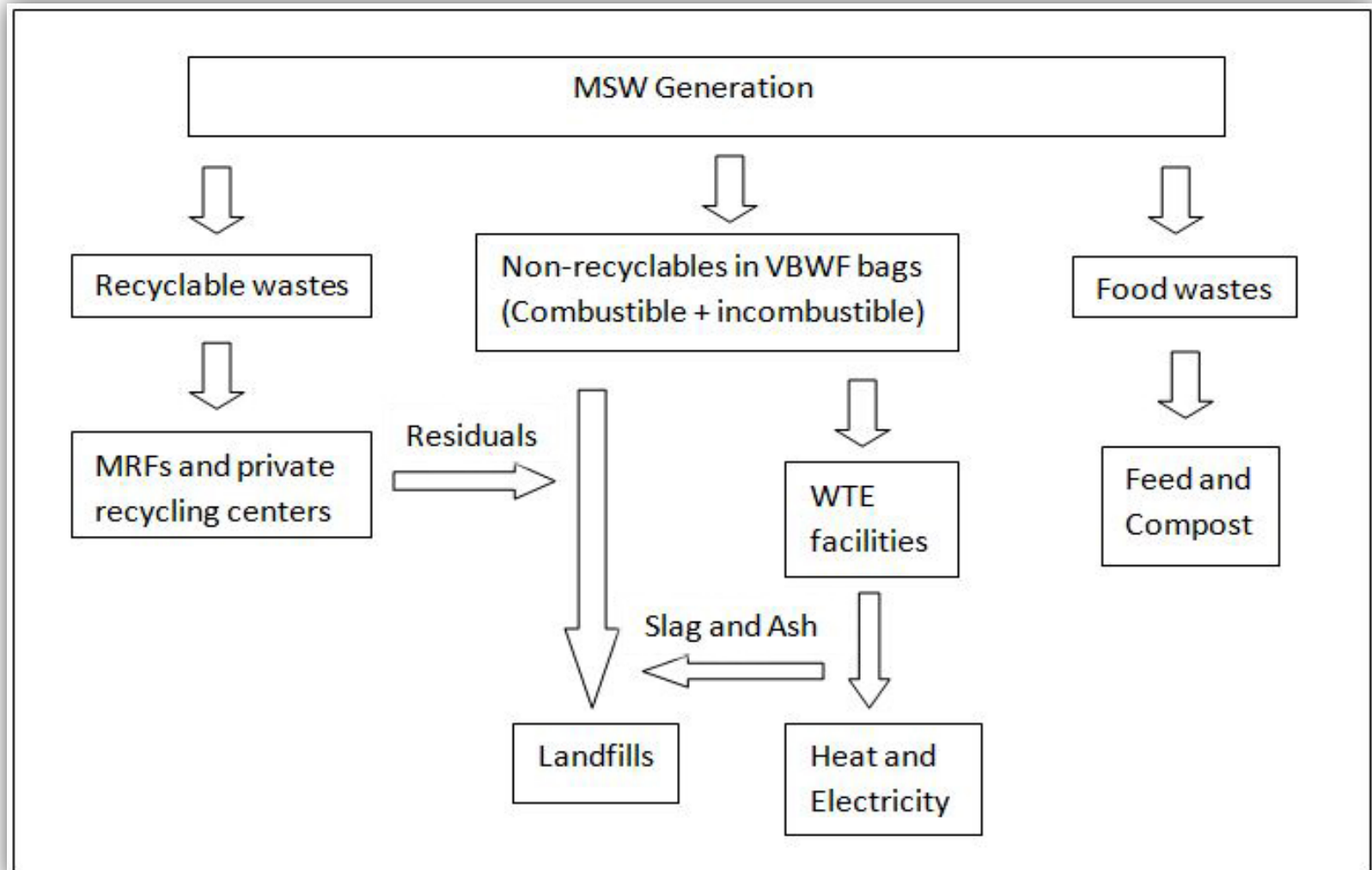
Implementation of Volume-Based Waste Fee (VBWF) system (1995)

- This system requires citizens and businesses to separate their MSW into two streams: (a) **Designated recyclable materials** and (b) **all other wastes are placed in VBWF bags** purchased at supermarkets, grocery stores, etc.
- The municipality collects two streams: The source-separated recyclables and the VBWF bags.
- The VBWF system provides an economic incentive for recycling rather than disposing materials in the VBWF bags.
- Average prices of VBWF bags in 2010:
\$0.06 USD for a 3-liter bag
\$2.10 USD for a 100 liter bag



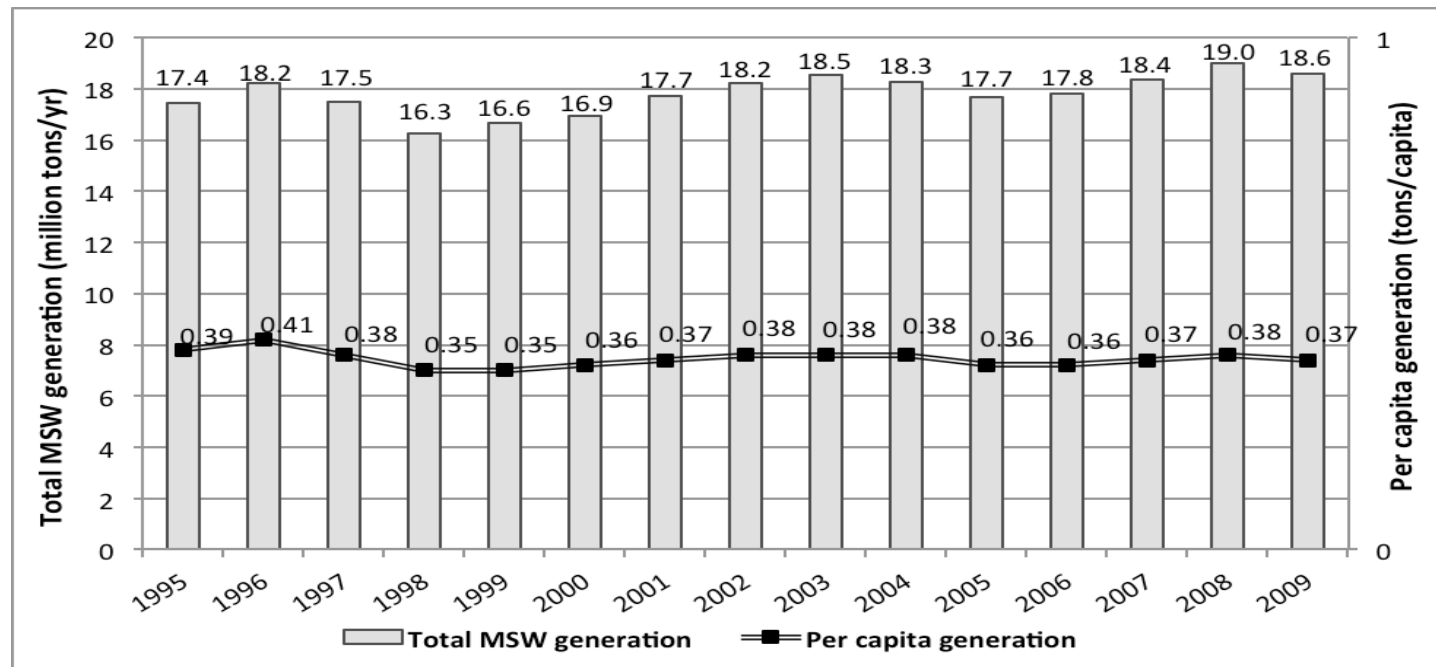
VBWF Bags

Current MSW management system in South Korea



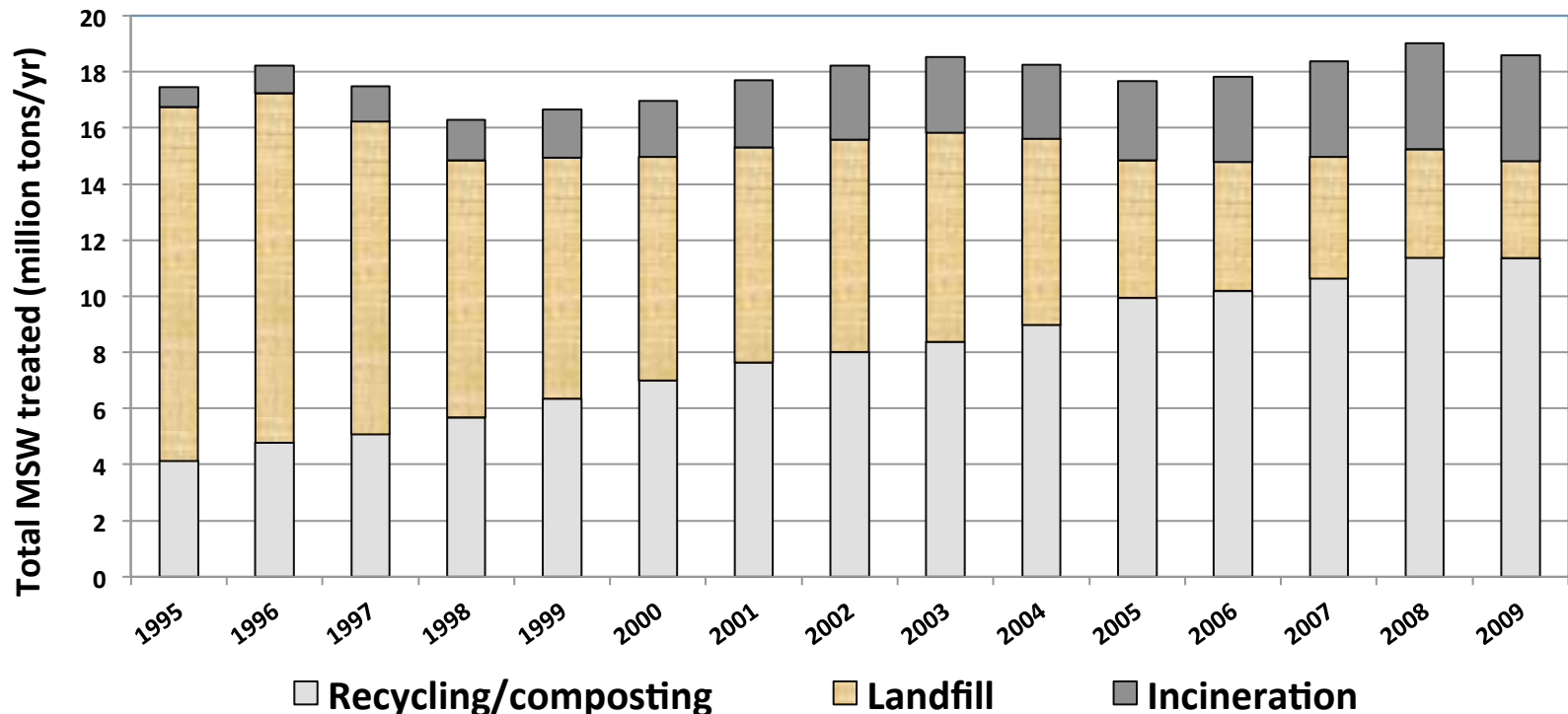
Trends in MSW Generation in the Republic of Korea (1995 - 2009)

- Despite rapid economic development and urbanization, the MSW generated in 2009 (18.6 million tons) was only 7% greater (17.4 million tons) than in 1995
- The per capita generation decreased slightly from 0.39 to 0.37 tons per capita



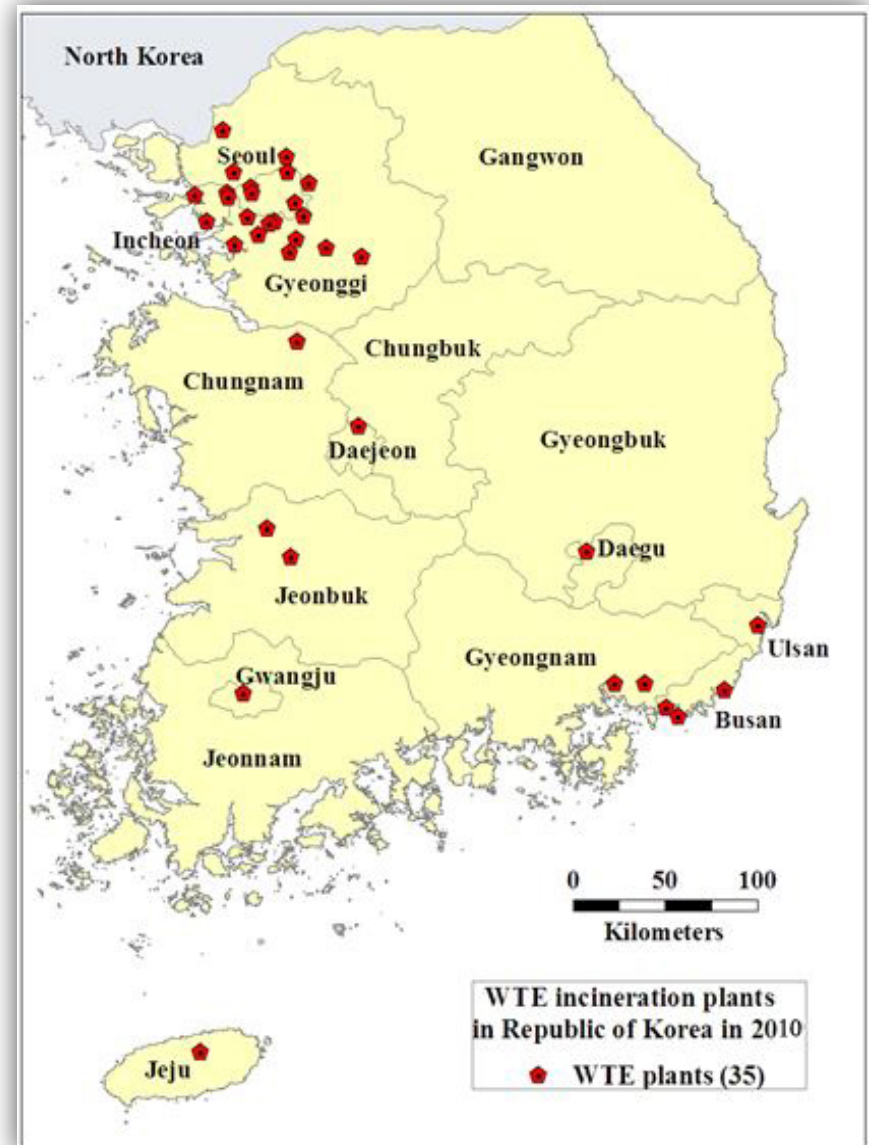
Major changes in MSW treatment in the Republic of Korea (1995 – 2009)

- Recycling plus composting nearly tripled (11.4 million tons: 61% in 2009) from only 4.1 million tons (24%) in 1995
- Waste-to-energy increased from 0.7 million tons (4%) in 1995 to 3.8 million tons (20%) in 2009
- Landfilling was reduced from 12.5 million tons in 1995 to 3.5 million tons in 2009 (19% of total MSW)



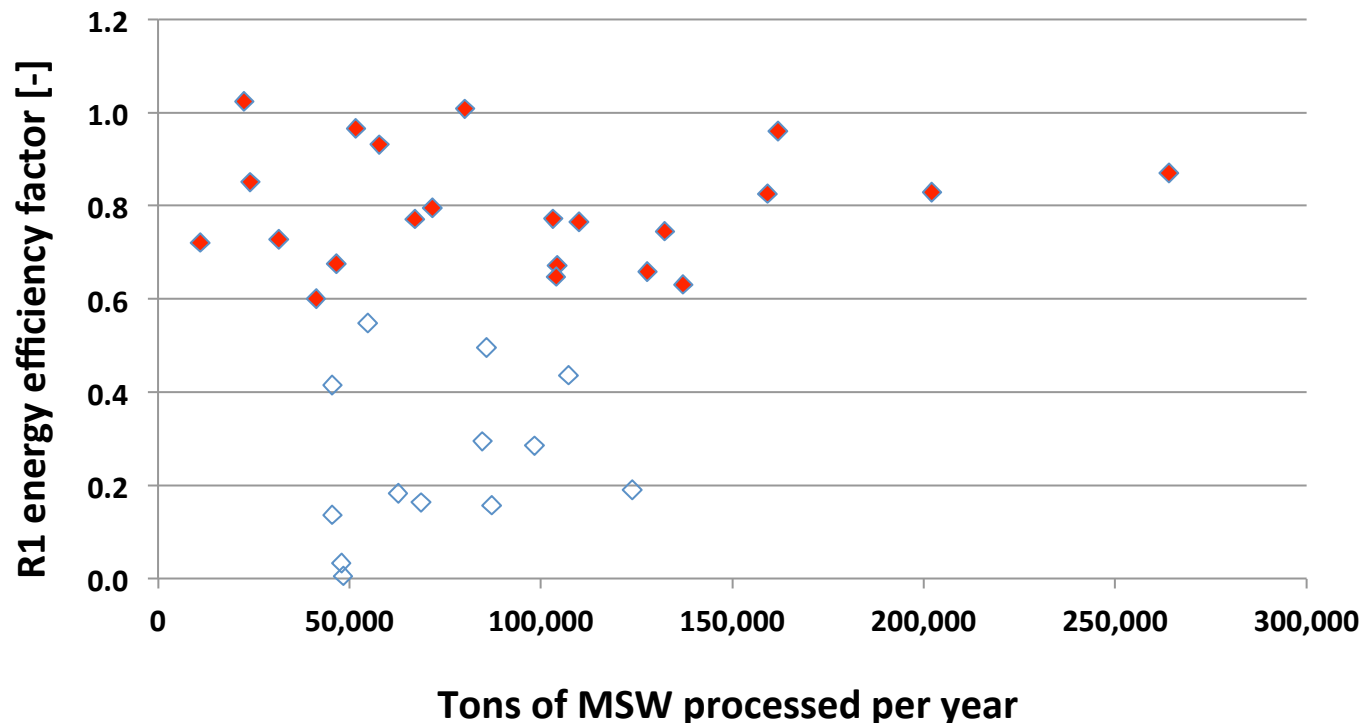
Waste-to-Energy (WTE) in the Republic of Korea

- In 2010, 35 large WTE plants, mostly moving grate furnaces, combusted **3.1 million tons** and accounted for 90% of the total incineration capacity
- In 2010, the thermal energy input to the 35 WTE plants was 8.3 million MWh, of which **4.5 million MWh (1.45 MWh/ton)** were provided to the nation in the form of district heat and electricity
- The heating value of Korean MSW ranged from a low of about 7 to a high of 12 MJ/kg and the average value for the 35 WTE plants was **9.7 MJ/kg**.



Energy efficiency of Korean WTE plants (2010)

- Using the R1 factor, as specified in the E.U. legislation, **22 of the 35** Korean WTE plants achieved R1 factors above 0.61, required to qualify as energy recovery plants, rather than “waste disposal facilities”
- The average R1 of these 35 WTE plants was **0.59**.



Air pollution control of Korean WTE plants

- The Columbia study (Yoonjung Seo thesis, 2013) showed that in 2010 all WTE plants met the Korean air emission standards for the six air pollutants: **Dioxins, SO_x, NO_x, HCl, CO, and PM**.
- The average dioxin emission for all plants in 2010 (**0.005 ng TEQ/Nm³**) was a small fraction of the Korean standard of 0.1 ng TEQ/Nm³ (same as E.U. and U.S. standard).

	Dioxin (ngTEQ/Nm ³)	SO _x (ppm)	NO _x (ppm)	HCl (ppm)	CO (ppm)	PM (mg/Sm ³)
Average emissions of all 35 WTE plants:	0.005	1.7	30.5	2.8	7.0	2.0
Korean air emissions regulation for MSWI:	0.1	30	70	20	50	20

Conclusions

- As a result of the successful implementation of several national waste management policies, the generation of Korean MSW has decreased slightly, from 0.39 tons in 1995 to 0.37 tons in 2009, despite the considerable economic development in this fifteen year period.
- Of the 18.7 million tons of MSW generated in 2009, only 3.5 million tons (19% of the total) were landfilled, while 11.4 million tons (61% of the total) were recycled and 3.8 tons (20% of total) were combusted with energy recovery.
- Korea has made much progress in the recovery of energy from MSW but it is still not as high as in some of the leading countries in Europe. Only 22 of the 35 Korean WTE plants have attained R1 factors that qualify them as energy recovery plants.
- With regard to stack emissions, all Korean WTE plants are excellent performers, with emissions below the Korean and E.U. standards.
- South Korea is near the top of the sustainable-waste-management nations, despite the fact that its per capita GDP is only 63% of the U.S. This exemplifies what can be achieved through intelligent national planning and policies for waste management.

WTERT-Korea

The WTERT-Korea sister organization is being developed under the leadership of Prof. Yong-Chil Seo of Yonsei University, Republic of Korea.

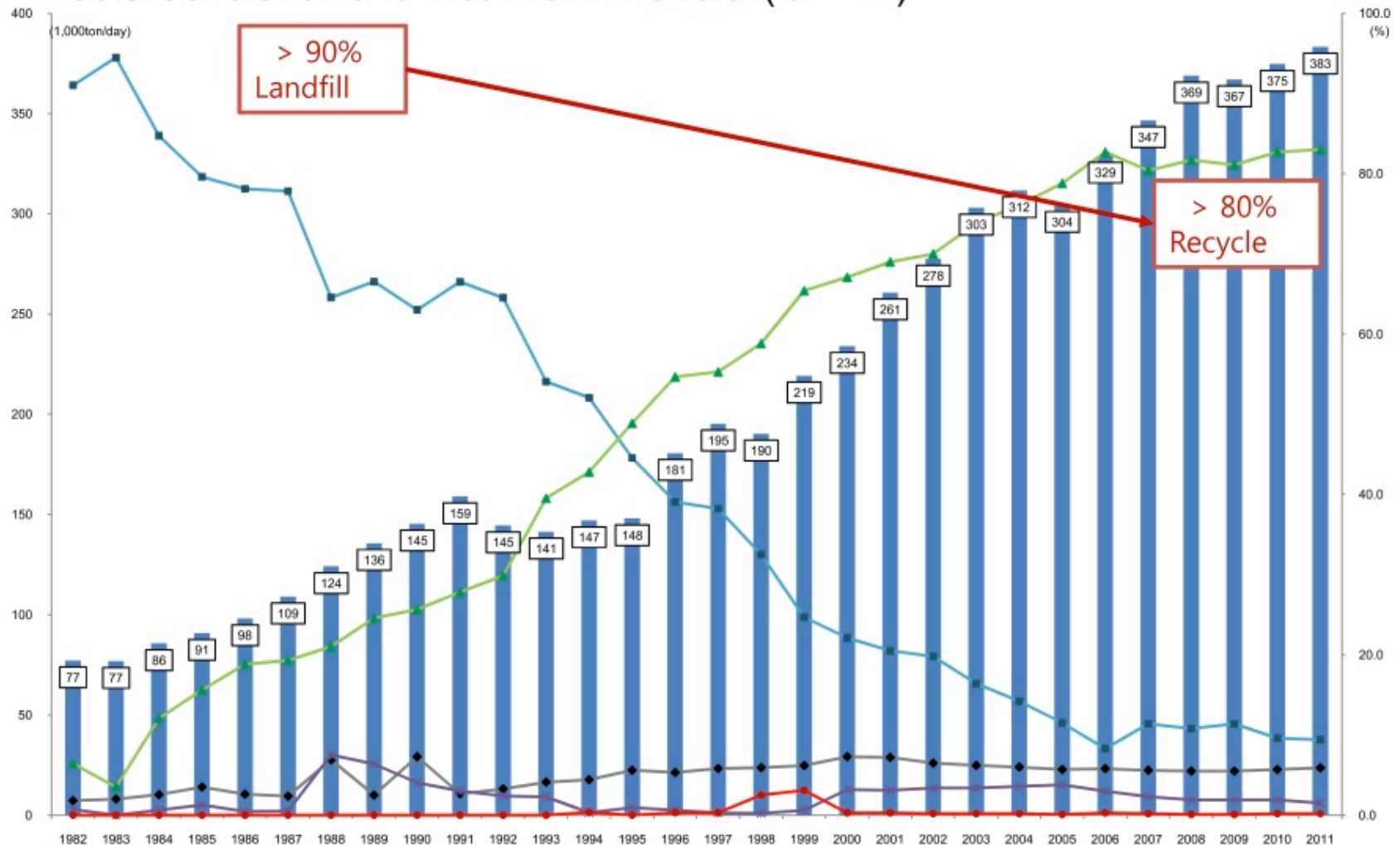


The following slides were contributed by Prof. Seo, past President of the Korean Waste Management Association (as well as film clip incorporated in WTERT 2014 Awards film

History of Waste Management



Waste Generation and Treatment in Overall('82~'11)



Source: Environment statistics yearbook, Korean Ministry of Environment

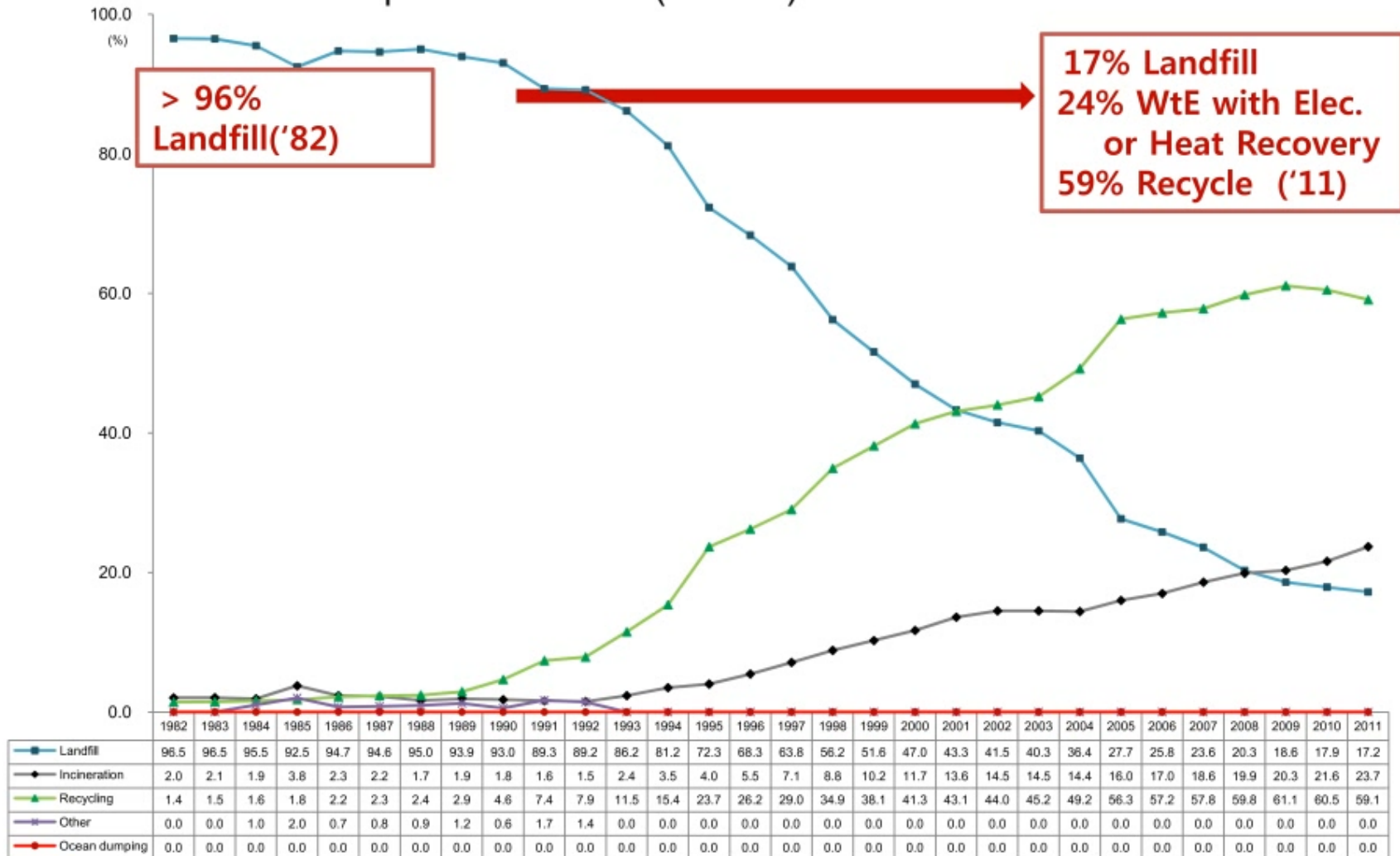


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History of MS Waste Management



■ Treatment of Municipal Solid Waste ('82~'11)



Source: Environment statistics yearbook, Korean Ministry of Environment



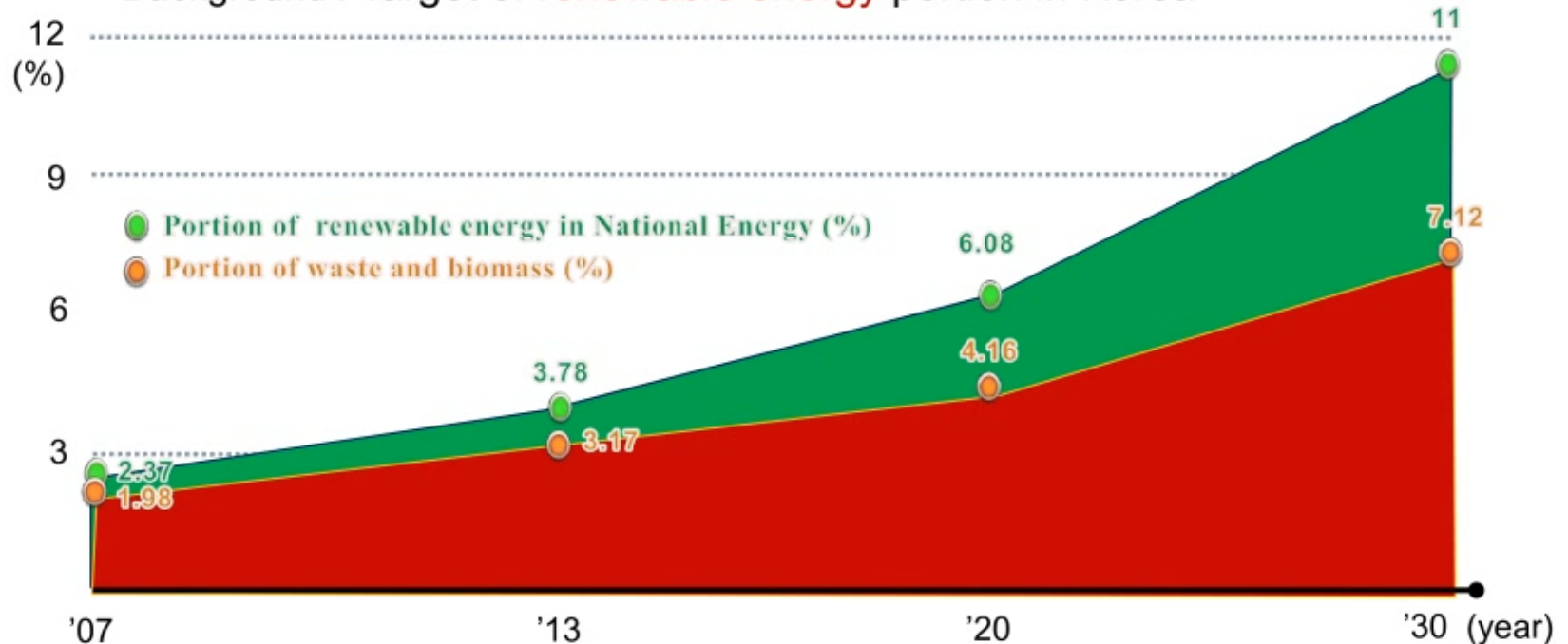
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WtE Plan in Renewable Energy Policy



■ Comprehensive Plan on Waste to Energy (2008-)

Background : Target of **renewable energy** portion in Korea



- For achieving to supply the share of national renewable energy (6.08 and 11% in 2020 and 2030, respectively), still around 70% of renewable energy would be supplied by utilizing waste and biomass to energy
- **Waste to Energy** has been in situation of main fraction in renewable Energy in Korea

Source: Korean Ministry of Environment

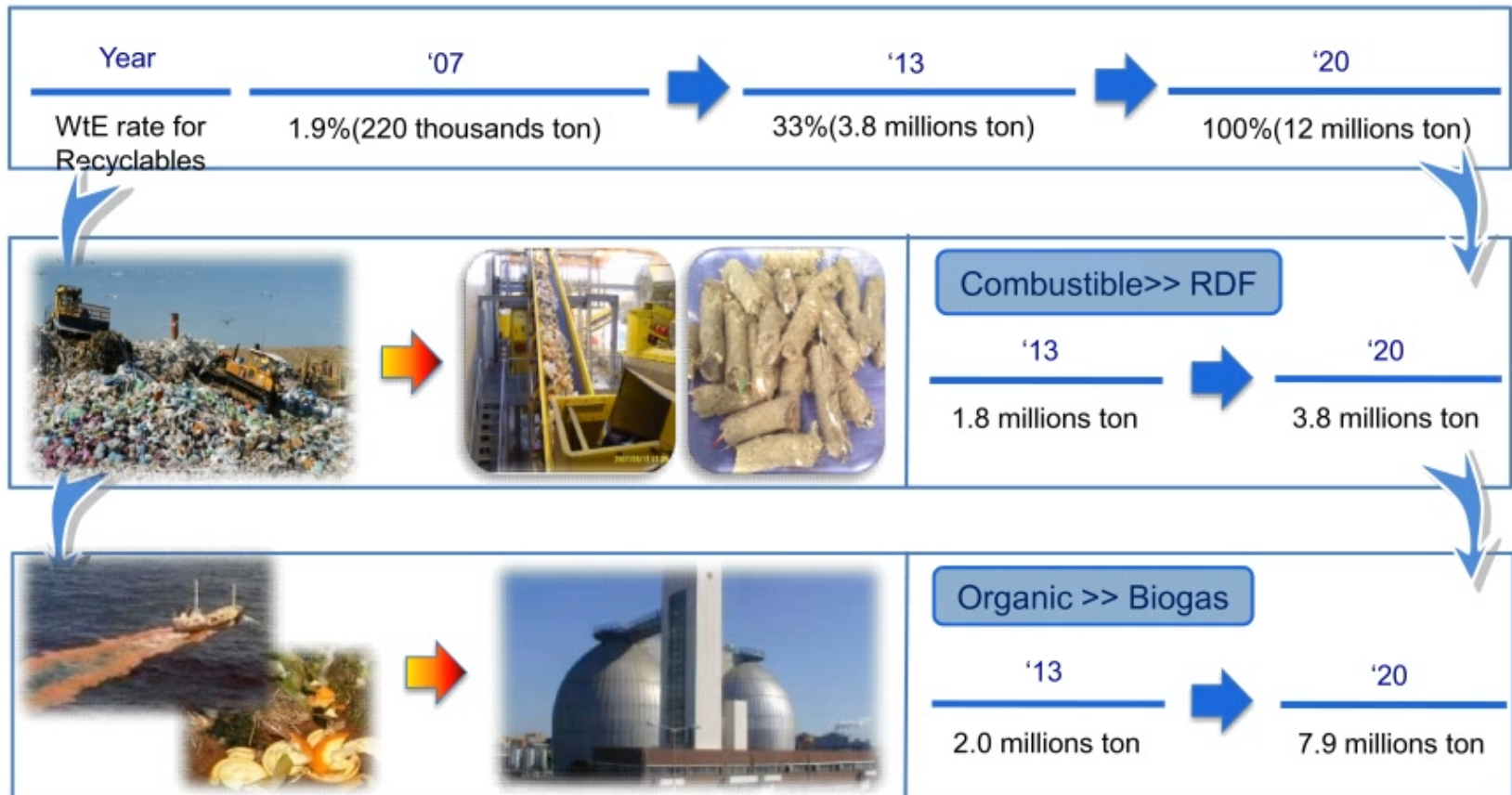


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WtE Plan in Future



- Comprehensive plan on waste to energy (2008-2020)



Source: Korean Ministry of Environment



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