

*WTERT-Asia Inaugural Meeting
Nanjing, April 26-28, 2017*

**Sustainable Waste Management, Waste-to-Energy,
and the Role of the Universities**

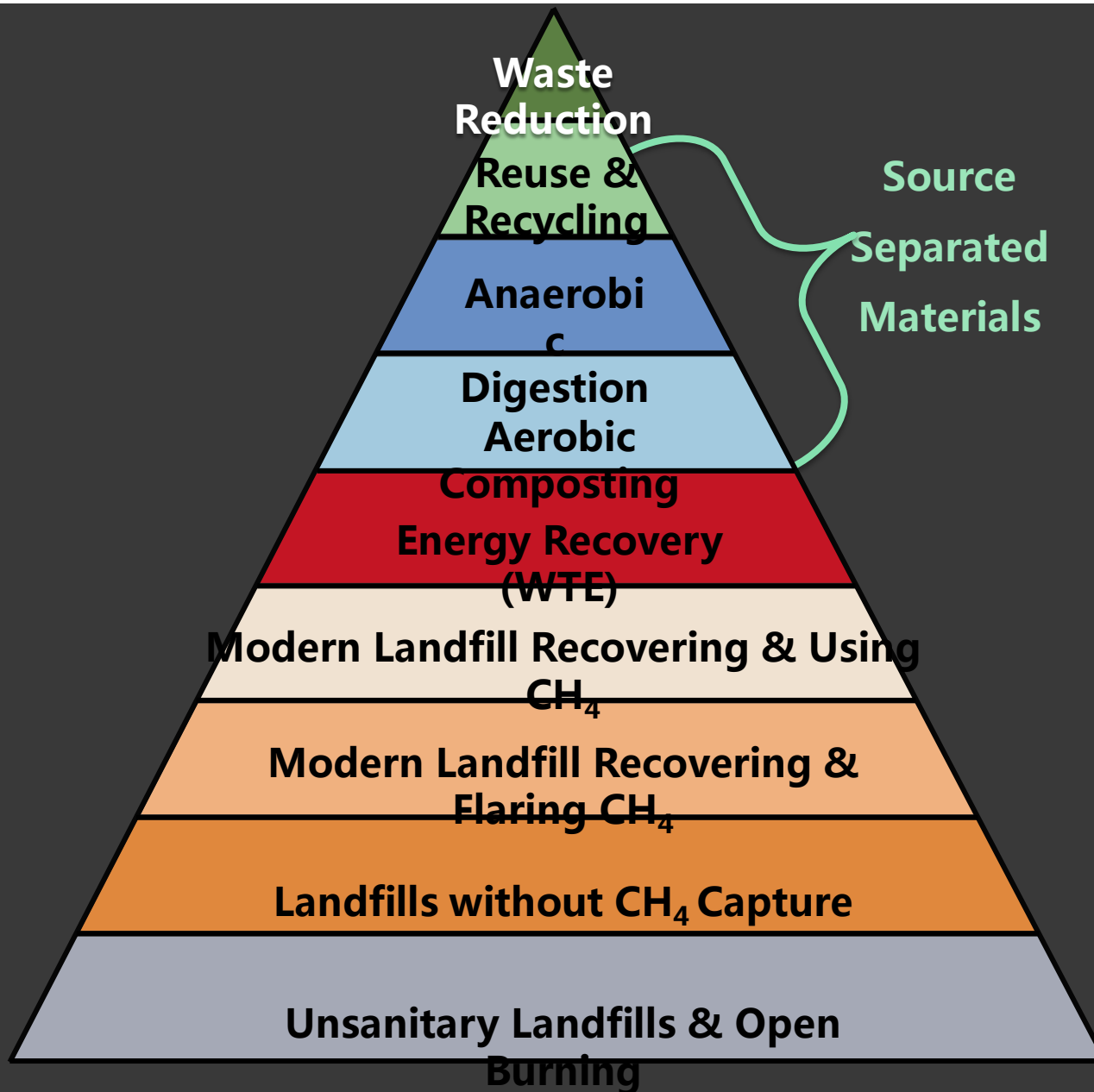
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EARTH ENGINEERING CENTER

Chair, Global WTERT Council (GWC)





Hierarchy of waste management

Largely overlooked issue: The disposition of wastes generated by humanity

Estimated global disposition of collected post-recycling municipal solid wastes:

- Combustion with energy recovery (WTE): 230 million tons
- Sanitary landfill, partial CH₄ recovery: 250 million tons
- Landfilled without CH₄ recovery: >800 million tons (mostly in Asia)

MSW generation has tripled in the last sixty years and is expected to double between 2015 and 2030

Global use of land for landfilling in one year

Estimated average ultimate use of land for proper (sanitary) landfilling of MSW: One square meter used up for ever, for every 10 tons of MSW landfilled

- Current global landfilling converts an estimated 100 square kilometers of greenfields to landfills
- If it were done at one landfill it would use up a land surface equal to that of metropolitan Paris
- At present rate of MSW generation, continued landfilling will transform 10,000 square kilometers of greenfields into landfills in this century

Managing of post-recycling wastes

There are only two options to manage post-recycling wastes:

- Thermal treatment with energy recovery (WTE)
- Sanitary landfills

WTE advantages over sanitary landfilling:

- **Destruction of pathogens**
- **Conservation of land near cities**
- **Electricity production: >0.5 MW over sanitary LF**
- **Reducing GHG emission: 0.5 -1 ton per ton MSW to WTE**
- **Metal recovery**



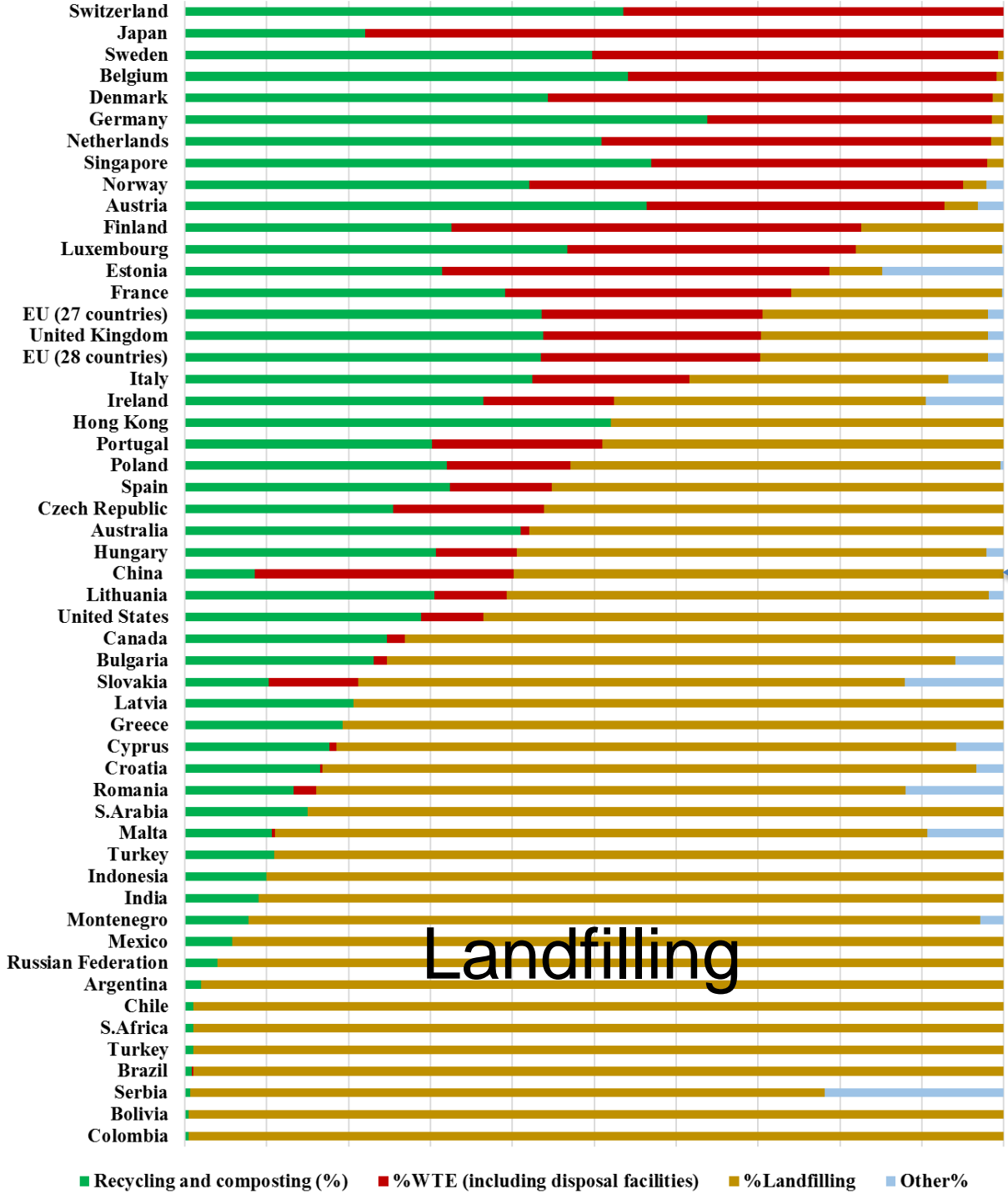
What is happening in Asia?

- Most of the Asian MSW is landfilled
- Exceptions: Japan, Singapore, Republic of Korea
- New major WTE world player: China

Despite projected doubling of the global WTE industry by 2030, there will be more landfilling.....

**.... because the generation of MSW
will also double**

Note: Future estimates of MSW generation in a city or nation can be based on energy use projections for a city or nation



“Ladder of Sustainable Waste Management of nations

← China



Why landfilling is still dominant in developing countries?

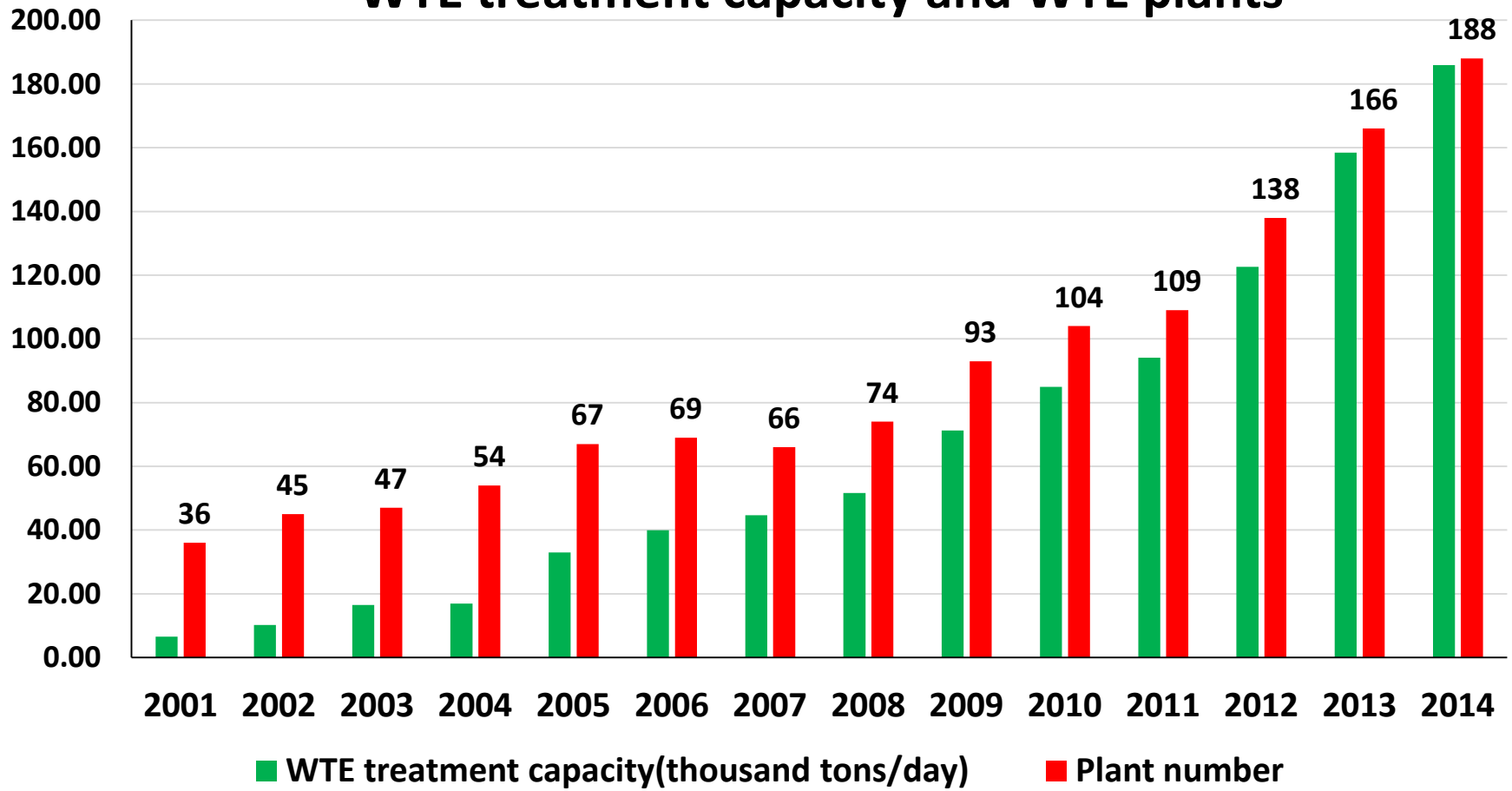
- Initial capital cost of a sanitary landfill much lower than that of a WTE plant
- **Gate fee difference** between sanitary landfills and WTE, **in the U.S.**, about \$20/ton MSW (more for WTE)
- In **Latin America**, the additional gate fee of \$20/ton required for WTE would disappear if the CAPEX of WTE plants can be reduced by \$200 per annual ton of capacity (equivalent to about \$20/ton MSW).

Reducing the initial capital investment in WTE plants makes WTE plants competitive with sanitary landfills

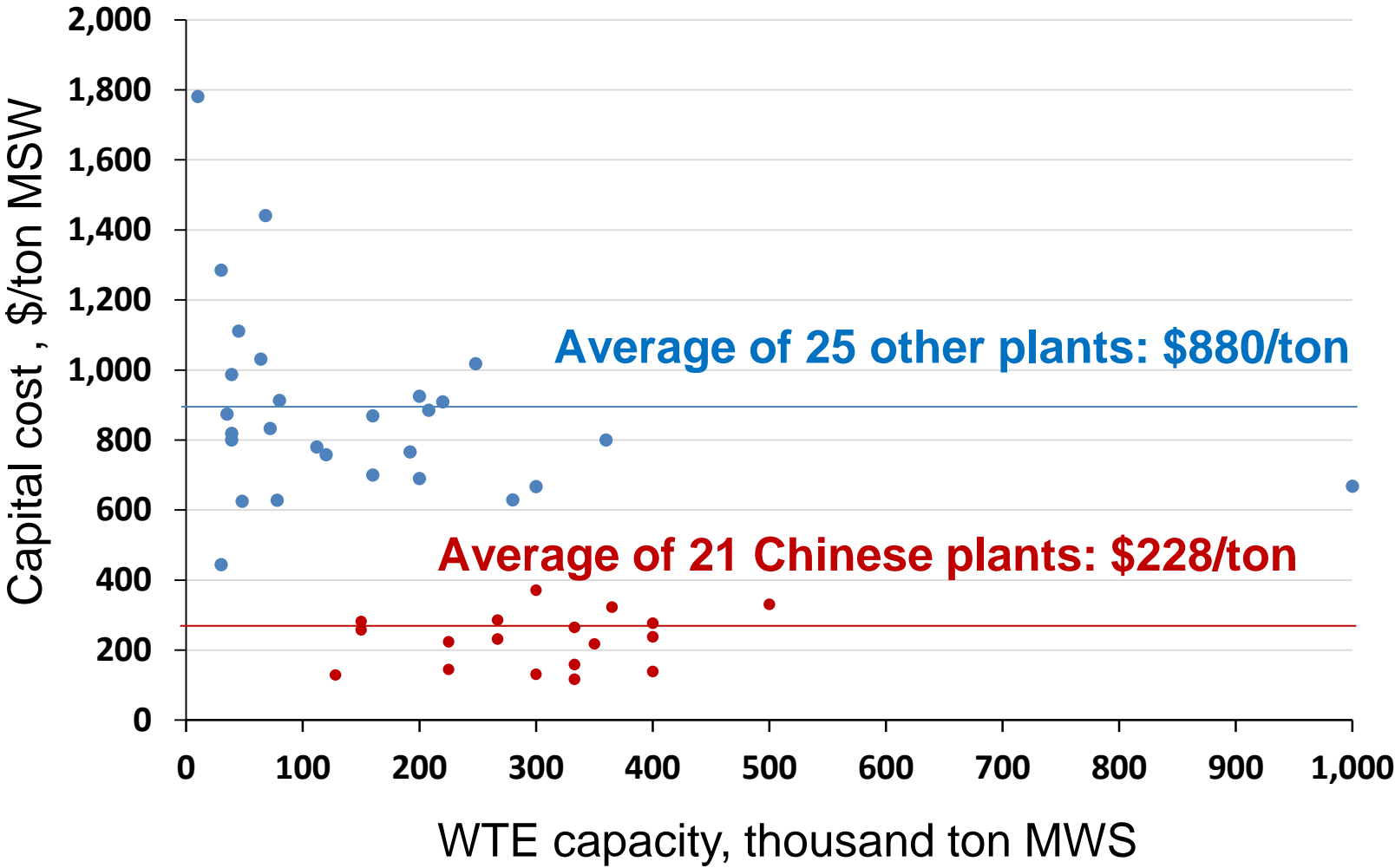
- China has demonstrated that it is possible to reduce the capital cost of WTE plants by means of
 - Industrial and academic R&D
 - Rapid growth on industry (30 plants/year), instead of one plant at the time
- Other China incentives to WTE: Credit for renewable energy production (\$30/MWh of electricity produced by WTE vs coal-fired power plants)

21st century growth of WTE industry in China

WTE treatment capacity and WTE plants



Recent WTE plants built in China, both by moving grate (MG) and CFB technologies, at a much lower CAPEX



How about the Air Pollution Control systems of modern WTE plants?

....Detailed studies by Columbia University have shown that

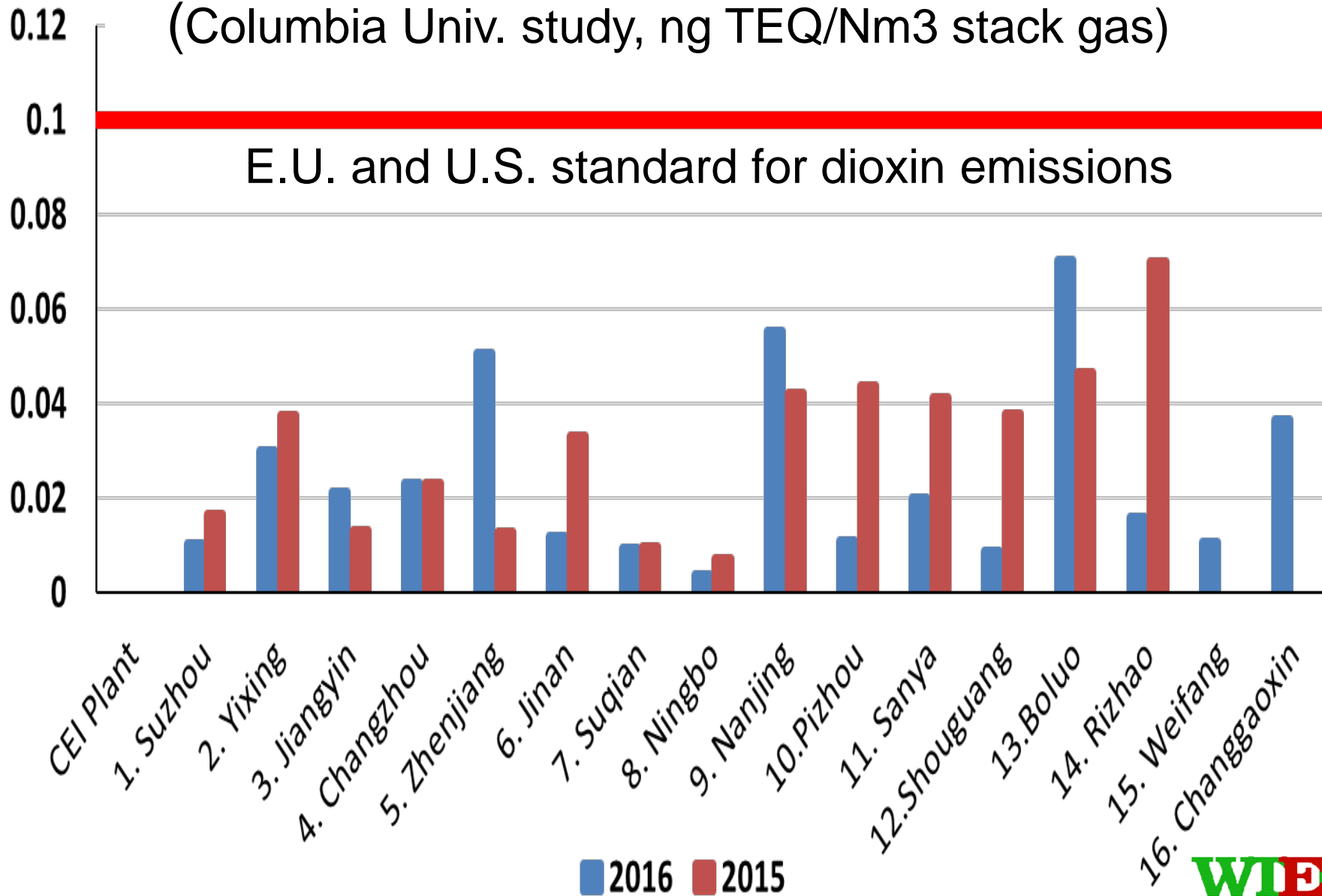
- **Modern WTE plants are the cleanest high temperature processes**
- **For every ton of solid wastes going to a WTE instead of a sanitary landfill, Greenhouse Gas emissions decrease by 0.5 -1 ton CO₂,eq**

U.S. dioxin emissions from all industrial and from area sources (forest and landfill fires, flaring of LFG), in grams TEQ

	1987	1995	2000	2012
Total industrial sources	13,833	2,634	998	511
WTE dioxins as % of all industrial	68.7%	45.6%	7.7%	0.59%
Total ind'l plus area sources	16,125	4,925	3,827	3,808
WTE dioxins as % of total U.S. dioxins	58.9%	24.4%	2.0%	0.08%

Dioxin emissions of Everbright plants

(Columbia Univ. study, ng TEQ/Nm³ stack gas)



Columbia detailed studies of four nations annual WTE dioxin emissions

Country	Year of study	MSW processed (million tons)	Average Dioxin Emissions (ng TEQ/Nm³)	Total Dioxins Emitted g TEQ/year
USA	2012	25.9	0.027	2.90
France	2010	13.8	0.013	0.79
South Korea	2010	3.9	0.007	0.11
China	2015	61.8	0.1*	24.7

*Assumed average; Everbright average: 0.04 ng TEQ/Nm³



Example of China becoming a world leader in WTE in about ten years

- China is a good example for other Asian countries to follow
- It took several decades for developed nations to reach their present state of achievement in sustainable waste management
- Developing nations can use Chinese knowhow and capital to leapfrog in the application of WTE technology and phasing out of landfilling

Role of universities in disseminating credible information on major environmental problems

- People generally resist change, even when change is for the good.
- The first central systems for potable water, for wastewater treatment, for management of solid wastes have been resisted for lack of adequate information.
- Some people acquire “fame” by leading movements against necessary change
- `it is therefore necessary for universities to lead the effort for sustainable development

How universities can fulfill their role:

- Through educational programs
- Through academic research
- Through the dissemination of credible information (publications, the web, public meetings)

*With thanks to China Everbright for hosting
the inaugural WTER-Asia meeting!*

謝謝



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