

WTERT Bi-annual 2010 Meeting, New York, October 7-8,2010

2008-2010 contributions of the Earth Engineering Center to reducing carbon footprint of waste management

Prof. Nickolas Themelis, Director



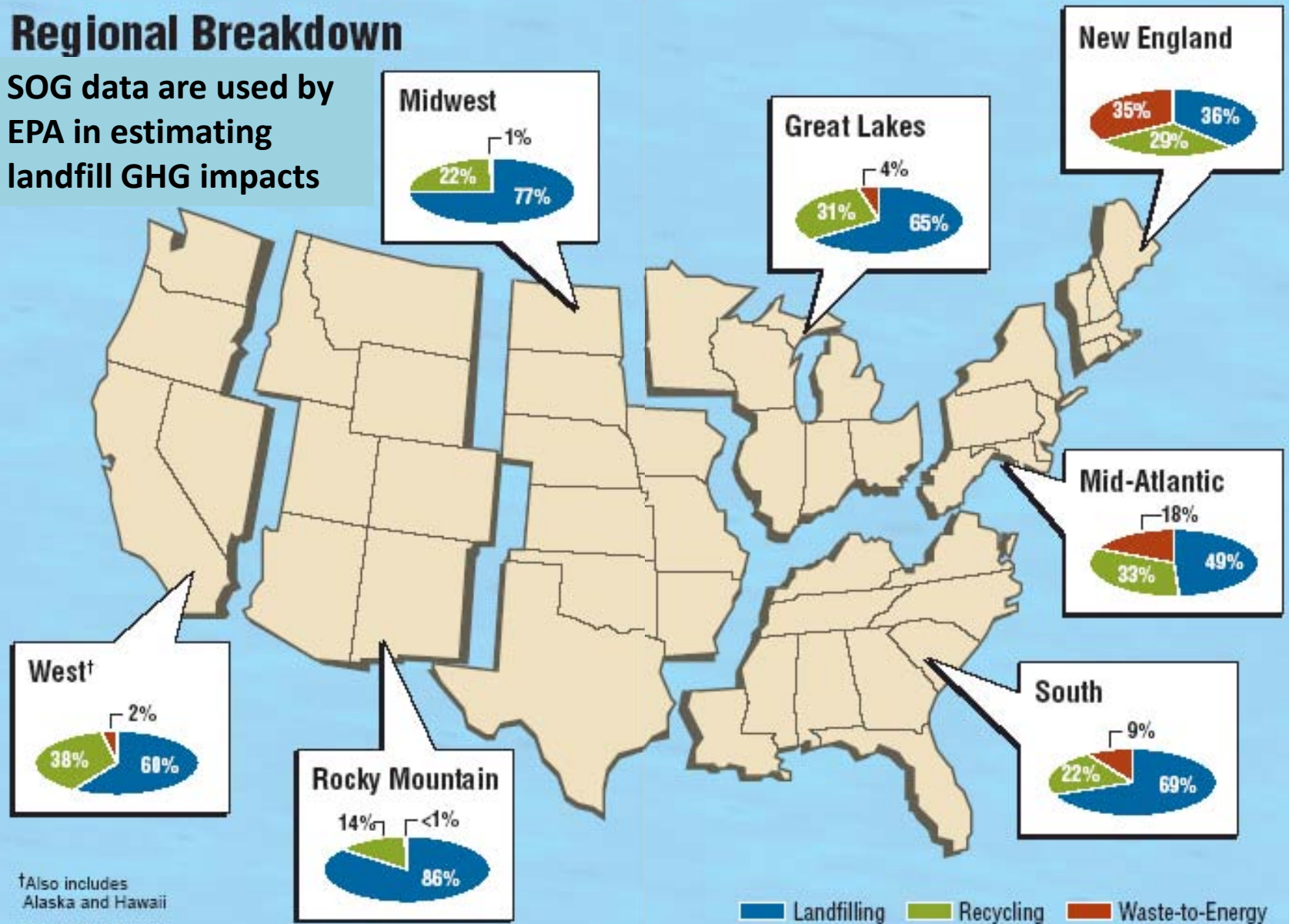
COLUMBIA UNIVERSITY
EARTH ENGINEERING CENTER

"State of the Garbage in America" (SOG)

EEC/BioCycle Survey of MSW Generation and Disposition in the U.S. (2004 data)

Regional Breakdown

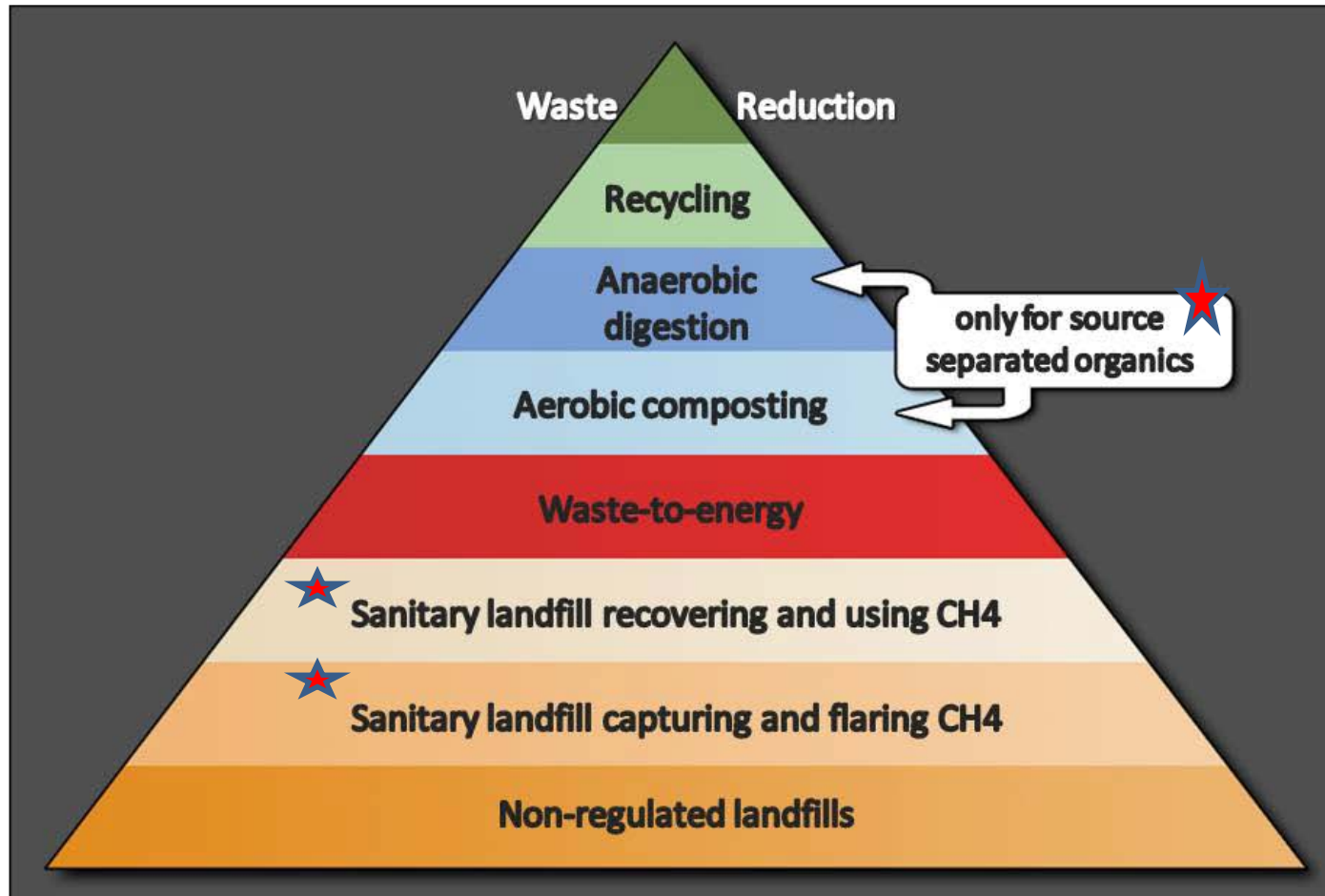
SOG data are used by EPA in estimating landfill GHG impacts



As of 2008, U.S. EPA uses the BioCycle/EEC “State of Garbage in America” survey to calculate Greenhouse gas (GHG) emissions of landfilling in the U.S.

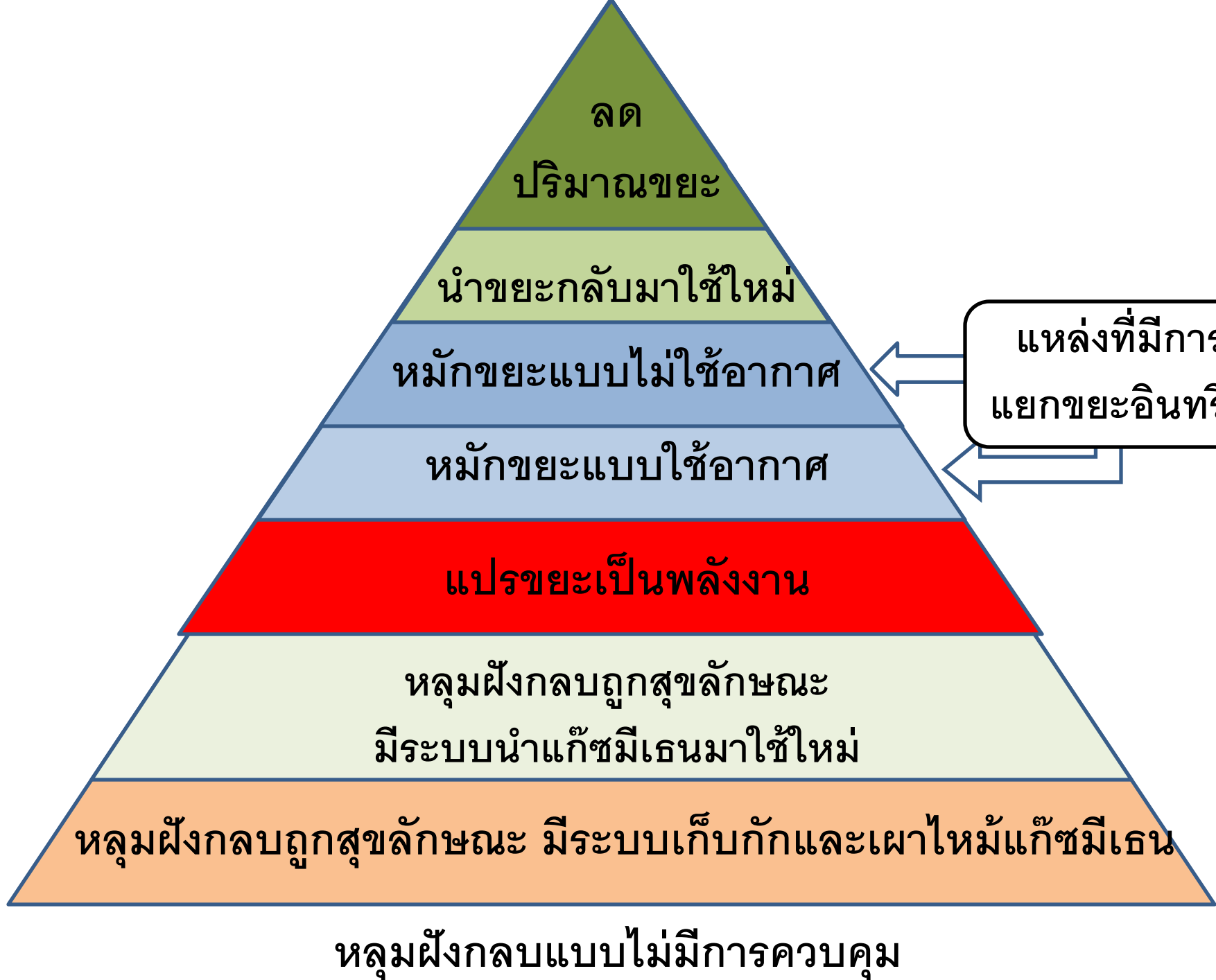
EEC has contributed to the EPA calculations being closer to the “mark” by 100 million tons of MSW landfilled. The overall objective of the SOG survey is to encourage communities to adopt sustainable waste management means. This afternoon, Rob VanHaaren will discuss the evolution of this survey over the years.

EEC's “expanded” Hierarchy of Waste Management
is intended to reduce★ the carbon footprint of
waste management (*GWMS, 2008*)



By now the “Hierarchy” has been translated into five languages.....

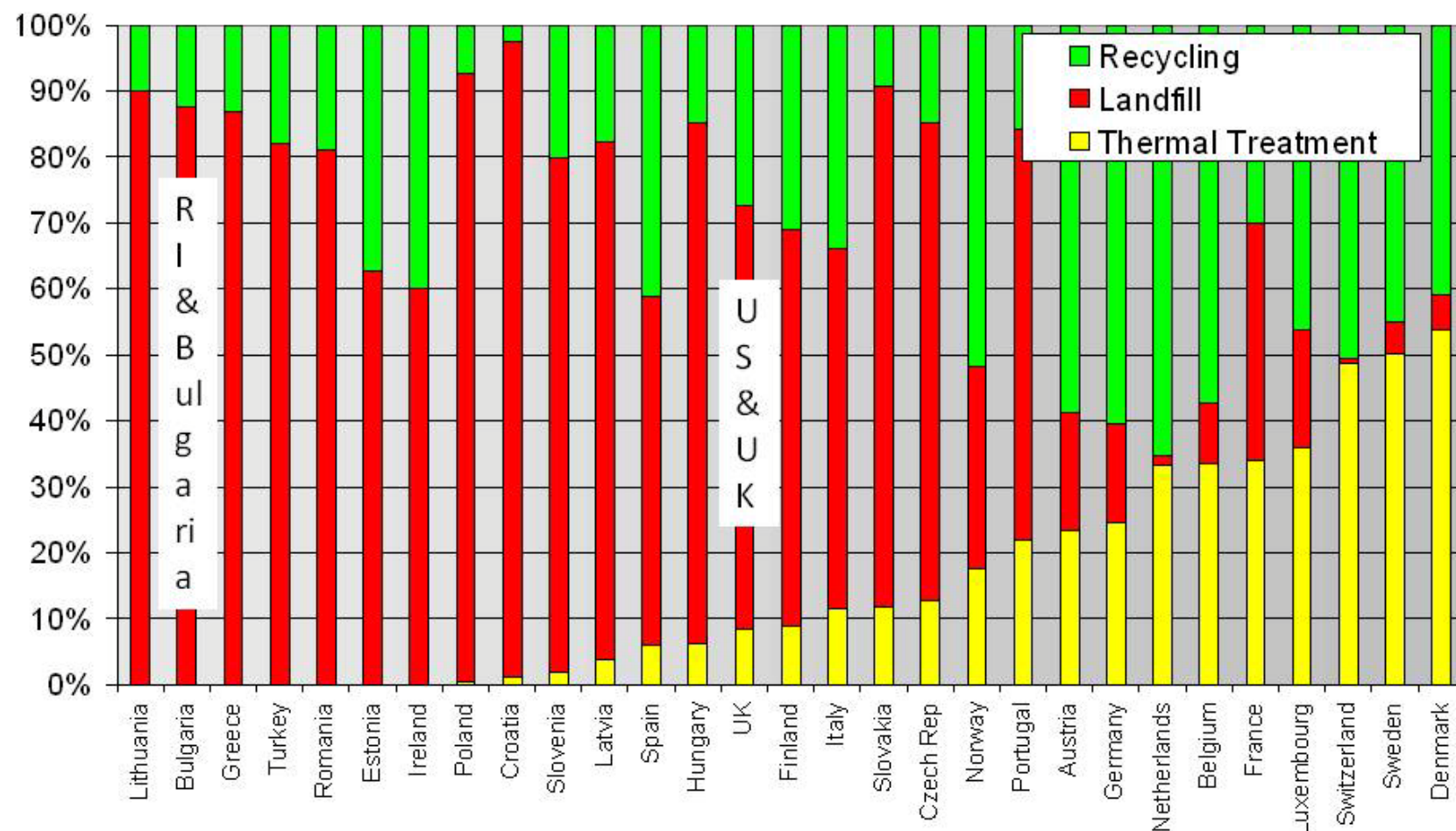
....including Thai (thanks to Chak!)



EEC has debunked the myth that WTE interferes with recycling

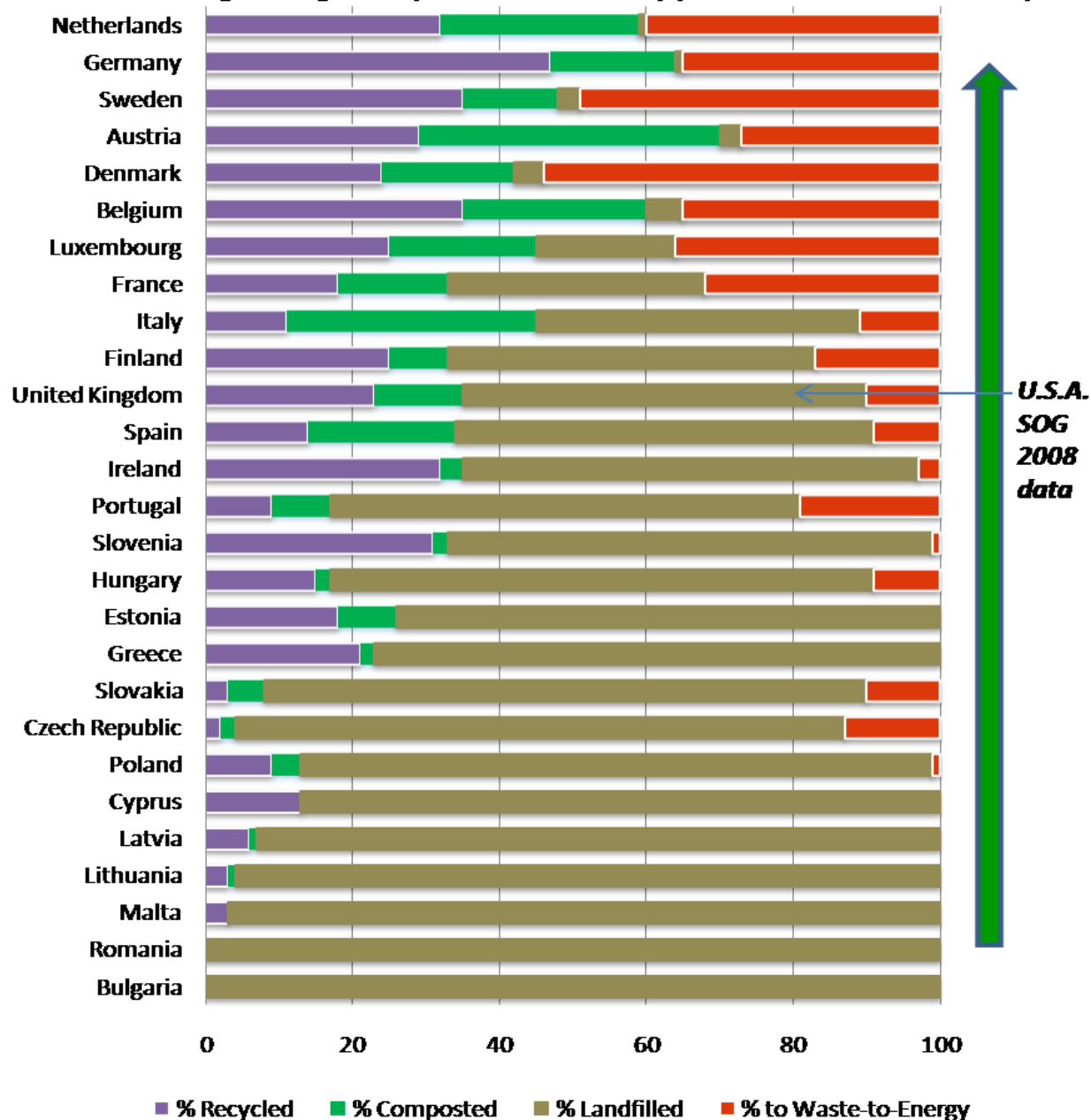
(e.g., EEC presentation to Rhode Island Assembly Committee)

DISPOSITION OF MSW IN EUROPE, THE U.S. and R.I.



The Sustainable Waste Management Ladder

Earth Engineering Center, Columbia University (based on Eurostat 2008 data)



The bottom line of not-sustainable waste management = Tons landfilled per person

	California	New York	Mass.	Rhode Island
Population	36,250,000	19,282,000	8,434,000	1,062,000
MSW generated, tons	49,926,000	21,687,000	9,160,000	1,351,000
Tons MSW per person	1.38	1.12	1.09	1.27
Tons recycled, tons	19,409,000	7,694,000	3,410,000	167,000
Tons recycled per person	0.54	0.40	0.40	0.16
MSW to WTE	591,000	3,492,000	3,100,000	-
Tons to WTE per person	0.02	0.18	0.37	-
MSW landfilled	29,926,000	10,501,000	2,650,000	1,182,000
Tons landfilled per person	0.83	0.54	0.31	1.11



The Mauritius story

The Mauritius story

- Usual island story: Only landfill on Mauritius (pop. 1.27 million) has filled up.
- Local construction/development company and Covanta-Asia have already designed a 300,000ton/year WTE to serve the island. A site has been selected and national/local government is supporting.
- But island's French minority and some highly influential environmentalists in France have opposed WTE strenuously because of dioxin fears.
- Therefore, in 2009-2010, EEC initiated an M.S. thesis by French engineer, Yohann Benhamou, to find out why French public opinion is against WTE, despite the fact that France is served by 128 WTE plants. Could it be that French WTEs are behind other E.U. and U.S. WTEs in installing modern gas control systems? "Tune in" this afternoon to presentation by Prof. Ange Nzihou of WTERF-France.

Mauritius fallout: Waste Management Conference and new program co-organized by Prof. Karagiannidis of WTERF-Greece and Prof. Romeela Mohee at Mauritius, 2012



The China story

- China is rapidly expanding its WTE capacity as well as its manufacturing of WTE equipment. You will hear more about WTE in China at this meeting from our WTERT-China partners (CQUST, Chongqing; and Zhejiang U., Hangzhou).
- In 2009, there were demonstrations against new WTEs in Beijing and other places, because of health effect fears.
- In collaboration with a third WTERT-China partner (Prof. Zhang of Hangzhou-Dianzi U.), EEC conducted a critical analysis of dioxin emissions from Chinese WTEs.
- The results were presented at WasteEng 2010 in Beijing and also published in Waste Management World (July-August 2010).

Most of China's WTEs are in the southwest



- Dioxin emissions of **13** grate combustion WTE plants in China (E.U. and U.S. standard = 0.1 ng/Nm³)

Plant # (Ni et al)	Tons/day	Micrograms TEQ per ton MSW	Nanograms TEQ per Nm ³ of stack gas*
1	225	0.286	0.06
5	150	10.72	2.14
7	500	0.343	0.07
8	385	1.887	0.38
9	385	1.973	0.39
10	250	1.871	0.37
11	500	1.279	0.26
12	385	0.935	0.19
13	385	0.848	0.17
14	225	1.592	0.32
16	200	0.169	0.03
17	500	4.789	0.96
19	400	5.04	1.01
Average	345	2.441	0.49
Ave. tons/y	114,000		
Total t/y	1,482,000	U.S. WTEs before MACT (1989): 50 ng/Nm ³	

- Dioxin emissions of 6 circulating fluid bed (CFB) WTE plants in China (E.U. standard = 0.1 ng/Nm³)

Plant Number (Ni et al)	Tons/day	Micrograms TEQ per ton MSW	Nanograms TEQ per Nm ³ of stack gas
2	385	0.678	0.14
3	500	0.226	0.05
4	200	0.581	0.12
6	225	0.390	0.08
15	165	0.294	0.06
18	250	0.811	0.16
Average of six plants	288	0.497	0.10
Ave. tons/y	95000		
Total t/y	570000	U.S. WTEs before MACT (1989): 50 ng/Nm³	



U.S. plastic wastes going to landfills

- Estimated generation of plastic wastes: 30 million tons/year
- Less than 2 million tons are recycled to same plastic (“Primary Recycling”) or to new plastics (e.g. plastic lumber; “Secondary Recycling”)
- About 3 million tons in mixed MSW go to WTE plants and are converted to about 2.8 GWh (twice the calorific value of MSW)
- About 25 million tons in mixed MSW are landfilled

This afternoon Jawad Bhatti of EEC will discuss in more detail the recycling of post-consumer U.S. plastics

A new EEC project: Potential for using plastic wastes that are now landfilled



- Not suitable for “primary” or “secondary” recycling
- Very suitable for fuel or energy recovery (also called “Tertiary Recycling”) by:
 - Pyrolysis to a liquid fuel
 - Gasification to syngas
 - Producing “engineered fuels” for co-combustion in dedicated power plants, or in high-temperature processes (e.g., cement kilns, etc.).



Feedstock and products of pyrolysis (Envion pilot plant, MD)



Feedstock



Oil product



Heavy oil/tar residue

Three pyrolysis and one gasification processes have been examined by EEC



Pyrolysis:

- Envion (Montgomery County, MD)
- Global Climax Energy (Fairfax, SC)
- Covanta (Rochester MA)

Gasification:

- Alter-NRG (Westinghouse Plasma) (Madison, PA)



Gasification

- Partial combustion of plastic wastes with air, oxygen-enriched air, or pure oxygen.
- It converts most of the carbon in the feedstock into syngas.
- The syngas can be used to produce electricity or it can be converted in valuable chemicals via the Fischer-Tropsch process.
- Some of the required energy is derived from partial combustion of the fuel.

*This afternoon Prof. Marco Castaldi will
discuss gasification research sponsored by
WTERT*



Engineered Solid Fuel Production

- Production of Refuse Derived Fuel (RDF) from non-recyclable combustible fraction of MSW mixed with plastic wastes
- RDF briquettes can be used as a fuel in cement kilns, gasification, co-combustion in power plants, etc.
- Processes EEC has reviewed:
 - Dongara
 - Pirelli Ambiente



Engineered fuel: The Dongara Process

- Based at Woodbridge, Ontario, operating a plant of 200,000 tons/y of MSW plus 60,000 tons/y of carpet waste
- The fuel is made of non- recyclable fraction of MSW mixed with carpet waste as high calorific additive.
- Fuel has calorific value of 27 MJ/kg
- Dongara has high potential but more information is needed

How to collect plastic wastes?



- Non-recyclable plastic wastes are now excluded from Multiple, Dual, or Single Stream collections of recyclables. However, EEC has determined that it is feasible to include plastic wastes in **Single Stream** collection and processing systems. The plastic wastes FPW would then be sorted out as a separate stream at the MRF.
- Shifting the plastic wastes from landfill trash would save the community the landfilling cost. However, there would be an extra cost for sorting out the plastic wastes at the MRF.

Will non-recyclable plastic wastes (PW) have a positive or negative value?



- At present time, non-recyclable plastic wastes have a negative value: A “gate fee” has to be paid per ton of plastic wastes delivered to a landfill or WTE.
- However, plastic wastes can have a positive value when used as feedstock in a fuel or energy-generating process.

Can plastic wastes have a positive value?

- For example, Envion claims it can produce up to **4.8 barrels of oil/ton plastics**.
- We know that the U.S. WTE industry generates electricity equivalent to **1 barrel of oil/ton MSW**.
- Since plastic wastes have over twice the heating value of MSW, a WTE fuelled by FPW would produce the equivalent of **2 barrels of oil/ton plastic wastes**.
- Therefore a successful pyrolysis/gasification process (that presumably will be more thermally efficient than combustion) should produce somewhere **between 2 and 4.8 barrels of oil/ton plastic wastes**.



Can plastic wastes have a positive value? (cont.)

- At the mid-point of this range (i.e. **3.4 barrels/ton FPW**), and at current crude oil price (\$75/barrel), the value of plastics-derived oil would be **\$255/ton plastic wastes**. The corresponding thermal conversion efficiency is calculated to be of 48% and is scientifically reasonable.
- **\$255 per ton plastic wastes** would be more than enough money to pay for collecting, sorting and processing plastic wastes to fuel oil.



How would removal of plastics from MSW affect present WTEs in the U.S.?

- Since capacity of present WTEs is limited by steam (i.e., heat) production, removing plastics from the MSW stream would increase the tonnage of MSW processed in a WTE by about 2.5 tons of MSW per ton of plastics recovered from MSW.
- In effect, the U.S. WTE capacity would be increased, while the landfilling of plastics would decrease.
- Increase in capacity of an existing WTE== higher gate fees



EEC is proud of the WTERT organizations in various nations (year of formation)

There will be brief presentations on Friday morning

- ❖ WTERT, U.S. (2002) www.wtert.org
 - ❖ SYNERGIA, Greece (2007) www.wtert.gr
 - ❖ WTERT, China (2008) www.wtert.cn
 - ❖ CEFWC, Canada (2008) www.wtert.ca
 - ❖ WtERT, Germany (2009) www.wtert.eu
 - ❖ WTERT, Japan (2010) www.wtert.jp
 - ❖ WTERT-Brasil, Brazil (2010) www.wtert.com.br
 - ❖ Under formation: WTERT-France; WTERT-U.K.; SUR*-India, SUR*-Argentina, SUR*-Mexico, SUR*-Thailand, MEFW-Italy
- *SUR: Consortium for Sustainable Use of Resources**

Thank you!

