### **HERAKLION 2019**

# Waste Management in Milan, E.U., Greece and China

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### Rational way to manage urban wastes

- "Recycling": Source-separated wastes that can be used as materials or composted to soil conditioning "compost"
- "Post-recycling": Materials remaining after all possible/practical "recycling"
  - After nearly 100 years of research, only two ways of dealing with "post-recycling" wastes:
    - sanitary landfilling (LF)
    - thermal processing with energy recovery (WTE)

### Example of intensive recycling: Milan, Italy

- Milan is a good example of <u>intensive recycling</u> that the author has observed personally.
- Population of 1.35 million people (2015); 80% live in high rise buildings with several households.
- The city collects five separate streams:
- three streams of recyclables (paper, glass, and metals with some types of plastics);
- a fourth stream of compostable organics
- and a fifth stream of post-recycling wastes combusted at a WTE plant located within the city.

## Example of intensive recycling: Milan (cont.)

- Milan provides 5 collection bins to each multi-story building and each house.
- The city also provides to <u>each household</u> a small covered container for temporary storage of food/yard wastes. The compostable bags used in these containers are purchased at supermarkets and other stores, at €0.10/bag

## Example of intensive recycling: Milan (cont.)

- Recycling regulations in Milan are strongly reinforced by <u>periodic inspections</u> by city government of the materials discarded in the various recycling bins.
- <u>Infractions are heavily fined</u>, e.g., by a \$200 fine on a building, which at the end of the year is divided among the households in the building.
- The Milan recycling infrastructure and citizen participation have resulted in <u>one of the best waste</u> <u>management systems in Europe.</u>
- The results of this intensive recycling are shown in following Table.

## **Results of intensive recycling of Milan**

Materials collected	Tons/year	%
Paper	78,000	9.6%
Plastics & metal	44,000	5.4%
Glass	65,000	8.0%
Total recycled	187,000	23.1%
Composted	141,000	17.4%
Total recycled and		
composted	328,000	40.4%
Post-recycling waste to		
Silla 2 WTE Power Plant	483,000*	59.6%
Total MSW, tons/year	811,000	100.0%

# How urban wastes are managed in various countries?

We call the following graph :

"The ladder of sustainable waste management"

 The nations higher up the "Ladder" are doing less or no landfilling



Similarity between denying "Climate Change" and opposing "Waste to Energy"

- The vast majority of scientists believe that carbon emissions cause climate change
- The vast majority of scientists in sustainable waste management believe that WTE is much preferable to landfilling (LF)



### Most deeply rooted misconceptions

- Humans do not cause global warming (despite all scientific evidence and several national multi-billion dollar disasters)
- 2. You do not need either landfilling or waste-toenergy. All that is needed is 100% recycling (despite the fact that no city or country has even come halfway close to this goal)



# If WTE is much preferable to LF why over 80% of global urban wastes go to landfilling?

#### No. 1 reason:

- Waste dumping costs practically nothing
- Sanitary landfilling can be done for an overall cost of \$30 to \$40 per ton (depending on biogas capture
- Because of the high initial capital investment, WTE rrequires a gate fee of \$60 per ton, at \$60/MWh of electricity; and \$40/ton, for \$100/MWh

#### Notes:

- a) the above costs do not include the "external" environmental costs of landfilling
- b) In Greece, on a 20-year horizon, WTE would be more economic than sanitary landfilling.

# If WTE is much preferable to LF why over 80% of global urban wastes go to landfilling? (cont.)

#### No. 2 reason:

- Continuing misinformation within the general public and even policymakers as to the "external" environmental costs of landfilling:
  - Loss of land (estimated at about 400,000 square meters annually for Greece)
  - Greenhouse gas emissions of landfill gas (estimated at 4 million tons CO2<sub>equ</sub> for Greece)
  - Severe dioxin and mercury emissions during unintentional landfill fires (about three thousand fires annually, in the U.S.)

## If WTE is much preferable to LF why over 80% of global urban wastes go to landfilling?

#### No. 2 reason (cont.):

- Misinformation against WTE is spread by well-intentioned "environmental" organizations who believe that WTE conflicts with recycling. They effectively perpetuate landfilling.
- Sanitary landfilling is a very profitable industry. It can afford strong lobbying and public relations to ensure its future well being.

## **Progress made in European Union (EU)**

- The E.U. has put in place <u>directives</u> which should phase out landfilling in the first half of this century
- Some EU members have already <u>phased out</u> <u>landfilling</u>, as shown in earlier graph
- Some others have not moved, even though they have to pay large fines for non-compliance



#### Changes in E.U. generation & disposition of MSW, 1995-2015 (Eurostat data, August 2017)



2015 EU MSW generation: 243 million tons 2015 EU population: 510 million y-axis: kg per capita

## Sustainable waste management in Asia

- Japan was the <u>first country in the world to abolish</u> <u>landfilling</u> by a combination of recycling and WTE
- South Korea has policies that promote recycling and WTE but still does some landfilling

### Emerging WTE leader in Asia: China:

- National 5-year energy plan includes energy from MSW
- Credit of \$30/MWh for WTE electricity
- Place for WTE in Belt and Road Initiative (BRI) funding



## Remaining obstacle to expansion of WTE, both in developing countries and, also, in the U.S.

- Initial capital investment: Repayment of the capital investment, per ton of MSW processed, is the major cost item of a WTE plant, affecting the gate fee of WTE vs landfilling
- This is true even for the U.S., where the WTE gate fee (e.g. \$60/per capita) is a minute fraction (1/1000) of the GDP per capita, because federal and state governments do not participate in waste management infrastructure.

# China has gone a long way since the Wang Juliang film "Beijing besieged by landfills"



#### 21<sup>st</sup> century growth of WTE industry in China By 2019: 330 WTE plants plus 200 under construction



In the course of the last fifteen years, China has become a major player in the global WTE industry

China has demonstrated that it is possible to <u>reduce the</u> <u>capital cost of WTE plants</u> by means of :

- Dedicated Industrial and academic R&D
- Rapid growth of industry, instead of custom building one plant at the time
- Assembly line production of WTE equipment
- Favorable national policies (e.g., \$30/MWh credit to WTE electricity)

Lower CAPEX offered by Chinese companies makes the WTE technology more cost-competitive with sanitary landfills (for sure in Greece)

- As the use of WTE grows in Asia, it will force developed countries (e.g., U.S., Canada and Australia) to reconsider WTE vs sanitary landfilling, especially with regard to GHG emissions
- Cities in the developing world can skip the sanitary landfill stage and move directly from waste dumps to WTE power plants (e.g. Azerbaijan, Ethiopia, Belarus, Vietnam).

## A new energy challenge: What to do with Non-Recycled Plastics (NRP)

- The Chinese ban on "recycled" plastics has certified the known fact that <10% of the global plastic wastes are actually recycled
- Two possible routes for Non-Recycled Plastics (NRP):
  - 1. Plastics to Energy power plants (PTE)
  - 2. Pyrolysis of NRP to synthetic oil



## Worldwide WTE examples: Copenhagen, Denmark (400,000 tons, ARC)



## West Palm Beach, Florida, USA (1 million tons per year; Babcock Wilcoxr)





## Ningbo WTE plant, China (SUS Environment)



## Guidelines for Sustainable Management of Municipal Solid Waste

 A 530-page compendium of accumulated experience in E.U., U.S., Japan, and China. Several case studies



#### A collaboration of:

- WtERT-Asia and China Everbright
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## GLOBAL WTERT COUNCIL Thanks!

