

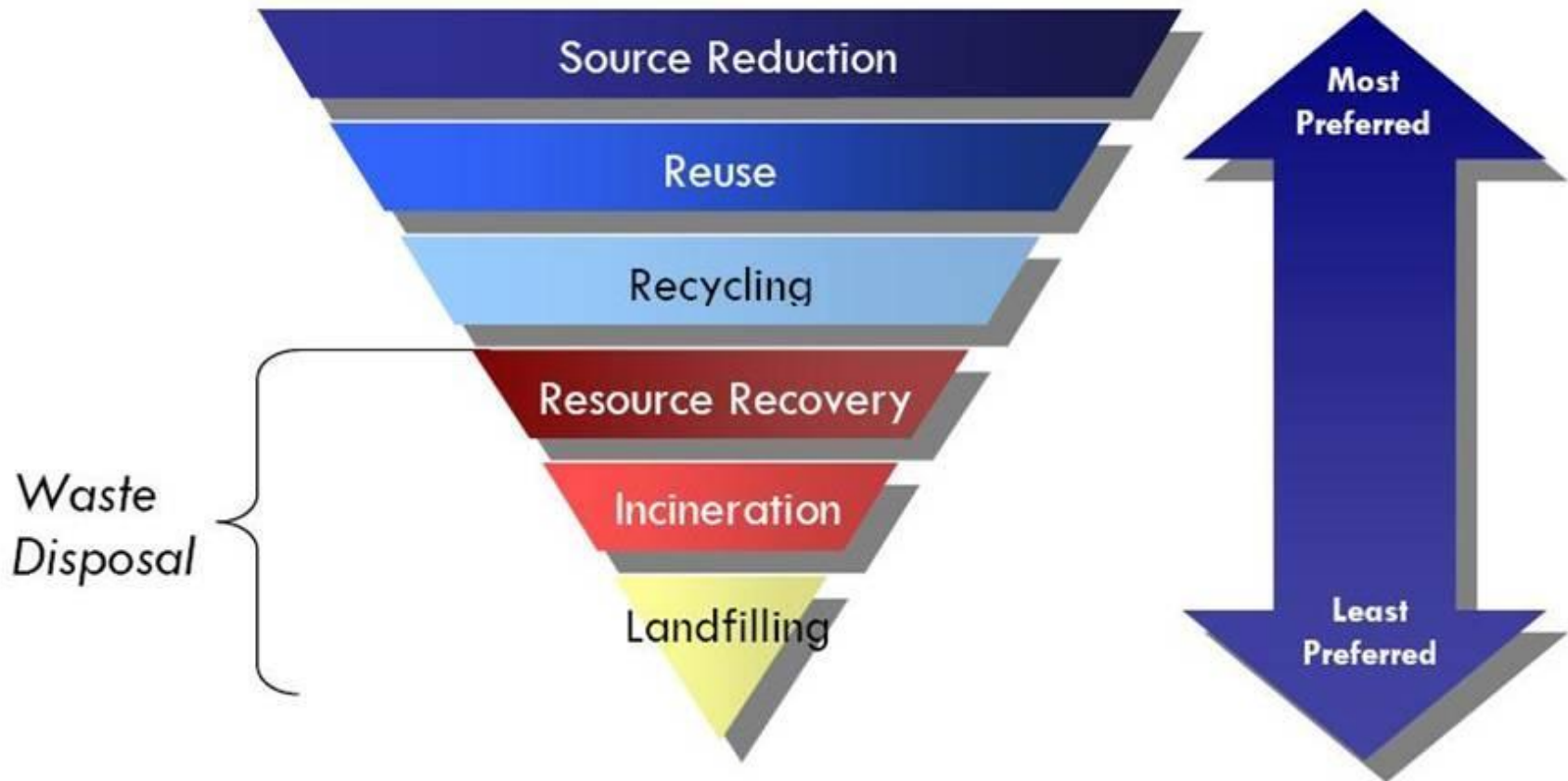


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Towards Smart and Sustainable Energy and Waste Management Solutions for Cities

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The Solid Waste Management Hierarchy



Integrated Solid Waste Management:

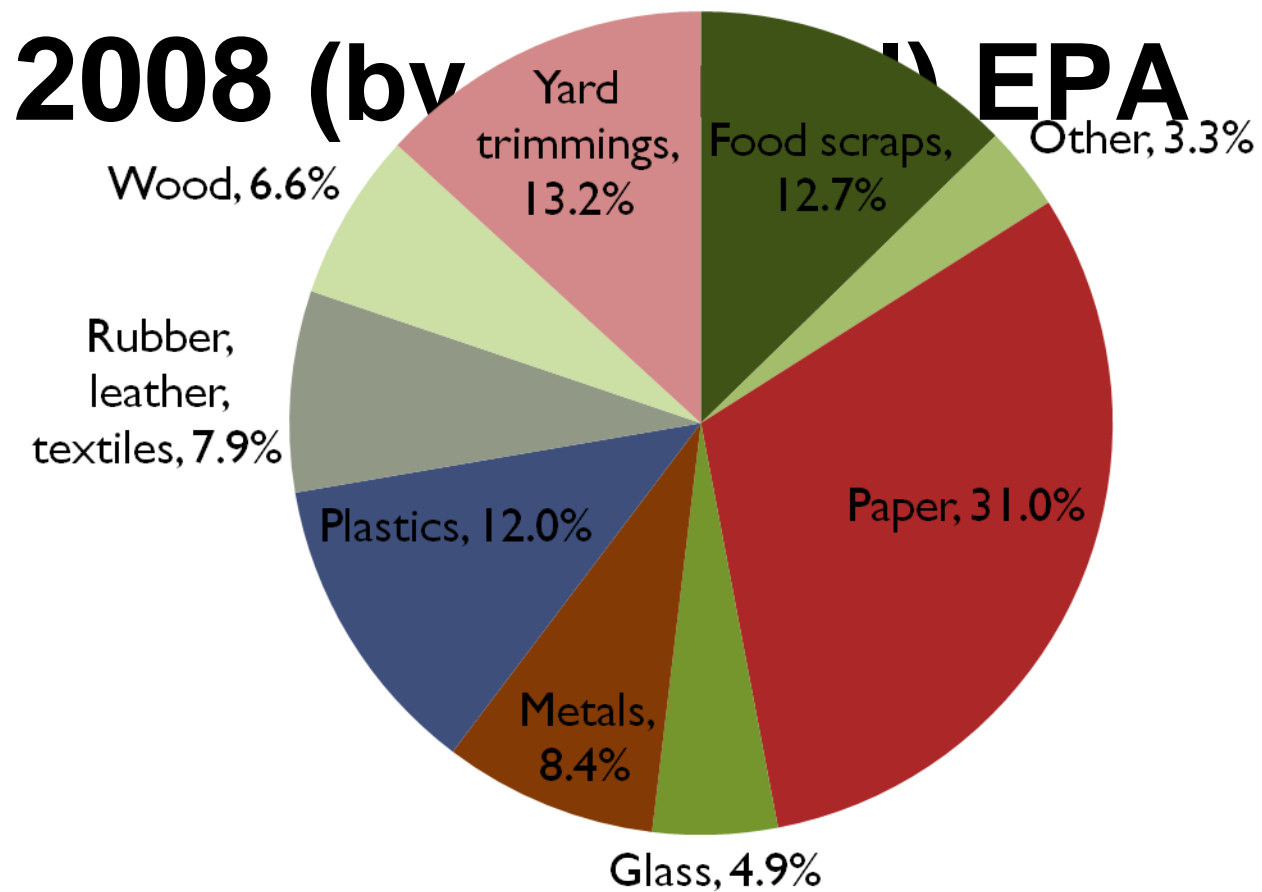
- A set of plans to manage solid waste
- Adopted by many governments
- A means of achieving sustainability

Why Manage Waste?

- Conserves resources & energy
- Reduces water & air pollution
- Saves landfill space
- Waste = Food
 - In nature there is no waste
 - Cradle to cradle design
 - Product components are recyclable or biodegradable
 - Extended Producer Responsibility (EPR) or Product Stewardship

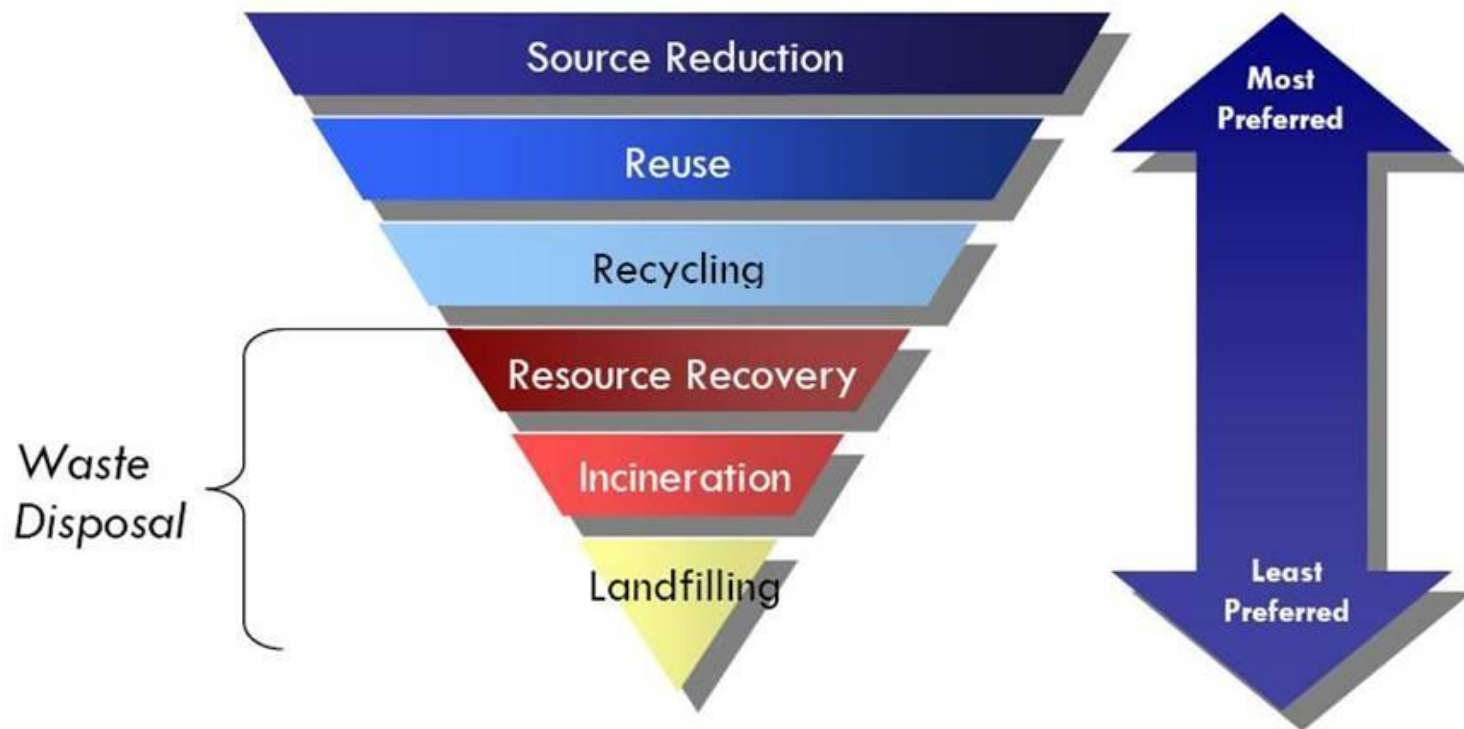


Total US MSW Generation

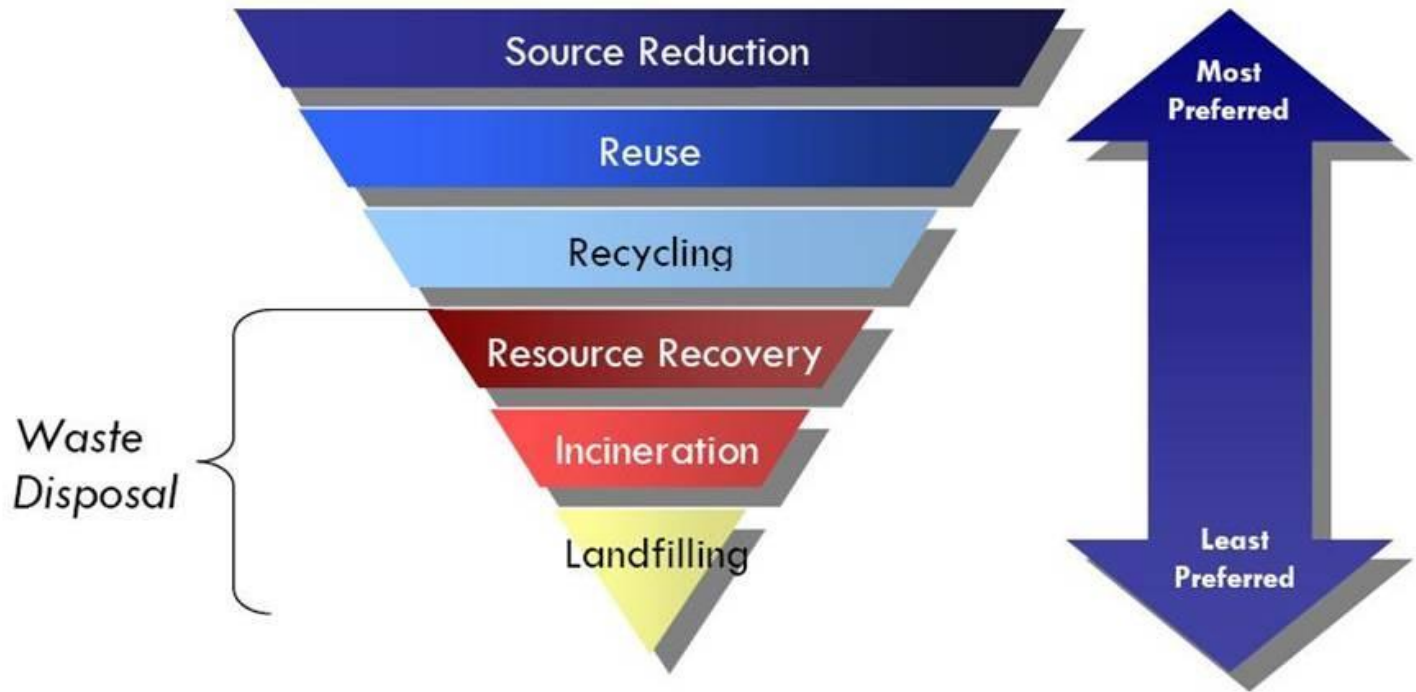


Source Reduction

The Solid Waste Management Hierarchy



The Solid Waste Management Hierarchy



Metal vs. Plastic Spoon:

- 50 cents for metal vs. one cent for plastic
- **Cost to Produce & Maintain:**
 - Resources (metal, petroleum, water, chemicals, etc.)
 - Energy used (in extraction, manufacturing, transportation)
- **External Costs:**
 - Pollution (during extraction, manufacturing, transportation)
 - Disposal (landfill, incineration, litter clean-up)
- **Savings from repetitive use of metal spoon:**
 - Priceless!

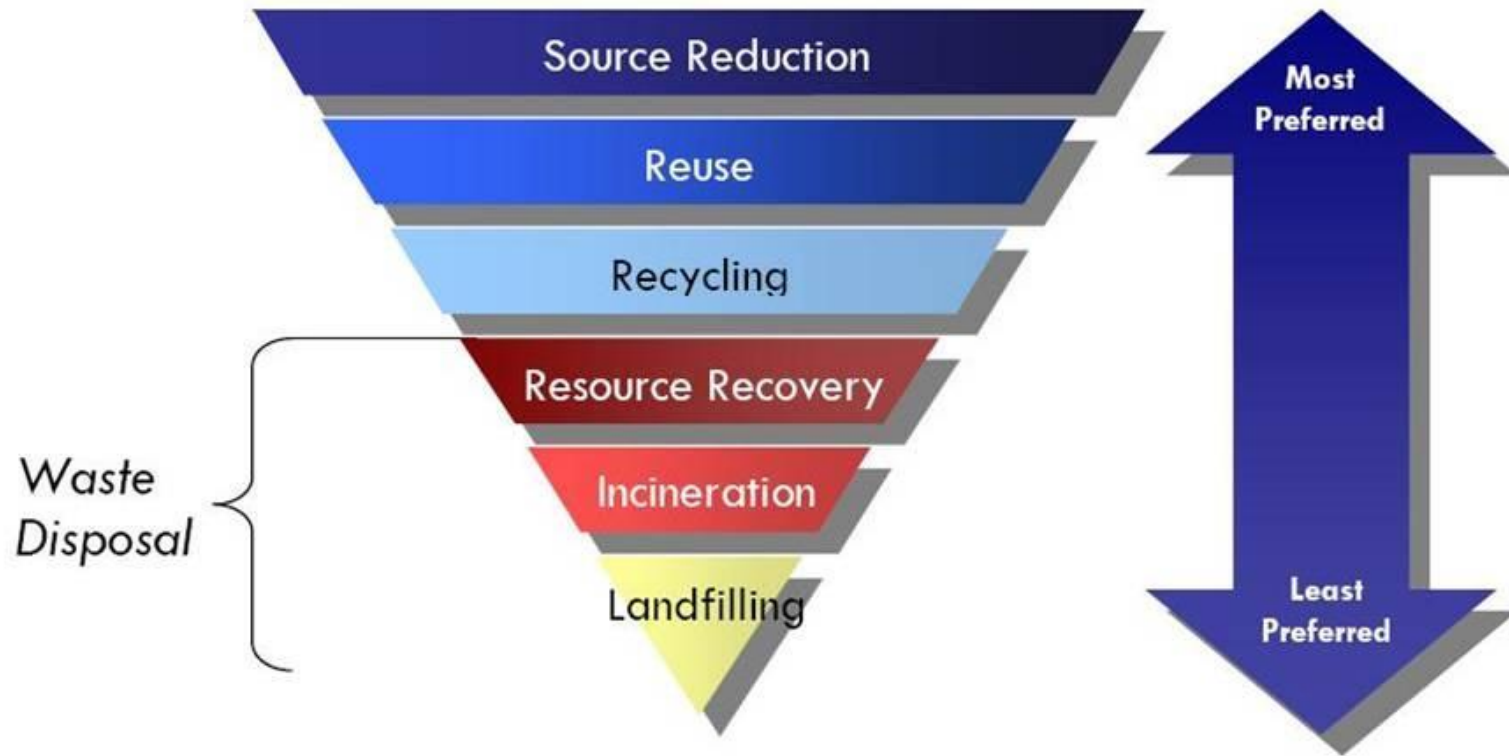
Waste Disposal

Incineration & Landfilling

- Items barely decompose in a modern landfill
- Landfills face capacity restrictions
- NIMBY syndrome



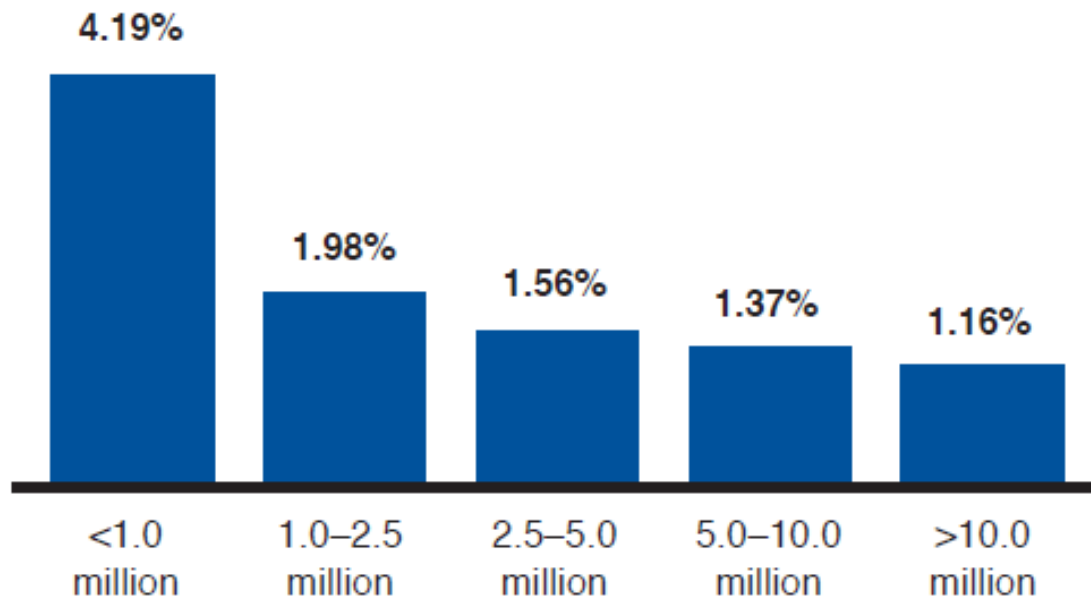
The Solid Waste Management Hierarchy



- Resource depletion, pollution and landfills are not the legacy we want to leave to future generations
- Recycling/reuse saves precious resources & energy
- Best solution is to reduce waste in the first place

Exhibit 5 *Urban Population Growth*

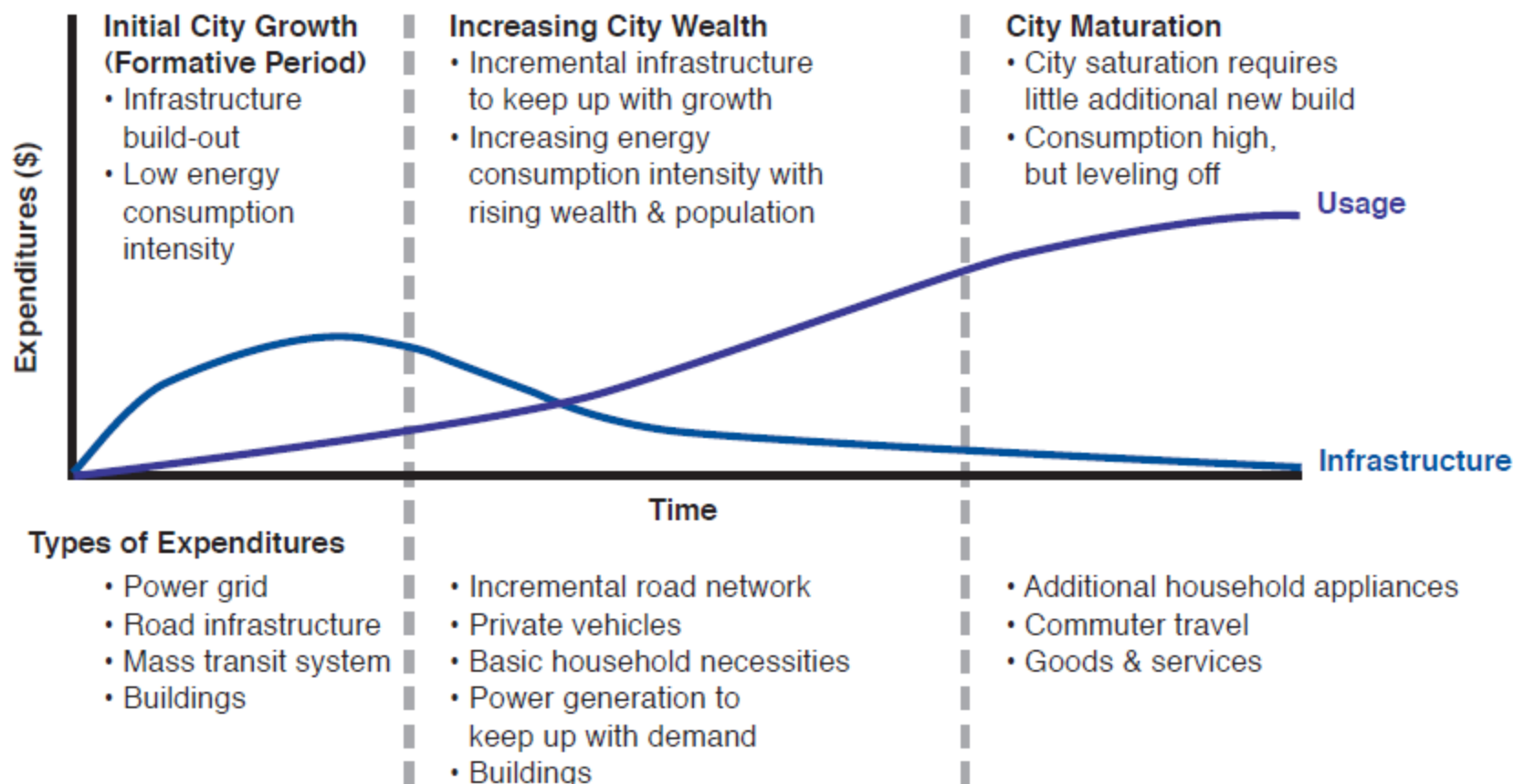
Urban Population Growth Rates by City Size (2009–2025)



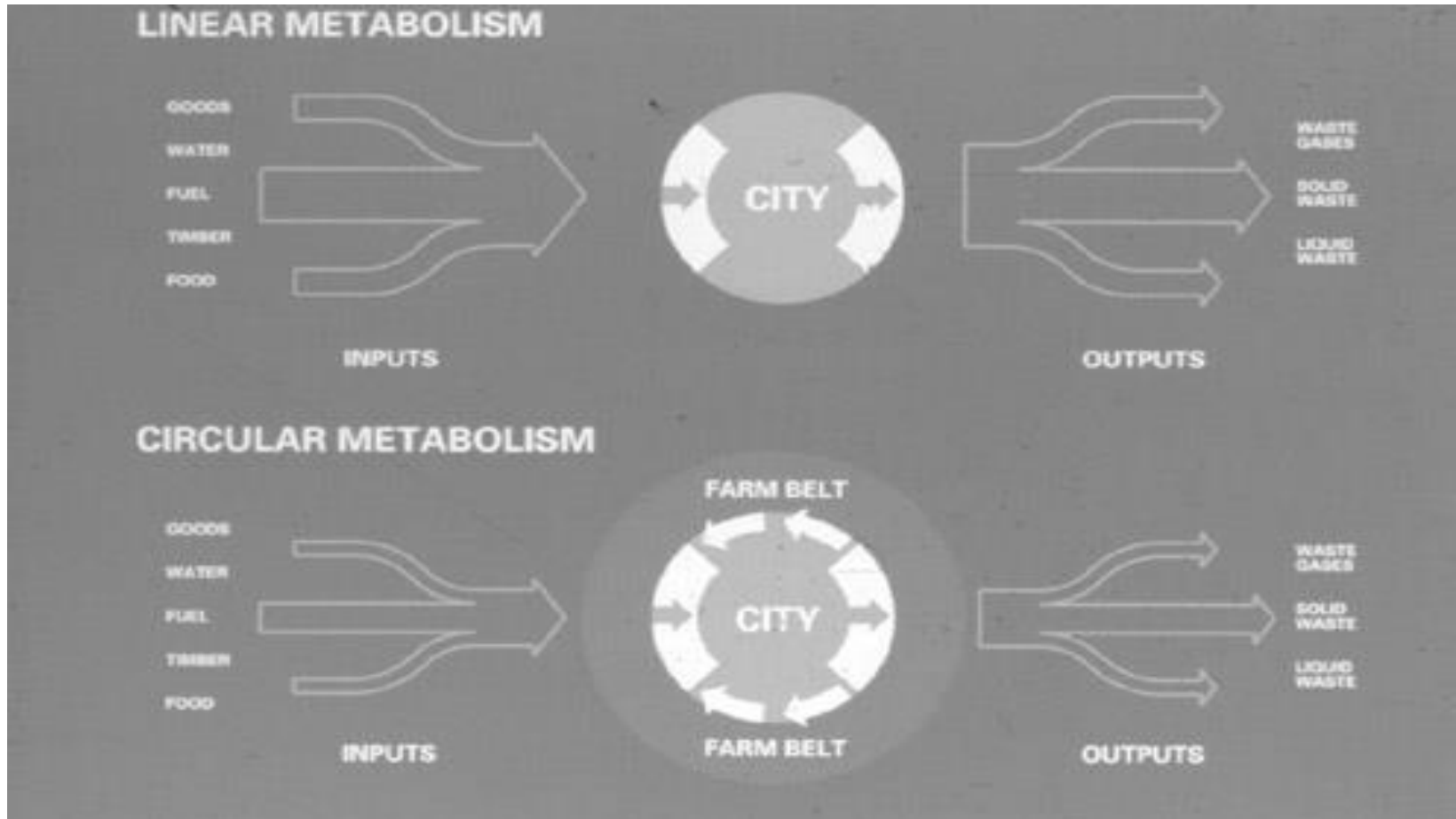
Source: "Demographia World Urban Areas & Population Projections"
(www.demographia.com/db-worldua2015.pdf); Booz & Company analysis

Exhibit 6 The Infrastructure Life Cycle of Cities

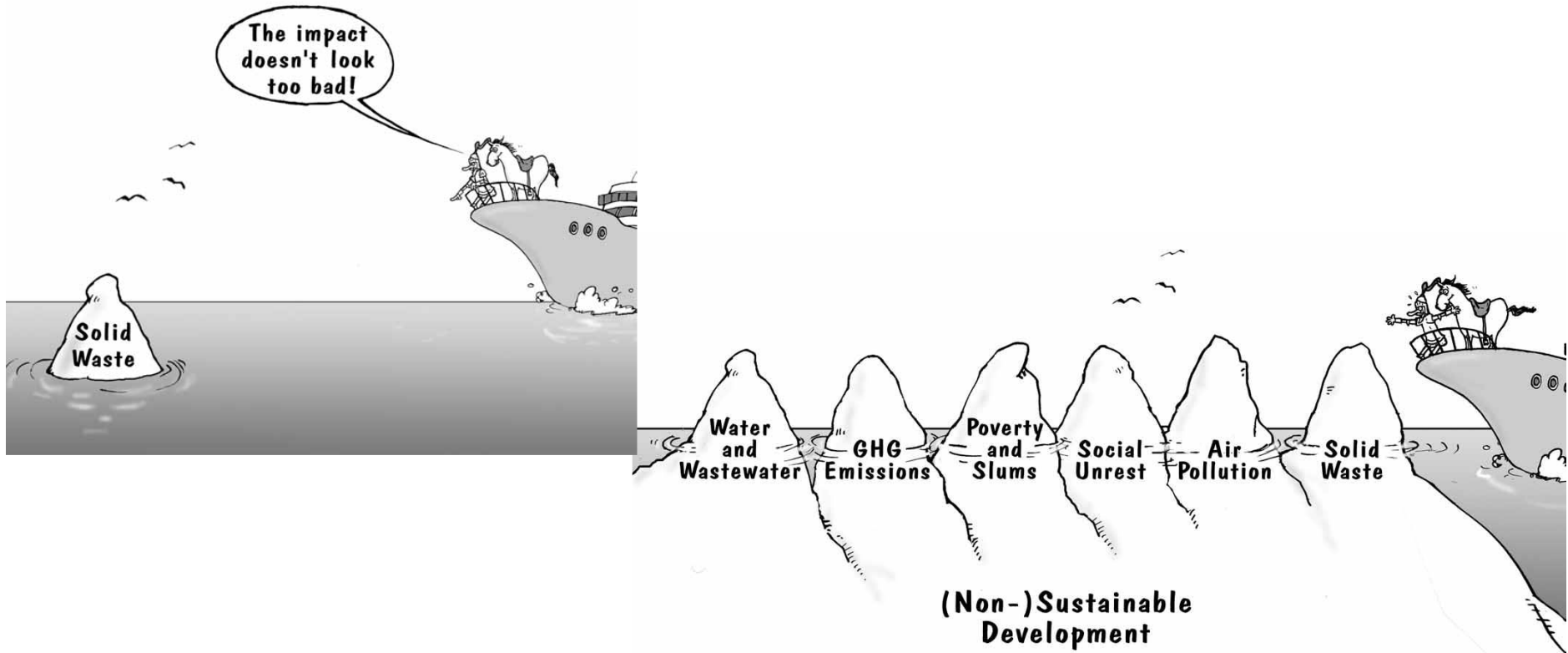
Typical City Expenditures and Emissions Trajectory



Urban Metabolism



The Challenge



Global Municipal Solid Waste (MSW)

- Global urbanization and increasing incomes have resulted in significant rise in MSW by urban inhabitants in the past 10 yrs. - .64 kg/person/day to 1.2kg/p/d – and 1.42kg/p/d by 2025
- *In LAC - total amount of waste generated per year in this region is 160 million tonnes, with average per capita value of 1.1 kg/capita/day - Caribbean highest levels*

Region	Waste Generation Per Capita (kg/capita/day) Averages	Project Waste Generation per Capital by 2050
Organization for Economic Co-operation and Development Member States (OECD)	2.2	2.1
Latin American and Caribbean (LAC)	1.1	1.6
Middle East and North Africa (MENA)	1.1	1.43
Africa region (AFR)	0.65	0.85
South Asia region (SAR)	0.45	0.77
Europe and Central Asia region (ECA)	1.1	1.5
East Asia and Pacific region (EAP)	0.95	1.5

LAC – Solid Waste Management Overview

- Approx. 60% of LAC waste is disposed in landfills, yet outside capital cities, most waste is deposited in open dumps
- Waste incineration is very limited in the region, predominately due to costs
- Composting (centralized) has not been successful
- Recycling limited

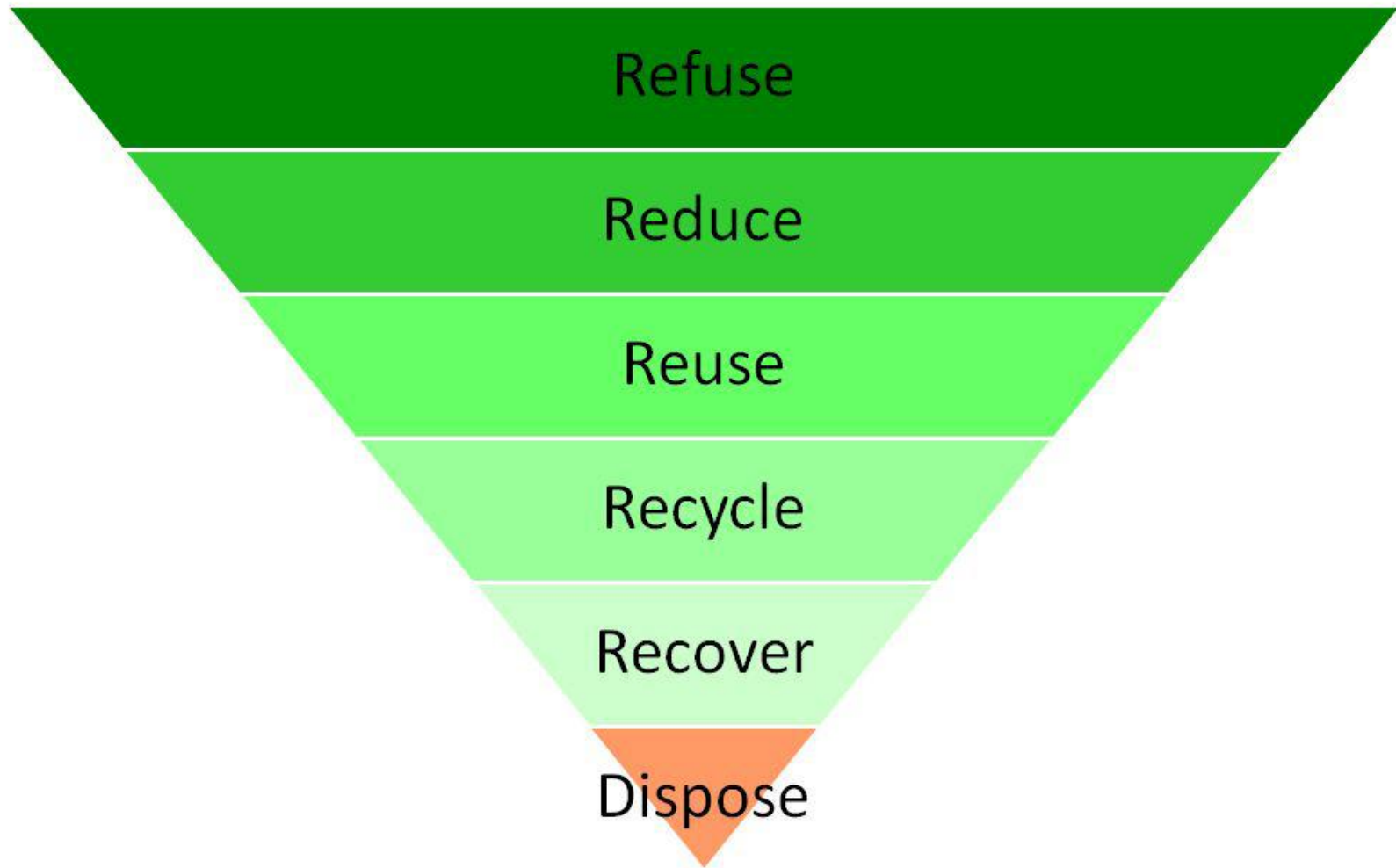
LAC – Solid Waste Management Opportunities

- Municipal solid waste management is one of the most important services provided (and controlled) by local governments - implications for city budget, GHGs, energy, employment, health, environmental protection, resource utilization, political image
- High organic content of waste in LAC generates methane gas quickly that could be captured for energy.

Solid Waste Management Principles for Sustainable Cities

- **Equity** for all citizens to have access to waste management systems for public health reasons;
- **Effectiveness** of the waste management system to safely remove the waste;
- **Efficiency** to maximize benefits, minimize costs, and optimize the use of resources; and
- **Sustainability** of the system from a technical, environmental, social (cultural), economic, financial, institutional, and political perspective (van de Klundert and Anschütz 2001)

Waste Pyramid

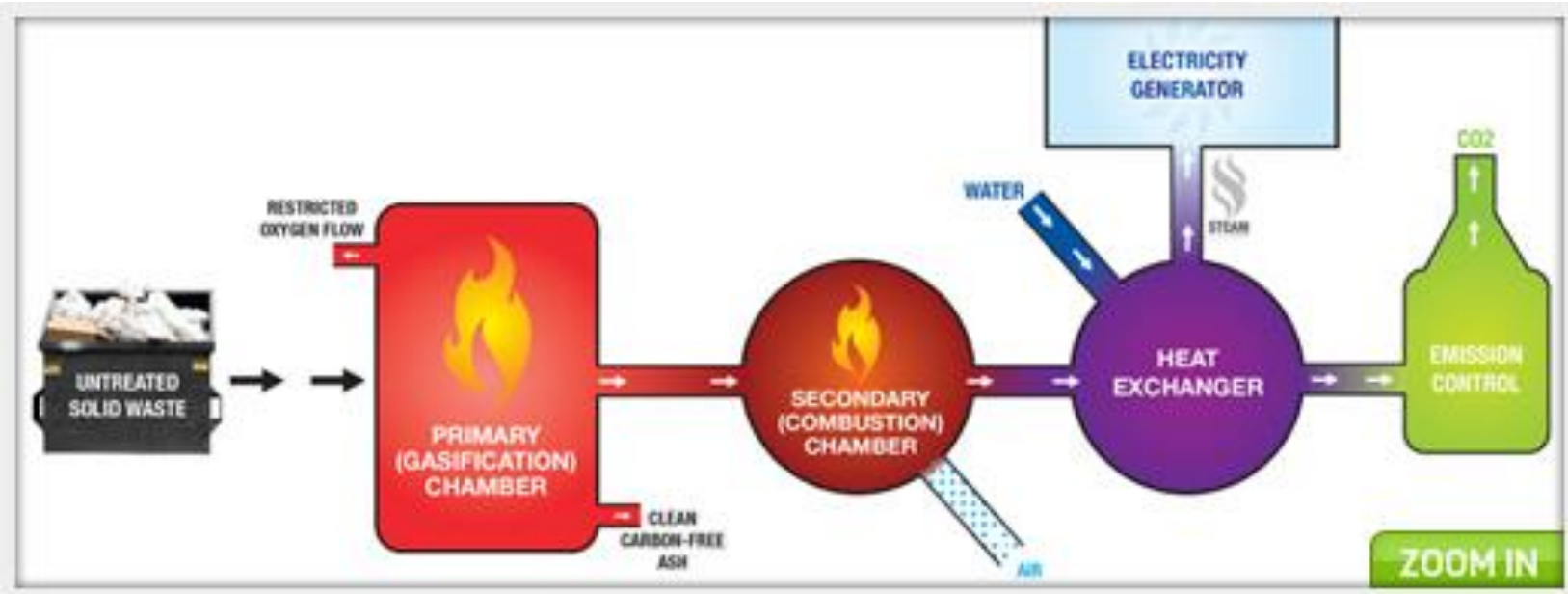


Waste – Energy Models/Practices

- **Waste Reduction:** *prevention, minimization, and reuse – product redesign and stem consumerism*
- **Recycling and Materials Recovery: 3Rs**
generates income and employment ; eg: construction wa
- **Composting and Biogas Production:** *composting of organic matter with oxygen (aerobic) for agricultural fertilizers or fuel; anaerobic digestion – methane collected and combusted for energy;*
- **Landfill/Methane Capture:** *most common among all countries; must be done properly to protect the environment and public health. Landfill gas (LFG) from organic matter decomposition can be recovered and the methane (about 50% of LFG) burned with or without energy recovery to reduce GHG emissions.*
- **Incineration/Gasification:** *burning of waste to reduces volume of waste (up to 90%); energy recovery models with waste streams with very high amounts of packaging materials, paper, cardboard, plastics and horticultural waste. Burning without energy recovery is not recommended - results in air pollution, health problems.*



Waste to Energy Model – Gasification



- **Benefits:** Feedstock flexibility, Product flexibility, Near-zero emissions, High efficiency, Energy security
- **Challenges:** high capital costs; institutionalized waste mgmt system; economies of scale (~1 million inhabitants)
- Very broad estimate for separated dried household waste :
 - 1 ton of input = 1.3MW - 1.7MW electric net output. (~700 homes (OECD))
 - calorific value of approx. 12 - 14 MJ/Nm³ @ gross electric efficiency of 80%.

10-Year Framework of Programme (10 YFP) on Sustainable Consumption and Production (SCP) *adopted at Rio+20 Conference*

- *SCP is about promoting resource and energy efficiency and sustainable infrastructure while offering opportunities such as creating new markets and generating green and decent jobs, such as markets for organic food, fair trade, sustainable housing, renewable energy, sustainable transport and tourism. SCP is especially beneficial for developing countries as it provides an opportunity for them to “leapfrog” to more resource-efficient, environmentally sound and competitive technologies, allowing them to bypass inefficient and polluting phases of development*
- *A sustainable city includes compact, efficient land use; less automobile use yet with better access; efficient resource use, less pollution and waste; the restoration of natural systems; good housing and living environments; a healthy social ecology; sustainable economics; community participation and involvement; and preservation of local culture and wisdom.*
- Brazil, Colombia, Cuba, the Dominican Republic, Ecuador, Mexico, Peru and Uruguay have developed national action plans, <http://www.unep.org/resourceefficiency/Home/Assessment/tabid/55520/Default.aspx>
- <http://www.unep.org/10yfp/>



Durban Adaptation Charter

<http://durbanadaptationcharter.org>

- Global Agreement/platform launched at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) 17 2011). Signed by over 1000 cities committing themselves to:
- ***Availability of urban data and local government plans***
- ***Ensuring that adaptation strategies are aligned with mitigation strategies;***
- ***Promoting the use of adaptation that recognizes the needs of vulnerable communities and ensuring sustainable local economic development;***
- ***Prioritizing the role of functioning ecosystems as core municipal green infrastructure;***
- ***Seeking innovative funding mechanisms.***