Gear Up for Safety

Keppel Seghers

Solutions for a Cleaner Future

Recovering Energy from Waste

Exploring Trends, Challenges and Opportunities: Energy for our Future Generations

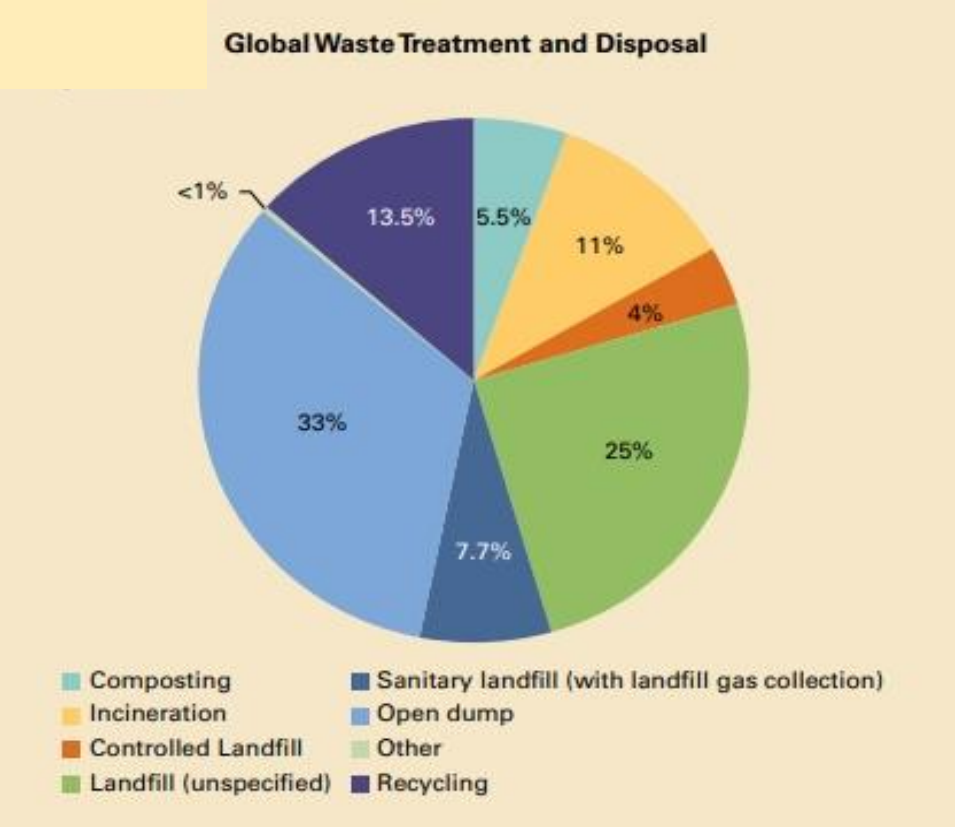
How many tonnes of municipal solid waste (“MSW”) are globally produced annually?

Estimated 2,000,000,000 tons in year 2016

Projected to reach 3,400,000,000 tons in 2050 based on business as usual scenario

Source: What a waste 2.0 A global snapshot of Solid Waste Management to 2050 – World Bank 2018

So what happens with this Waste?



36.7% Landfilled

33% Open dump

13.5% Recycled

11% Incinerated

5.5% Composted

< 1% Others

Source: What a waste 2.0 A Global Snapshot of Solid Waste Management to 2050– World Bank (2018)

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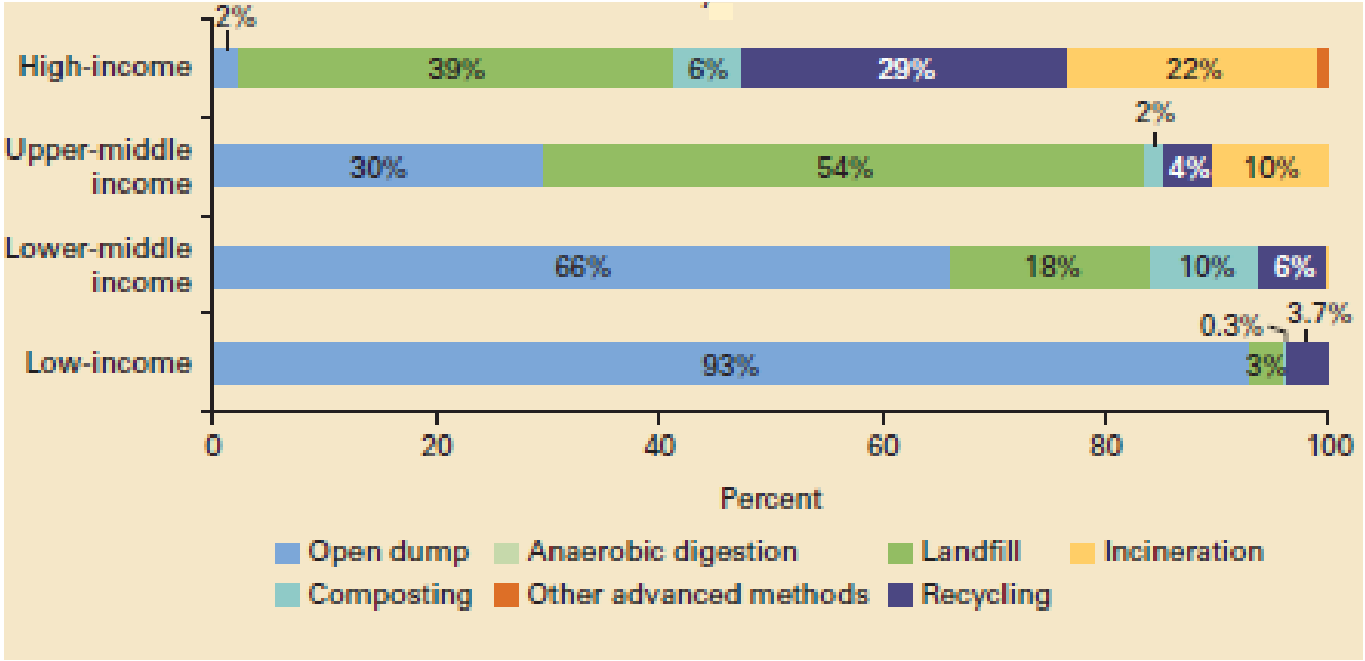


Source: What a waste 2.0 A Global Snapshot of Solid Waste Management to 2050– World Bank (2018)

What is Residual Waste?

Waste Hierarchy – Lansink's Ladder

Oxford definition of ***Waste***
"Unwanted or unusable material, substances, or by-products"

Oxford definition of ***Residual***
"Left over or remaining after the greater part or quantity is gone"

Residual Waste are left over after reuse or recycling

Source: https://en.oxforddictionaries.com/definition/waste
https://en.oxforddictionaries.com/definition/residual
https://www.recycling.com/downloads/waste-hierarchy-lansinks-ladder/

When is waste a resource?

Sources: https://www.recyclingtoday.com/article/scrap-metal-services-contracts-with-aperam-belgium/ |http://ssmb.in/kowloon-station/

When is waste a resource?

Source: https://www.okchem.com/showroom/recycled-plastic-pet-pellets-for-sale.html

When Waste remains as Waste

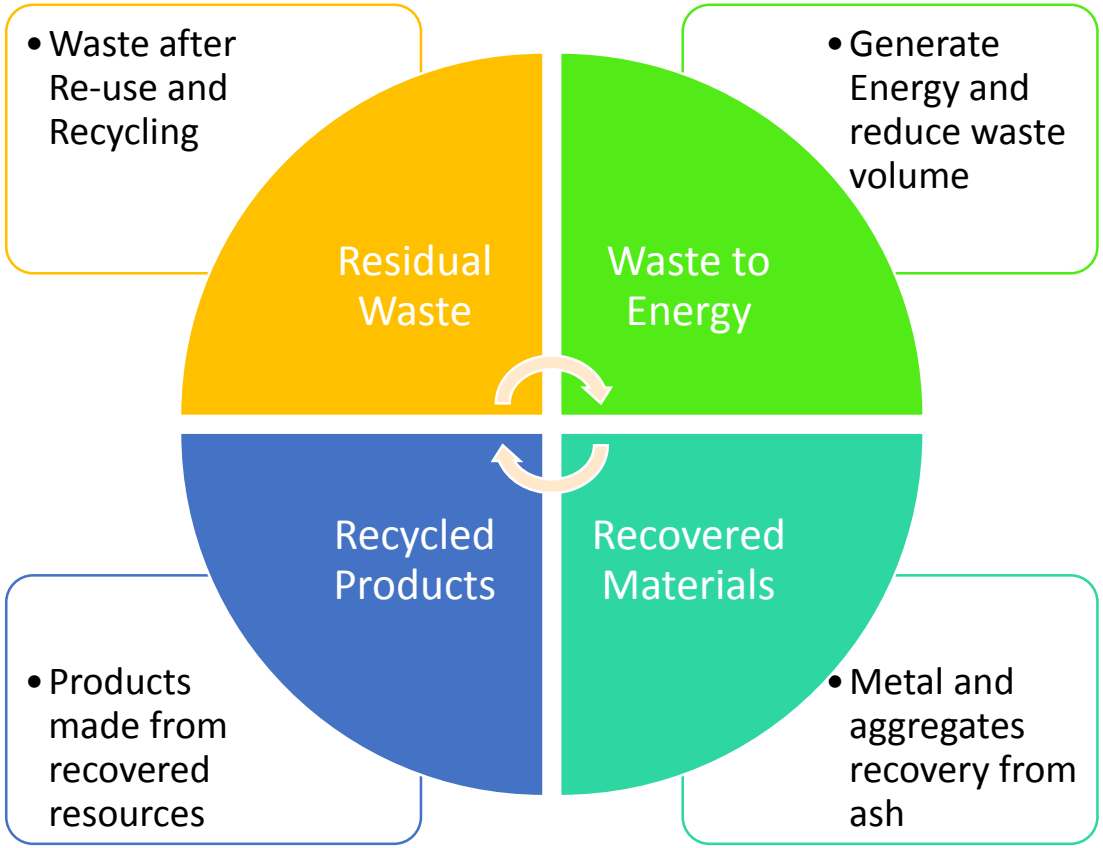
Source: https://www.weforum.org/agenda/2015/11/how-can-we-manage-our-waste-and-make-money-doing-it/

Residual Waste as Energy Resource

Resource recovery from Bottom Ash

Sources: Thermo-Recycling implenting the new recycling concept to effectively recovery metals from IBA – Morf & Böni (2018) VDI Conference
MSW IBA Utilization in Finland – Rantsi (2018) VDI Conference

Part of the effort towards Circular Economy



Landfill versus Waste to Energy

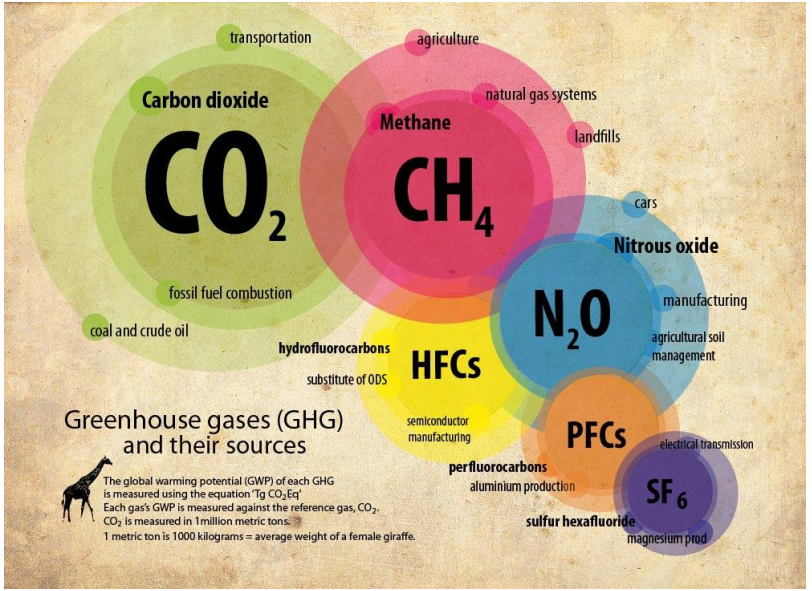
	Landfill	Waste to Energy
Energy Production	Generally not	Yes
Land area optimization	No	Volume reduction by >90 %
Pollution	Uncontrolled	Treated and controlled
Net greenhouse gas reducer	No	Yes
Vermin	Yes	No
Odour and visual nuisance	Yes	Controlled
Reduces dependency on fossil fuels	No	Yes
Complementary with other industry	Generally not	Steam and energy delivery District cooling and heating
Material Recovery	Generally not	Material recovery system can be incorporated

Sources: http://swdahsv.org/benefits-of-waste-to-energy/
http://www.cewep.eu/

Indirect Greenhouse gas avoidance – Green energy from waste

- Avoid greenhouse gasses
  - Landfill: source of methane (20-30 times higher impact than CO_2)
  - Metals: Recycling metals saves around 1.5 kg CO_2 per kg iron scrap and about 10 kg CO_2 per kg aluminum.

- Waste to Energy produces CO_2
  - 30-50 % of organic source – Green source



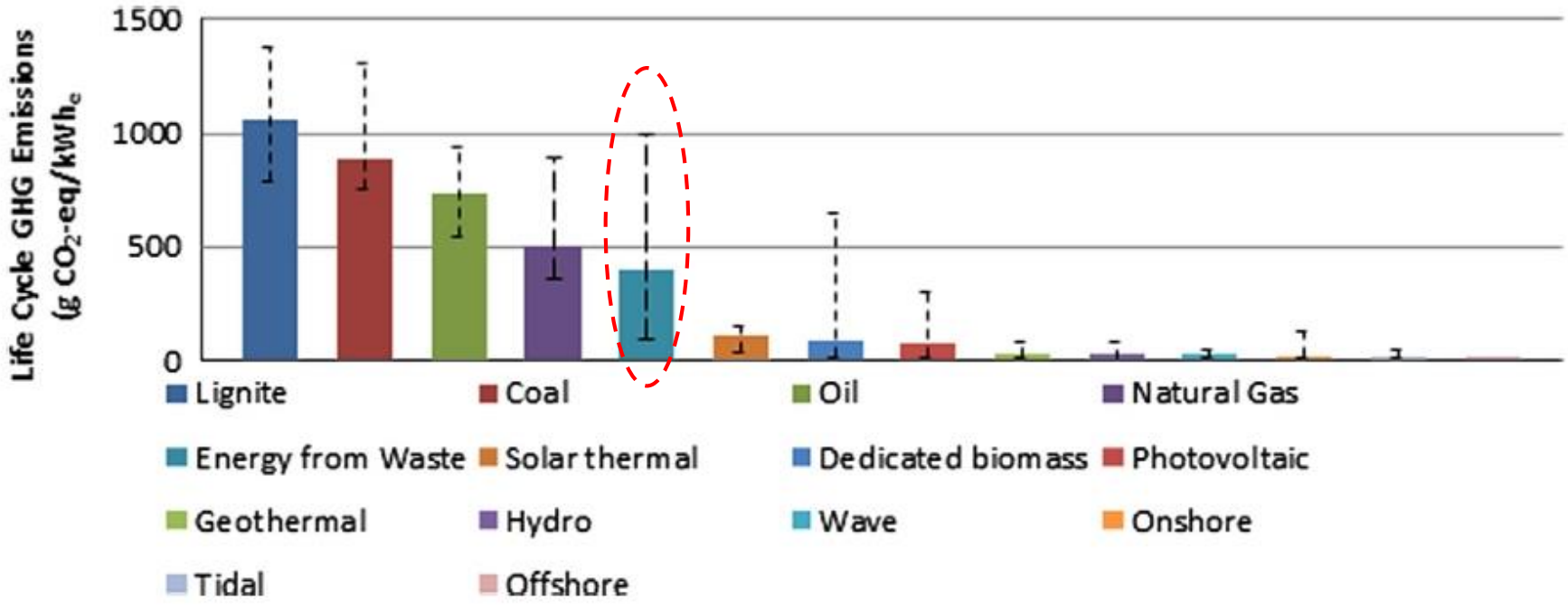
Sources: www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf
http://wtert.co.uk/faqs
https://waste-management-world.com/a/waste-to-energy-the-carbon-perspective
https://www.greenandgrowing.org/what-are-greenhouse-gases/

Comparing Waste to Energy with other Power Plants

	Type of energy generation				
	Fossil fuel	**Waste to Energy**	**Solar**	**Wind**	**Nuclear**
Size (MWe)	> 1000	< 100	> 100	> 100	> 1000
Efficiency of electricity generation	32-53%	19-33%	4-22%	23-45%	30-36%
Fuel Type	Oil, gas, coal	Residual waste	Renewable	Renewable	Uranium, Plutonium
EU Emission limits (mg/Nm^3)					
SO_2	400	50	n.a.	n.a.	n.a.
NO_x	300	200	n.a.	n.a.	n.a.
Dust	20	10	n.a.	n.a.	n.a.

Sources: Comparing the sustainability parameters of renewable, nuclear and fossil fuel electricity generation technologies - Evans et al. 2010
Waste-to-energy is compatible and complementary with recylcing in the circular economy – Van Caneghem et al. 2019
Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations – Amponsah et al. 2014

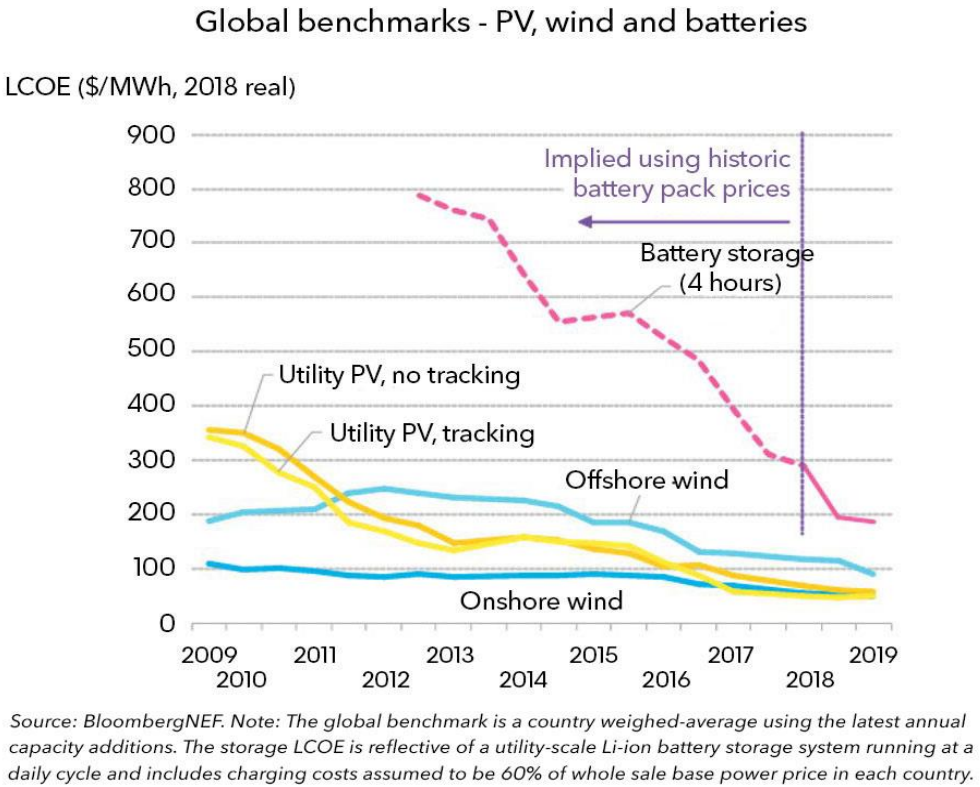
Comparing Waste to Energy – Green house Gas emissions



Life cycle GHG emission estimates of electricity generation methods.

Source: Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations – Amponsah et al. 2014

How do we see the energy landscape changing?



Source: BloombergNEF. Note: The global benchmark is a country weighed-average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-ion battery storage system running at a daily cycle and includes charging costs assumed to be 60% of whole sale base power price in each country.

- Prices of renewables are going down
- Economic and ecologic drivers to implement these technologies for energy production

Source: The Switch by Chris Goodall

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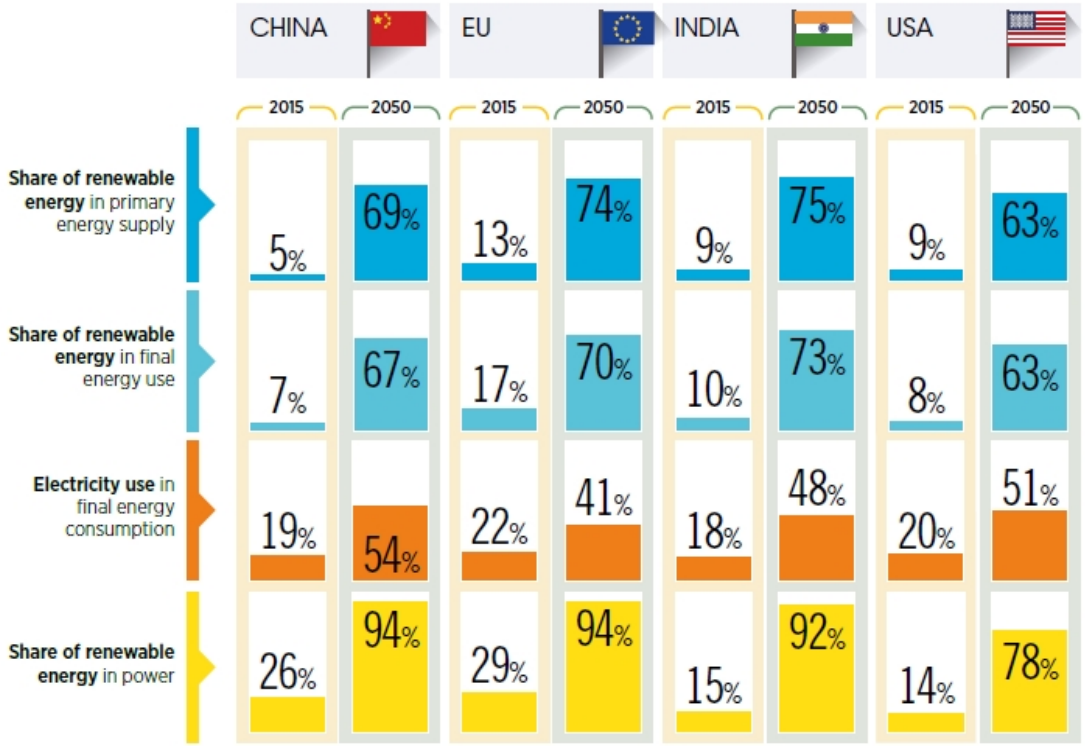

- Increase in the use of electricity as a form of energy.
- Substantial increase in the adoption of renewable energy over the next 30 years.

Source: Global Energy transformation a roadmap to 2050 –IRENA (2018)

Role of Waste to Energy in the future

Waste Sector	Energy Sector
• Success of Re-use & Recycling effort • Residual Waste trends • Landfill diversion rate • Technology advancement for Waste to Energy	• Reduction in green house gases • Stricter emission control on power plants

Gear Up for Safety

Thank You