



Municipal
Solid Waste to Energy
Technologies:
Environmental Assessment

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Workshop on "Sustainability of Solid Waste Management in Thailand"
King Mongkut's University of Technology Thonburi, Bangkok
October 11, 2010



- Status



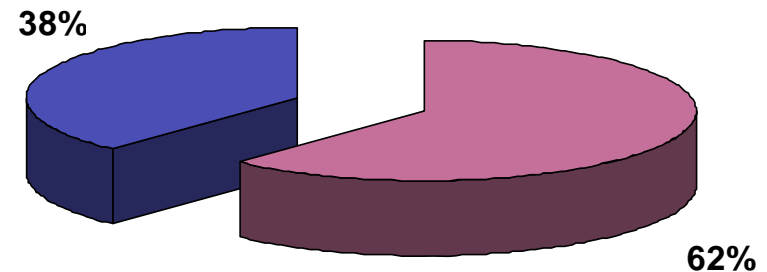
0.6-0.7 kg/capita/day

✘ 66 Million People



40,000 ton/day

Only 38% of total solid waste is managed by sanitary disposal system





- Status

Sanitary landfill is the most commonly used system in Thailand.

BY RECYCLING PLASTIC YOU'RE REDUCING THE AMOUNT OF OIL NEEDED TO MAKE THE STUFF, AND THE NUMBER OF LANDFILL SITES USED TO DISPOSE OF ALL THE PLASTIC THROWN AWAY!

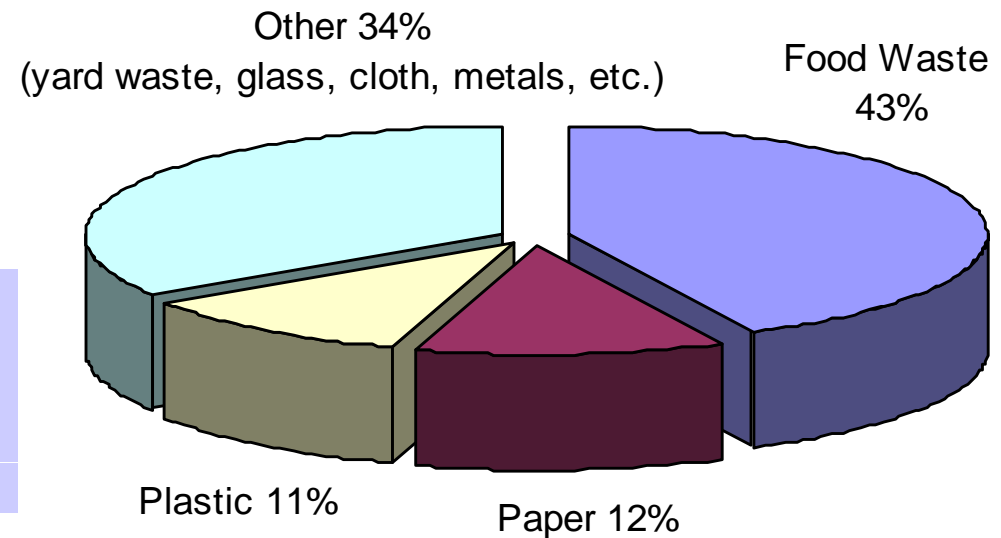


Resources are embedded in the soil regardless of effective benefits.



- Bangkok MSW Composition
- Electricity Production Potential

Bangkok MSW Composition (PCD, 2008)



100 ton MSW can produce 1 MWh electricity.
(Rule of Thumb)

40,000 ton MSW can produce 400 MWh electricity .



- Waste to Energy Quote

The old practice of waste disposal has been to dump in open landfills, which results in *garbage in and garbage remains*.

The goal for the new millennium must be *garbage in and energy out* in an environmentally acceptable manner.

(Gupta, 2004)



- Waste to Energy
- WtE Technologies

Waste to Energy (WtE)

refers to any waste treatment that creates energy in the form of electricity or heat from a waste source.

Waste to Energy Technologies

- Incineration
- Anaerobic Digestion
- Landfill Gas to Energy
- Refuse Derived Fuel; RDF
- Plasma Arc



- Incineration

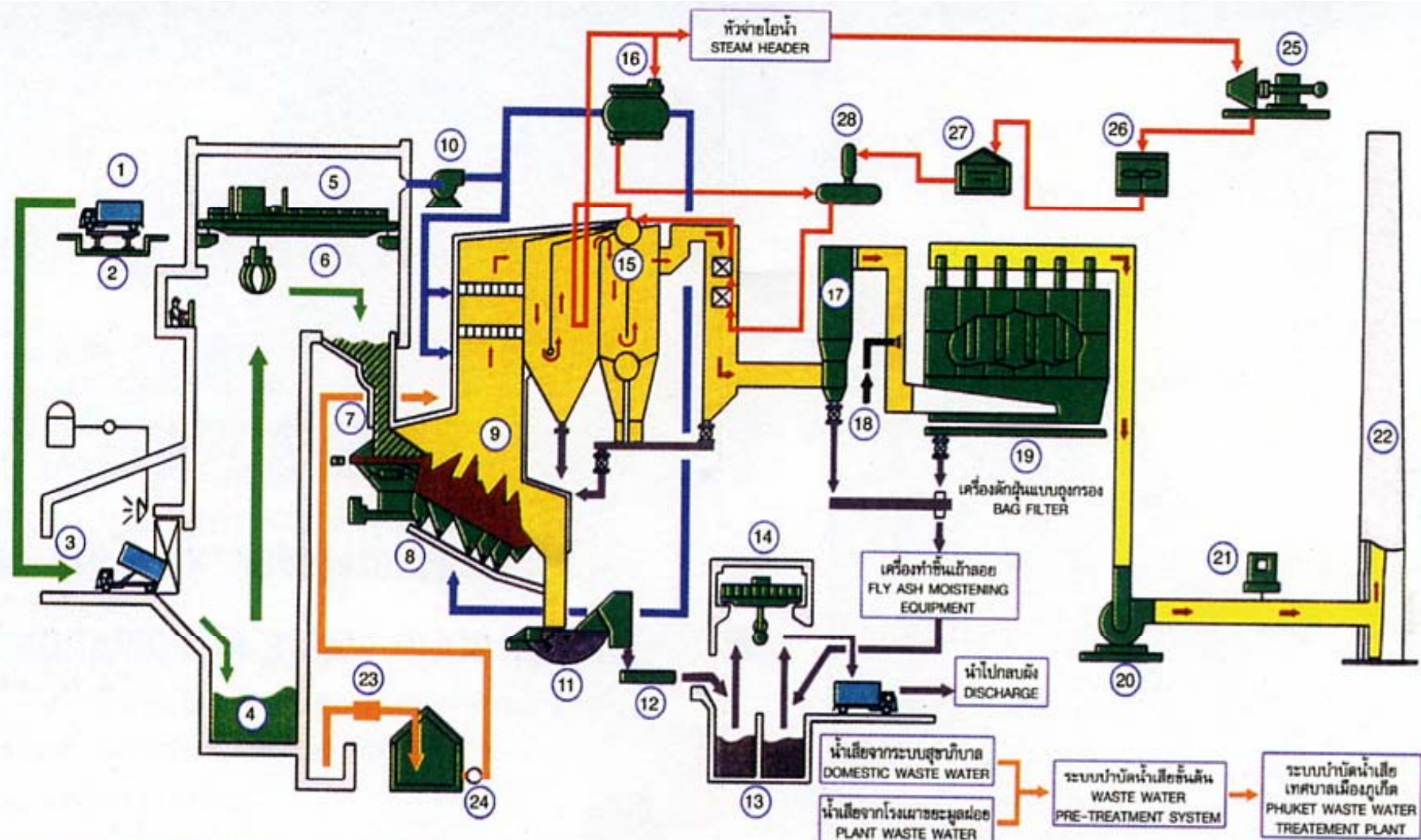
- Incineration is described as “thermal treatment” for
 - reducing mass and volume of wastes
 - effectively destroying hazardous components of the waste
- High temperature (650-1,200 °C) is employed for combustion process.
- Incineration of waste materials converts the waste into ash, flue gas and heat.
- Effective controls are required to prevent the negative impacts on human health and environment.



Phuket Incineration Plant

- continuous burning grate-type
- 250 tons MSW/day
- 2.5 MW power production





น้ำเสีย WASTE WATER FLOW.	ไอน้ำ STEAM FLOW	อากาศ AIR FLOW	ก๊าซร้อน FLUE GAS FLOW	เถ้า ASH FLOW	ขยะ REFUSE FLOW
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• Anaerobic Digestion

- Anaerobic digestion can be used as a **pre-treatment** to reduce the volume and stabilize material for disposal in landfills.
- Organic fractions in MSW is decomposed by anaerobic microorganisms.
- **Methane** is a predominant product from anaerobic digestion.
- In addition to energy recovery, digestate can be further used as soil conditioner.



Rayong Anaerobic Digestion Plant

- 60 tons organic waste/day
- 0.625 MW power production





• Landfill Gas to Energy

- Landfill stands alone as the only waste disposal that can deal with all materials in the solid waste stream.
- Landfill is considered the simplest, and in many areas the cheapest, of disposal methods.
- Outputs after composition are:
 - The final stabilized solid waste
 - Leachate
 - Landfill gas
- Collection and control of landfill gas is needed for safety and environmental reasons.
- The collected landfill gas can be:
 - Flared of
 - Used as a fuel

Kampaeng Saen Landfill Project

- Initial landfill gas recovery project
- Horizontal gas collector
- 6,000 ton MSW/day
- 870 (435×2) kW electricity generator





- Refuse Derived Fuel: RDF

- RDF involves the mechanical processing to recover recyclable materials and to produce a combustible product.
- RDF can be processed to half the calorific value of coal.
- RDF can be co-fired with other fuels in a variety of industrial boilers.
- Weaknesses
 - High investment
 - high electrical power consumption and maintenance





- Plasma Arc

- Temperatures 4,000°C to over 7,000 ° C
- Hazardous & toxic compounds broken down to elemental constituents by high temperatures
- Organic materials are converted to fuel gases
- Residual materials (inorganics, heavy metals, etc.) immobilized in a rock-like vitrified mass which is highly resistant to leaching



The Plasma Arc Plant at Mihama-Mikata, Japan converts unprocessed MSW and WWTP sludge to fuel gas.



- WtE: Environmental Assessment

Environmental Assessment of Energy Production from MSW Incineration

Liamsanguan and Gheewala (2006)



- Objective
- Functional Unit

- ▣ The comparison of environmental impacts of electricity production from **incineration** with those of **Thai conventional power plants**.
- ▣ Functional unit: **1 MWh net electricity produced**

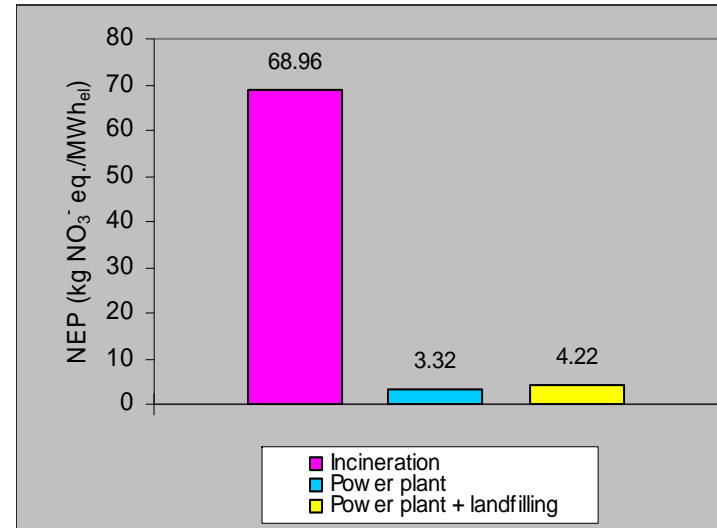
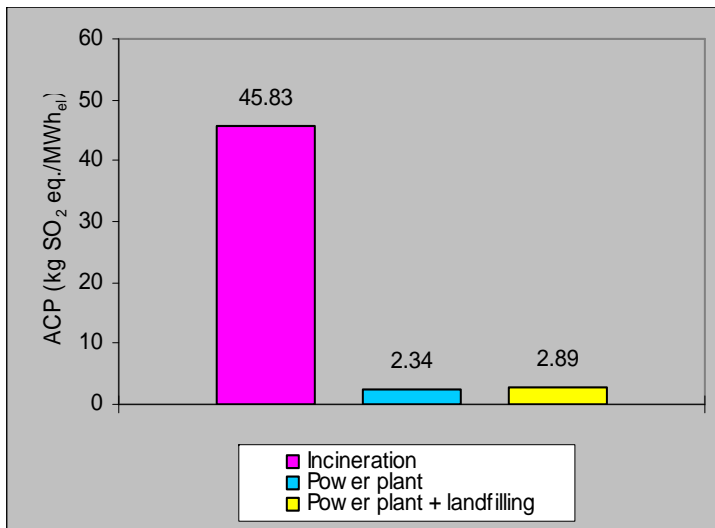
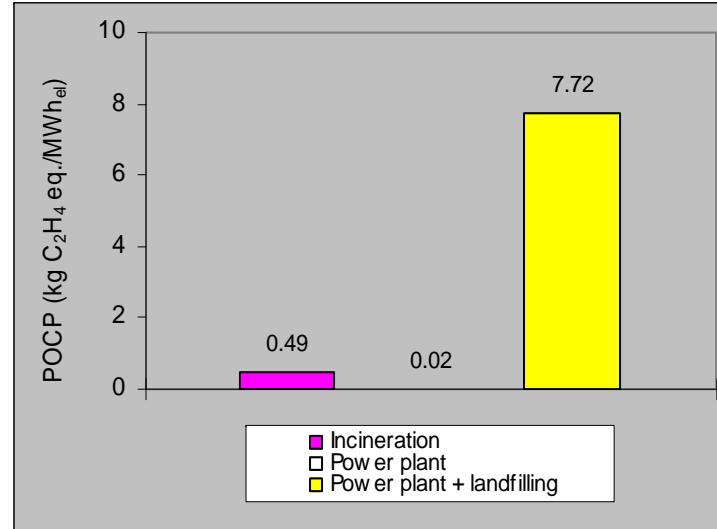
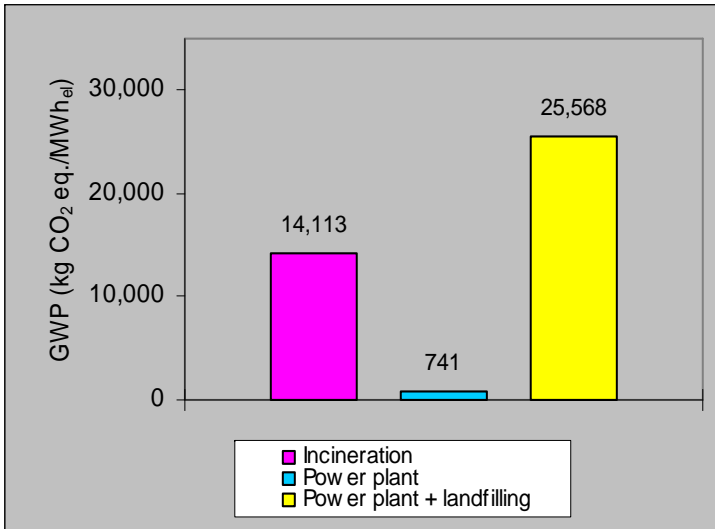


- Phuket MSW Characteristics

Waste composition (%)	
Plastic	27.71
Food	18.12
Wood/grass	13.65
Paper	11.45
Cloth	3.06
Rubber/leather	1.85
Incombustible	15.44
Others	8.71
Waste properties	
Density (kg/m ³)	379
Moisture content (%)	41
LHV (kcal/kg)	1,750



• Results





- Conclusion

- From holistic comparison, incineration is **advantageous** for global warming and photochemical ozone formation but is **disadvantageous** for acidification and nutrient enrichment.
- Incineration could not play the major role for electricity production, but in addition to being a waste management option, could be considered **as a complement to conventional power production**.
- To improve the environmental performance of MSW incineration, providing **deNO_x and dioxin** removal processes, separation of **high moisture content** waste fractions and improvement of the **operation efficiency** should be considered



- WtE: Environmental Assessment

Environmental Evaluation of MSW Management in A Life Cycle Perspective

Liamsanguan and Gheewala (2007)



- Objective
- Scope of the Study

- ▣ To compare the holistic environmental impacts of MSW management systems between **landfilling** and **incineration**

**Incineration
with energy recovery**

or

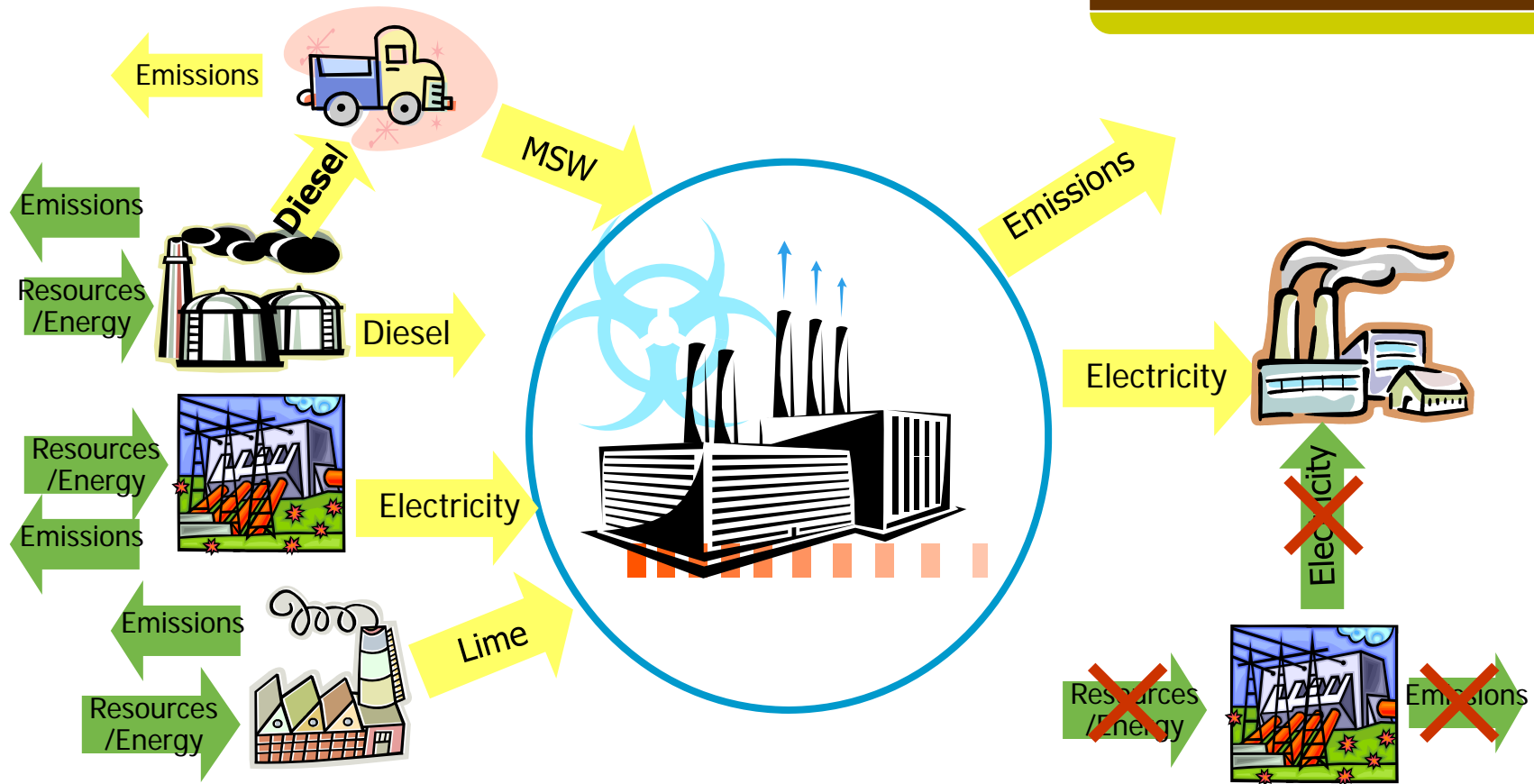
**Landfilling without
energy recovery**

Which is a superior system ?

- Study site: **Phuket**
- Functional unit: **1 ton of Phuket MSW treated**

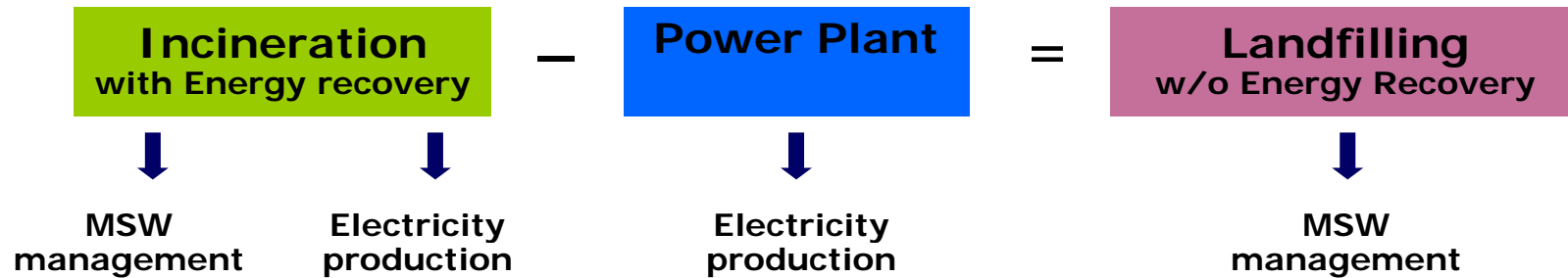


• Incineration



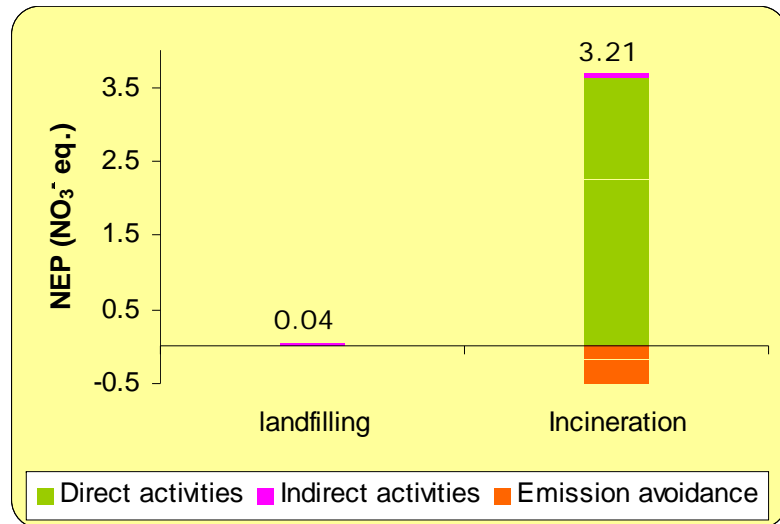
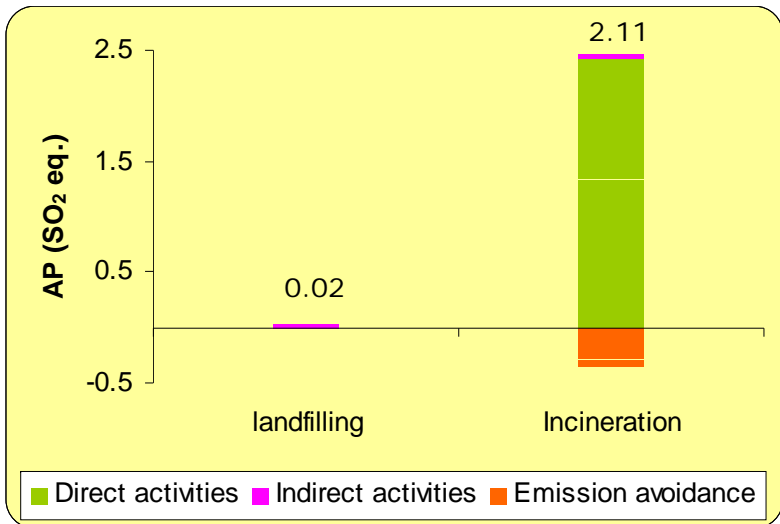
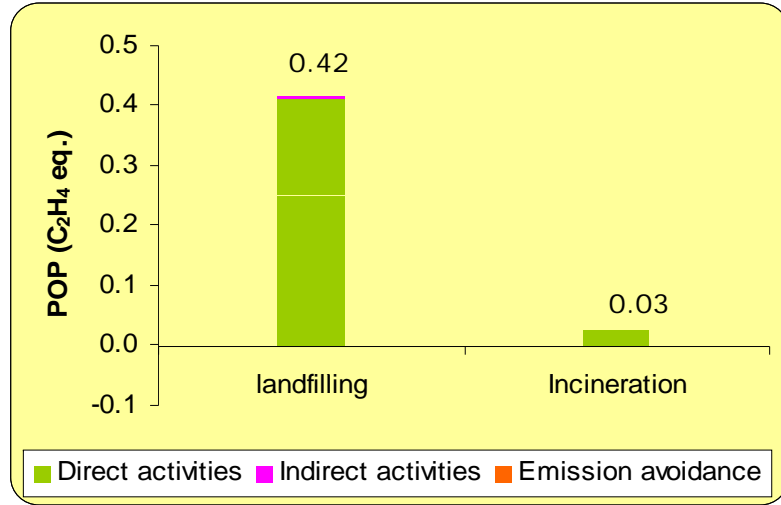
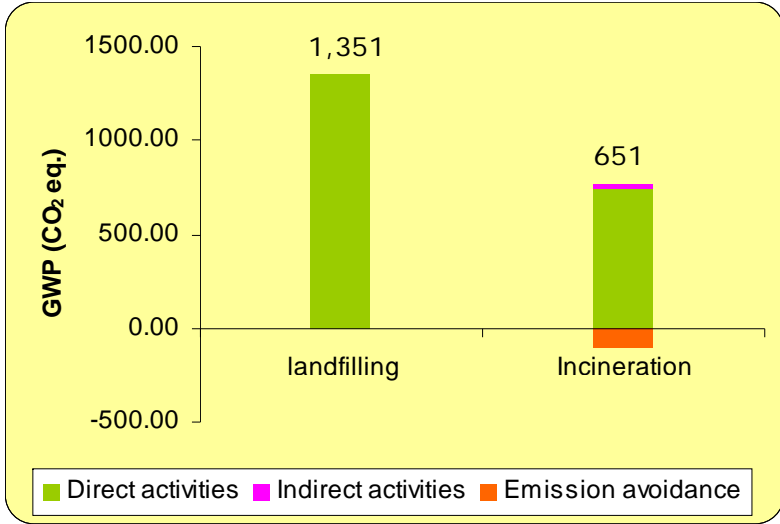


- System Comparison from a Life Cycle Perspective





• Results





- Conclusion

- Major contributor to each impact

Impact category	Major contributor
Global warming	<ul style="list-style-type: none">■ CH₄ from Landfilling■ CO₂ from incineration
Photo-oxidant formation	<ul style="list-style-type: none">■ CH₄ from Landfilling
Acidification	<ul style="list-style-type: none">■ NO₂ from incineration
Nutrient enrichment	<ul style="list-style-type: none">■ NO₂ from incineration



• Conclusion

- Incineration was found to be superior superior to landfilling in term of global warming and photo-oxidant formation
- Landfilling was better for acidification and nutrient enrichment.
- Landfilling reversed to be superior to incineration in term of global warming when methane is recovered for electricity production
 - 50% recovery of landfill gas leads to the reduction of 58% GWP and 37% POP
- Aspects influencing the environmental performance of Incineration
 - Increasing the efficiency of plastic separation can reduce GWP
 - Separation of high moisture content of feed stock could improve the environmental performance of MSW incineration
 - If NO_2 is removed by de- NO_x equipment, AP and NEP will be decreased



• Thing to think about....



Organic Waste



Recyclable Waste



Combustible Waste



Other Waste



How to separate??

THANK YOU



*You cannot love a thing
without wanting to fight for it.*

Chesterton

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