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Chulalongkorn University
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Thailand's Master Plan for MSW Management

"Developments of Energy, Environment and Ecosystems (3E) Nexus Initiative for Sustainable Development in Asian Countries"

18-19th January 2017
Tokyo, Japan

Outline

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- Waste Classification and Technologies
- Waste Management and Examples in Thailand
  - ➢ Incineration (Direct burning)
  - ➢ Gasification
  - ➢ RDF (Refuse Derived Fuel)
  - ➢ Anaerobic digestion & Landfill gas
  - ➢ Plastic wastes to pyrolytic oil

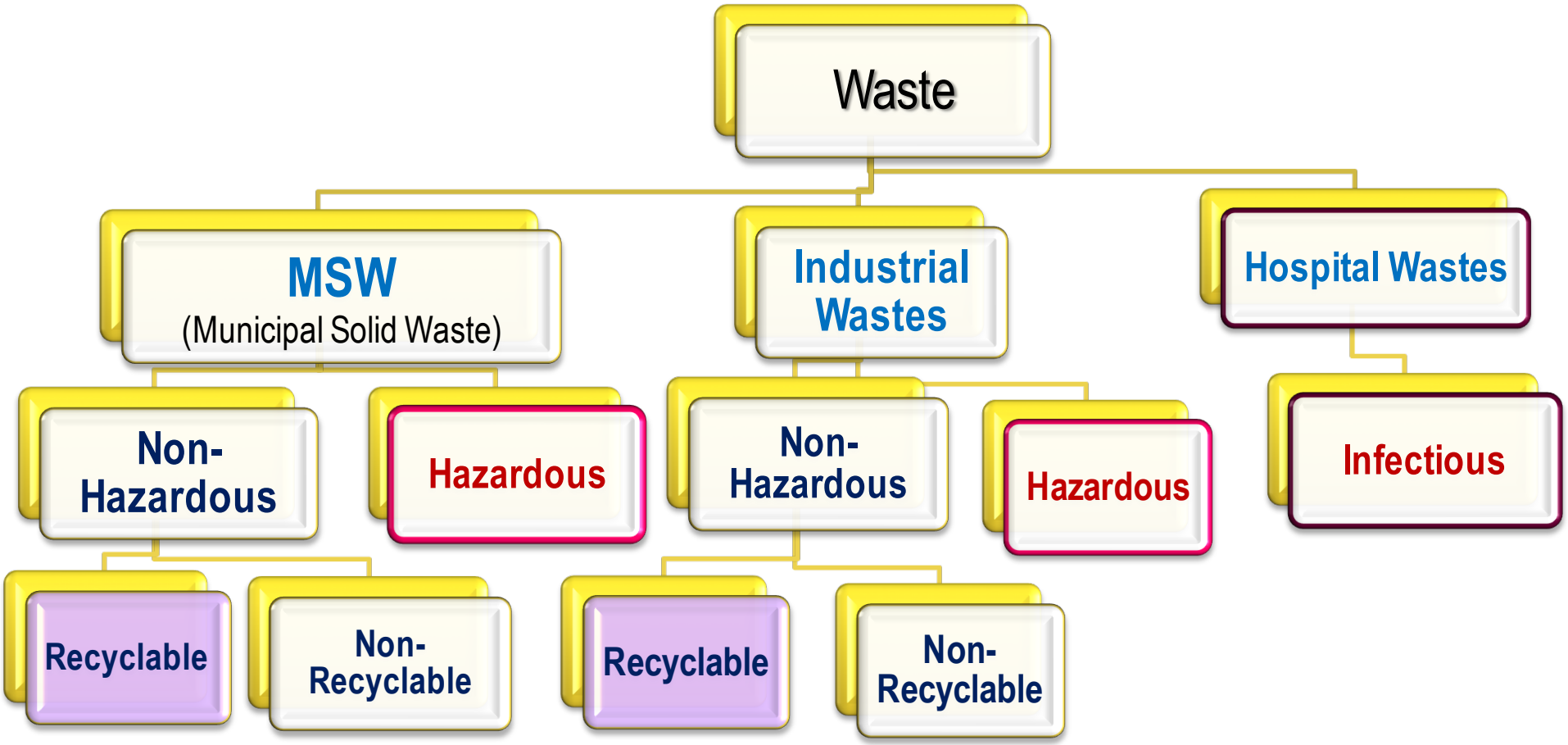
Wastes having Calorific Value
➢ **Energy Recovery**

- Co-processing in Cement Kilns
- Resource Recovery & Recycling

Wastes without Calorific Value
➢ **Materials Recovery**

- Thailand's MSW Situation and Master Plan

Waste Classification



MSW Management and Technologies

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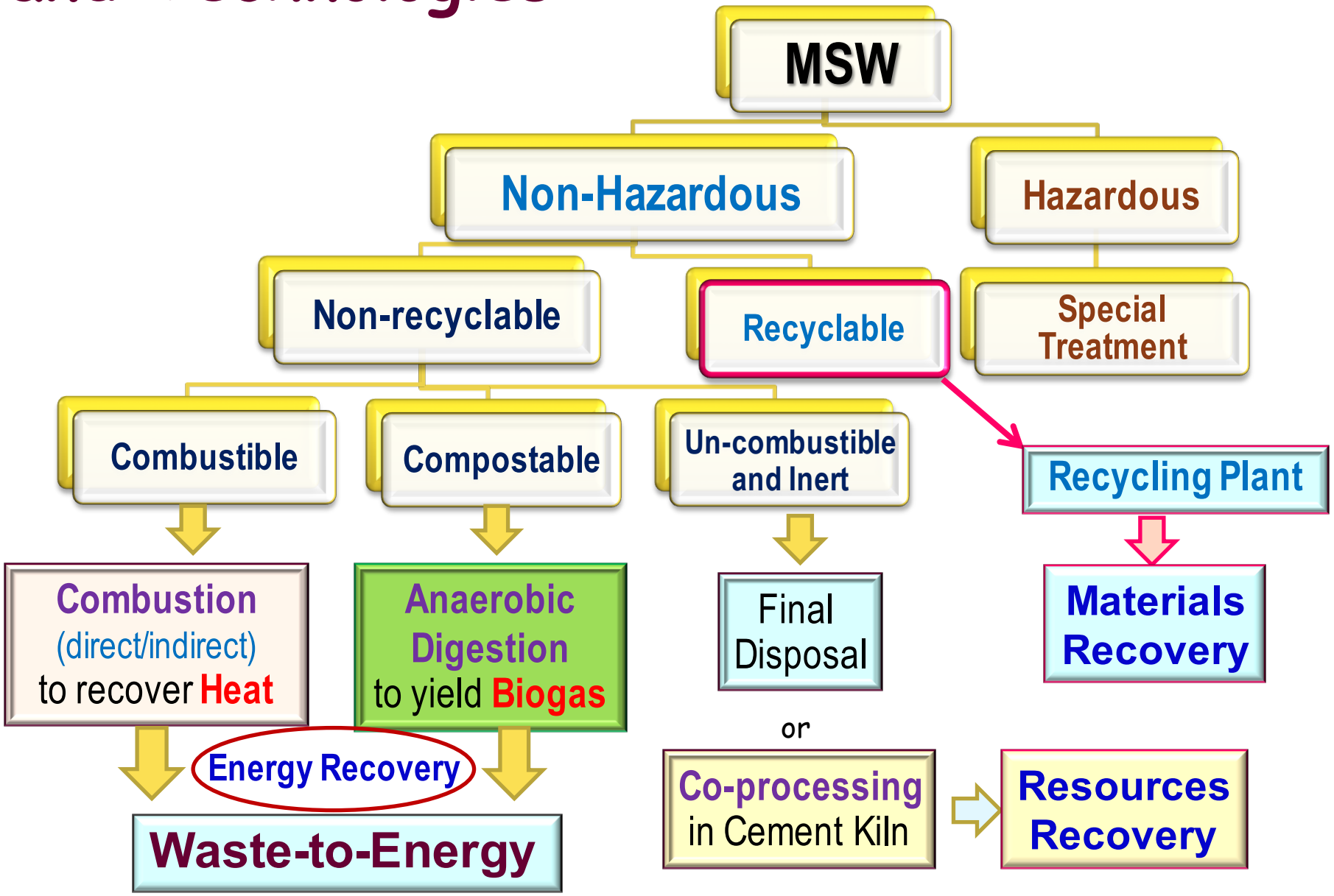
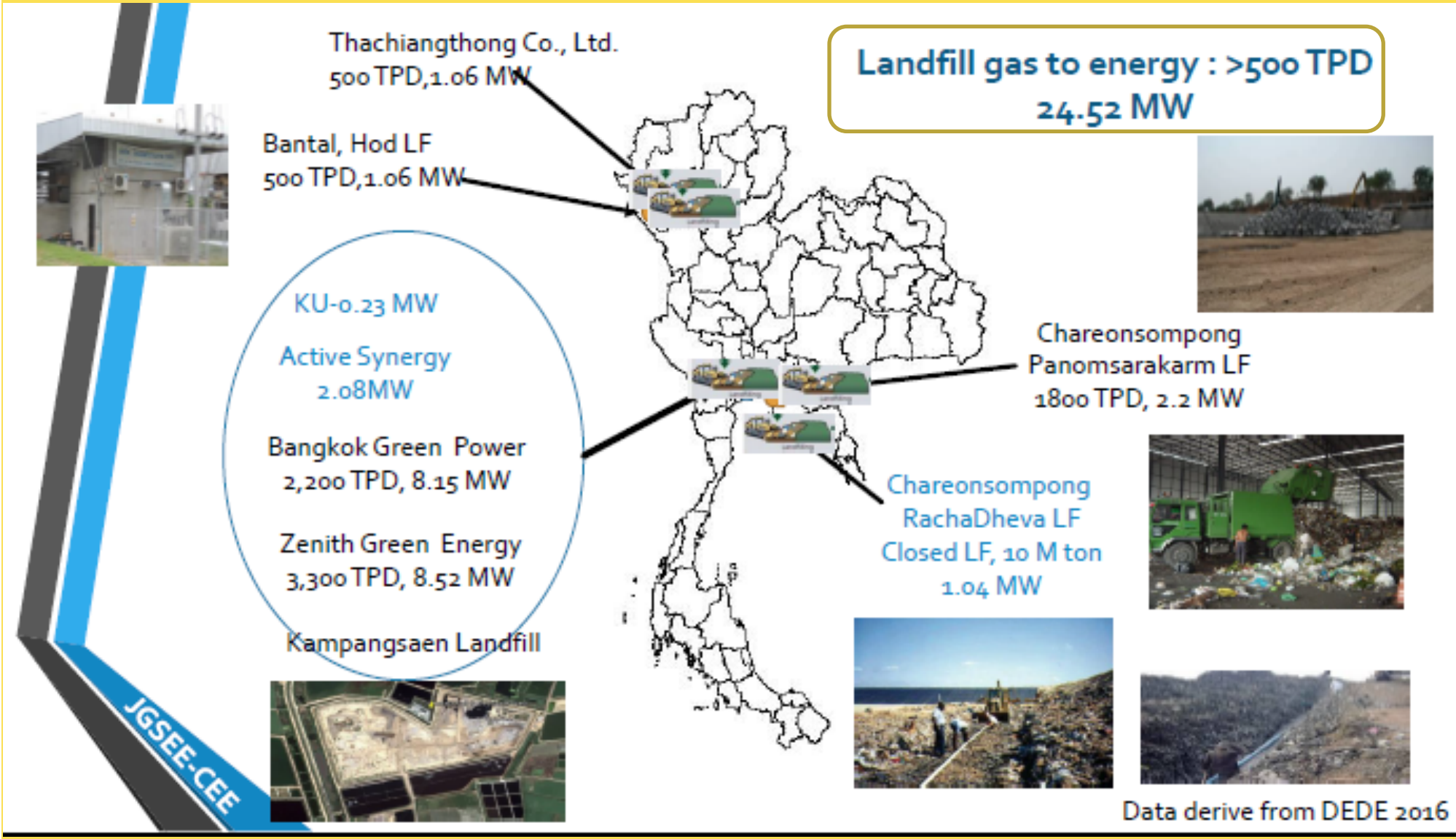


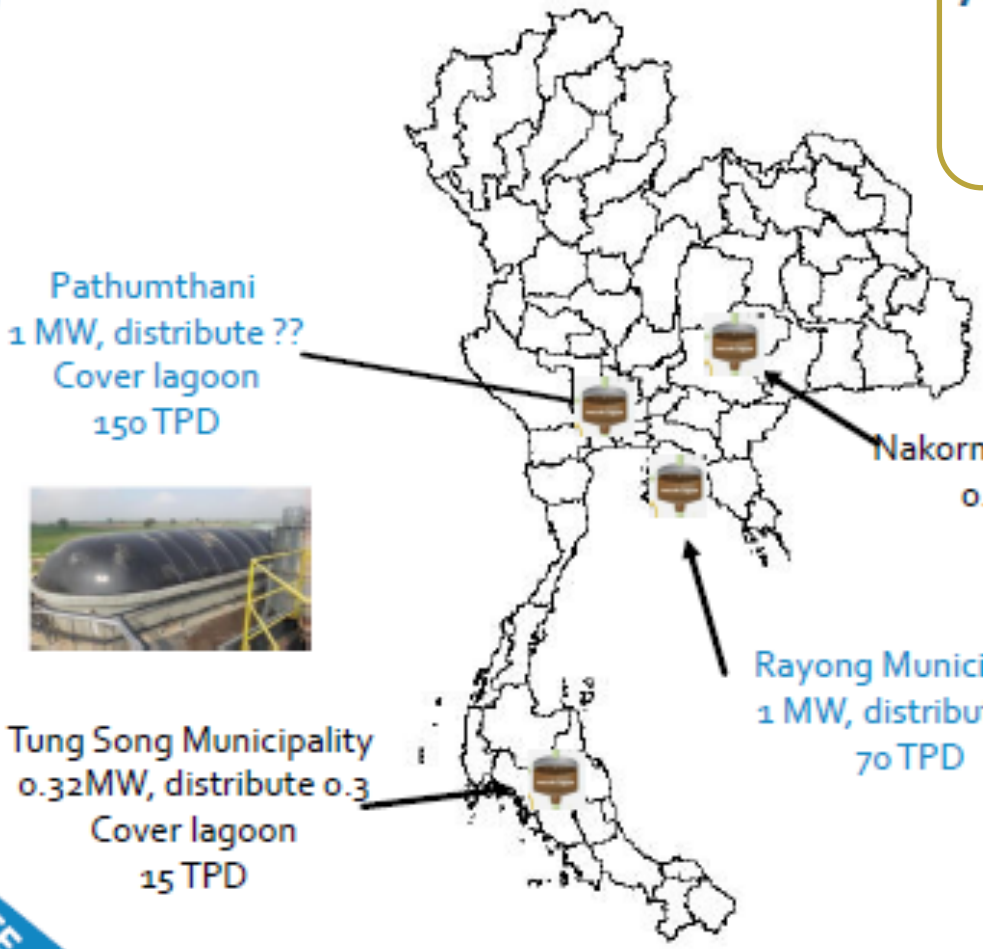
Waste to Energy Technology in Thailand

Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016



Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

Anaerobic digestion 2.2 MW
Install Capacity 0.2-1 MW
MSW 15-250 TPD



Pathumthani
1 MW, distribute ??
Cover lagoon
150 TPD

Nakornratchasrima Municipality
0.8 MW, distribute 0.3
Two stage reactor
MSW 250TPD

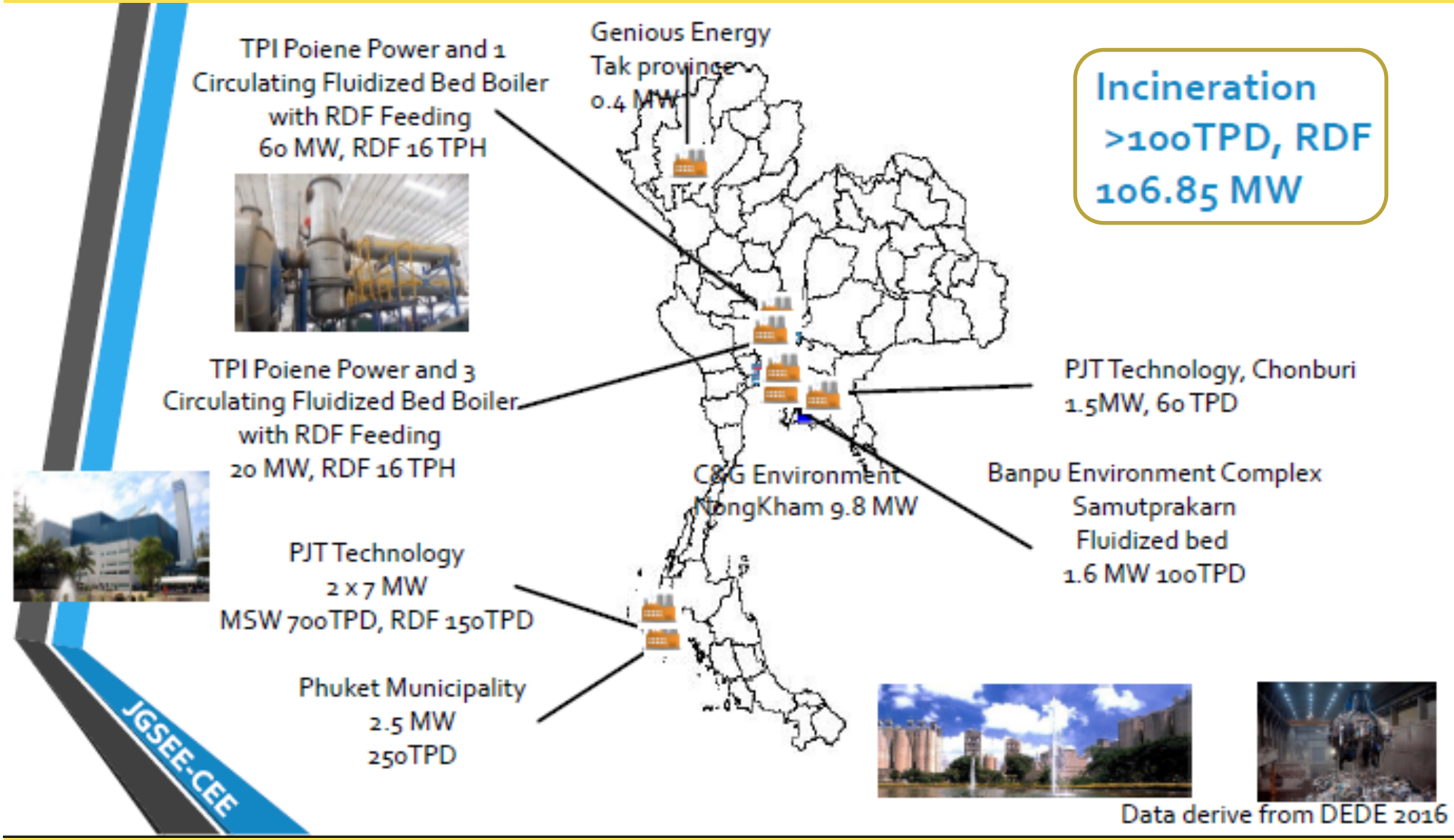
Rayong Municipality
1 MW, distribute 0.6
70 TPD

Tung Song Municipality
0.32MW, distribute 0.3
Cover lagoon
15 TPD

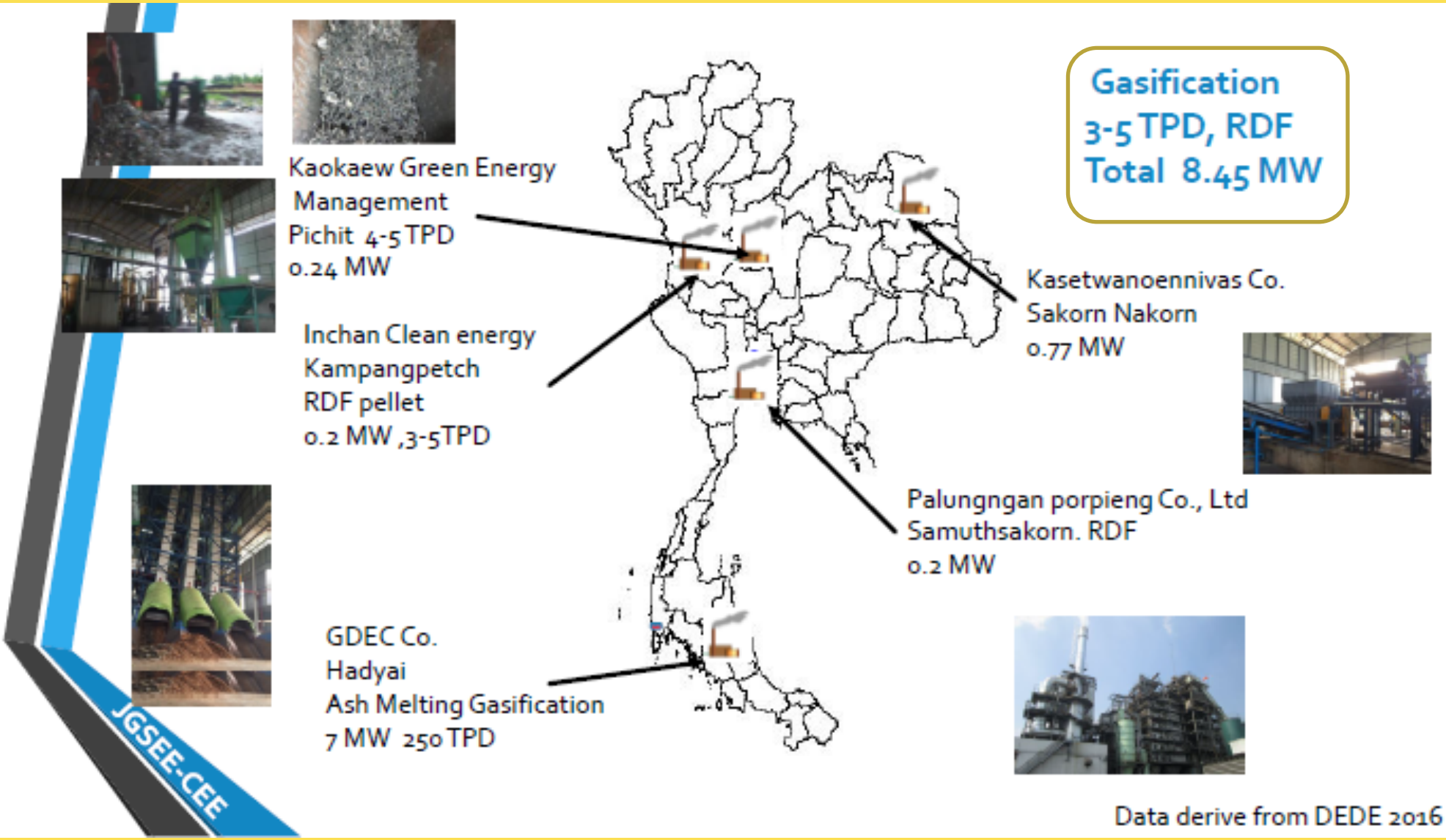
Data derive from DEDE 2016

JGSEE-CEE

Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

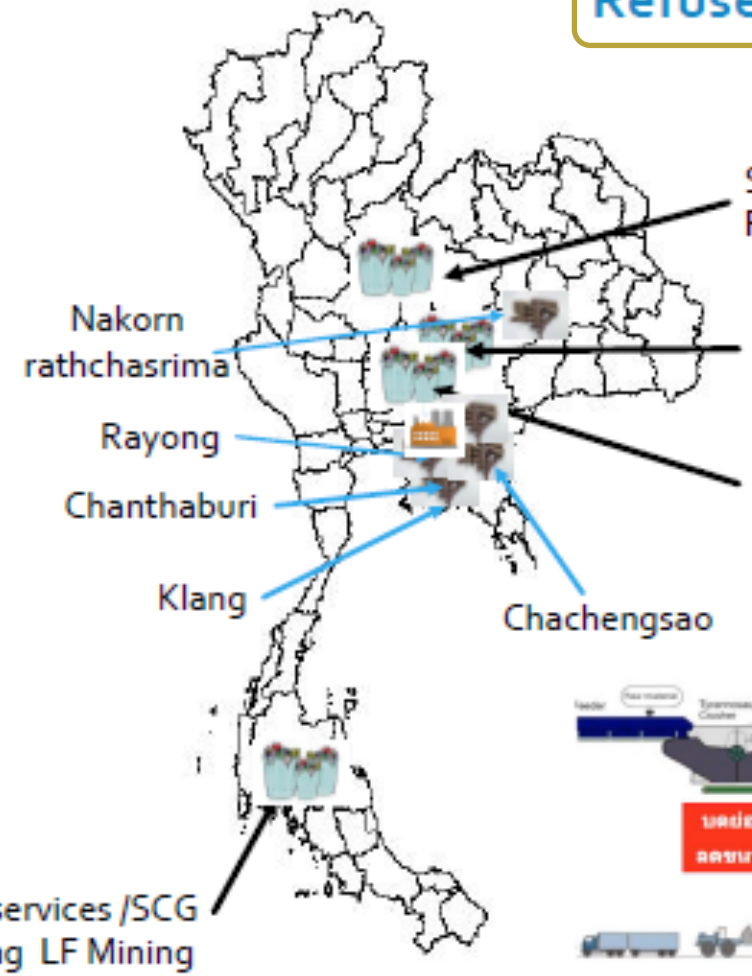


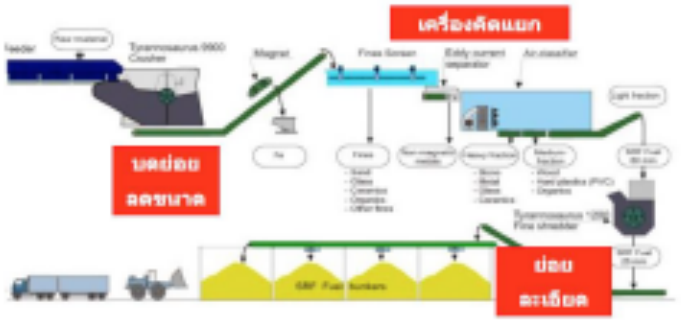
Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016



Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

Refuse derive fuel (RDF)





Data derive from DEDE 2016

JGSEE-CEE

Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

Combustible Wastes ⇨ WtE / EfW

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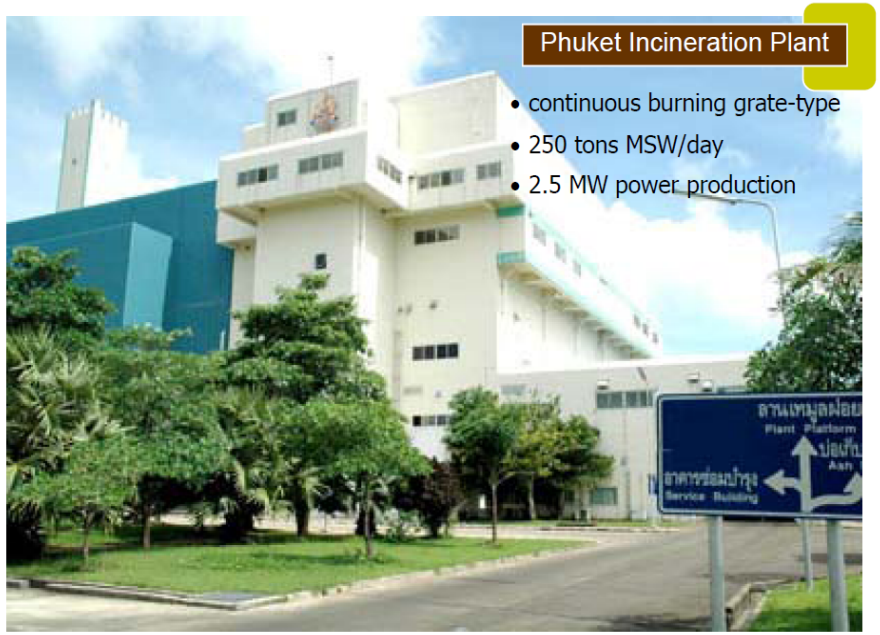
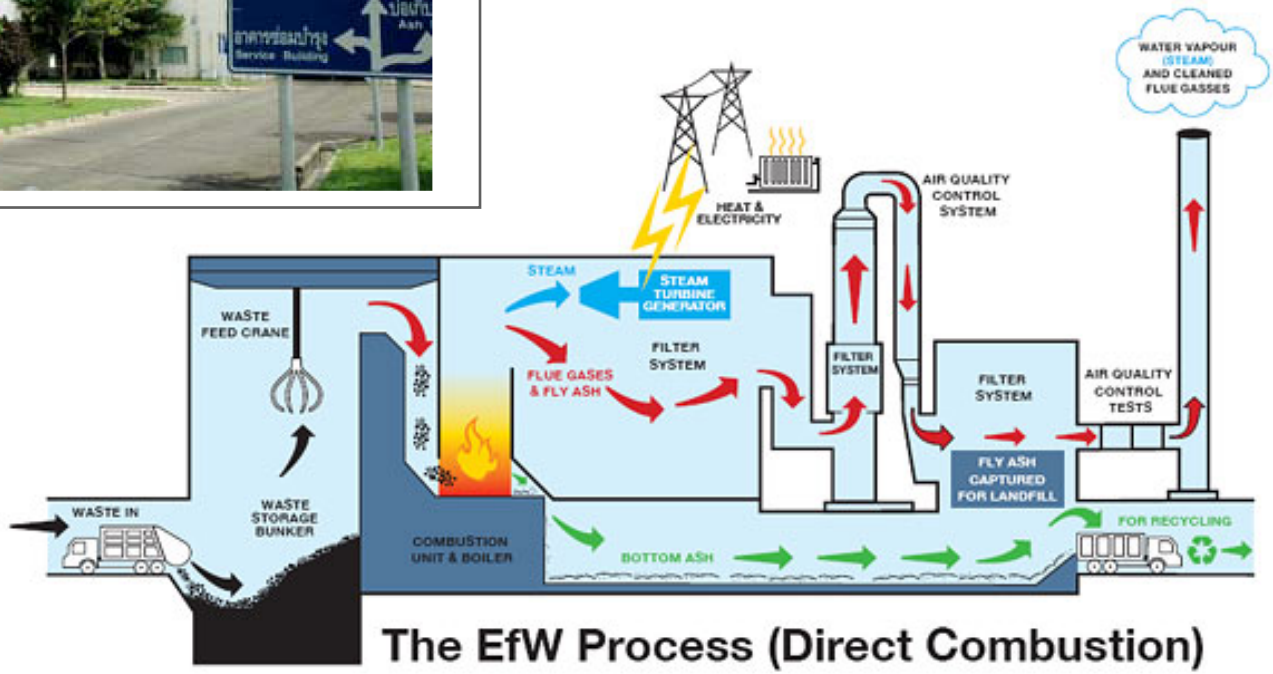


Phuket Incineration Plant

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



The EfW Process (Direct Combustion)

http://www.arc21.org.uk/opencontent/?itemid=27&section=Residual+Waste+Project

Combustible Wastes ⇨ WtE / EfW

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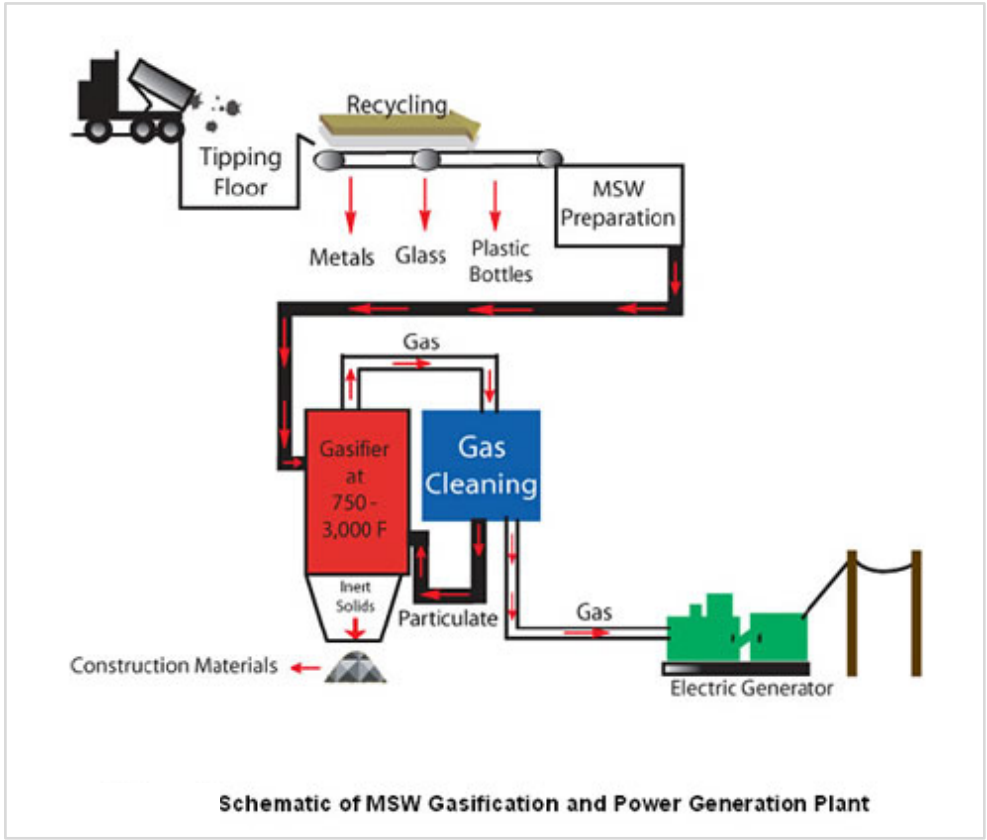
Had Yai
Gasification Power Plant



Schematic of MSW Gasification and Power Generation Plant

MSW
250 tons/day
24 h Operation

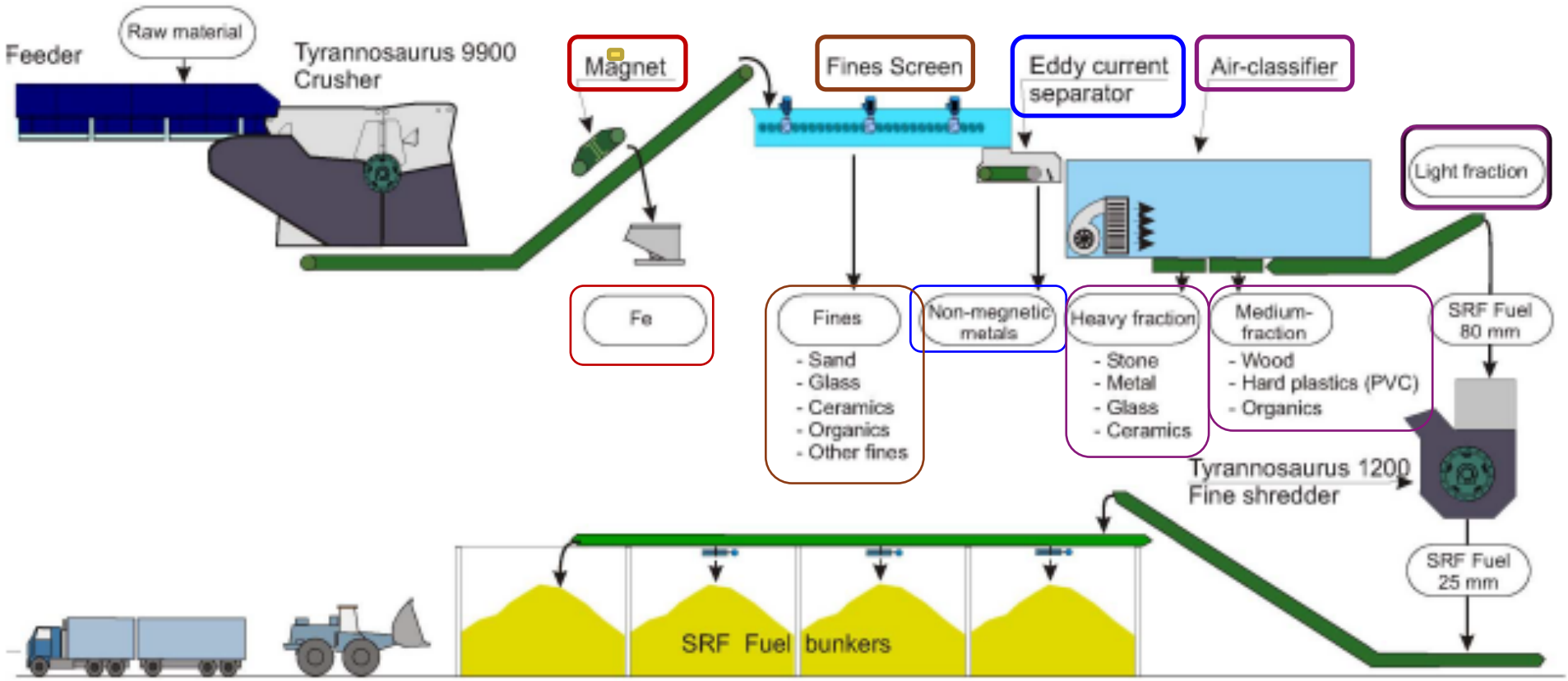
1,200 ° C

6.7 MW

http://www.altenergymag.com/content.php?issue_number=09.06.01&article=zafar

Combustible Waste ⇨ SRF/RDF

TYRANNOSAURUS® SRF Production Process

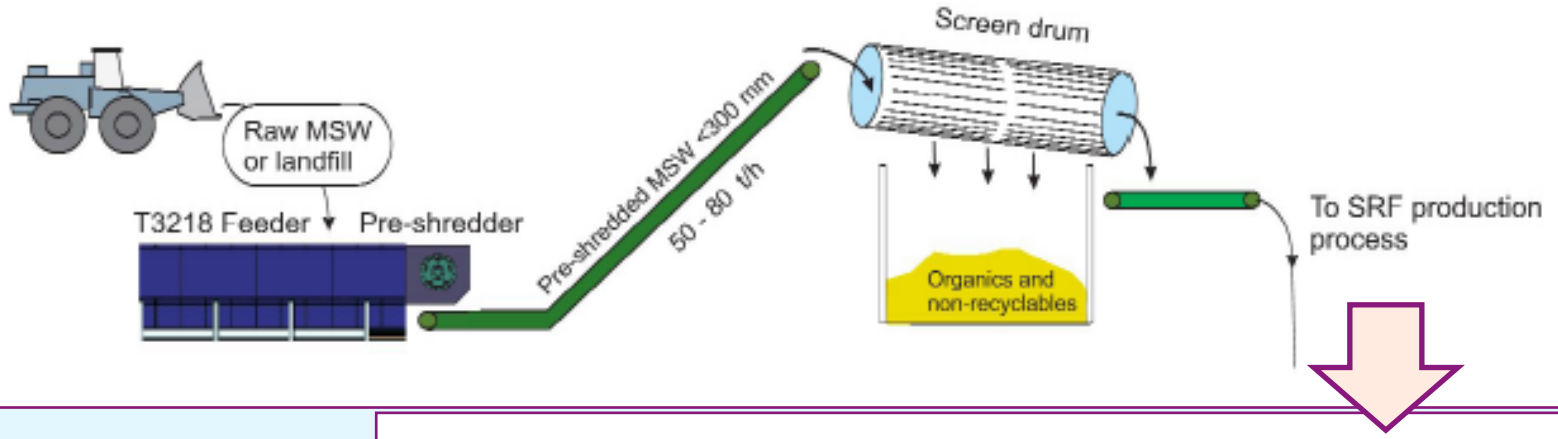


Note: **SRF** = Solid Recovered Fuel
RDF = Refuse Derived Fuel

Source: Raja Equipment Ltd., 3rd June 2011

TYRANNOSAURUS® MSW Pretreatment Process

Pretreatment of MSW



SRF(Solid Recovered Fuel)

Source: Raja Equipment Ltd.

RDF/SRF Power Plant in Thailand:
TPI Polene Power @ Saraburi Province

Source: http://www.tpippipo.com/

TPI Polene Power Public Company Limited: The Biggest WtE Power Plant in Thailand

Transforming from **Cement** to **Waste-to-Energy** Play

3 WtE power plants with **total** licensed capacity of **143 MW**.

- 100% stake of each project.
- Already **signed a power purchasing agreement** (PPA) with EGAT for the first two projects (total licensed capacity **73 MW**)
- Already **received LOI approval from EGAT** for the 3rd project (**70 MW**)
- Obtained a seven-year adder (incentive credit) of 3.50 THB per unit and the right of free corporate tax from BOI (the Board of Investment of Thailand) for eight years and a 50% corporate tax discount for the next five years.

TPI Polene Power PLC:
The Biggest WtE Power Plant in Thailand

The 1st WTE power plants (licensed capacity **18 MW**): **Waste Heat + RDF** with installed capacity of 20 MW began operating on 16 Jan 2015.

⇨ This project uses **waste heat** emitted from cement plant line No.3 line blended with **RDF** to generate electricity.

The 2nd WTE power plants (licensed capacity **55 MW**): **RDF** with installed capacity of 60 MW began operating on August 2015.

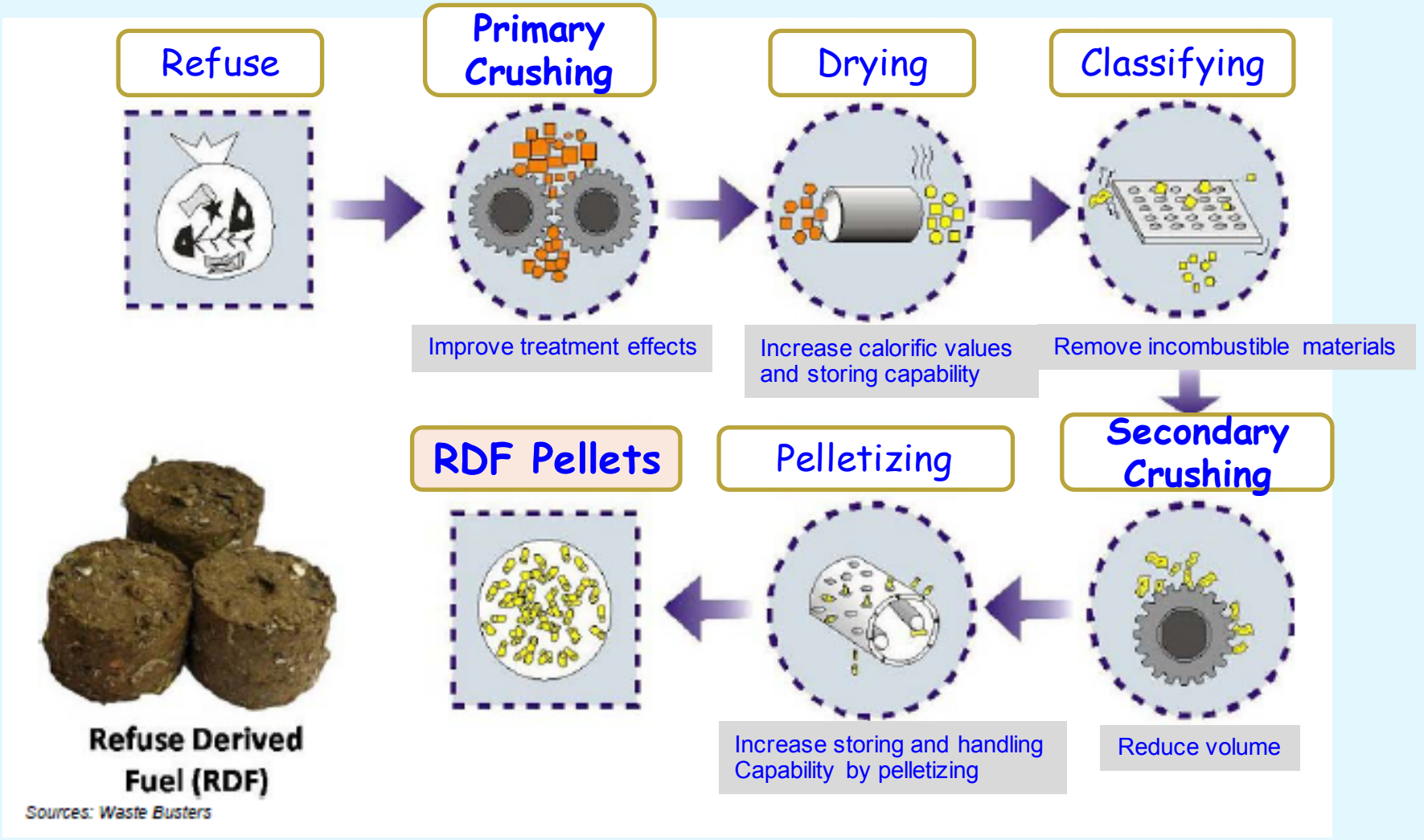
⇨ This project is designed to consume **RDF** to generate electricity.

The 3rd WTE power plants (licensed capacity **70 MW**): **Waste Heat + RDF** with installed capacity of 90 MW began operating on August 2015.

⇨ This project uses waste heat emitted from the new cement plant No.4 line. The remaining 60 MW output uses **RDF**.

Total: 18 + 55 + 70 = **143 MW**

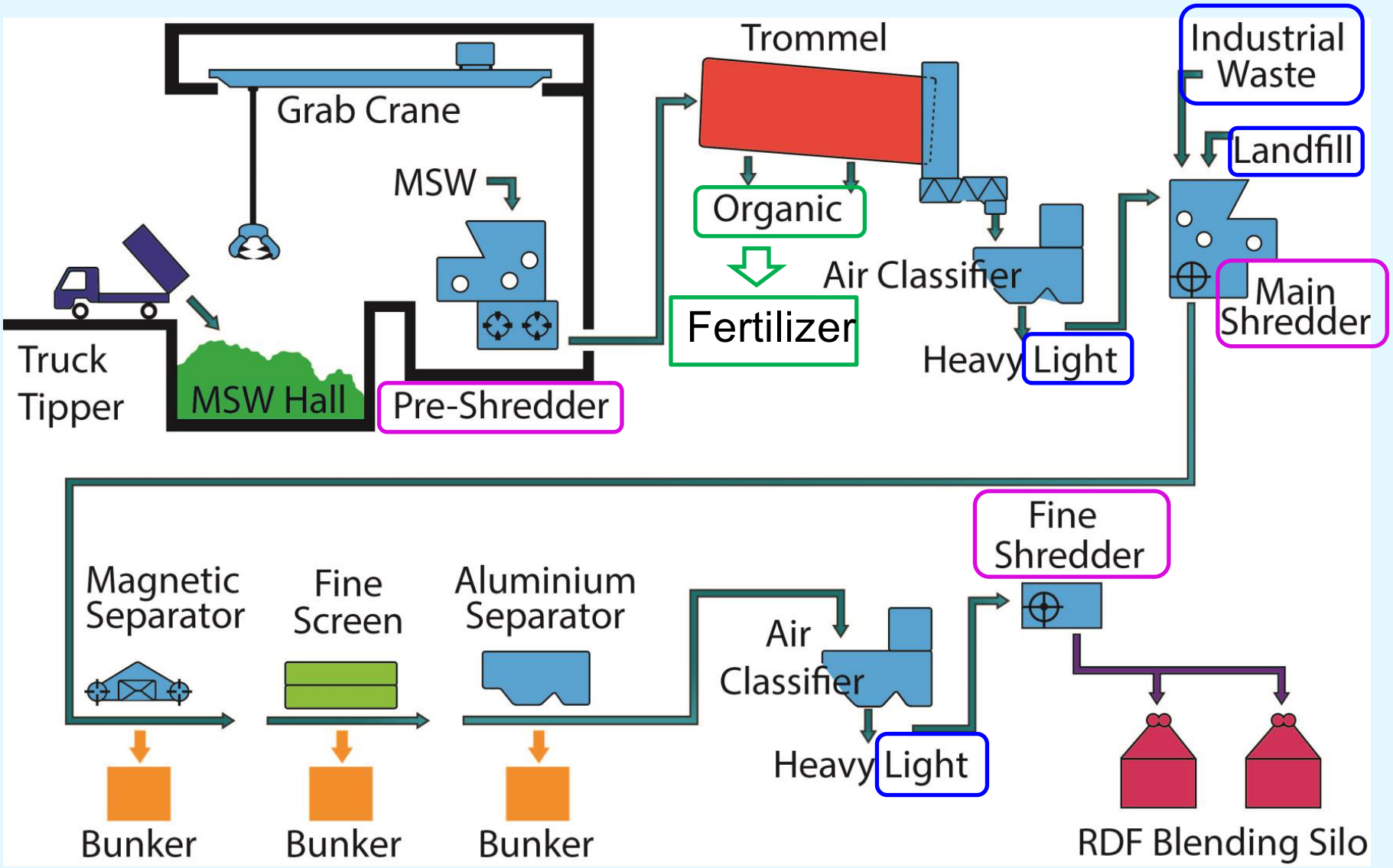
Process Flow Plan



Note: Organic waste is now composted to produce fertilizer by Autothermal Thermophilic Aerobic Digestion (ATAD), but planning to reduce moisture by biological process before sending to produce RDF.

Source: Krungsri securities Research, 4th September 2015.

Process Flow Plan



Source: TPIPL

RDF Specification for TPI Polene

NCV > 3,500 Kcal/kg

%Moisture < 35 %

Chloride < 0.5 %

Ash < 15 %

Type 1: MSW without separation

No Buying

ITems		Unit	Spec.	Price/Ton
1.1	GCV (AR)	Kcal/Kg	<1,500 Kcal/kg	300 THB/Ton Fee
			1,500-2500 kcal/kg	No Payment

Type 2: MSW with partial separation

ITems		Unit	Spec.	Price/Ton
2.1	GCV (AR)	Kcal/Kg	2,500 Kcal/kg (Min)	(GCV x 0.20 THB/Kcal) + 500 THB/ton
2.2	Sulfur (@30%Moisture)	%	1.0% (MAX.)	
2.3	Chloride (@30%Moisture)	%	0.6% (MIN.)	

Source: TPIPL

WtE @ TPI Polene

Waste heat from Cement Plant	⇨ Waste heat recovery power
MSW, Landfill Waste, Industrial Waste	⇨ RDF Plant
RDF	⇨ Power Plant
Organic Parts	⇨ Organic Fertilizer
Waste Tires	⇨ Pyrolysis Oil

Note: **3 Main sources for RDF**
(**MSW** 5,000 tons/day, **Landfill** 3,000 tons/day, **Industrial Waste** 1,000 tons/day)

Compostable Wastes

Biogas

Rayong Anaerobic Digestion Plant

Compostable Wastes

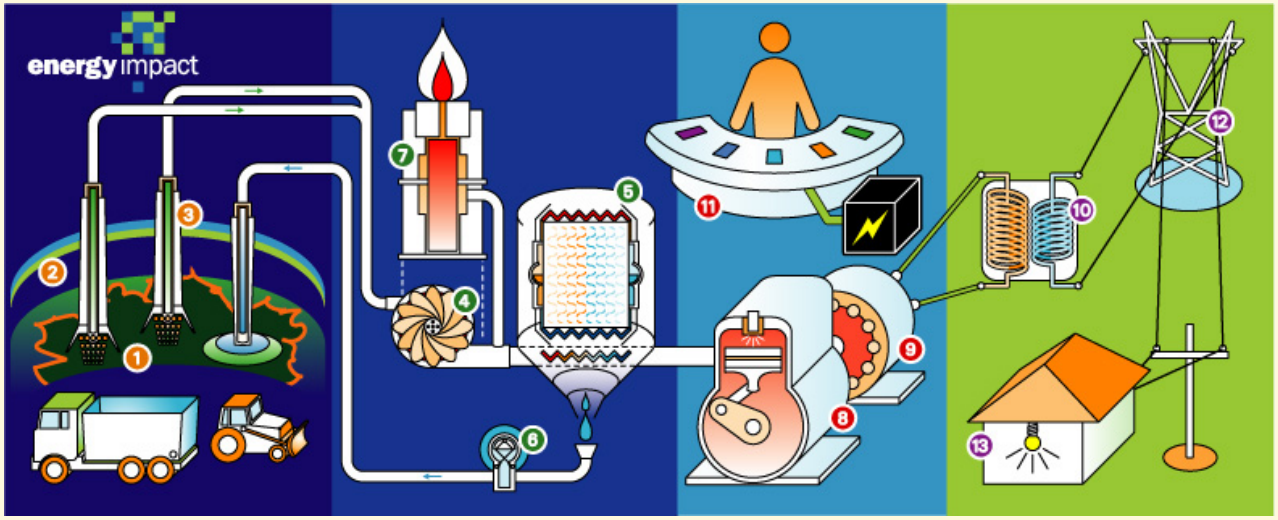
↓

Landfill Gas

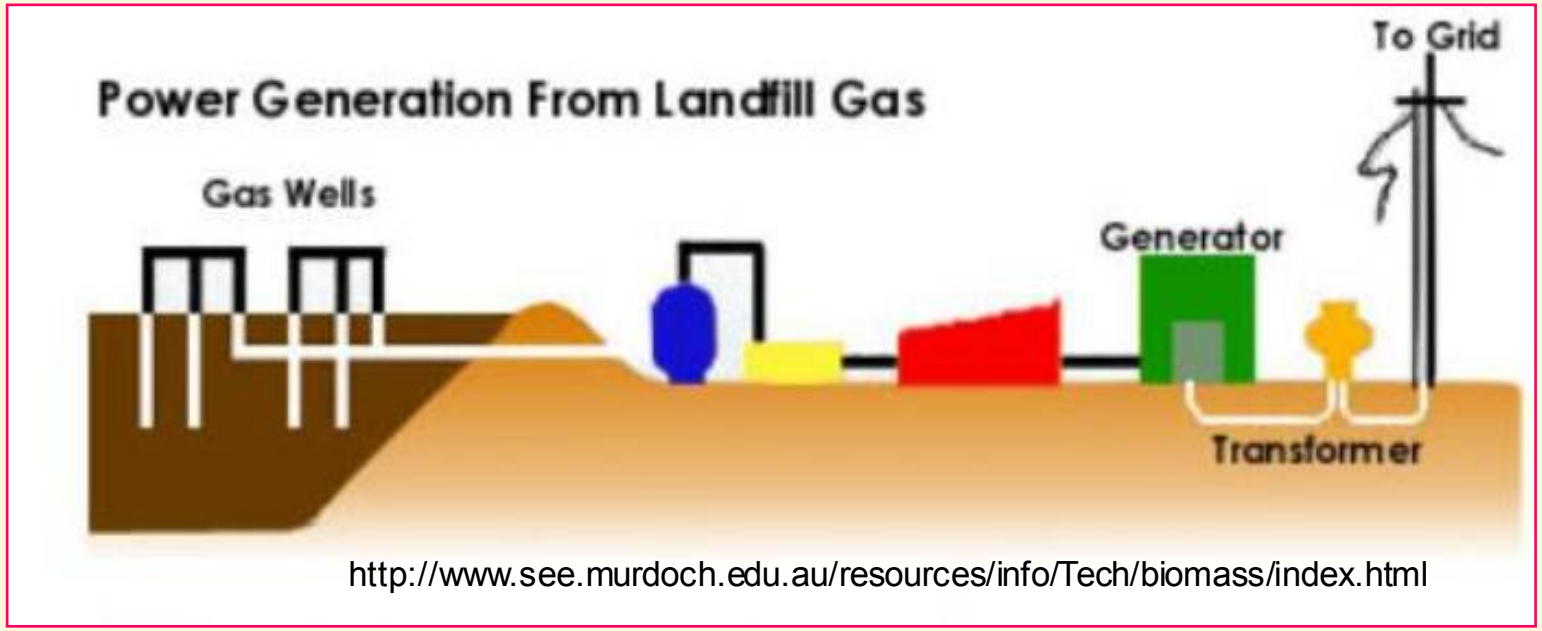
Kampaeng Saen Landfill Project

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

Landfill Site Power Plant



http://www.energex.com.au/switched_on/power_up/power_up_landfill.html



http://www.see.murdoch.edu.au/resources/info/Tech/biomass/index.html

Landfill Mining

Landfill mining (mining of old landfill sites) to recovery **energy** and/or **materials** from waste is another type of **resource recovery**.

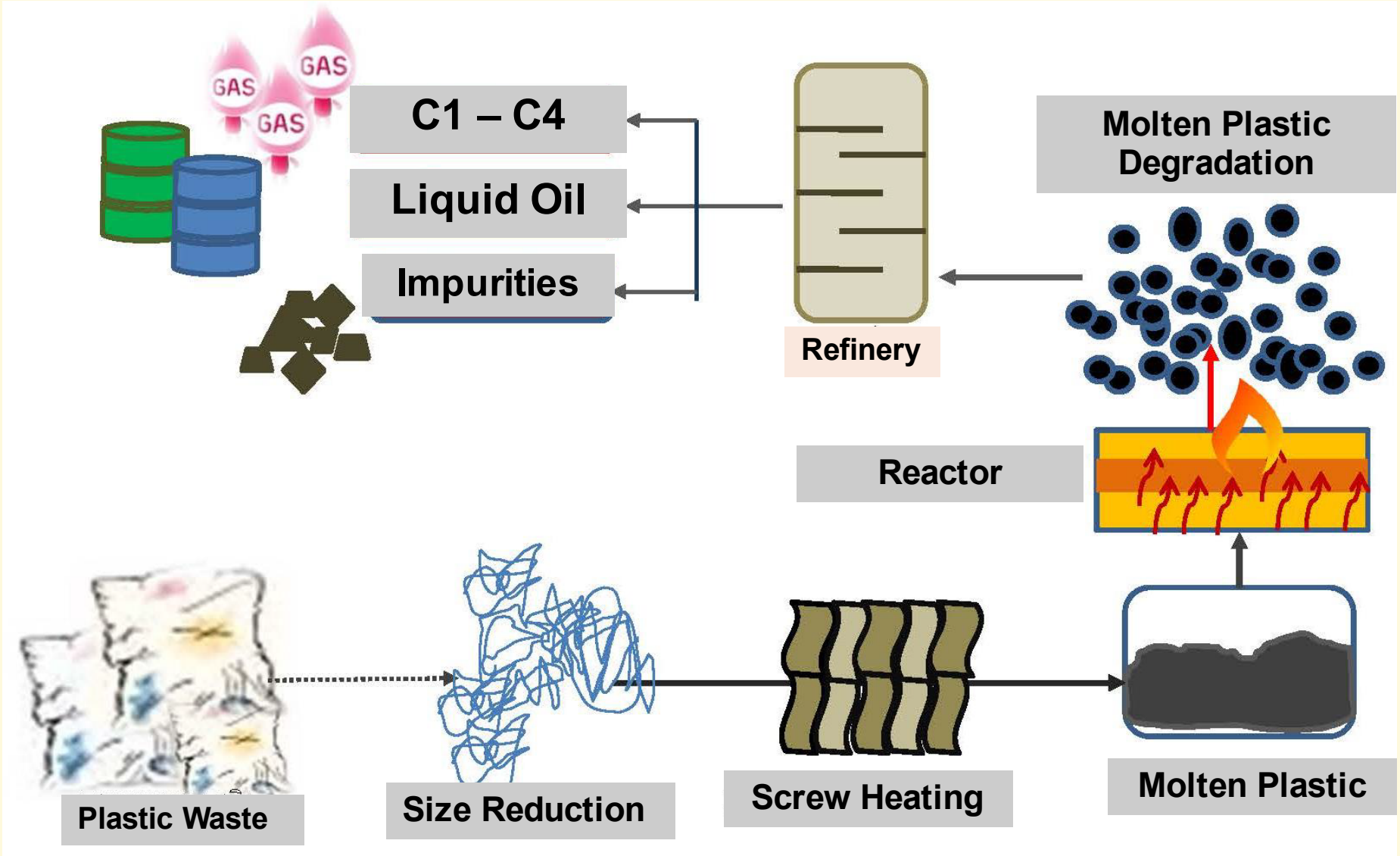
Recovery of Energy from Waste

RDF from Old Landfill

Recovery of Energy from Waste

Plastic Waste to Oil

Pyrolysis Oil from Plastic Waste



Source: TEI

A Pilot Plant at Suranari University

Note: MBT = Mechanical & Biological Treatment
Source: TEI (Thailand Environment Institute)

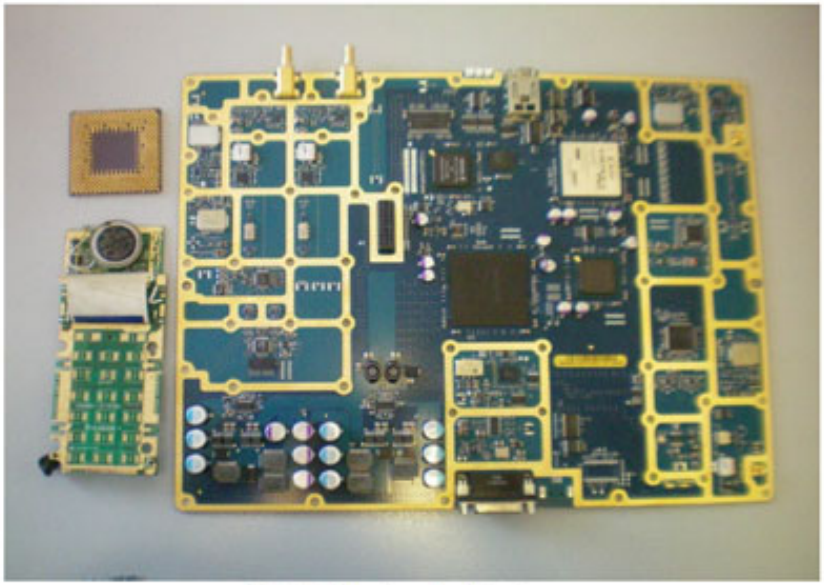
MSW

MBT

Plastic Waste
6,000 kg

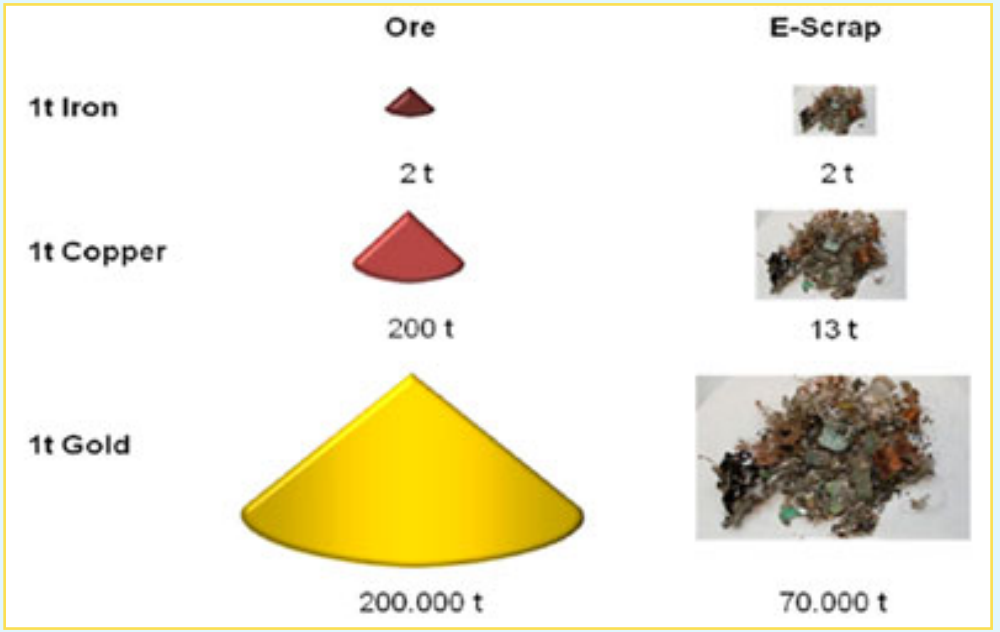
Pyrolysis Oil
(50-60% Diesel)
4,000 – 5,000 L/day

Recovery of Metals from E-Waste



Typical Electronic Waste

Demand of material resources for 1 ton of metal:



If 100 tons of electronic waste is processed
then approximately 1.5 kg of gold could be recovered.

http://www.mackaygreenenergy.ph/ewaste.html

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Transforming waste into Alternative Fuel through Co–processing in cement Kilns

What is Co-processing?

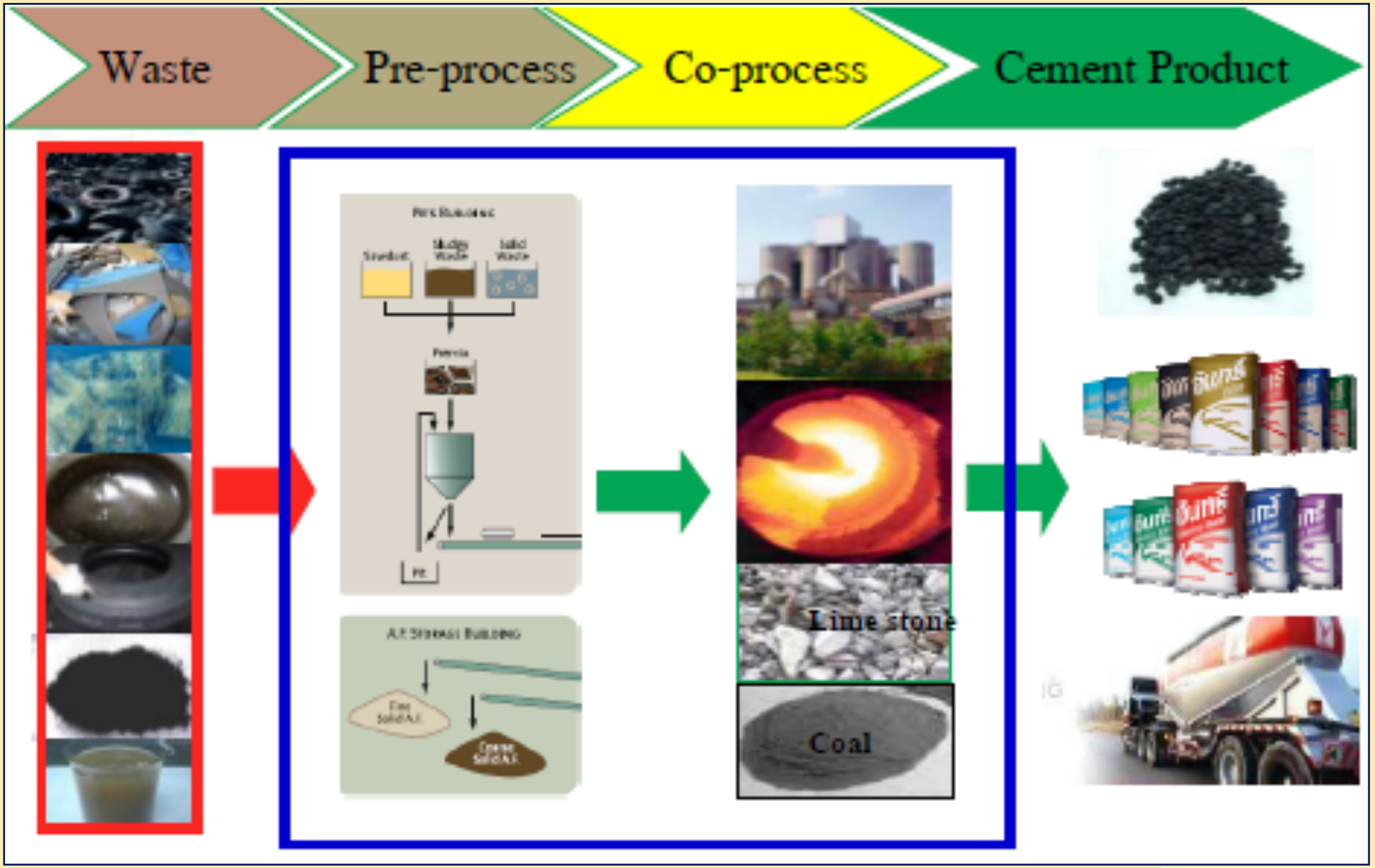
Co-Processing refers to the use of waste materials or by-products from one industrial process to substitute primary fuel and raw material in another process.

These materials are referred to as Alternative Fuels and Raw materials (AFR)

Industries where co-processing is applicable include:

- Cement manufacturing
- Thermal power industry
- Steel industry
- Lime production
- Ceramics, bricks, glass
- Chemical industry
- Petroleum industry

Transforming Waste into Alternative Fuels and Co-Process in Cement Kilns



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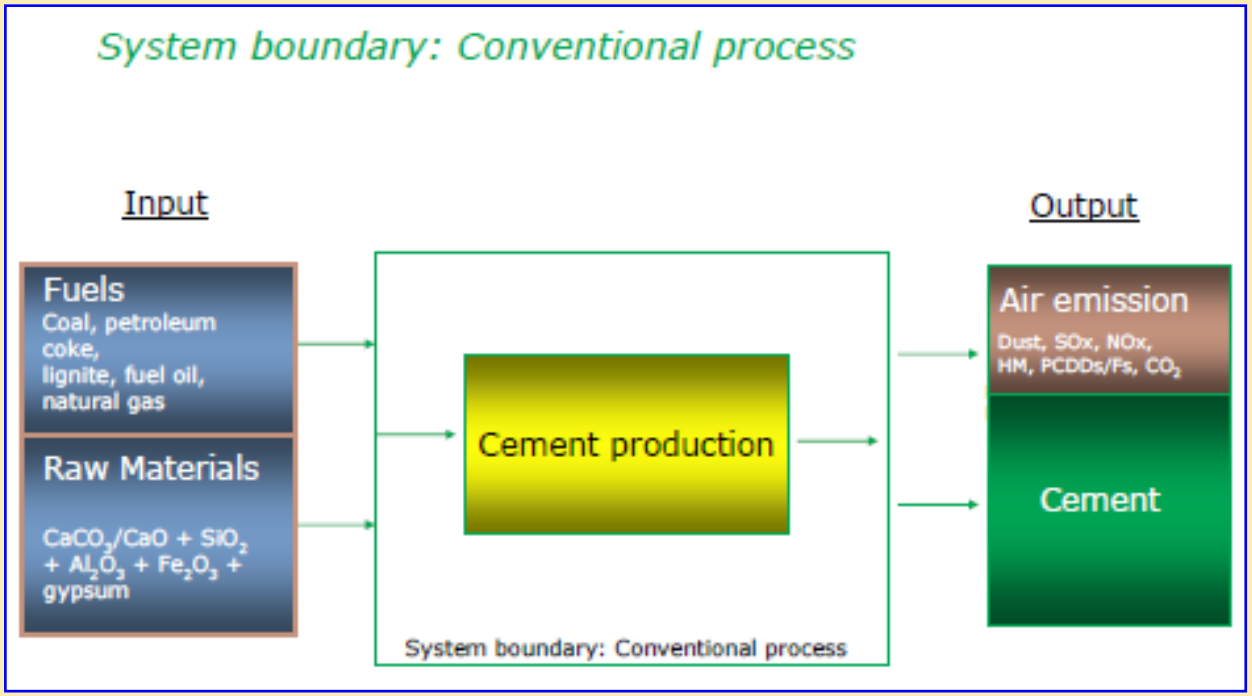

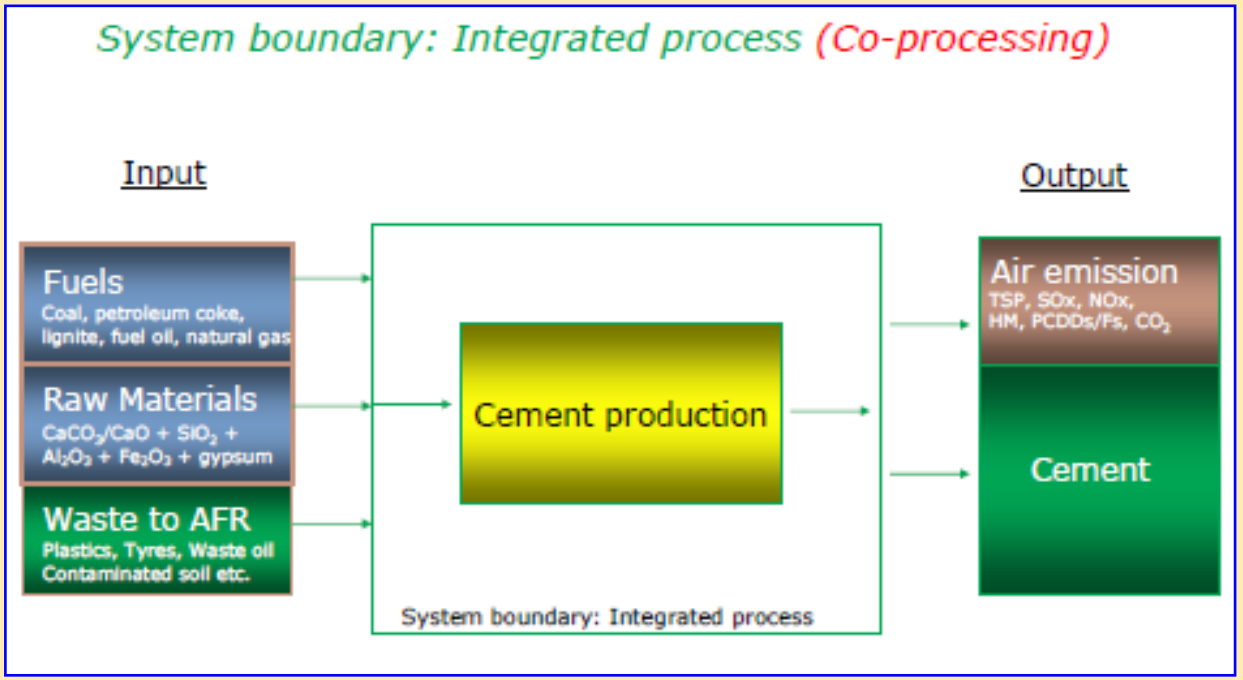

Cement Kilns can accept wastes with no calorific value and mineral contents
⇨ Help solving local waste management problem.

Cement industry can provide services by **disposing of waste** with no useful energy and mineral contents, and also heavy metal contaminated crops or even hazardous wastes.

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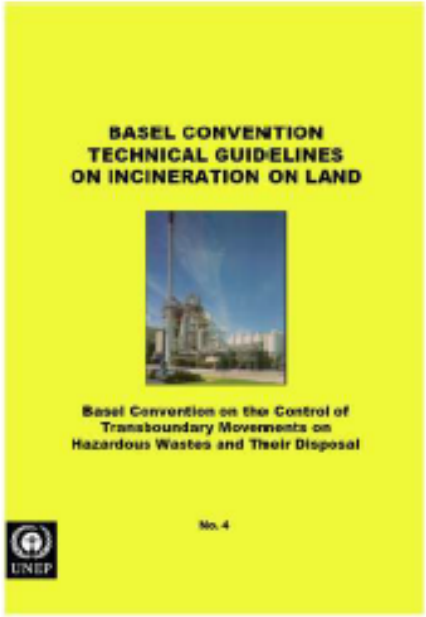
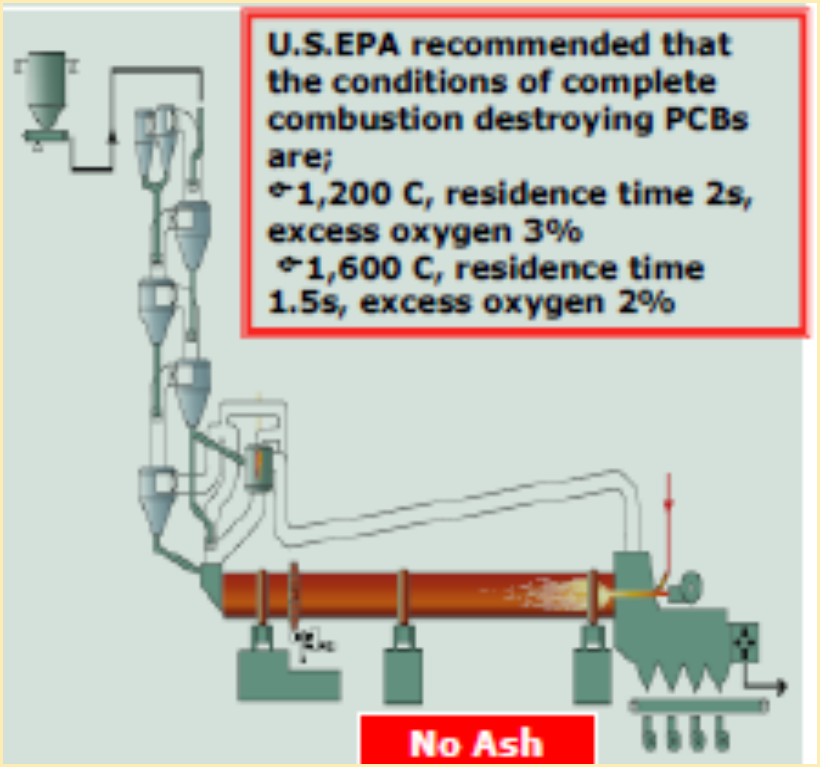
World views of Co-processing of Hazardous Waste in cement kilns

- **..is recognized as an environmentally sound disposal method of hazardous waste in the context of Basel Convention Technical Guidelines.**





Temperature at main burner	> 1800 ^{O}C flame temperature
Residence time at main burner	> 5-6 sec and > 1800 ^{O}C
Temperature at precalciner	> 1000 ^{O}C flame temperature
Residence time at precalciner	> 2-6 sec and > 800 ^{O}C

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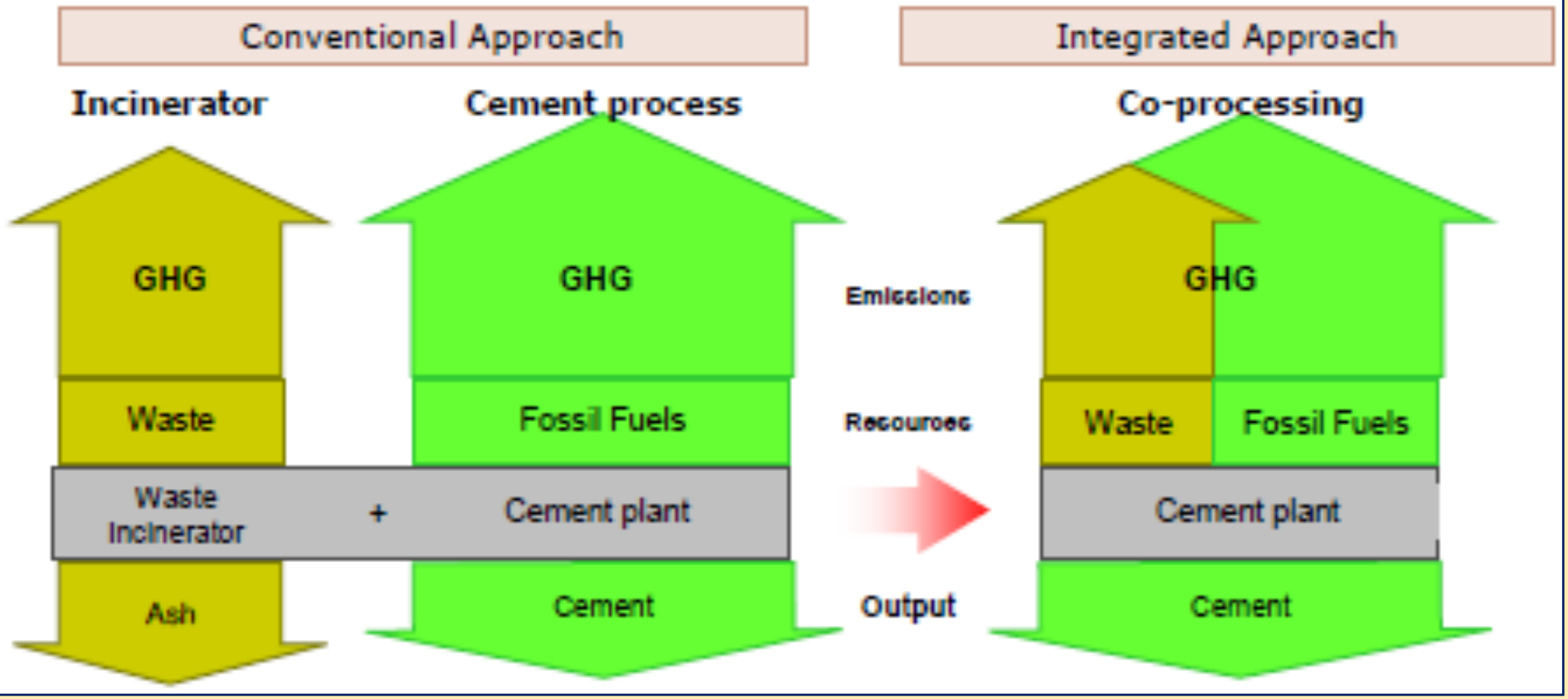
World views of Co-processing of Hazardous Waste in cement kilns (cont'd)

- **Substituting fossil fuel and virgin material by waste (AFR) will <u>further reduce overall CO_2 emissions</u>** (GTZ-Holcim, 2006)



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Destroying confidential documents for various customers, e.g. off-spec banknote paper

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Destroying diplomatic pouch from Ministry of Foreign Affaires

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Destruction of Cadmium contaminated of un-husked rice

Co-Processing Success Story

Co-Processing Contaminated Rice : Best Environmental Solution for Tak Community

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Destruction of off-spec corn seed

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Overseas case studies: Helping authorities to dispose of waste that cannot be disposed of by other methods.

Destruction of contaminated sand in Spain 2005

Destruction of animal feed contaminated with mad-cow disease in Europe

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Thailand's Waste Management Master Plan

(2016 - 2021)

Thailand Solid Waste Situation

Unit: Million Tons

Pollution Control Department, September 2016

Thailand Solid Waste Situation 2015

Generated Waste

26.85 Million Tons

Approx. 73,560 Tons / Day

Generated Rate

Approx. **1.13** Kg./Person/ Day

50%

Utilization
19%

4.94
Million Tons

Proper Management
31%

8.34
Million Tons

50%

Non-Proper Management
27%

7.15
Million Tons

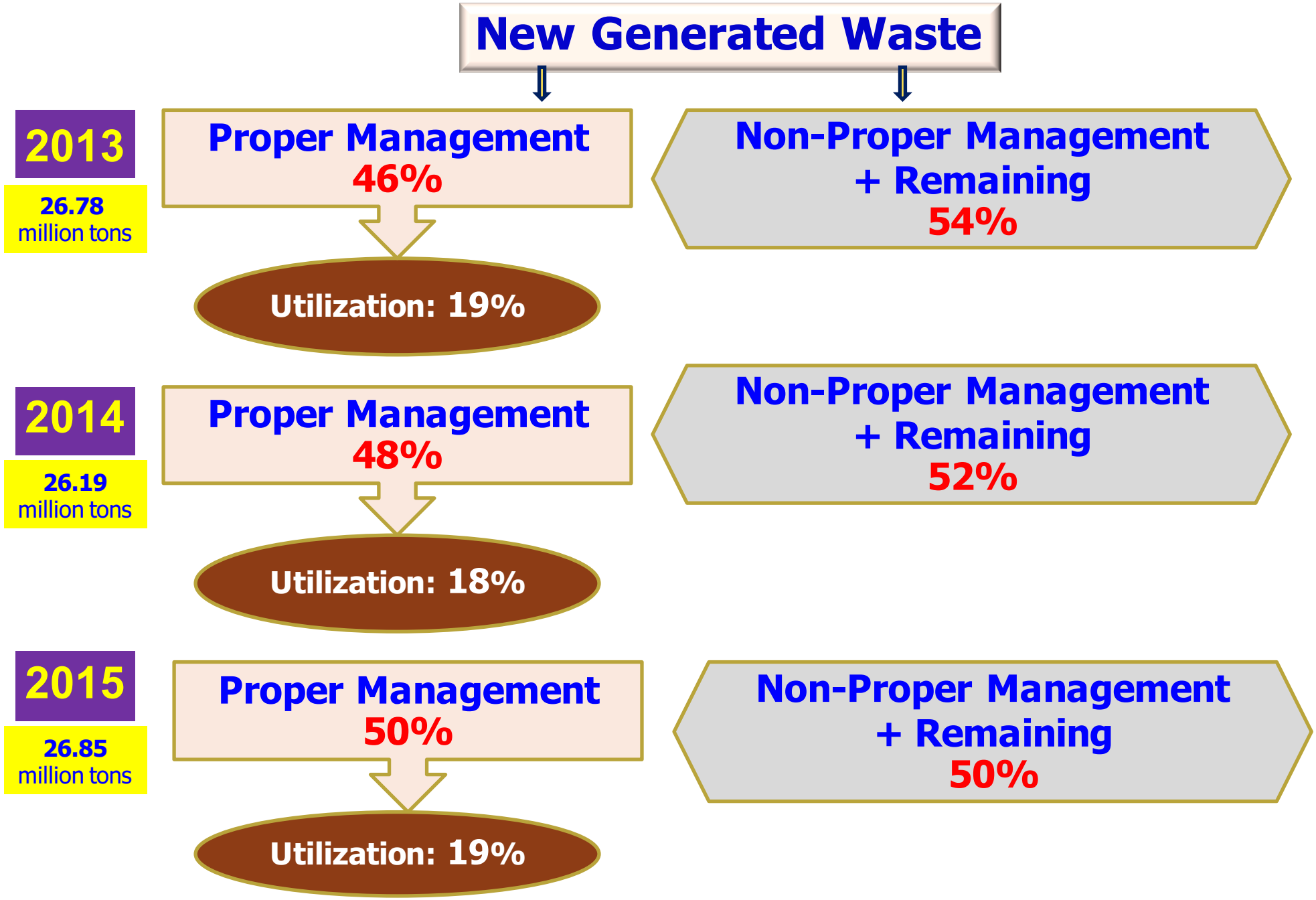
Remaining w/o Management
23%

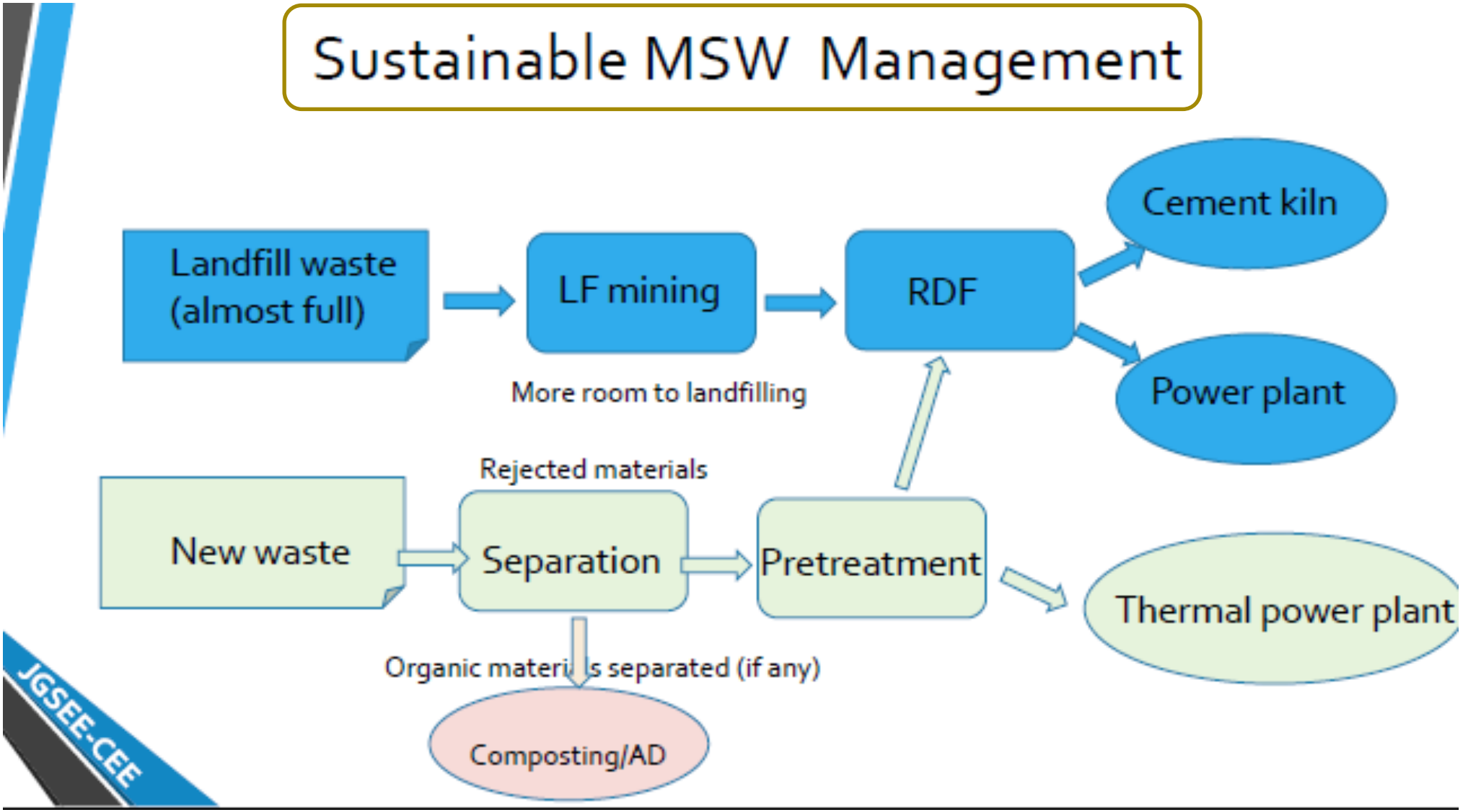
6.22
Million Tons

Note: As of 2014, Utilization 18%, Proper Mgt 30%, Non-proper Mgt + Remaining 52%
⇨ **Accumulated waste 30.49 Million Tons,** 65% of which have been managed under roadmap.

Pollution Control Department, September 2016

More than half is non-proper management, but slightly improved from **2013** to **2015**





Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

National Waste Management Policy

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- **Promote 3R's Strategy** with participation from community and recycling business,
- Encourage local administrations to establish **central solid waste disposal facilities with integrated concept** of appropriate technology and beneficial waste utilization
- **Area Clustering Approach** for establishing central MSW management facilities

MSW Strategic Approach 1:
Integrated Waste Management System

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Source Reduction & Separation → Waste Diversion
- Composting
- Energy Recovery
- Material Recovery

→ Final Disposal (Sanitary Landfill)

Opportunity:
- MSW Strategy and Roadmap
- AEDP (25% alternative energy by 2021
  ⇒ 160 MW from MSW + **Incentives**
  (Adder/FIT, 8 years corporate tax exemption,
  5 years 50% in corporate tax bill for AE project)

MSW Strategic Approach 2:
Area Clustering

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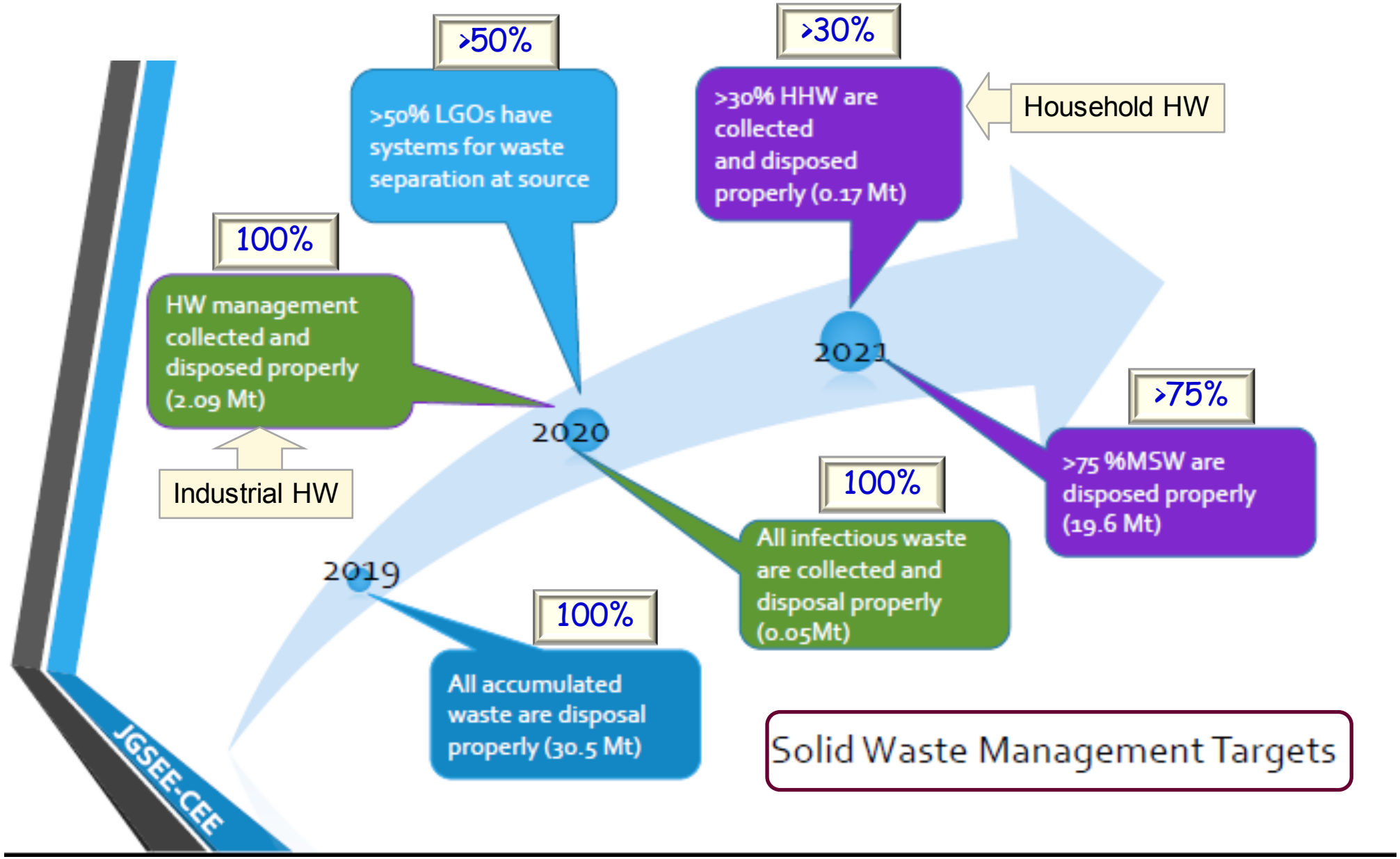
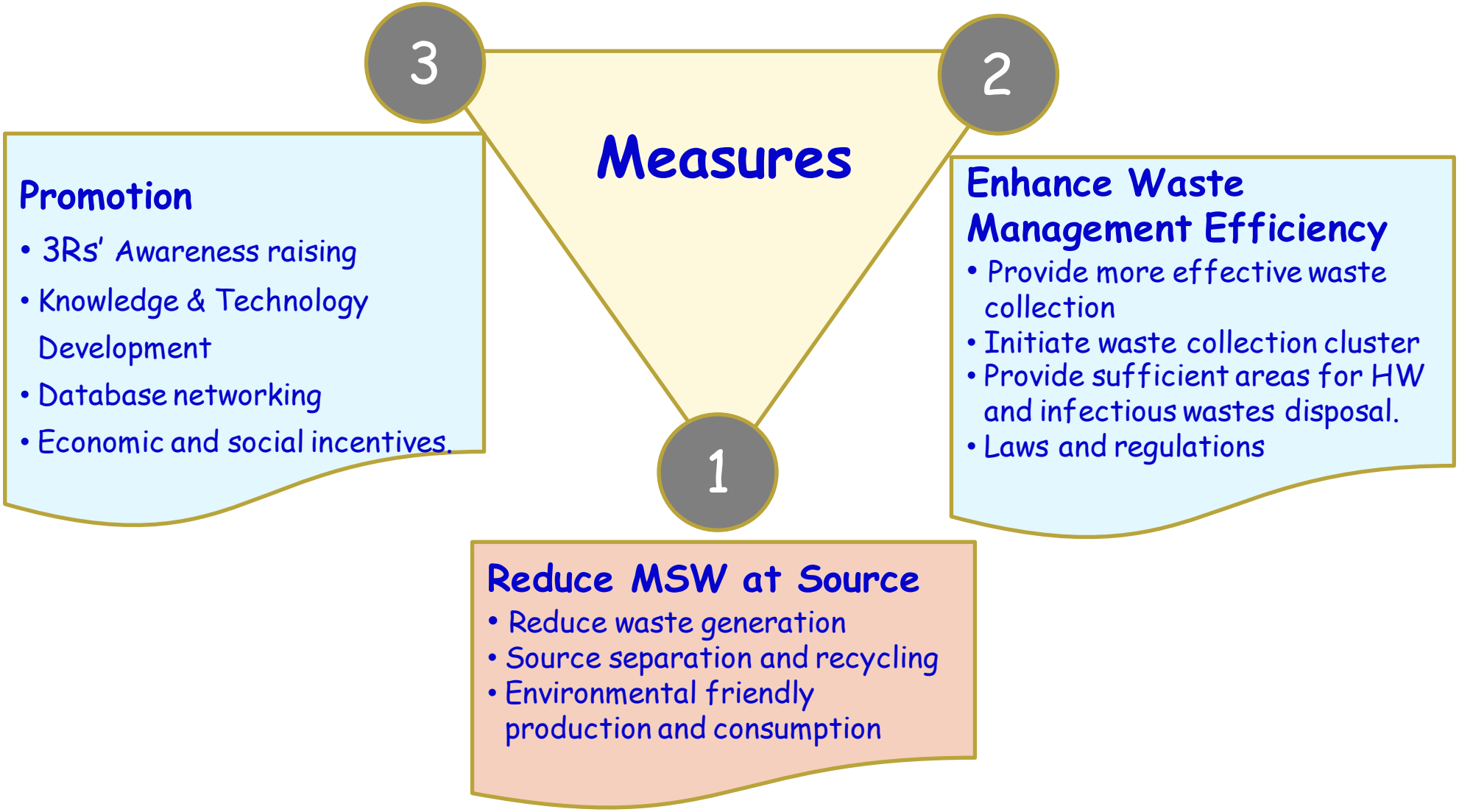
Cluster Type	Tons/Day	Technology	No. of area
Large	>500	Separation + Biological Decomposition + Incineration + Landfill	3
Medium 1	250-500	Separation + Biological Decomposition + RDF/Incineration + Landfill	26
Medium 2	100-250	Separation + Biological Decomposition/RDF + Landfill	89
Medium 3	50-100	Separation + Biological Decomposition/RDF + Landfill	91
Small	<50	Separation + Biological Decomposition	90



Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016



Source: Joint Graduate School of Energy and Environment (JGSEE), June 2016

Conclusion

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MSW generated 23-26 million tons/year

≥50% non-proper management + remaining

⇒ >30 million tons accumulated

MSW Roadmap + AEDP

- All accumulated wastes & Hazardous Industrial wastes will be properly disposed **by 2019**.
- All infectious waste will be properly disposed **by 2020**.
- ≥50% LGOs have system for waste separation by **2020**.
- ≥75% MSW and ≥30% HHW will be properly disposed by 2021.

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Thank you

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