An Overview of MSW Waste to Energy and Climate Co-benefits: A Case of Thailand.

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Outline

- Municipal Solid Waste (MSW): A Global Urban Challenge
- MSW and Climate Change
- MSW Management through Energy Recovery
  - What is Waste to Energy (WTE)
  - WTE Benefits
  - Challenges & Issues related to WTE
- Waste to Energy Recovery from MSW in Thailand

Waste Generation- Facts & Figures

- Worldwide MSW : 5.2 Mt/day, Developing Countries : 3.8 Mt/day
- Currently, world cities produce 1.3 bn t of waste/yr.
  By 2025, projected to 2.2 bn t/yr.
- MSW generation Urban Asia to reach 1.8 Mt /d in 2025
- As the world rapidly urbanizes, this waste is concentrated in cities
- Effective management of MSW is one of the greatest challenges faced by urban local governments today

Mt = Million tonnes
Bn t= Billion tonnes

Waste Growth in Asia is Inevitable

Climate Change and Waste Management Challenges

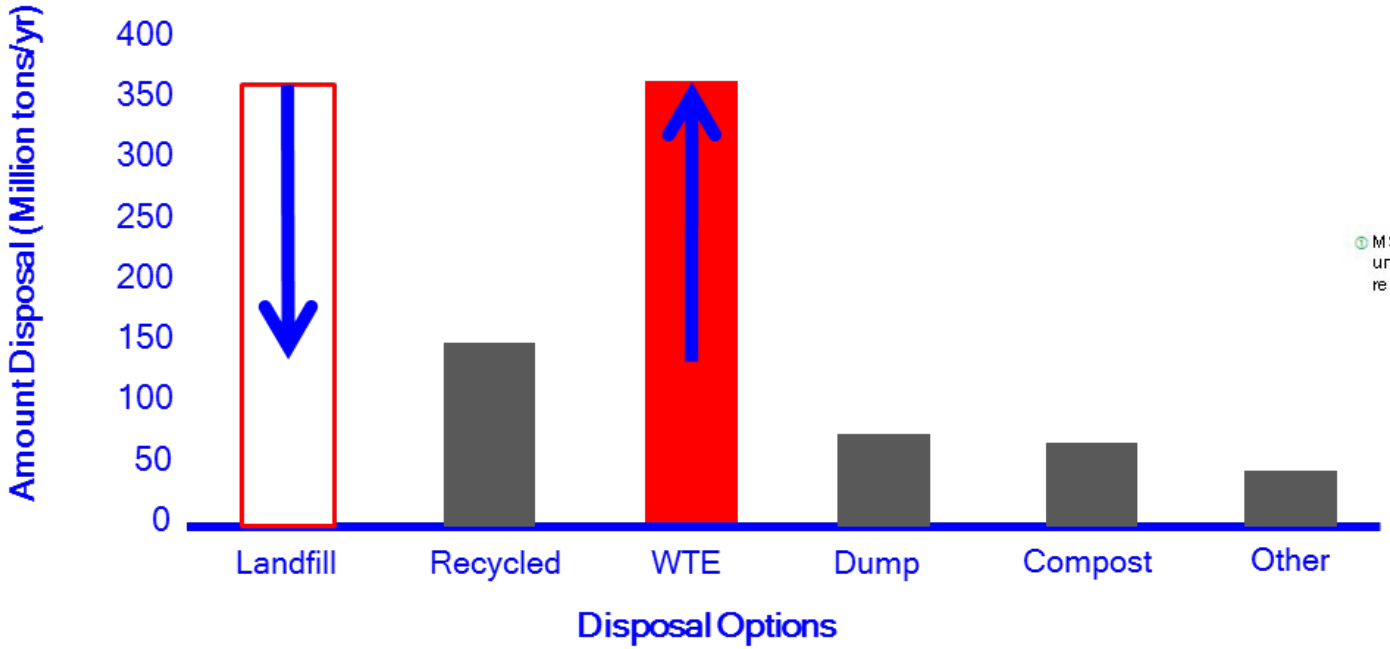
- Four imperatives tend to drive cities to develop or improve their waste management plans are:

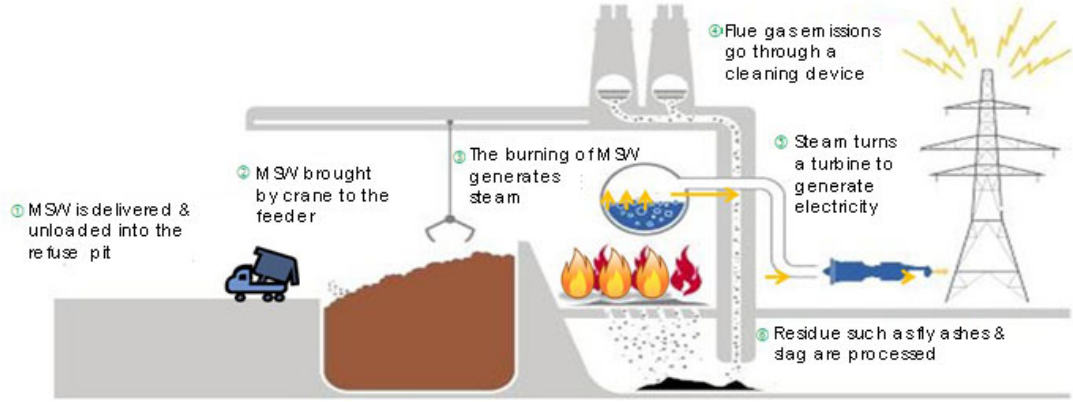
1. Public Health
2. Environmental Protection
3. Resource Recovery
4. Climate Change

- Climate change is an emerging driver, leading to consider the GHG implications of the waste management

Scope for financing climate abating waste plans through CDM and Carbon Markets

Waste to Energy (WTE) as Waste Management Solution

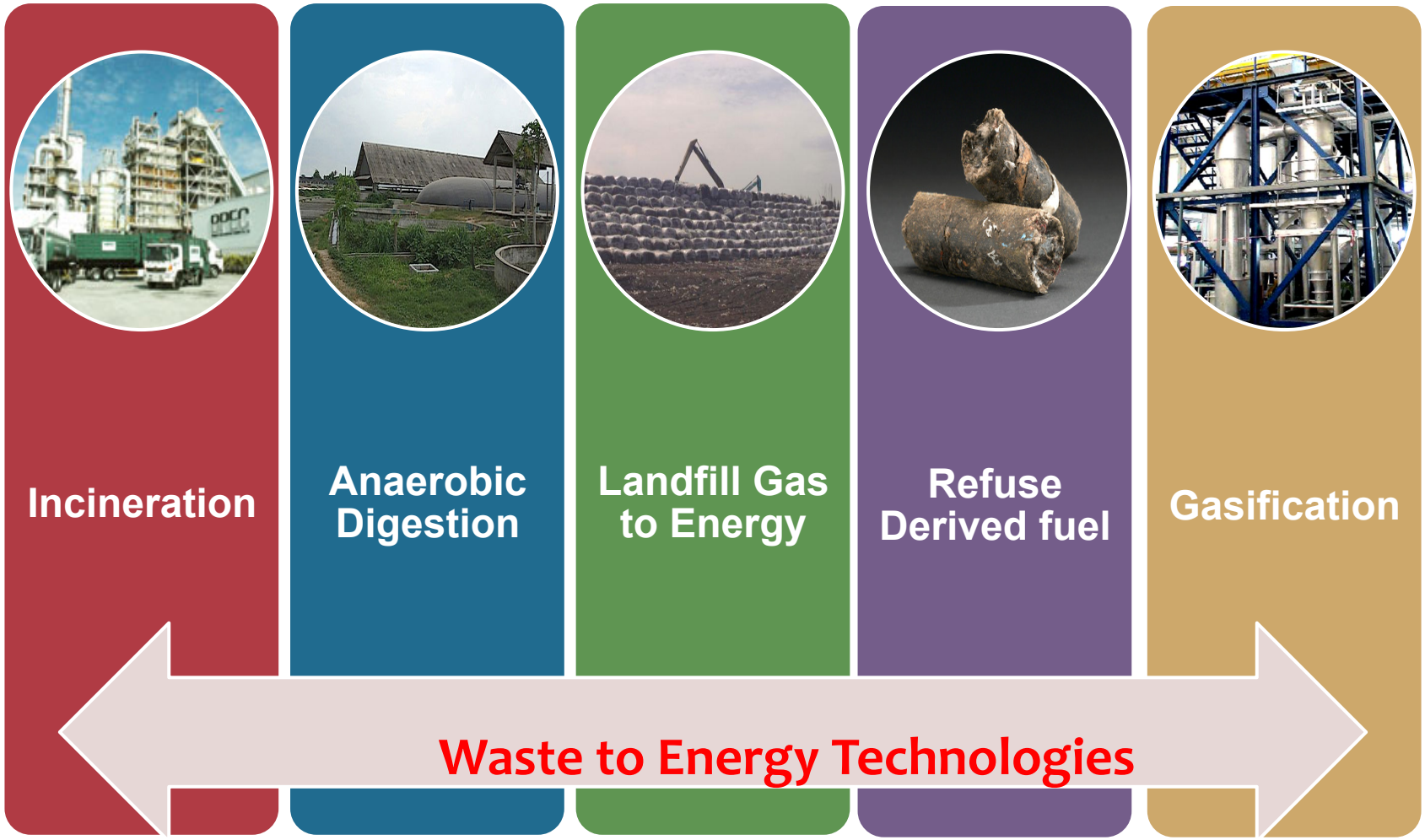




Recently, WTE projects have dominated the waste management category:

- Significant reduction of waste volume
- Production of renewable energy

WTE Technology & Process



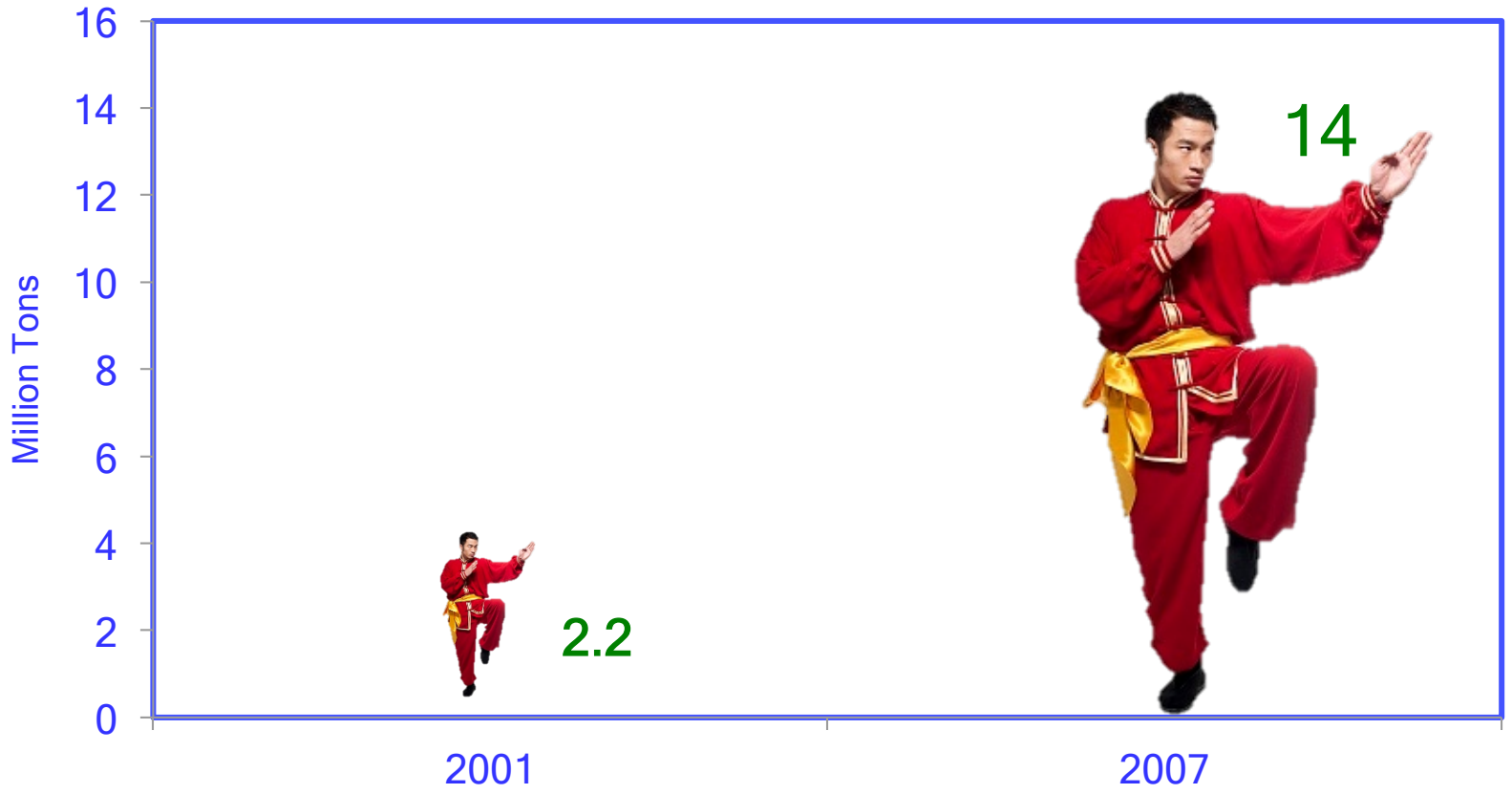
Global WTE Facility in 2010

Total : 1302
Asia : 764
Others : 538

Japan	: 700
Taiwan	: 24
Korea	: 26
Singapore	: 4
Thailand	: 2
China	: 7

Source: Waste to Energy: Technologies & Project Implementation
Rogoff & Screve, Elsevier Publication, 2011

Largest Recent WTE Market: China

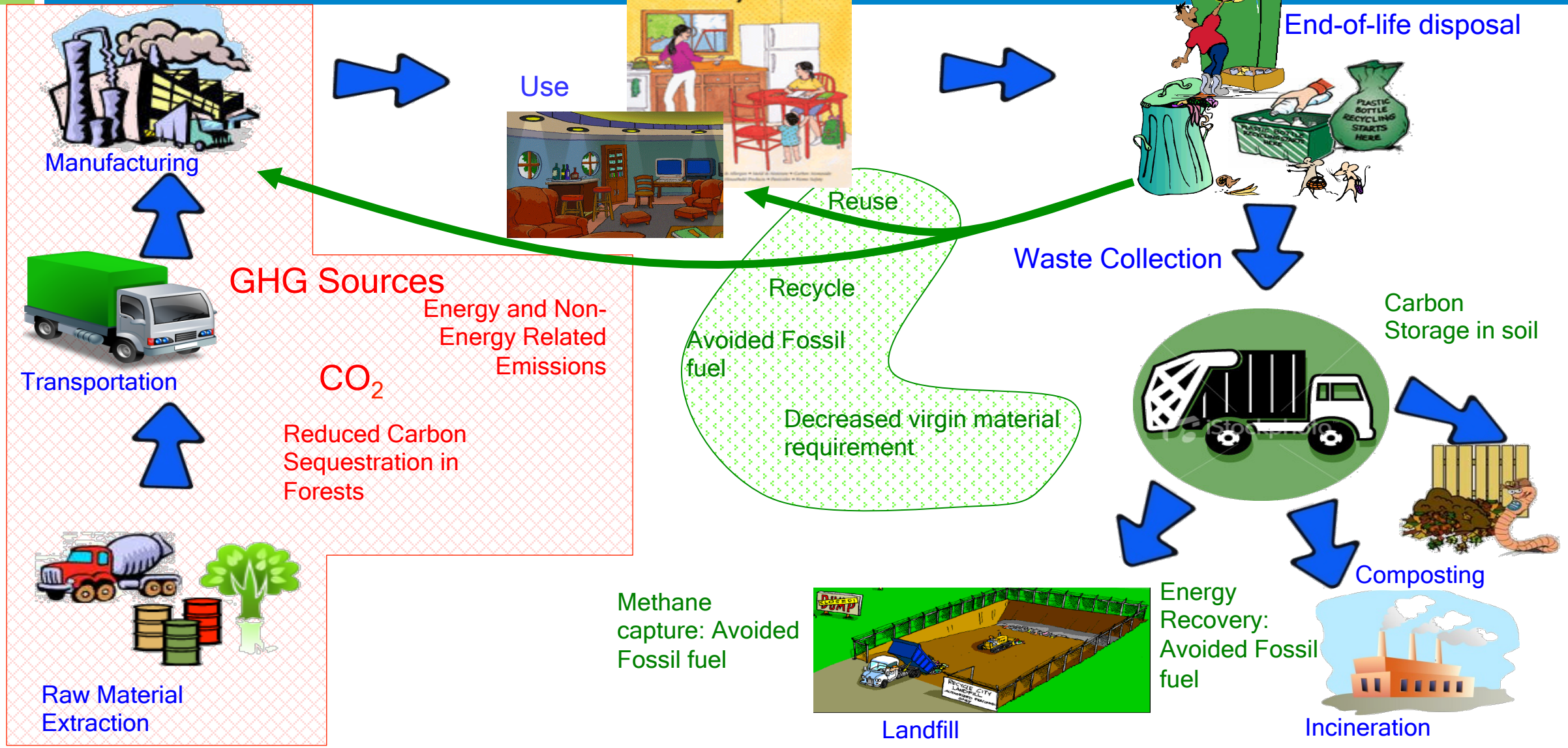


Drivers

- Proactive Government Policy to Promote WTE
- Energy Price & Sources: Renewable Energy

Source: Waste to Energy: Technologies & Project Implementation
Rogoff & Screve, Elsevier Publication, 2011

Sources of GHG Emission and Avoidance During Waste Handling & Management



Climate Co-Benefits of Waste to Energy

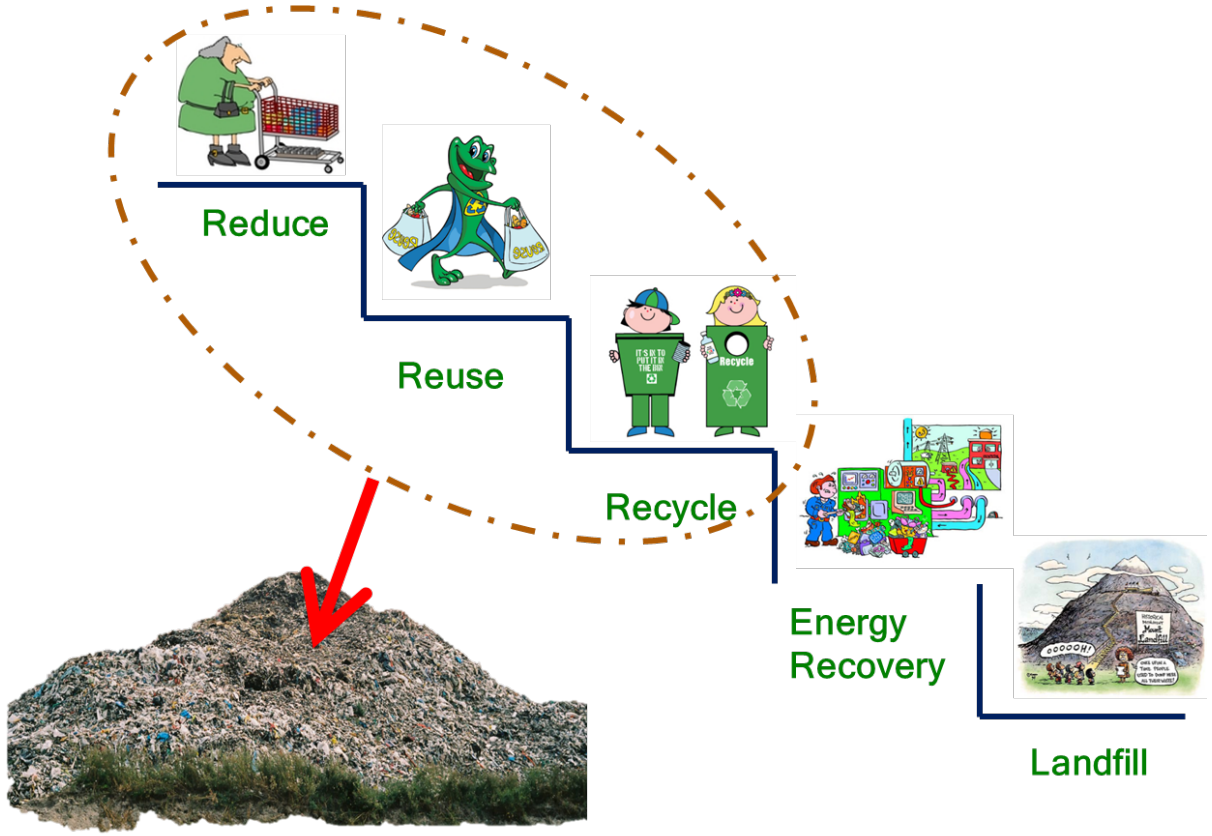
- WTE:
  - One of the 8 technologies which could lead to Law-Carbon Energy systems
- Best WTE Facility:
  - Save 100-350kg of CO_2 equivalent / ton of waste processing
- WTE Facility Development Driver:
  - Carbon Credits
  - CDM
  - Energy Price

Challenges of WTE

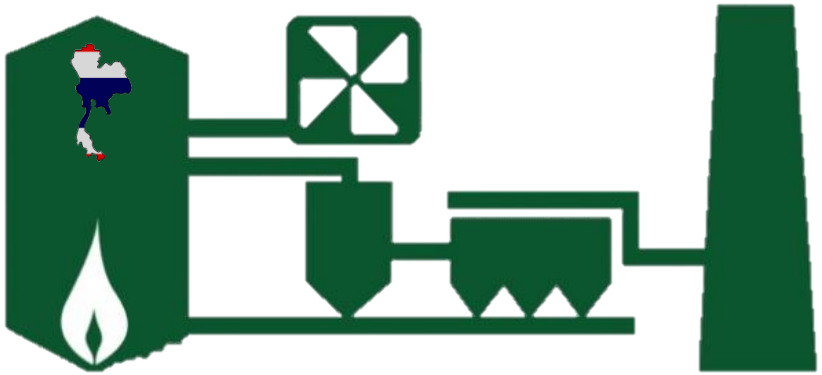
- Usually large scale projects/infrastructures: need for longer term financing

- More difficult to get planning approval:
- Suffers negative “image” as polluting technology
- Heavily mechanized operation causes loss of jobs for informal waste sector
- Requires large feeding- competition for wastes as feed with informal waste sector

- Conflict with Waste Hierarchy: WTE projects undermining the resource recovery/recycling

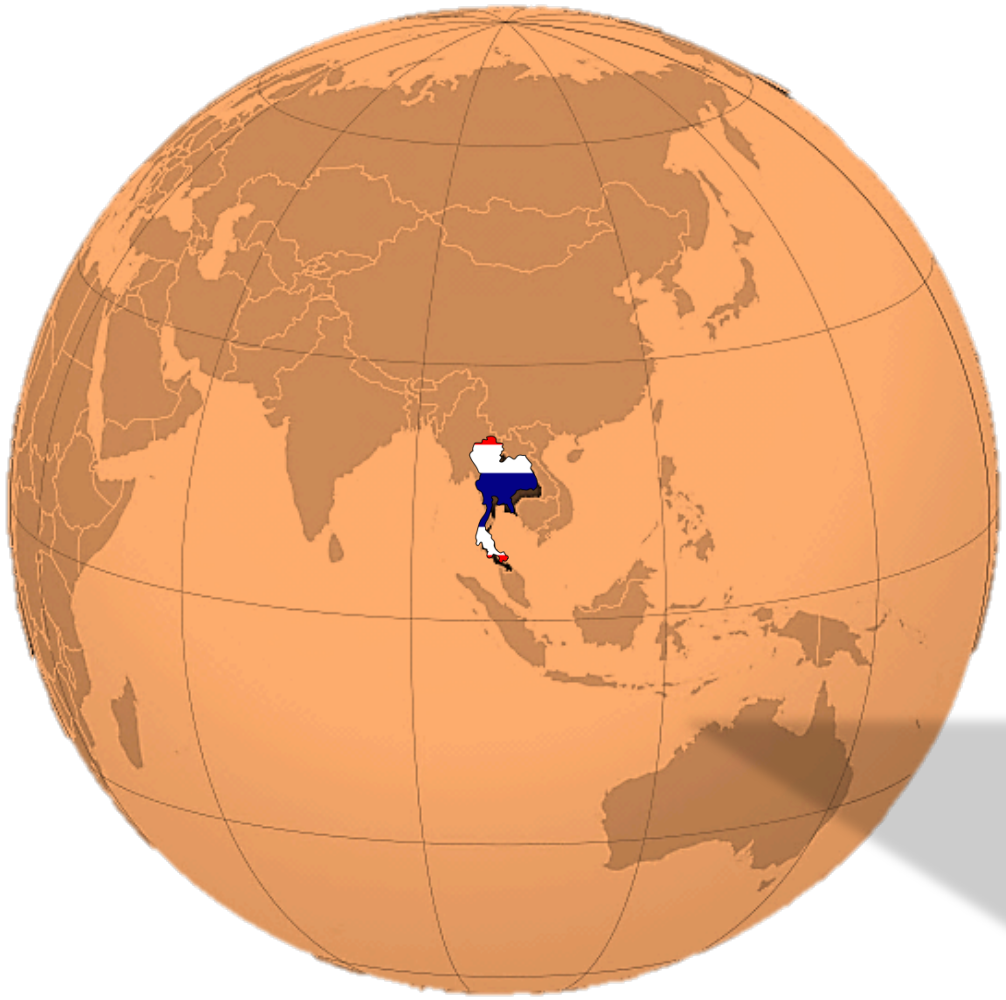


Overview of MSW Waste to Energy Systems in Thailand

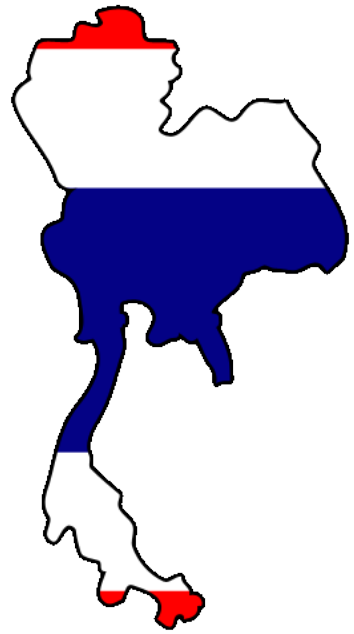


1. Overview of MSW Management in Thailand
2. Waste to Energy in Thailand
3. Challenges & Opportunities for WTE

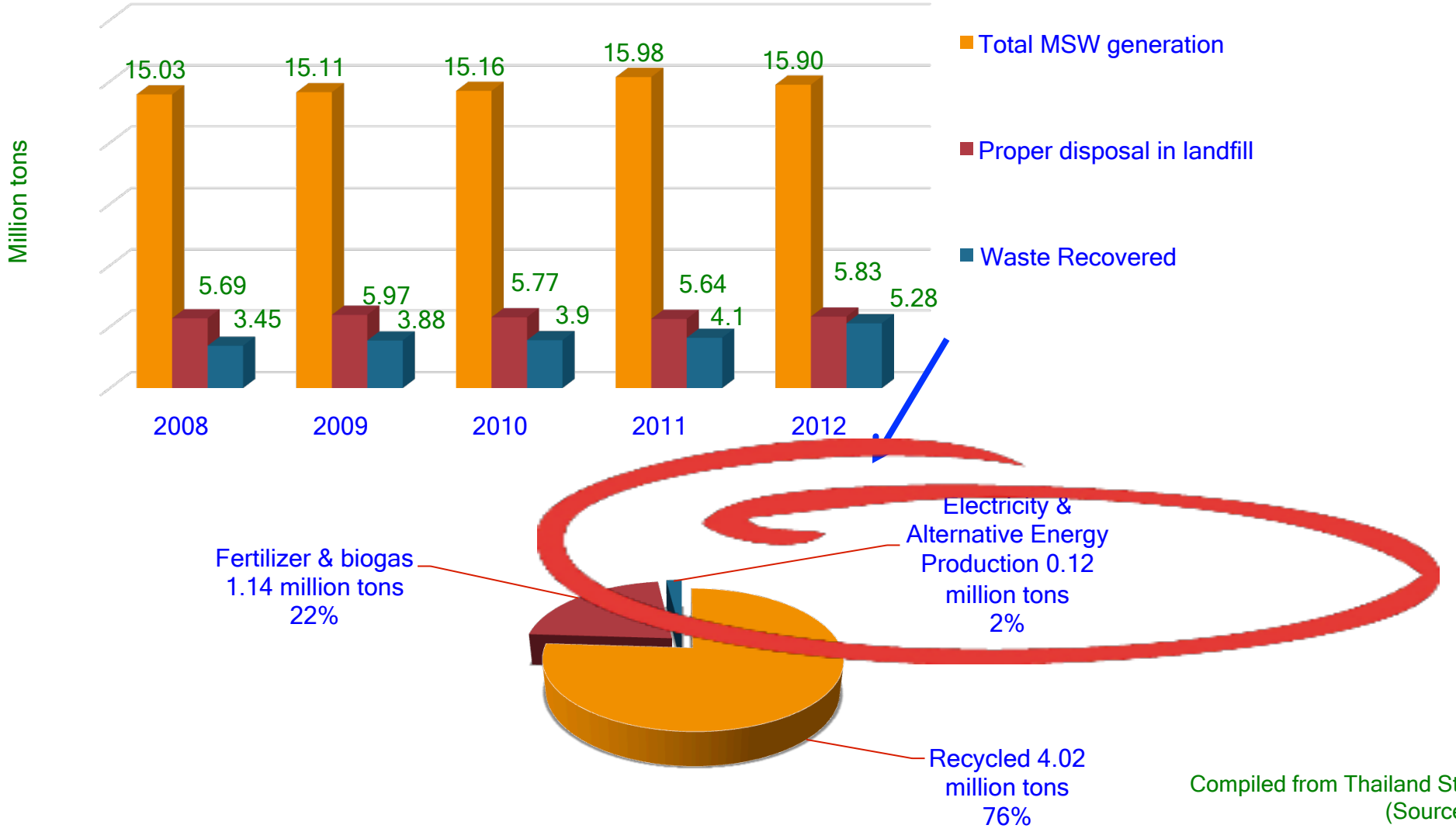
Thailand



Capital	Bangkok (Thai: Krung Thep)	
Official language	Thai	
Legislature	National Assembly	
Area	513,120 km^2	
Population (2011)	66 Million	
GDP (PPP) 2011	$616.783 billion	
GDP Composition		
	Agriculture	10%
	Industry	46%
	Services	44%
Per capita		$9,396
HDI (2011)	0.682 (medium) (103rd)	
Demographic data		
	Age 0-14	20%
	Age 15-65	71%
	Age >65	9%



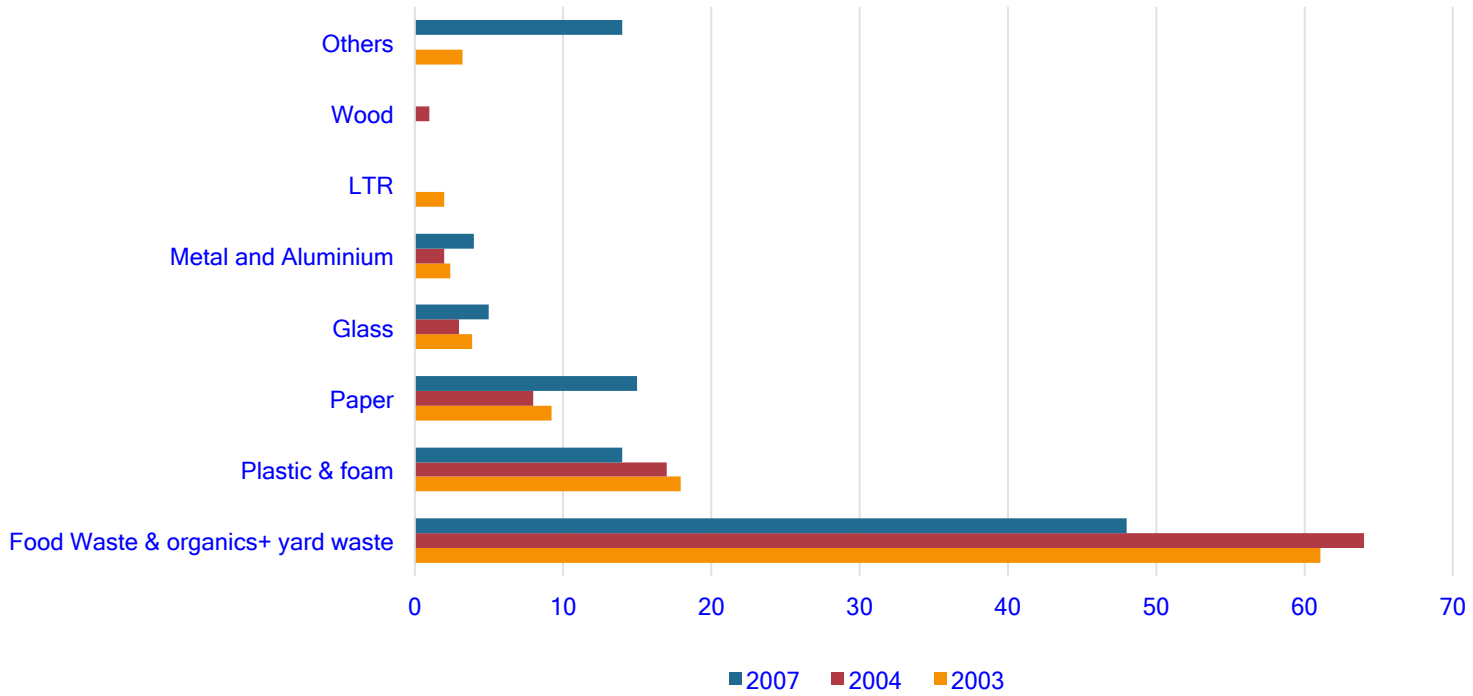
Overview of MSW in Thailand



Compiled from Thailand State of Pollution Report (2008-2012)
(Source: PCD Reports)

MSW Composition in Thailand

S.N.	Component	(2003)	(2004)	(2007)
1	Food Waste & organics+ yard waste	61.06	64	48
2	Plastic & foam	17.94	17	14
3	Paper	9.24	8	15
4	Glass	3.89	3	5
5	Metal and Aluminium	2.42	2	4
6	LTR	1.96	1(textile only)	
7	Wood		1	
8	Others	3.23	4	14



Moisture content : 50.60%

Average calorific value: 2,500-12,000 kJ/kg.

Waste characteristics and calorific value shows the suitability for AD/thermal recovery of energy

Composition of municipal solid waste (Source: PCD Reports)

MSW Related Policy & Legislative Framework

- Prime minister
  - National Environment Board
  - Ministry of Industry
    - Department of Industrial Works
    - Industrial Authority of Thailand
  - Ministry of Science Technology and Environment
    - Office of Environmental Policy and Planning
    - Pollution Control Department
      - Provincial Environmental Office
  - Ministry of Public Health
    - Department of Health Department
  - Ministry of Interior
    - Department of Local Administration
      - The Provincial Administration Organization
        - Municipality
        - The Sanitary District
        - Sub-district Administrative Organization
    - Department of Public Works

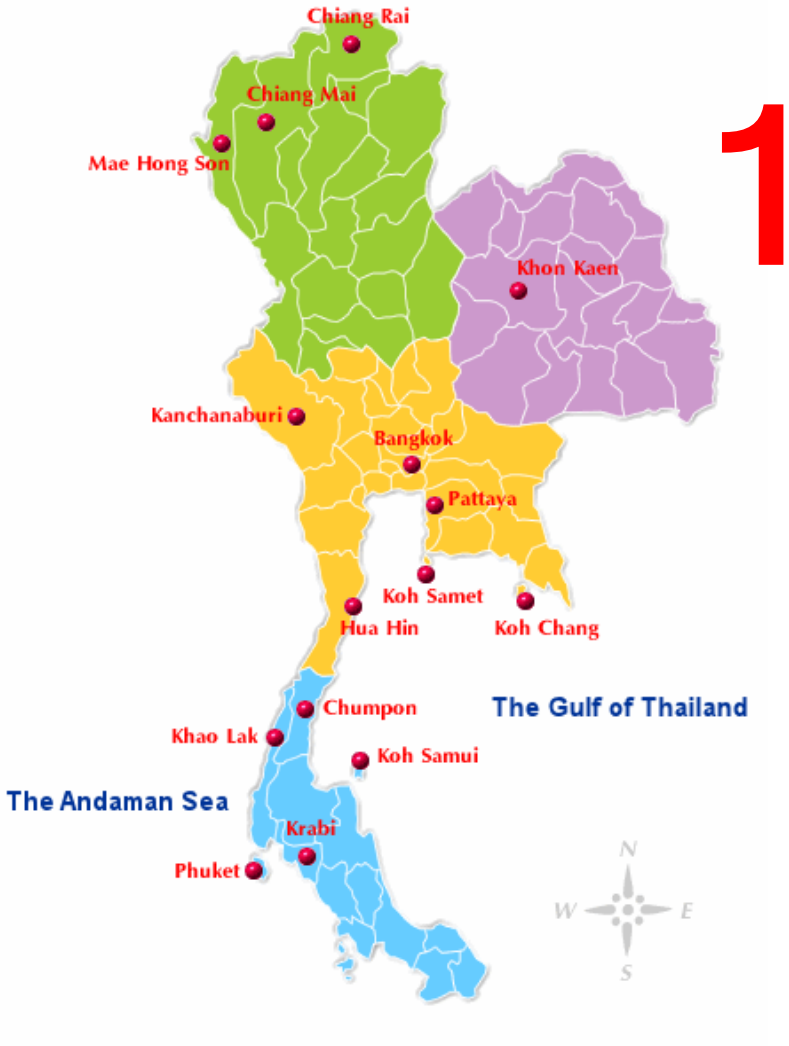
National Waste Management Policy

1. Promoting 3R's hierarchy (Reduce, Reuse and Recycle) with participation from community and recycling business

2. Encourage local administrations to establish central solid waste disposal facilities with integrated concept of appropriate technology and beneficial utilization of waste such as compost material and energy recovery.

3. Area Clustering Approach for Establishing Central MSW Management Facilities

MSW Treatment Systems



118

3

15

Sanitary Landfill

Working-100 sites
Never Run -7 sites
Stop Operating -11 sites

Incineration

Phuket-500-600 tons/day
Samui Island -150 tons/day
Tao Island -8-10 tons/day

Integrated Systems

Nakhon Ratchasima Municipality -300-400 tons/day
Wieng Fang (Chiang Mai) -30-50 tons/day
Rayong Municipality -80-90 tons/day
Mae Sai (Chiang Rai) -30-50 tons/day
Siprachan (Suphan Buri) --30-40 tons/day

Working-14 sites
Stop Operating -1 sites (Chon Buri PAO)

Source: Pollution Control Department, 2013

Government Policies and Planning for WTE

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Committed to the development of low-carbon society

Government Funding On R & D Activities

Alternative Energy Development Plan (AEDP : 2012-2021)

Encouraging Private-Led Investment

Target 25 % of RE in Total Energy Consumption By 2021

Solar	Wind	Small + Mini Hydro	Bio Energy			Biofuels	Others
2,000 MW	1,200 MW	1608 MW	Biomass	Biogas	MSW	• Ethanol 9 Million l/d • Biodiesel 5.97 Million l/d	• Tidal wave 2 MW • Geothermal 1 MW
100 ktoe (Heat)			3,630 MW	600 MW	160 MW		

Target: Renewable Energy Strategy

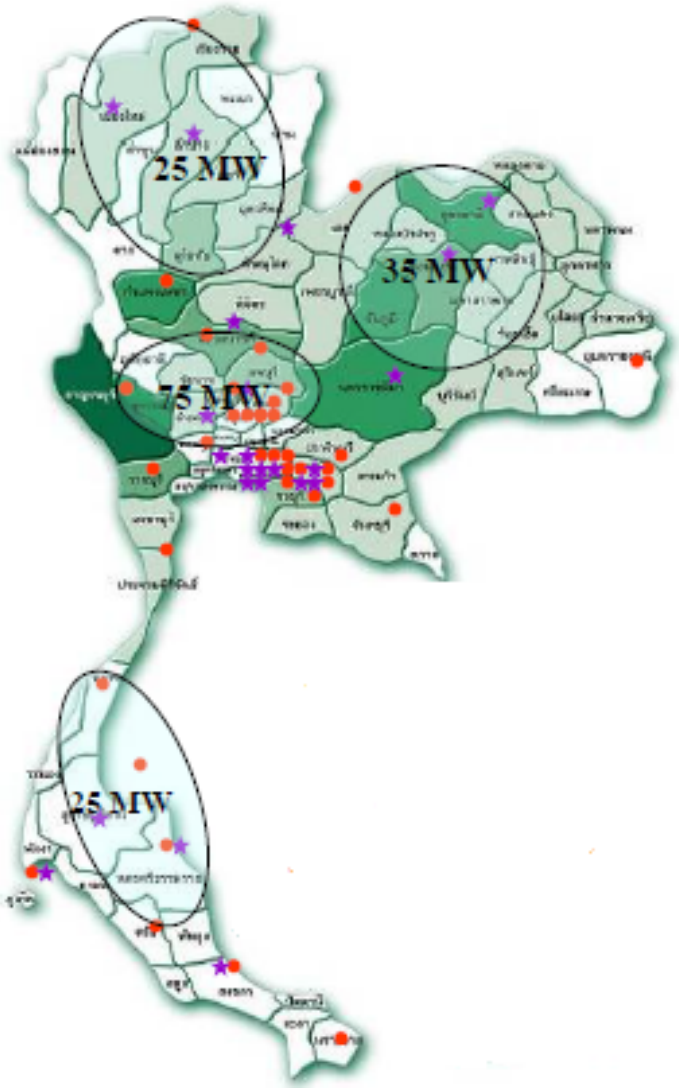


Photo : Ministry of Energy

Current power generation is 27.484 MW from targeted capacity at 160 MW

Applications of almost 50 projects in MSW energy have been submitted, majority Very Small Power Projects VSPP (MW ≤ 10)

However, actual numbers of project execution from these approved projects is a significant challenge

Promote an investment by private entities with the garbage elimination cost subsidised by the local administrative organisations

- According to Renewable Energy Strategy, the establishment of WTE project must not be less than 100 MW.

Driving Force

- Promote MSW in medium/small size Local Admin Organization
- Speed up Joint Venture (Co-working private sector with Local Admin Organization)
- Promote “RDF” Refuse-Derived Fuel

Government Incentives for WTE

Department of Alternative
Energy Development and Efficiency
MINISTRY OF ENERGY

Promote community produce & consume RE

Promoting People Knowledge

Appropriate incentives

Improving Infrastructure

Amending Laws & Regulations

Research & Development

Government Incentives for WTE

Fuel Type`	Adder (Baht/kWh)	Periods (years)
1. Biomass		
- Install capacity <= 1 MW	0.50	7
- Install capacity > 1 MW	0.30	7
2. Biogas		
- Install capacity <= 1 MW	0.50	7
- Install capacity > 1 MW	0.30	7
3. Municipal waste		
- Fermentation or Landfill	2.50	7
- Thermal Process	3.50	7
4. Wind		
- Install capacity <= 50 MW	4.50	10
- Install capacity > 50 MW	3.50	10
5. Mini Hydro		
- Install capacity 50 kW - <200 kW	0.80	7
- Install capacity < 50 kW	1.50	7
6. Solar	8.00	10

Fuel	Adder (B/kWh)		Special Adder * (B/kWh)	Supporting period (year)
	VSPP	SPP		
Waste (not hazardous industrial waste, and inorganic waste)				
• AD & LFG	2.5	2.5	1	7
• Thermal process	3.5	3.5	1	7

Import duty exemption on equipment or machines

8-year corporate income tax holiday (any income from selling RE or saving energy), and 50% tax holiday from 9th-13th years.

Three types of renewable energy can apply for investment grant for Design, Consultant and Partial Investment:

- Biogas (10-30%),
- Municipal waste (25-100%), and
- Solar hot (30%), with max cap at 50 million baht per project

"Adder" tariff to be a supplement of normal purchasing tariff of electricity to the national grid.

Important WTE Projects

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Important projects :

- Pilot Projects on community-based biomass
- Developing and promoting the Biogas Fermented Tank from instant organic wastes in education institutions, military camps, and localities in 540 places
- Demonstration Projects and Promotion of RDF.
- Cooperation with municipalities to promote waste-to-energy projects

Next movement

- Researching, developing, and promoting the process of wastes to petrol
- Supporting policy on financial measures

Current status of Electricity sales

Submitted : 34 projects (455 MW)
- Very Small Power Projects (VSPP): 29 projects 125 MW
- Small Power Projects (SPP): 5 projects 330 MW

Signed : 19 projects (103 MW)
All are VSPP projects

On grid : 14 projects
Capacity 13.45 MW

WTE Projects/Facilities in Thailand

Government Initiative

- Anaerobic digestion of Rayong municipality.
- Chonburi MSW central treatment plant
- Kampangsan landfill LFG
- Rachathewa landfill LFG
- MSW incineration - Samui Island, Surat Thani
- MSW incineration - Phuket Island

Private Initiative

- Fully Integrated MSW Treatment Plant Chonburi, MSW central treatment plant
- Recovery of Organic Fertilizer and Refuse Derived Fuel Prachinburi
- Production Enhancement Project of Biomass to Energy Saraburi
- Korat Waste to Energy (KWTE) Project (AD) , Muang District

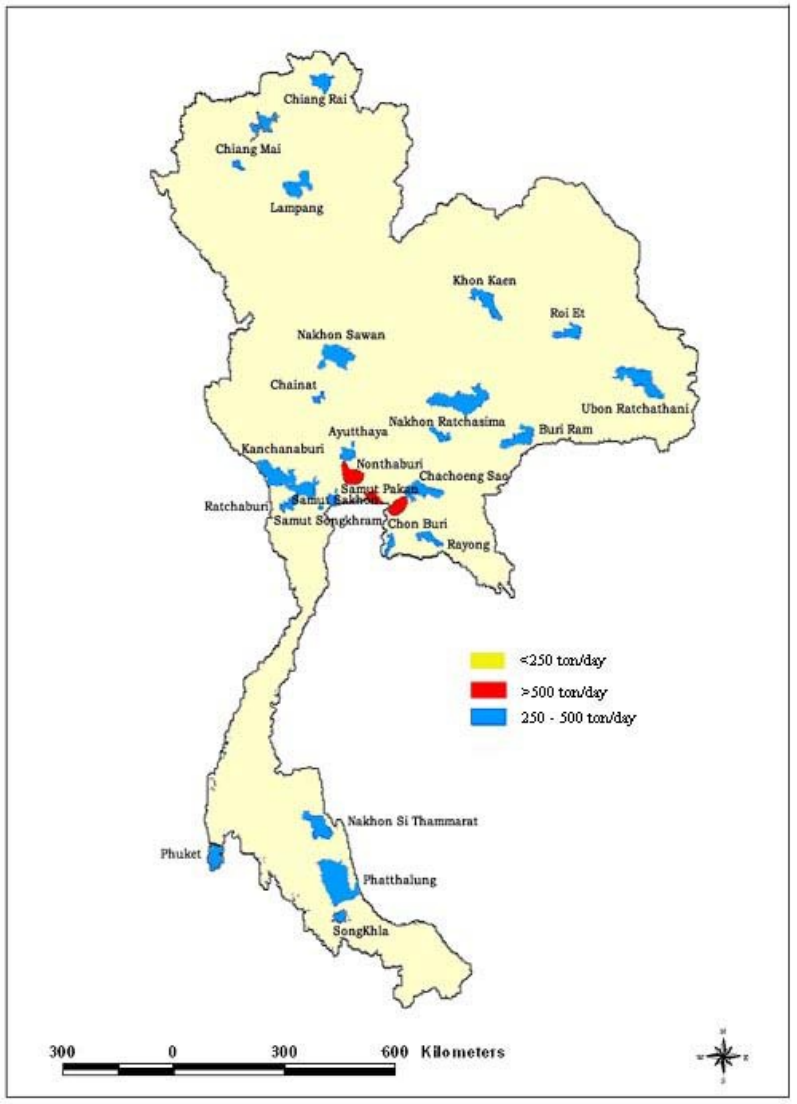
Key Players and Investors

Project/ Authority	Technology	Type of energy	Capacity	Location
Biogas Production from Food Waste by Energy Policy and Planning Office	Anaerobic Digestion (AD)	Thermal	343 toe	33 of Hotels, Supermarket, Restaurant and Industrial Factories in Thailand
Energy Production System Archetypes from Waste by Department of Alternative Energy Development and Efficiency	Fermentation	Thermal	209 toe	Lopburi
Waste to Energy Project by Department of Alternative Energy Development and Efficiency	Fermentation	Thermal	415 toe	Kamphaengphet, Sakon Nakhon, Suphanburi, Prachuab Khirikan, Nakorn sri Thamaraj
Power plant from biogas	Anaerobic Digestion: Cover lagoon	Electricity	0.055 MW	Pathum Thani
Thachiangthong Co., Ltd.	Landfill Gas (LFG)	Electricity	1 MW	Chiang Mai
Palungnganporpieng Co., Ltd.	Gasification	Electricity	0.220 MW	Samutsakorn
Thung song renewable energy power plant Co., Ltd.	Anaerobic Digestion (AD)	Electricity	0.32	Nakhon Si Thammarat
Thermal Tech Co., Ltd.	Anaerobic Digestion (AD)	Electricity	0.034	Suphan Buri

Key Players and Investors

Project/Authority	Technology	Type of energy	Capacity	Location
Phuket Incinerator Power Plant by PJT Technology Co., Ltd.	Incinerator	Electricity	2.5 MW	Phuket
Rayong power plant	Anaerobic digestion (AD)	Electricity	0.625	Rayong
Rachathewa Power Plant by Chareon Sompon Part., Ltd.	Landfill Gas (LFG)	Electricity	1 MW	Samut Prakarn
Kamphaengsaen Landfill Project by Active Synergy	Landfill Gas (LFG)	Electricity	1 MW	Nakorn Prathom
Amata Incinerator Plant by PJT Technology Co., Ltd.	Incinerator	Electricity	1.5 MW	Chonburi
Kamphaengsaen Landfill Project by Zenith Green Energy	Landfill Gas (LFG)	Electricity	8 MW	Nakorn Prathom
Rak Baan Rao Co., Ltd.	Anaerobic Digestion (AD)	Electricity	1 MW	Pathum Thani
Power plant project from biogas of Kasetsart University	Landfill Gas (LFG)	Electricity	0.23 MW	Nakorn Prathom
Phanonsarakam Landfill Project by Chareon Sompon Part., Ltd.	Landfill Gas (LFG)	Electricity	2 MW	Chachoengsao

Area Cluster Approach-Thailand



Cluster in Thailand

Area size	Amount of MSW (ton/ day)	Number of Area
Large Cluster	>500	3
Medium 1 Cluster	250-500	26
Medium 2 Cluster	100-250	89
Medium 3 Cluster	50-100	91
Small Cluster	<50	90

Cluster	Technology
Large Cluster	Separation + Biological decomposition + Incineration + Landfill
Medium 1 Cluster	Separation+ Biological decomposition + Gasification/Pyrolysis/Stoker Incineration + Landfill
Medium 2 Cluster	Separation + Biological decomposition + Pyrolysis/Gasification + Landfill
Medium 3 Cluster	Separation + Biological decomposition+ Pyrolysis/Gasification + Landfill
Small Cluster	Separation + Biological decomposition + Landfill

WTE Sizing, Cost and Power Generation Potential

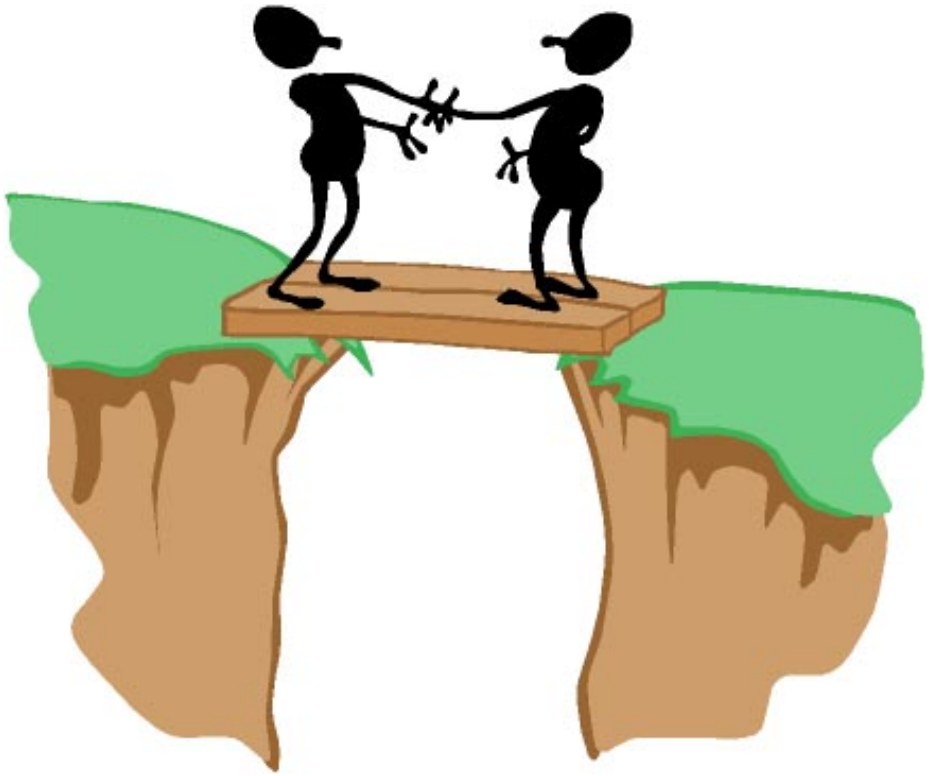
Systems	Sizing (T/d)	Capital (Million B/t)	O&M (Baht/t)	Power Generation Potentials
1. Refuse Derived Fuel (RDF)	> 50	0.74-1.75	248-629	1 ton of waste produced 0.17 -0.23 ton of RDF; 1 ton of RDF generated power more than 300 kWh
2. Landfill Gas to Energy	> 100	0.94-1.25	257-932	More than 1.38 tons/ton of waste (based on 20-year landfill lifespan)
3. Stoker Incinerator	75 - 500	6.5-1.5	800- 2 ,000	More than 150 -200 tons/ton of waste
4. Fluidized Bed Incinerator	> 100	N/A	N/A	
5. Gasification	> 15	2-4.9	638-1,004	more than 170 -190 tons/ton of waste
6. Pyrolysis	N/A	7	N/A	-
7. Anaerobic Digestion	>100 (per unit)	1.25-1.8	128-704	more than 80 -120 tons/ton of waste

Challenges & Opportunities for WTE

Challenges

- Technology development and Transfer
- Local MSW characterization-design capacity???
- Business Models
- Policy and Regulatory Issues
- Funding Constraints

Bridging the Gap



Opportunities

- Stakeholders incentivizing
- Changing Policies, local authorities
- Cluster formation &RE
- Funding opportunities- CDM/carbon credits

THANK YOU…

Bangkok Kamphaeng Saen East: & West Landfill Gas to Electricity Project ("Thailand MWE Projects)

Project Title	Bangkok Kamphaeng Saen East & West: Landfill Gas to Electricity Project
Registration date of the project activity	21/01/2011
CDM Registration Number	3462 (East) & 3483 (West)
Activity	Extract, capture and utilize landfill gas (LFG) to generate electricity and connect to the local grid.
Project participant(s)	• Bangkok Greenpower Co., Ltd. (Thailand) • Xentolar Holdings Limited (UK) • Sindicatum Carbon Capital Ltd (UK)
Power Generation	There are two 8.0 MW power generation
Expected CO_2 emission reduction	1.9m and 1.7m tonnes of carbon dioxide equivalent (CO2e) for the West and East project respectively over the first crediting period (2011-2015).

Source: http://cdm.unfccc.int/Projects/DB/SGS-UKL1267631662.24

Bangkok Kamphaeng Saen East & West Landfill

- Bangkok Kamphaeng Saen Landfills is Bangkok's largest landfill, also one of the largest landfills in Asia.
- Daily waste input is over 5,000 tons/day since March 2005
- This landfill site has two individual sites immediately adjacent to each other
  - Kamphaeng Sean West accepting around 3,000 tons/day
  - 2,000 tons/day of waste received in Kamphaeng Sean East
- Have 10 years contract to dispose of municipal solid waste with the Bangkok Municipal Authority (BMA) or until the prescribed contract value has been reached whichever is first.

Kamphangsan Sanitary Landfill

Kamphaeng Sean West : Receiving around 3,000 tons/day
Kamphaeng Sean East : Receiving around 2,000 tons/day

10, 000 t/day
3 Transfer stations
2 Transfer station handled by Group 79 79-Kamphangsan, the 1 TS by Piroj Group, at Ratchadevi LF

Project Location

- Nakhon Pathom Province, Kamphaeng Saen District

Landfill Waste to Energy as CDM Project

Project Title:	Bangkok Kamphaeng Saen East & West: Landfill Gas to Electricity Project
Registration date of the project activity	21/01/2011
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Activity	Extract, capture and utilize landfill gas (LFG) to generate electricity and connect to the local grid.
Project participant(s)	• Bangkok Greenpower Co., Ltd. (Thailand) • Xentolar Holdings Limited (UK) • Sindicatum Carbon Capital Ltd (UK)
Expected operational lifetime of the project activity	21 Years
This is expected to achieve emission reduction of	1,911,564 tCO2 over the first 7 years crediting period (approximately 273,086 tCO2e yearly). The start date of the crediting period was 21/01/2011.

Source: http://cdm.unfccc.int/Projects/DB/SGS-UKL1267631662.24

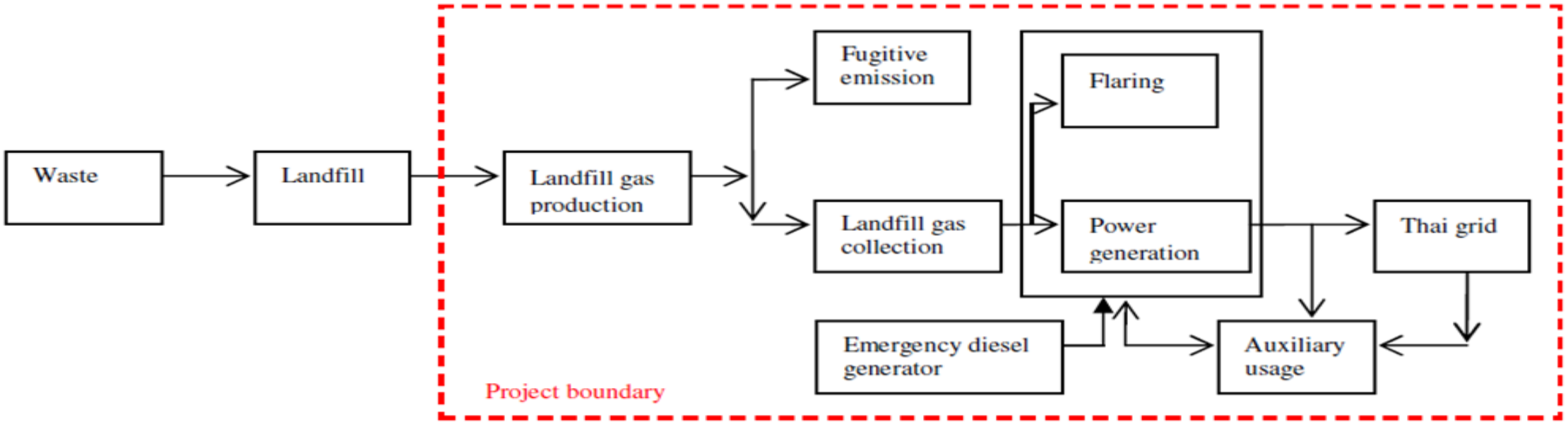
Landfill Waste to Energy as CDM Project

Project Implementation

Construction of landfill gas extraction pipe system commenced	August 2009
Landfill gas has been extracted and combusted by flare since	February 2010
Physical installation of the first four engines and construction of the grid connection completed	March 2010
Following commissioning the project exported electricity to the Thai Grid	April 2010
An additional 2 engines were installed	During April 2011 and commissioned during May 2011
A further 2 engines were installed	During December 2011 and commissioned during January 2012
Total emission reductions achieved in the monitoring period (01/11/2011 – 31/03/2012)	132,230 tCO_2e

Technology Description

- LFG is extracted and captured using “OBC TM Technology” developed by Sindicatum Carbon Capital (ordered by Xentolar Holdings Limited, a project participant),
- Electricity generated is exported to the Thailand electrical grid
- Whenever there is surplus LFG, due to engine maintenance or other site factors, LFG is sent to an enclosed ground flare where it is flared thus minimizing methane emissions and maximizing carbon abatement.



Technology Description

- Landfill gas collection: High-density polyethylene (HDPE) horizontal collection pipes are connected via main carrier pipes to the LFG extraction plant. The LFG, comprising approximately 50% methane and 50% carbon dioxide is used for power generation with any surplus gas flared.

- Pre-treatment: Recovered LFG passes through the pre-treatment plant where moisture and particulates are removed prior to the power generating engines.

- Power generation units/LFG generator sets: After the LFG has passed through the pre treatment plant the gas is sent to spark ignition power generation units. The electricity produced is distributed to the Thailand Electric Grid. Currently the project activity consists of 8 generator sets.

- Flare system: Surplus gas is destroyed by a flare system. The combination of power generation and flare optimizes the destruction of landfill gas. The flare system is equipped with a monitoring system to measure flow, pressure, methane concentration and the temperature in order to comply with the tool.

Responsibility and CDM Management

- The project runs with a team of 30 local staff.
- A CDM Manager is appointed with responsibility for overseeing the implementation and monitoring all project related activities and organizing training.
- A CDM Monitoring Team, is responsible and reports to the CDM Manger for checking instrumentation, record keeping, data handling and data processing, filing, reporting, organizing repair and maintenance of monitoring equipment and ensuring the monitoring plan is adhered
- All relevant information, notes of meetings, data files, maintenance records, defect reports, hard copy and computerized records of monitoring are kept at a designated location and arranged in an orderly and transparent manner to facilitate auditing as and when required.
- **The Project won the Outstanding Green Initiative award in 2011.**

Benefits Offered by the Project

Environmental Benefits:

- Reduction of GHG and improvement in local air quality; reduction of odours
- Production of renewable source of energy

Social Impacts:

- Improved neighborhood
- Collection of the landfill gas will improve the safety aspects of the landfill, reducing the dangers of combustion and explosion of methane pockets.

Economic Impacts:

- Revenue from sales of electricity and CERs n additional source of revenue (CER)

Technology Transfer:

- Introduction of new technology to the landfill management sector in Thailand (Sindicatum Carbon Capital proprietary LFG collection technology currently installed at similar landfill sites in China.)

Polymer Energy Plant, Rayong Municipality

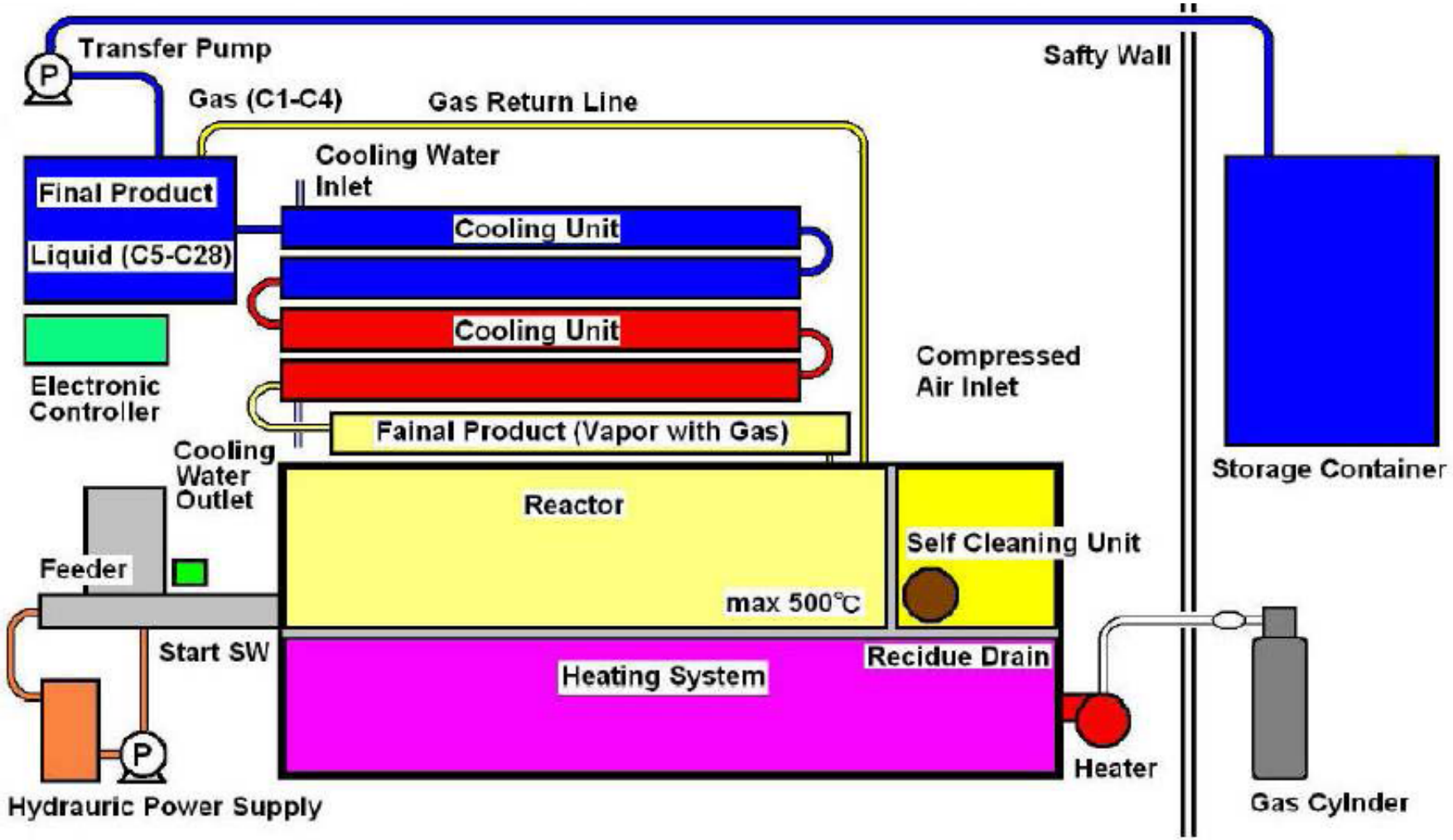
Polymer Energy Plant, Rayong, Thailand

- Catalytic pyrolysis
- Technology from Poland
- Doesn't use PVC – dioxin
- Capacity : 6 tons/day but now only 1ton/day
- Output: 583 liters /day

Polymer Energy Technology Process

- Technology from Poland
- Well-known in Poland and EU countries
  - Polymer Energy System uses a process called Catalytic Pyrolysis to efficiently convert plastics to crude oil.
- Produce liquid oil from plastic
- Amount of plastic waste required –
  - 300 kg/d or 162 tonnes/month (1830 tonnes/y)
- Amount of oil produced
  - 60% by weight of total waste fed.
  - 135,000 L/month or 1,620,000 L/year

Step 8: Converting Plastic to Oil




Feeding Unit
Pre-heating
Reactor

Final Product – Crude Oil

THANK YOU…