Waste (power generation) [i]

1. Introduction

Electricity or thermal energy production from renewable energy waste is an alternative to help reduce the problem of the environment. However, presently, Thailand has an electricity generation capacity from solid waste disposal of only around 5 MW. While the goal of waste renewable energy promotion is 160 MW by 2022. Several barriers including as unclear laws and regulations are the main obstacles to investors of waste-to-energy technology. There is also a lack of management and campaign of waste separation at the community level including a lack of confidence in the existing technology.

To achieve waste electricity generation, cooperation from all relevant sectors is required. Guidelines are needed from the government to assist, support and stimulate the investment in the waste energy production. In the past, the policy was not clear because most of the waste energy production was derived from government operations or financially supported by the government for construction and project implementation.

To materialize the goal of waste-to-energy promotion, it is necessary for all the stakeholders throughout the supply chain to cooperate (as shown in Fig A 4). As a result, the ministry of energy collaborated with government institutes, private sectors and local administrative organizations to integrate waste-to-energy technology in the master plan of Bangkok. In addition, the Pollution Control Department (PCD) issued the guideline to produce energy from solid waste while the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy established the waste energy production promote plan to set targets and goals for waste-to-energy development.

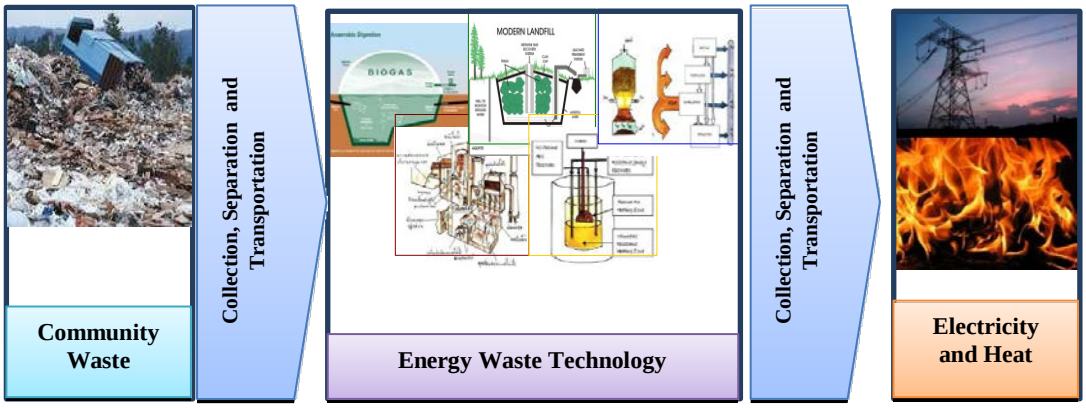

Fig A 4 Waste to energy supply chain
Source: DEDE, 2008 (DEDE, 2008)

2. Technology characteristics

Currently, there have several principle waste energy technologies which have different advantages and limitations as shown in Table A4.

Table A 4 Waste energy technology characteristics

Technology	Advantages	limitations
1. Incineration	• Highly flexible waste type; various waste can be burnt at the same time • Reduce a lot of mass and volume • Short treatment time • High energy yield • Require small space for the system.	• High investment, operation, and maintenance cost. • The facility should have the capacity greater than 250 tons per day to be cost effective. • Advanced and emerging technology; cannot be developed in Thailand yet. .
2. Anaerobic Digestion, AD	• Clean technology • Large amount of biodegradable waste in Thailand • Simple technology; can be developed easily in Thailand.	• Have to campaign the organic waste separation from the beginning. • Require the development of microbial species enable to digest waste at various environmental conditions and produce high gas yield. • Require soil conditioner marketing to increase the revenues of the system.
3. Landfill Gas to Energy	• Decrease the release of methane (GHG) to the atmosphere • Decrease risk of explosion or fire hazard from landfill • Simple technology; can be developed easily in the country	• The volume of waste in landfill must be greater than 1 million ton for cost effectiveness • Hard to predict the gas generation rate due to complex phenomena governed by various factors.
4. Refuse Derived Fuel	• Clean technology • Capable of using with pyrolysis / gasification • The RDF can be stored and used when needed • Require small space for the system • Simple technology; can be developed easily in the country.	• Unable to complete the waste destruction; need a further waste treatment to complete the treatment/destruction process. • No market for the RDF in Thailand just yet.

Technology	Advantages	limitations
5. Gasification	• Clean technology • Reduce a lot of mass and volume • Short treatment time • High energy yield • Require small space for the system	• Must be used with a basis waste destruction process such as RDF. • Require high investment, operation and maintenance cost. • Advanced technology; cannot be developed in the country
6. Plasma Arc	• High heating temperature increases waste destruction efficiency. • Residual of the high temperature process is slag, which stabilizes hazardous substances generally found in the residual of low temperature such as ash.	• High investment, operation, and maintenance cost. •
7. Plastic waste into fuel processing technology.	• Liquid fuel can be transported easily and economically. • The fuel can be stored to use when needed. • Require small space for the system • Simple technology; can be handled by the country	• Require the effective plastic waste separation process. • Require cleaning process for the plastic waste.

3. Country specific / applicability

Thailand has implemented many technologies mentioned above. Some examples are as follows:

(1) Phuket municipal waste burner: started in January 2003, the system uses of burner technology from Japan. The system can receive 250 tons of waste per day, and the waste heat is brought to produce steam to generate electricity capacity of 2.5MW.

(2) Rayong municipal organic fertilizer and energy factory: started in December 2004, the system uses of anaerobic digestion technology from Finland. The system can receive the organic waste about 60 tons per day which generates the energy at the capacity of 625 kW .

(3) Samutprakan, waste landfill power generation project : the system uses piping technology to collect biogas from the landfill by domestic expert. The electricity is generated by a gas engine at the capacity of 950kW.

(4) Nakhonpathom, waste landfill power generation project: started in May 2008, the same technology as at Samutprakan. The electricity is generated by a gas engine at the capacity of 1 MW.

4. Status of technology in country

The status of Thailand waste-to-energy source is as follows:

(1) The composition and quantity of waste.

Waste composition changes according to the season and climate conditions, socio-economic behavior, lifestyle, habit and consumption behavior. The average waste composition in 30 municipalities, are summarized in Table A 5.

Table A 5 Average waste composition in municipalities with more than 100 tons/day and 50-100 tons/day

Component	Quantity > 100 tons/day	Quantity 50-100 tons/day
Food / vegetables / fruits	53.49 %	57.18 %
Plastic	20.12 %	19.40 %
Paper	8.95 %	8.38 %
Grass	5.02 %	3.47 %
Metal	1.80 %	1.52 %
Other	10.62 %	10.05 %

Source: Department of Alternative Energy Development and Efficiency, 2012(Department of Alternative Energy Development and Efficiency, 2012)

Table A6 summarizes the amount of waste generated and treated in Bangkok, the municipality and Pataya, and outside the municipality. The details can be described as follows:

Table A 6 The amount of waste handled correctly by the principles in 2007

Area	Amount (Tons/Days)	
	Occurred	Eliminated
Bangkok	8,532	8,532
Municipality and Pataya (6,500 location)	13,600	4,810
Outside the municipality (6,500 location)	18,200	1,090
Total	**40,332**	**14,432**

(i) Bangkok. The amount of waste generated is 8,532 tons/day, 21 % of the total waste of the country. All the waste is treated or disposed. 87% is disposed in landfills while 13% is used as fertilizer. Bangkok has 3 waste transfer stations. The On-Nut waste transfer station can receive 3, 335 tons / day (31%) and is disposed in a landfill at the Phanom Sarakham, Chachoengsao around 2, 221 tons / day (25%) while 13% (1, 102tons / day) of the waste was composted and used as fertilizer. The Nongkhaem waste station can receive 3, 113tons / day (32 %)while the Tharang waste Station can received 2, 083tons / day (24%). All of the waste from these two stations is disposed in the landfill at Kamphaeng Saen, Nakhon Pathom.

(ii) The Pataya municipality: the total waste is 13, 500tons / day , 34% of the country. Only, 35% (4810tons / day) is disposed per day.

(iii) Outside the municipal waste: the total waste is 18,200 tons / day , 45 % of the country. Only, 6% (1, 010tons / day) is disposed per day.

The details of waste quantity in 2005 to 2007 are shown in Table A7 and Fig A5.

Table A 7 The amount community waste in 2005-2007

Area	Amount of Community Waste(Tons/Day)		
	2005	2006	2007
1. Bangkok	8,291	8,379	
2. Municipality and Pataya	12,635	12,912	13,600
2.1 Central and East	5,499	5,619	
2.2 North	2,148	2,195	
2.3 Northeast.	2,906	2,971	
2.4 South	2,082	2,128	
3. Outside the municipal	18,295	18,295	18,200
Total	**39,221**	**39,988**	**40,322**

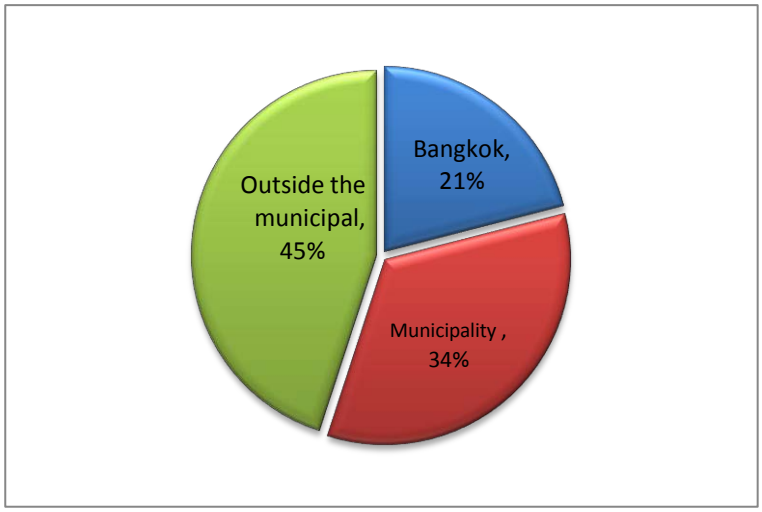

Fig A 5 The amount of waste classified by area condition in 2007 (40,322 tons/day)

The linear regression analysis of the waste data (Table A7) reveals that in 2022, Thailand will reach 45,855 tonnes of waste per day (Fig A6). By using the assumption that 100 tons of waste can generate electricity 1 MW and that 70% of waste is capable of energy production, the energy generation potential from waste is 320 MW.

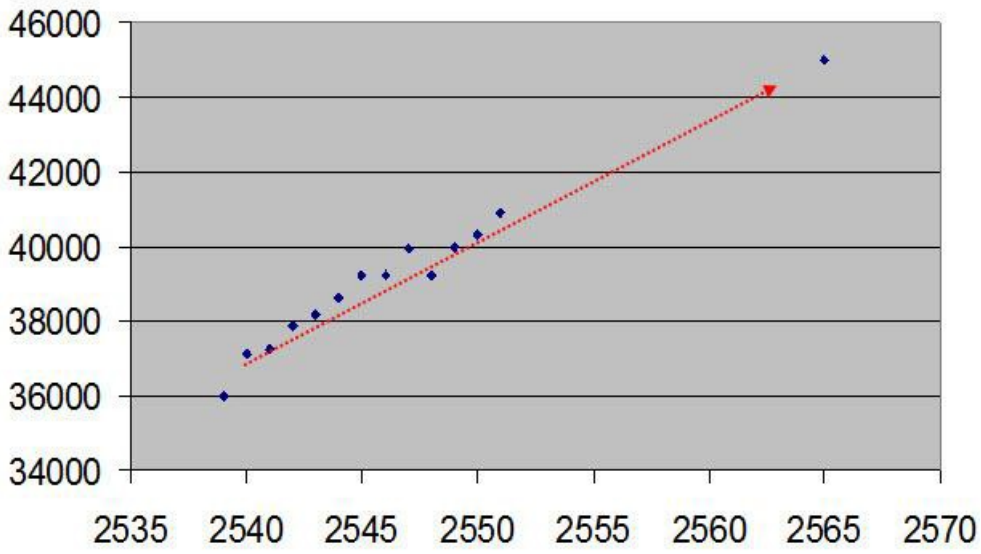

Fig A 6 Estimate the amount of waste in 2022

Thailand has the target to promote waste-to-energy generation only 50% (160 MW, or 72 ktoe (Plant Factor = 60%) of the full potential by considering the possibility of management and waste collection.

(2) Hydrothermal treatment of waste

Hydrothermal treatment technology is a new technology developed by the Tokyo Institute of Technology. The advantage of this technology is that the toxic from typical thermal treatment techniques such as dioxin can be transferred into liquid and subsequently treated. Moreover, the technology is applicable for all types of waste without waste separation (excluding hazardous waste and flammable waste). It is suitable for a country with limited appropriate waste separation like Thailand.

Fig A7 illustrates the hydrothermal. Waste is fed into the reactor and undergoes the hydrothermal reaction with saturated steam supplied from the oil-fired boiler as the heating source. At the same time, the waste is stirred by a rotor unit to obtain homogeneous mixture. After reaching intended temperature, the reactor is set to maintain the temperature for a certain holding period. The hydrothermal treatment finishes by releasing the pressurized steam to the condenser until the reactor reaches atmospheric pressure. The products can then be pushed outside by rotating the stirrer acting as a screw conveyor. The water condensed in the condenser is sent to the water treatment facility to be fed back to the boiler as feed water for steam generation, constituting a closed-loop of water flow.

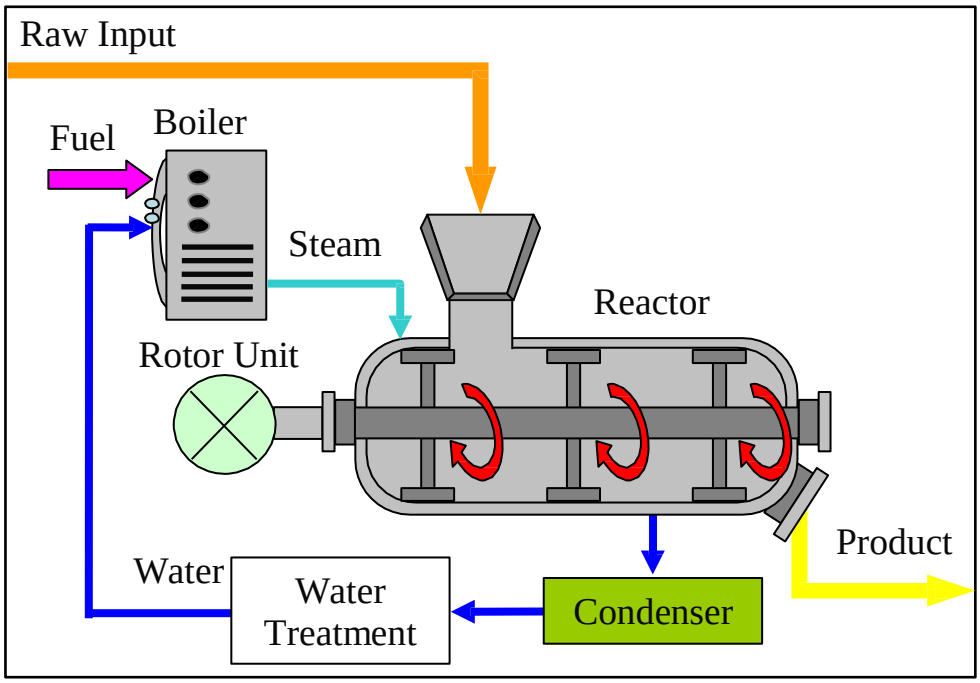

Fig A 7 Developed commercial hydrothermal treatment system diagram

The waste residual through the hydrothermal process will have high moisture content (~, 40-70% moisture); then, the residuals dried by natural means. The final product (dry, 10% moisture) can used as fuel to produce energy in system as shown in Fig A8.

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[i] **This fact sheet has been extracted from TNA Report – TECHNOLOGY NEEDS ASSESSMENTS REPORT FOR CLIMATE CHANGE MITIGATION – Thailand. You can access the complete report from the TNA project website http://tech-action.org/**