



Plastic Fuel: The Case Study Of Thailand

(EE489 Seminar In Industrial Economics)

Supervisor

AJARN SUPRUET THAVORNYUTIKARN

**BACHELOR OF ECONOMICS
FACULTY OF ECONOMICS, THAMMASAT UNIVERSITY
BANGKOK, THAILAND
SEMESTER1/2014**

Abstract

Environmental issue is a last long problem experienced by many countries. Despite the rising trend of green energy, the problems of environment have not been solved. One of the issues that Thailand has faced is Garbage pollution. Pyrolysis is an alternative method that could solve the garbage pollution and will be focused throughout this paper. The paper aims to investigate the factors that this business is not widely interested among Thai industry by using cost and benefit comparison and qualitative approach. The paper found out that, to run this business successfully, it required the favorable policies that encourage the cooperation of this business with private and public sectors. In addition, the conversion of plastic waste to liquid fuel could reduce the amount of garbage significantly by maximizing the usage of resources and also generate new sources of energy.

1. Introduction

Recently, energy have become a necessity to the human living, especially, Oil, Gas or Fuel that is a source of energy that is used in almost every business. Fuel consumption is a major issue that many countries are facing and also a factor that drives the increase in price of gas. Therefore, people are more concern on fuel efficiency as the demand of fuel is keep rising while the oil reserves are running out. In Thailand, we need to import crude oil and other petroleum product from abroad. Also we need to take the market prices that fluctuate according to the world economy. Therefore, Renewable energy would be a choice that many institute start to pay attention on.

Why Renewable Energy? Renewable Energy in Thailand has been developed more and more. Renewable Energy or Alternative Energy could come from many sources: Sunlight, Wind, Water, Biomass and Garbage, etc. There is an alternative energy technology that could transfer waste to bio-treasure like renewable energy such as; fuel, biogas, electricity, etc. At the same time, the number of garbage keeps increasing while we also keep consuming and wasting. Overflowing garbage problem is a big issue for every country especially the plastic waste that causes many problems to ecosystem.

Even though the garbage in Thailand is rising up to 26.77 million tons this year, the conversion of waste to fuel is still less concern among Thais. There are many alternative use of plastic such as recycle. This research will compare the cost of production between the converting waste to fuel and the alternative use of Garbage. Importantly, the paper aims to search for “the reasons why converting trash to fuel still have not commercialized used in Thailand”.

In addition, this paper would benefit for the business starter who interested in conversion of waste to fuel and contribute the green business that could increase overall welfare of environment. This research also aims to promote the sustainability of garbage management in Thailand.

2. Literature Review

According to the Alternative Energy Development Plan: AEDP (2012-2021), Thailand has plenty natural resource or natural energy such as; solar energy and wind energy, etc. Therefore, it would be a great opportunity for Thailand to develop the new source of energy in order to meet the demand. Ministry of Energy in Thailand has expected that the Energy demand of Thai people will increase from 71,728 ktoe (ktoe=Kilotonne of Oil Equivalent) in 2012 to 99,838 ktoe in 2021. Therefore, the renewable and alternative energy plan has specified to increase the consumption of alternative energy from 7,413 ktoe in 2012 to 25,000 ktoe in 2021 or 25% of the whole energy consumption within 10 years.

The objective of this plan, firstly, tends to improve and use renewable energy as one of the main energy supply in order to compensate the fossil fuel and the imported energy. The second objective is to ensure the country's energy supply. Thirdly, the plan tends to promote the alternative energy usage in the rural area. Fourthly, the objective also wants to support the industrial of producing the renewable energy technology in Thailand. And lastly, the plan wants to reinforce the research about alternative energy in order to compete in the global market. According to AEDP, the plan tends to support the energy from waste start within the community such as; School, temple and rural community, etc. The plan is still developing and also encouraging the private sector to join the investment.

2.1 The Importance of Renewable Energy in Thailand

The higher modernization, the larger undesirable output we produce. The source of energy and material that we consume will later become waste and categories into three different forms, which are solid waste, air pollution, and wastewater. Those excess output would be one of the factors that cause the pollution to the environment. According to Ministry of Energy, Thailand still needs to rely on imported energy especially petroleum. We have to import crude oil, petroleum products and natural gas around 56% of all domestic demand. Renewable energy or alternative energy is a solution that has played a key role in Thai's society especially in the rural areas. The alternative energy consumption is increasing from 5,551 ktoe to 7,292 ktoe in 2012, which mainly use for Heat; solar, Biomass, and Biogas, follows by Biofuel; Ethanol and biodiesel, [Figure 1 and 2] (Thailand Energy Statistics, 2012).

Biofuel could be produced by biomass, most referring to plant, and waste which mostly from agriculture. In the present research, solid waste like plastic could converse into petrol (Raja and Murali, 2011). With Pyrolysis-Catalytic Cracking technique [Figure.3], plastic waste can be decomposed into three fractions: gas, liquid and solid. The liquid part could turn to fuel oil 50-65%. This process require sorting system as the pyrolysis equipment's corrosion is not fit with every type of plastic, such as; Polyvinyl chloride or PVC that contain chloride which could cause a negative effect to the machine or car when the fuel used. The following research will explain more about the importance of renewable energy and conversion of WTE.

2.2 What is Pyrolysis?

Plastic are manufactured from by-product of petroleum, which are Liquid Petroleum Gases or LPG and Natural Gas Liquids or NGL. Some plastic product could be reused such as; plastic bottle, plastic cups, etc. while some plastic product such as; plastic bag especially

the plastic bag that contain food. In Thailand, the most common way to manage municipal waste is to do the landfills, which then vastly affects the environment. According to the research paper of Suadsom and Permsin (2006), there are five ways to use the plastic waste efficiently. 1.) Reuse the plastic waste, for example, use the water bottle to contain the dish washing liquid 2.) Recycle or turn the plastic waste into other form of useful product 3.) Use as fuel 4.) Use as a component and mix with other material 5.) Liquefaction or Pyrolysis which is the technology that transfers the plastic into liquid and gas. Pyrolysis is the technology that chemically decomposes organic materials by heat in the absence of oxygen. The technology will cut the molecule of polymer into a chain of oil and gas and transform the plastic bag into its original form. Type of plastic that is commonly used to convert into fuel are the plastic that Polypropylene (PP), High Density polyethylene (HDPE) and Low Density polyethylene (LDPE).

2.3 Waste-to-Energy Success Factors in Sweden and the United States

According to Williams (2011), there are nine factors that drive the success of WTE in Sweden and the US. First, high gate fees or tipping fees as the landfills in Sweden is very expensive. Second, favorable policies on WTE, such as; carbon tax, which encourages the emitter to reduce emission; high landfill taxes in order to support recycling and WTE; Recognition of WTE as a renewable resource; Preference to WTE in the solid waste management hierarchy [Figure.4]; Renewable Portfolio Standards; and Direct Subsidies. These policy aims to support the WTE in order to help Sweden move away from dependency on fossil fuels. Third, the Extensive district heating network which is more efficient and better in pollution control. Fourth, the absence of cheap domestic sources of energy like fossil energy resources, as Sweden has to import the energy to meet the local demand, therefore, WTE could benefit to consumer needs. Fifth, the high price of electricity, WTE power producer could get higher price for the energy they produce when the electricity prices are higher.

Supply of waste is also an important factor as it is used as feedstock to create the energy. Since 1960s, in Sweden, the solid waste has tripled according to an increase in cost prohibitive of landfill that mean more waste is now being funneled to the WTE process. In US, since 2009, the solid waste is being produced over 243 million tons or 220 billion kilograms per year or 4.3 pounds per person per day. Seventh, the commitment to the environmental and knowledge of environmental issues is concerned in Sweden according to a 2008 poll that 87 percent of Swedes who said they had taken action to decrease their CO₂ emissions which is the highest percentage among European countries. While, in US, the commitment to the environment issue is not that prevalent and less public support as compare to Sweden. Next, the recycling seems to be a direct competition to WTE but throughout Europe and the United States, the communities between WTE usages and recycling is in a positive correlation. Lastly, the limited land resources, WTE is mostly success in the densely populated areas as the real estate prices at those area is high and also the transaction cost of shipping waste to less densely-populated areas is costly, therefore, WTE is a good solution to manage those wastes.

2.4 Why Waste-to-Energy?

Recently, garbage pollution gets much attention from people nowadays especially solid garbage or plastic waste, as it will take almost 500 years to break down. Waste to energy could be a tool to improve environment, quality of life, and also Economy. In 2013, the volume of waste in Thailand increases up to 26.77 million tons, which equal to the building with hundred floors line up more than hundred buildings, and tend to increase more in the future (Pollution Control Department, 2013), [Figure 5]. In a research article by Berenyi, PhD (2013), in 2010, 85 WTE plants that are spread over 22 states in the US could generate approximately 14.2 million megawatt hours of electricity. From waste, it could generate power nearly 1.3 million homes. The Economic impacts of Waste-to-Energy serves

three main functions: 1) it is a major method of disposal of residential and commercial post-recycled waste; 2) it serves as a large recycler of municipal post-consumer metals; and 3) it serves as power generator, providing base load electric power to millions of U.S. residents and businesses.

Many countries around the world concern Waste-to-Energy conversion. And since green energy has now becoming a global trend, therefore WTE could be one aspect of producing energy at the same time reducing waste. Solid waste or plastic waste has been a concern as the indirectly cause of global warming. Even though, nowadays, we might be able to recycle those plastic, the conversion of solid waste to fuel might be another choice to reduce the plastic waste and also produce the demanded energy like fuel. WTE is very successful in many developed countries such as; Sweden and The United States, but in the case of Thailand, WTE is still in the process of developing and expect to increase in the future.

3. Methodology

The research mainly aims to investigate on “What are the factors that impact the investors decision on investing in this business?” The paper will initiate with finding the relevant paper in order to see the overall picture of renewable energy in Thailand and the case study of the existing company both local and abroad. The research is based on the interview of Professor Santivipa Phanichkul, environmentalist and executive of Single Point Energy and Environment, the polymer energy company. According to the interview, Professor Santivapa mentioned that the company is allowed to do the landfills mining and is supported by the local government. In order to get clearer picture of waste to fuel conversion in Thailand, the paper will estimate the cost of production of with subsidy and without subsidy and compare the data of two cases. Moreover, alternative use is considered as a factor that drives out the investor’s interest of waste to fuel conversion business and the product that

seem to be most concern for recycle business is plastic pallet. Therefore, the paper also compares the revenue and expenditure of polymer energy and plastic pallet, as well as the investing cost.

3.1 Interview Single Point Energy and Environment (SPEE)

The paper ask company's point of view on the overall market of conversion from waste to fuel business and problem of doing this business in Thailand. The paper discuss with the interviewee about the reasons why Pyrolysis technology and Waste-to-Fuel in Thailand is not popular among Thai businessman compare to other alternative use of plastic waste, like recycle into plastic pallet, and analysis the factors that could affect this business.

According to the interview, Professor. Santivipa Phanichkul, an environmentalist and executive of Single Point Energy and Environment (SPEE), emphasized that garbage pollution is a big issue that many people overlook especially the plastic waste that take almost 500 years to decompose and could affect both environment and ecosystem. She said that plastic is the best packaging but we need to use it fully efficiently. This is why the scientist comes up with the technology that could transfer the plastic to the useful product like energy.

For the experimental project, the SPEE Company coordinates with Ministry of Energy and receives supported input (garbage) from Rayong municipality. The Experiment factory is also located in Rayong municipality and the pyrolysis machine is imported from Poland. Professor Santivipa said that there are several type of the pyrolysis machine existing in the market, the high quality one is mostly produced in the western country like US, Poland, Sweden, and its cost around 50-70 millions baht. While the lower grade machine cost around 10-20 million baht and mostly produced in China and also in Thailand, but the output is still unaccepted from the oil refinery. She added up that Thailand need to do more research and development in order to improve our own machine that could reduce cost of production and

attract more investor to invest in this business which also lead to better environment. The inputs that come from the landfill mining need to sort out the type of waste which can separate into; Natural fermented soil, which can be sold as the conditioner soil; Resource Description Framework or RDF, which can be sold to the electricity plant in order to use as renewable resource to produce electricity; and PP, PE that the company use as inputs. 400 tons of garbage would consist of PP and PE plastic approximately 7.5%. The machine can be fed up to 10 tons of plastic waste, which could produce up to 28 barrels of liquid fuel a day and the excess of input can be sold to other pyrolysis company as well. This mean that the company consists of four businesses includes the Polymer energy, PP, PE, Conditioner soil and RDF.

Professor Santivipa said that the important factors that this business is not widely expanded in Thailand are 1.) Require Knowledge, as this technology is quite new for Thailand so it requires lots of research and development 2.) Contamination of waste that could affect quality of output, as campaign on waste segregation in Thailand has not been well managed and discontinuous so the input is mixed up with many type of garbage. The higher contamination lead to the lower in quality of fuel 3.) Cost of production, as this technology is still new for Thai people, so the company needs to import the machine from abroad and the price is pretty high. And as the garbage is all from landfill mining so investing in the sorting and cleaning machine is needed. It will clean and separate the PE, PP apart from other type of waste before put it into the polymer energy machine. Also the labor cost, management cost and Research and Development cost that we need for controlling the quality of input and maintaining the quality of fuel 4.) Subsidization, we need to do the landfill mining in order to search for the input because it will not be worth in case of purchasing garbage. And doing the landfill mining needs permission so we have to negotiate with the government agency or requires the government subsidy. She also intend to push this

project forward in order to make the government adopt the policy of turning plastic waste into energy and support this business.

3.2 Profit Comparison between with subsidy and without subsidy

In order to get clearer picture of why this business is still not commercialized in Thailand. The table 3.2.1 show the comparison of the revenue and expenditure of doing this business by separate into two cases; with subsidy and without subsidy. Assume that the quality of garbage that come from landfill mining (subsidy case) and the garbage that we purchase (without subsidy case) are the same, so it will come to the same amount of fuel and revenue respectively. According to the interview, with subsidy case, the garbage cost will equal to zero as the company can do the landfill mining by the permission of local government or municipality and it costs approximately 7,500 baht per month for the landfill mining.

For the case without subsidy, the price of garbage is estimated according to the market price which is cost approximately 5,000 (baht per ton) x 150 (tons per month) = 750,000 (baht per month) and the landfill mining is now equal to zero. By assuming that other extra cost are the same, the cost of without subsidy case tend to be higher (21,840,000 > 12,930,000). With the same revenue, the profit margin of the first case (with subsidy) is positive while the second case (without subsidy) is negative. Therefore, without any subsidy, this business is possibly to loss.

Table 3.2.1

Profit Comparisons	With Subsidy	Without Subsidy
Revenue (Approximately)		
Crude Oil Price (Baht per liter)	20	20
Amount of oil produce (Liter per month)	87,450	87,450
Total Income (Baht per month)	1,749,000	1,749,000
Total Income (Baht per year)	20,988,000	20,988,000
Variable Cost (Approximately)		
Garbage Cost (Baht per month)	0	750000
Landfill mining (Baht per month)	7500	0
Backhoe car (Baht per month)	240000	240000
Labor Cost (Baht per month)	300000	300000
Research and Development (Baht per month)	80000	80000
Electricity and Water Supply (Baht per month)	450000	450000
Total Variable Cost (Baht per month)	1077500	1820000
Total Variable Cost (Baht per year)	12,930,000	21,840,000
Profit Margin	8,058,000	-852,000

3.3 Alternative use of Garbage

There are also the alternative uses of plastic and the most common use in Thailand is the recycle of plastic waste into plastic pallet. The alternative use of plastic waste is also considered as a factor that could affect the decision making of investor. The paper will also compare the profit opportunity or benefit of investing in conversion from plastic waste to fuel with the alternative use plastic waste, which in this case is plastic pallet business. The table 3.3.1 illustrates the comparison of the investing cost of both businesses. Actually the Pyrolysis technology require more supervision and cleaner garbage which lead to higher cost on investing in cleaning and sorting machine. But to make it simple, except for the Pyrolysis machine and Plastic Extruder machine, this research assumes that other cost are the same. Therefore, it is clear that the Pyrolysis technology is a lot more expensive than the plastic recycling machine.

Table 3.3.1

Pyrolysis Oil (Approximately)		Plastic Pallet (Approximately)	
Fixed Cost (Approximately: Baht)		Fixed Cost (Approximately: Baht)	
Pyrolysis machine	60,000,000	Plastic Extruder machine	2,000,000
Cleaning and drying machine	500,000	Cleaning and drying machine	500,000
Shaft shredder machine	400,000	Shaft shredder machine	400,000
Conveyor Belt	100,000	Conveyor Belt	100,000
Land 4 rais	8,000,000	Land 4 rais	8,000,000
Manufacturing Electricity	1,500,000	Manufacturing Electricity	1,500,000
Total Fixed cost	70,500,000	Total Fixed cost	12,500,000

For the table 3.3.2, it compares the profit margin of the Pyrolysis oil (without subsidy) and Plastic Pallet. With the same amount used of garbage, the pyrolysis oil could be produced approximately 87,450 liters per month while the plastic pallet could be produced by 112,500 kg per month. And with higher price and quantity, the plastic pallet gain higher total income which is approximately 60,750,000 baht per year while the pyrolysis oil can generate approximately 20,988,000 baht per year as a total income. By assuming that both businesses have the same amount of variable cost, the profit margin of plastic pallet is a lot higher and more attractive than the pyrolysis oil. This could be a reason why the plastic pallet gains higher interest among Thai investor comparing to other recycle product.

Table 3.3.2

Profit Comparisons between Pyrolysis Oil and Plastic Pallet (Alternative use of Plastic Waste)			
Pyrolysis Oil (Approximately)		Plastic Pallet (Approximately)	
Revenue (Approximately)		Revenue (Approximately)	
Crude Oil Price (Baht per liter)	20	Plastic Pallet Price (Baht per kg.)	45
Amount of oil (Liter per month)	87,450	Amount of plastic pallet (Kg. per month)	112,500
Total Income (Baht per month)	1,749,000	Total Income (Baht per month)	5,062,500
Total Income (per year)	20,988,000	Total Income (per year)	60,750,000
Variable Cost (Approximately)		Variable Cost (Approximately)	
Garbage Cost (Baht per month)	750000	Garbage Cost (Baht per month)	750000
Dig Cost (Baht per month)	0	Dig Cost (Baht per month)	0
Backhoe car (Baht per month)	240000	Backhoe car (Baht per month)	240000
Labor Cost (Baht per month)	300000	Labor Cost (Baht per month)	300000
Research and Development (Baht per month)	80000	Research and Development (Baht per month)	80000
Electricity and Water Supply (Baht per month)	450000	Electricity and Water Supply (Baht per month)	450000
Total Variable Cost (Baht per month)	1820000	Total Variable Cost (Baht per month)	1820000
Total Variable Cost (Baht per year)	21,840,000	Total Variable Cost (Baht per year)	21,840,000
Profit Margin (Approximately: Baht per year)	-852,000	Profit Margin (Approximately: Baht per year)	38,910,000

4. Data Analysis

According to previous studies and the interview, there are three main factors that drive out the interest of this business. First of all, the complication of production process and lots of knowledge is required. This technology requires both mechanical and chemical skill. Pyrolysis is a chemical decomposition by heat in the absence of oxygen or in the close system which is possibly to cause the explosion in case of garbage is contaminated. So, this required mechanic to control the machine, as well as the chemist to control the quality of fuel. Secondly, the Contamination of garbage is another factors that devalue the quality of oil which cause the decline in purchasing price. Thirdly, the cost of production. Pyrolysis technology might be use widely in the country on western side, but in Thailand, Pyrolysis is still new and we need to imported from abroad which the price is pretty high. There are some Thai company start to produce or import the cheap machine from China and sell but the

problem is the quality of output that come from those machine is not good enough to send to the oil refinery.

5. Conclusions

5.1 Policy Implication and Suggestion

Pyrolysis technology is a good technology for recycling the plastic waste but with the factors above, it could not stand alone. The paper would suggest that to invest in this business successfully in Thailand, firstly, the government support. Without permission for landfill mining, this business don't have enough storage of input to feed the machine. Therefore, the company should coordinate with the government sector. Also, the tax incentive policy that could encourage more investor to enter this market. Secondly, this business should coordinate with related business. According to the interview, the interviewee's company has not only invested on Polymer Energy but also on other business which are the PP, PE plastic seller, sell RDF to the electricity plant and Conditioner soil. Therefore, the revenue of investing in this business could also come from the related business as well.

Quality of input is also important as the quality of oil would highly depend on the quality of input. Even though there are many campaigns on waste segregation but it still doesn't work well. The awareness on green energy in Thailand is starting to increase but in practical Thai people still lack of awareness on managing those waste and knowledge on separating the garbage. Therefore, thirdly, educating the waster simultaneously with campaigning on segregation would be recommended.

5.2 Contribution

The degradation of the plastic waste to fuel is considered as a recycle business that could contribute the overall welfare of the society and environment. Due to the limitation of land, the landfill mining could maximize the usage of land. Also, this business could enhance

the efficiency of resource allocation by reducing waste while increasing energy resources. This could be one way of managing the garbage, which lead to the sustainable development of environmental issue.

5.3 Further Study

Due to the limitation of this research as most of firm's information are confidential. Therefore, this paper would suggest that, if possible, the further research should include some more detail on the process of converting of garbage and recycle into plastic pallet in order to make the paper more complete in the sense that the cost and benefit comparison would be more practical. Moreover, the paper might also add more on the case study of alternative use of plastic waste to enhance reliability of the study.

References

- Alternative Energy Development Plan: AEDP (2012). 2012-2021. Bangkok.
- Alternative Energy and Efficiency Information Center Department of Alternative Energy Development and Efficiency, Ministry of Energy. (2012). 2010-2012 statistics report. Bangkok.
- Berenyi, E. B. (2013). Nationwide Economic Benefits of Waste-To-Energy Sector. *Governmental Advisory Associates, Inc.*
- Boonjit, A. (2007). *Thailand: in search of alternative energy*. Bangkok: Faculty of Political Science, Thammasat University.
- Chaiprasert, P. (2011). Biogas Production from Agricultural Wastes in Thailand. *Journal of Sustainable Energy & Environment Special*,63-65.
- Chiemhaisri, C., Juanga, J.P. and Vivanahan, C. (2006). Municipal solid waste management in Thailand and disposal emission inventory. *Environ Monit Assess*: DOI 10.1007/s10661-007-9707-1.
- Kumar, S., Abdul Salam, P., Shrestha, P. and Ackom, E. K. (2013), An Assessment of Thailand's Biofuel Development. *Sustainability*,5, 1577-1597; doi:10.3390/su5041577.
- Murali, A. and Raja, A. (2011). Conversion of Plastic Wastes into Fuels. *Journal of Materials Science and Engineering B* 1, 86-89. Formerly part of Journal of Materials Science and Engineering, ISSN 1934-8959.
- Phanichkul, S. The Factors That Impact the Investors Decision on Investing in Conversion of Waste to Fuel Business. *Personal interview*. 10 Nov. 2014.
- Pollution Control Department. (2013). 2008-2013, Bangkok.
- Sangiampaisalsuk, N. (2000). Solid waste generation rates and zoning. In *Analysis of Solid Waste Generation Characteristics in Bangkok*. Sirindhorn International Institute of Technology, Thammasat University.
- Suadsom, W., & Permsin, N. (2006). Pyrolysis and Gasification. In *Degradation Of The Plastic Waste To Liquid Fuel By Thermal Pyrolysis*. Faculty of Engineering, Thammasat University.

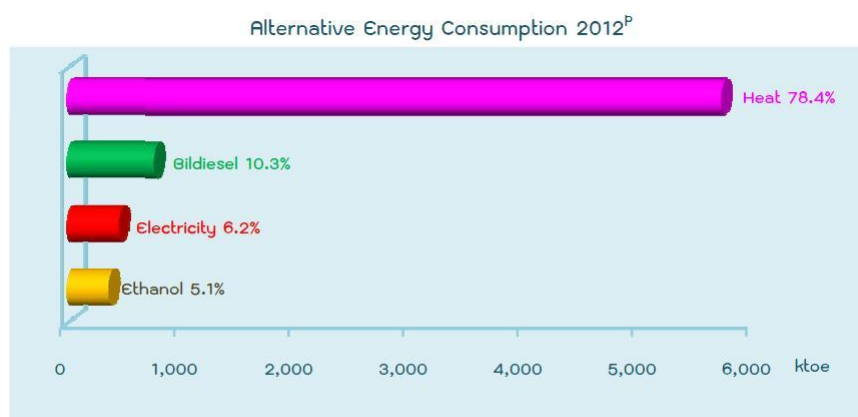
- Williams, M. (2011). Waste-to-Energy success factors in Sweden and the United States. *Analyzing the Transferability of the Swedish waste-to-energy model to the United States.*

Appendix

Alternative Energy Consumption 2012^P

ALTERNATIVE ENERGY CONSUMPTION	QUANTITY (ktoe)			GROWTH (%)
	2010	2011	2012 ^P	2012 ^P
1. Electricity ^{1/} (Solar, Wind, Hydro, Biomass, MSW and Biogas)	304	372	455	22.3
2. Heat ^{2/} (Solar, Biomass, Garbage and Biogas)	4,443	5,129	5,718	11.5
3. Biofuel	804	878	1,119	27.4
- Ethanol	329	331	364	10.0
- Biodiesel	475	547	755	38.0
Total	5,551	6,379	7,292	14.3

Figure 1: Alternative Energy Consumption during 2010-2012



1/ Excluding private generation for own use (off grid).

2/ Including fuel consumption of private generation for own use (off grid).

p : preliminary data

Figure 2: Graph show the Alternative Energy Consumption during 2010-2012

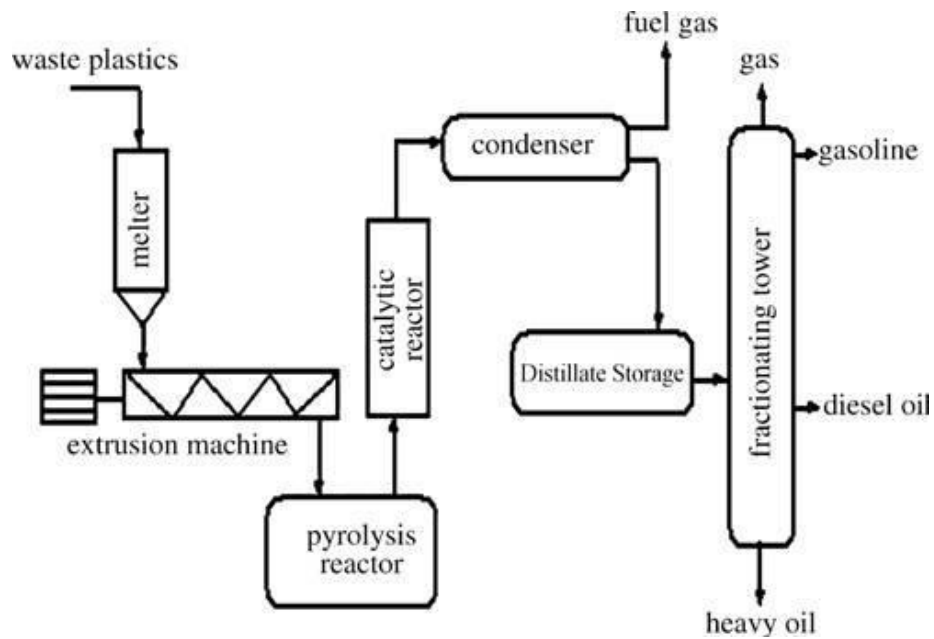


Figure 3: Pyrolysis catalytic cracking technique of plastic wastes.

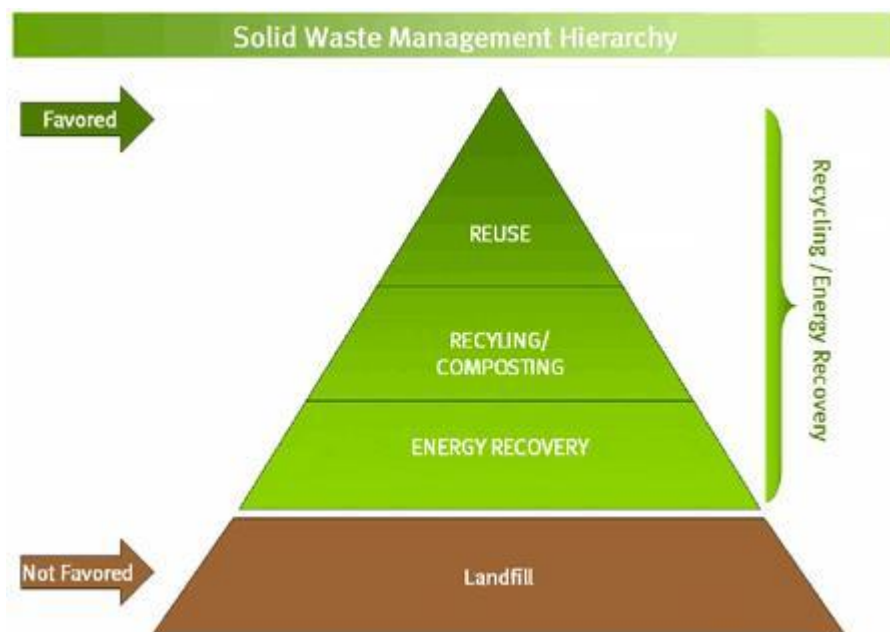


Figure 4: The EPA Solid Waste Management Hierarchy

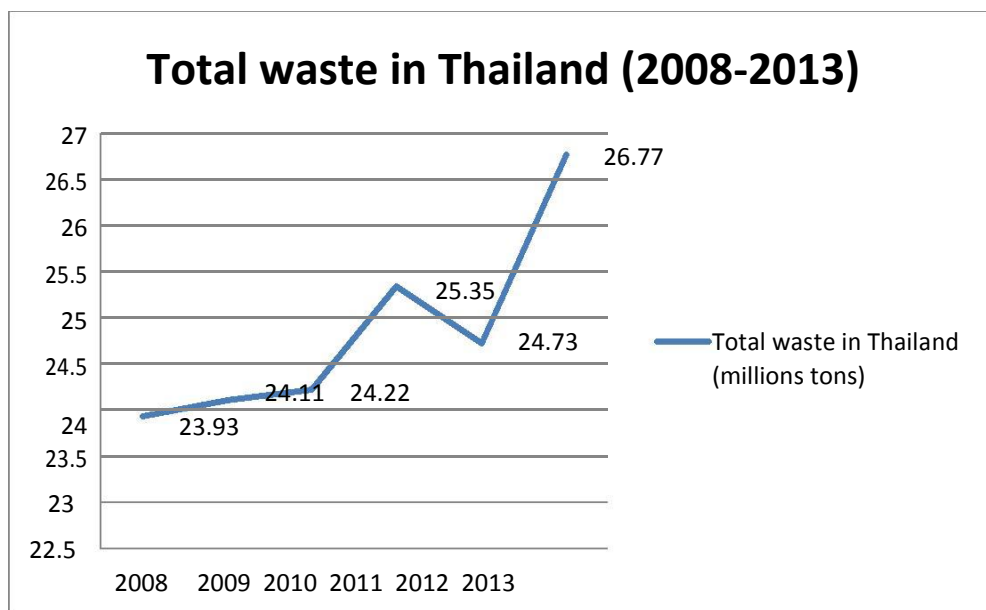


Figure 5: Total waste in Thailand during 2008-2013