กระทรวงพลังงาน
MINISTRY OF ENERGY

Alternative Energy Development Plan: AEDP2015

Department of Renewable Energy Development and Energy Efficiency
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1. Introduction

Ministry of Energy has developed the Thailand Integrated Energy Blueprint (TIEB) with focus on (1) Energy security, to supply energy in response to the energy demand which consistent with the rate of economic growth, the rate of population growth and the growth of urban areas, and diversified energy to the appropriate resources. (2) Economy, Taking into account the energy costs are reasonable and not an obstacle to economic and social development of the country in the long term. Reforms in fuel prices structure in line with costs and the tax burden reasonable to level up national energy utilization performance with the promotion of energy efficiency. (3) Ecology, increased domestic renewable energy production and production energy with high performance technologies to reduce the impact on environment and community.

In the TIEB, Ministry of Energy has reviewed five energy master plans during the year 2015-2036 in consistent with the national economic and social development plan. The five master plans are: The Power Development Plan, The Energy Efficiency Development Plan, The Alternative Energy development Plan, The Oil Development Plan and The Gas Development Plan. The Alternative Energy Development Plan: AEDP2015 was developed and focused on promoting energy production within the full potential of domestic renewable energy resources. Develop appropriate renewable energy production with considered to the appropriate and benefit in social and environmental dimensions of the community.

The AEDP's public hearing was held in August – September 2014 in the seminar of "Thailand Energy direction" to receive comment of stake Holder from the whole country and the focus group seminar was also held in August 2015 to collect comments from renewable energy experts.

2. Renewable Energy Development Status

The development of renewable energy in Thailand increased steadily. It was a result of the government promotion policy. Productions of renewable energy are in the form of electricity, heat and biofuels. In the year 2014, the total renewable energy consumption was at 9,025 thousand tons of oil equivalent (ktoe), up 9.6 percent from the previous year. It shares at 11.9 percent of final energy consumption.

Table 2.1 Status of renewable energy development in 2012-2014

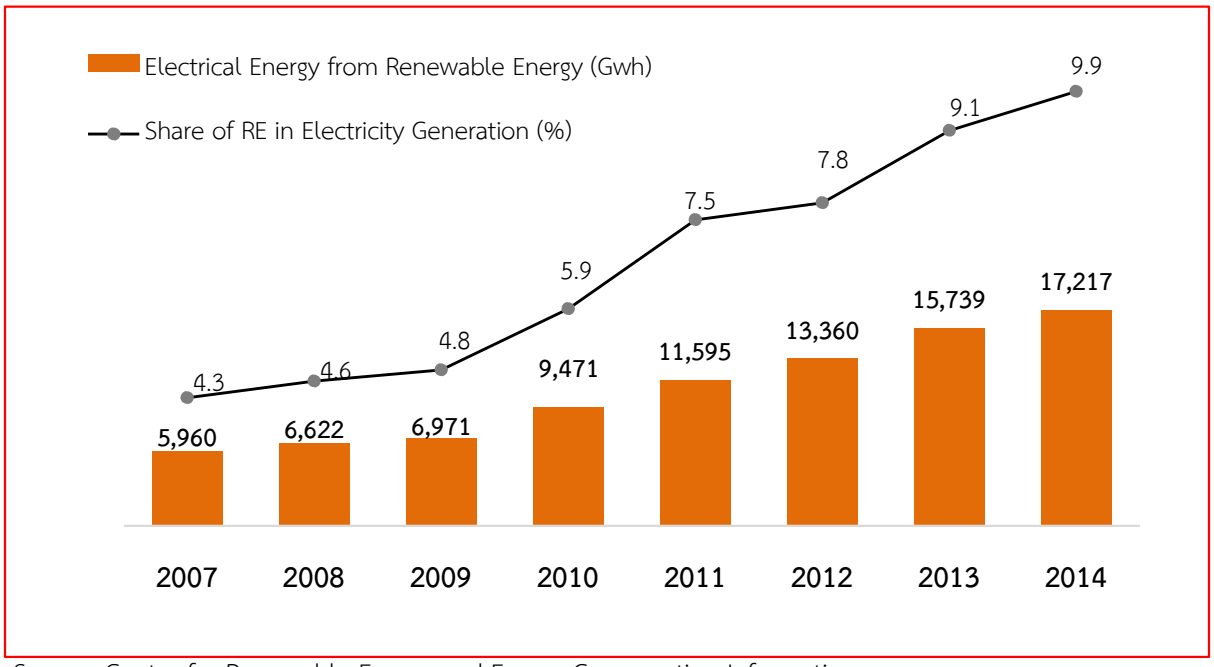
Renewable Energy	Unit	Status		
		2012	2013	2014
Electricity*	**MW**	**2,786**	**3,788**	**4,494**
	ktoe	**1,138**	**1,341**	**1,467**
1. Solar	MW	376.72	823.46	1,298.51
2. Wind	MW	111.73	222.71	224.47
3. Small Hydro	MW	101.75	108.80	142.01
4. Biomass	MW	1,959.95	2,320.78	2,451.82
5. Biogas	MW	193.40	265.23	311.50
6. MSW	MW	42.72	47.48	65.72
Heat	**ktoe**	**4,886**	**5,279**	**5,775**
1. Solar	ktoe	3.50	4.50	5.10
2. Biomass	ktoe	4,346.00	4,694.00	5,144.00
3. Biogas	ktoe	458.00	495.00	528.00
4. MSW	ktoe	78.20	85.00	98.10
Bio-fuel	Million liter/d	**4.20**	**5.50**	**6.10**
	ktoe	**1,270**	**1,612**	**1,783**
1. Ethanol	Million liter/d	1.40	2.60	3.21
2. Bio-diesel	Million liter/d	2.80	2.90	2.89
RE Consumption (ktoe)		**7,294**	**8,232**	**9,025**
Final Energy Consumption (ktoe)		**73,316**	**75,214**	**75,804**
Share of RE in Final Energy consumption (%)		**9.95**	**10.94**	**11.91**

*Including off grid power generation and not including power from the large hydro power plant

The renewable energy is highly consumed in the form of heat. It is about 60 percent of the total renewable energy consumption, followed by biofuels and electricity. In year 2014, the utilization of renewable energy in the form of heat, biofuel and electricity are 64, 19.7 and 16.3 percent of total renewable energy consumption, respectively.

2.1 Status of Power generation from renewable energy.

The Ministry of Energy has been promoting the production of electricity from renewable energy since 1989. It encouraged the Electricity Generating Authority of Thailand (EGAT) to purchase electricity from Cogeneration power plant of the Small Power Producers (SPP) that used waste or residues in agricultural sector as feed stock to produce electricity and heat. Heat left over from the manufacturing process can be used to produce electricity for sale to a transmission line to promote generation efficiency and the public investment in the production and distribution of electricity. Later, the policy was expanded to purchase electricity from other renewable energy such as solar, hydropower, wind power, biogas, waste from the Very Small Power Producers: VSPP (capacity no larger than 10 MW) to make more SPPs in remote areas to participate in the generation of electricity. Reducing losses in the power system and to reduce the investment in large power plant to supply electricity. By the adder measure which the additional tariff and time of support are difference depend on type of renewable feed stock used to produce electricity and the location of power plant (Power plant from renewable energy in the southern border provinces of Yala, Pattani, Narathiwat and four districts are in Songkhla can apply for Adder. This incentives driven electricity from renewable energy proportion rose annually. The proportion of electricity from renewable energy production from electricity generation system (Including off grid power generation) for the whole country increased 4.3 percent in 2007 and it is increased to 9.87 percent in 2014 (this excluding large hydro).

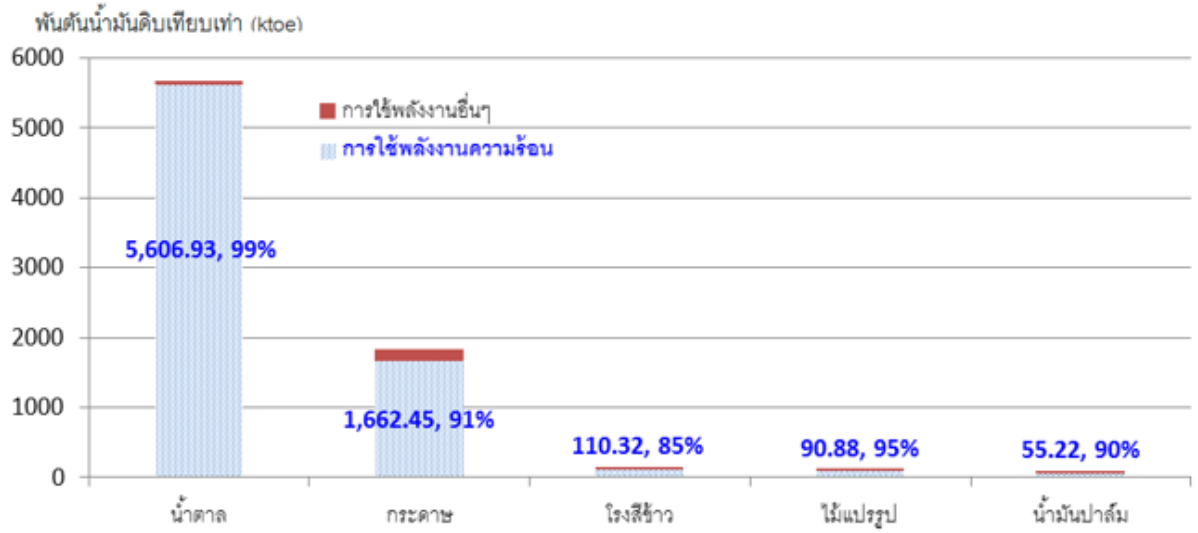


Source: Centre for Renewable Energy and Energy Conservation Information.
Department of Alternative Energy Development and Energy Conservation

Figure 2.1 The generation of electricity from renewable energy sources in 2007-2014.

2.2 Status of Heat Generation from Renewable Energy

The agricultural industries such as sugar, palm oil, tapioca starch, wood processing, paper mills and animal farms, is mainly used heat from renewable fuel. These are industries with waste scrap and waste from manufacturing processes that can be used as raw material in the production of energy in the form of biomass and biogas from wastewater. The wastes of biomass such as bagasse, rice husk, wood chips, palm fiber palm kernel shells and sawdust and biogas from wastewater are most popular and widely used renewable feedstock that have been consumed to reduce the fuel cost in agricultural industry.



Industry	Share of RE to Produce Heat
Sugar	bagasse 99.96% , husk 0.04%
paper	Black liquor 62.37% , Coal 19.58% , firewood 6.23%
Rice mill	husk 99.24%
timber	firewood 95.04% , saw dust 4.91%
Palm oil	Fruit bunch/palm fiber 84.27% , palm cornel 8.96%

Figure 2.2 Share of renewable energy for heat production in agro-industry

The promotion of electricity generation from renewable energy by combine heat and power system is one of government policies that encourage more investment in energy efficiency. This is including the biogas from manure and wastewater, solar energy to produce hot water and used in dry manufacturing business that increased the proportion of

renewable fuel to reduce fuel consumption. This affected to increase the competitiveness of the industry and help to improve health quality of people in communities around the factory.

Table 2.2 Renewable heat consumption year 2010 - 2014

Renewable Resource	Heat (ktoe)				
	2010	2011	2012	2013	2014
Biomass	3,449	4,123	4,346	4,694	5,184
Biogas	311	402	458	495	488
MSW	1.1	1.7	78.2	85.0	98
Solar	1.8	2.0	4.0	4.5	5.1
Total	**3,763**	**4,529**	**4,886**	**5,279**	**5,775**

In the year 2014, biomass is a renewable energy that has highest share of the heat production (89 percent of the thermal energy produced from all renewable energy). Biogas accounted for 9 per cent and the rest is thermal energy from waste and solar. The production of energy from waste and solar energy is also the need the government promotion for encouraging more utilization in services and household sector.

2.3 Biofuel Production from Renewable Energy Status

It was nearly a decade, the Ministry of Energy has introduced the concept of the King's renewable energy policies as a key to creating energy security and create renewable energy infrastructure in Thailand. Especially, the use of biofuels produced from domestic, renewable resources to replace gasoline and diesel fuel.

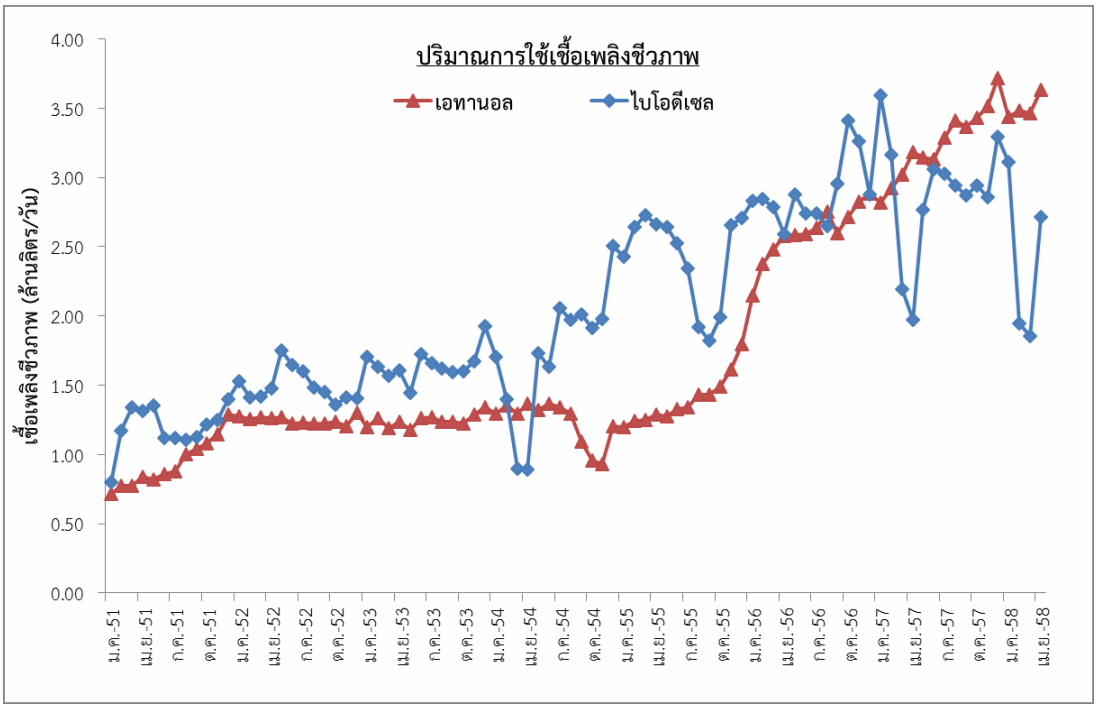


Figure 2.3 Bio-Fuels consumption by semester from 2008 - 2015

The Ministry of Energy has taken to promote biofuels as a concrete since 2004 by licensing for the biofuels factories, expanding more biofuels stations and promote public relations to make people more confidence in biofuels. However, the consumption of biofuels would not increase significantly. Until the world energy crisis occurred in year 2008. Crude oil prices rose above US $ 150 a barrel, resulting in increased demand for biofuels to replace and reduce imports of crude oil. The consumption of bio-ethanol rise up from 0.71 million liters per day to 1.29 million liters per day and the use of biodiesel increased from 0.80 million liters per day to 1.40 million liters per day.

The use of biodiesel began to increase significantly again in 2011, when the MOEN announced policy to blend more proportion of biodiesel from 3-5 percent and in 2014, MOEN step up the proportion of biodiesel blends to be 7 percent. However, due to the volume of crude palm oil, a raw material for biodiesel production, are seasonal fluctuations so some time MOEN would reduce the proportion of biodiesel blended down to balance of domestic material. In 2013, the biodiesel factory increased to 10 with the total capacity of 4.96 million gallons per day. Biodiesel was used to replace the regular diesel at 1,054.92 million liters which was equivalent to 2.89 million liters per day.

In 2013, the ethanol consumption increased significantly because the MOEN announced to ban 91 octane gasolines which was proportion of 40 percent of the total gasoline consumption, and the impact of the global crude oil price that trend to rise in the years 2013-2014, make people turn to use gasohol dramatically so the consumption of ethanol is increasing as well. By the year 2014, ethanol production facilities have been 22 factories with a total capacity of 5.31 million liters per day and the demand of ethanol was at 1,185.50 million liters per year or equivalent to 3.25 million liters per day.

Table 2.3 Ethanol and Bio-diesel consumption from 2010 – 2014

Bio-Fuels	Consumption (Million L/d)				
	2010	2011	2012	2013	2014
Ethanol	1.2	1.2	1.4	2.6	3.2
Bio-diesel	1.7	2.1	2.7	2.9	2.9
Total	**2.9**	**3.3**	**4.1**	**5.5**	**6.1**

3. The renewable energy development targets

The development of renewable energy as part of an overall energy policy is needed the integration with other energy plan to make all plan consistent. In the formulation of AEDP2015, the final energy consumption demands from the Energy Efficiency Plan: EEP 2015 was used especially in case of energy intensity is reducing by 30 percent in 2036 when compared to the year 2010. This was indicated that demand of final energy consumption in the year 2036 will be 131 000 tons of oil equivalent (ktoe). The electricity demand forecast from the power development plan: PDP2015 was also used to set the target of AEDP. PDP indicated that in the year 2036, net electricity demand will be 326,119 units or equivalent to 27,789 ktoe. The heat demand forecast in 2036 will be 68,413 ktoe and the forecast demand for fuel in the transportation sector from the fuel management plan for 2036 is 34,798 ktoe. The target of other plan as shown above, including consideration of the potential of renewable energy sources that can be developed, was used to formulate the target of AEDP2015 to replace 30 percent of final energy consumption (in from of electricity, heat and Bio-fuel) by 2036.

Table 3.1 AEDP Target

Energy	Share of RE (%)		Final Energy Consumption at 2036
	Status As of 2014	Target by 2036	
Electricity: Electricity	9	15 - 20	27,789
Heat: Heat	17	30 - 35	68,413
Bio-fuels : Fuels	7	20 - 25	34,798
RE : Final Energy Consumption	**12**	**30**	**131,000**

3.1 Target of electricity from renewable energy

To target electricity production from renewable energy with clear and consistent with the potential of fuel and the ability to support electrical system, Ministry of Energy has considered the issue as follow,

- Available renewable energy resources potential of each RE conversion technology.

Available of the RE resources potential was assessed by determine the Overall renewable energy resource minus RE resources that already consumed as the renewable resource.

- The electricity demand

Based on the demand forecast from electric demand by station of the Metropolitan Electricity Authority (MEA.) and the Provincial Electricity Authority (PEA.) stations and adjusted the demand in accordance with the EEP 2015 which was forecasted that Final electricity demand of the entire country as of 2036 was at 326,119 units.

- Capacity of transmission lines to receive the electricity produced from renewable energy

The Electricity Generating Authority of Thailand (EGAT) has been assessed the potential of the transmission line to support PDP2015 using annual data from its power stations. The result indicated that there are some grid limits to support the production of electricity from renewable energy in 2015 – 2024. However, Capacity of grid can be fully maximized to receive electricity from renewable energy by the year 2024 onwards.

- Merit Order using levelize cost of electricity and the social and environmental benefits of renewable power

It is based on construction costs, the system operation cost and maintenance costs of renewable power plant. This include the cost of raw materials (Fuel Cost) in the case of energy from biomass, energy from waste and energy from biogas that production from energy crops. The net cost electricity from renewable energy was calculated from the whole RE power plant project lifetime. The project will be prioritisd by environmental (the reduction of greenhouse gas emissions on the energy used to produce electricity) and the Employment coming up from project.

- RE Zoning

The target of generation power from various types renewable sources was set up using Renewable Energy Supply-Demand Matching principle. The available RE resource potential will be sort and sequence by the Merit Order of renewable energy technologies in accordance with the demand for electricity in the area and the limitation of the transmission system as follows.

(1) Prepared Merit Order as the cost of electricity from renewable energy and valued the benefit from social and environmental impact and then sequenced the Order in accordance with government promotion policy which was supported to RE from waste and bio-energy sector first this is because it benefit to farmers and communities. The electricity access of the people in remote areas is on of policy that account to Merit Order as shown follow

1	2	3	4	5	6	7	8
MSW	Biomass	Biogas (WW/SW)	Small Hydro	Biogas (Energy Crop)	Wind	Solar	Geothermal

(2) Electricity targets for each type of renewable fuel have been distributed for each zone. The amount of electrical energy that is already installed and plan to install (Projects that are bound to the public sector) will be used as basis to determine required power demand that must be carried out more (New project) to produce adequate and consistent electricity in the zone area. All limitations are taken into consideration include: restrictions on the additional electricity demand and restriction on transmission potential.

The AEDP2015 have set target of electricity from all renewable energy to achieve 20 percent of the net electrical energy demand, which complies with the fuel diversification ratio in the power development plan 2015 - 2036 (PDP2015) which indicated that the proportion of electricity generated from renewable energy in the range of 15-20 years in 2036.

Table 3.2 Status and Target of Electricity Generation by type of Fuel

Fuels	Status at end of 2014* (MW)	Target at 2036 (MW)
1. MSW	65.72	500.00
2. Industrial Waste	-	50.00
3. Biomass	2,451.82	5,570.00
4. Biogas (WW/SW)	311.50	600.00
5. Small Hydro	142.01	376.00
6. Biogas (Energy Crop)	-	680.00
7. Wind	224.47	3,002.00
8. Solar	1,298.51	6,000.00
9. Large Hydro	-	2,906.40**
Total install capacity (MW)	**4,494.03**	**19,684.40**
Electrical Energy (Million Units)	17,217	65,588.07
Total Electrical Energy Demand (Million Units)	174,467	326,119.00
Share of RE in Electricity Generation (%)	**9.87**	**20.11**

* Including off grid power generation and not including power generated from large hydro

** It is the existing capacity and the generation from large was included in the Target of AEDP2015

3.2 Goals heat production from renewable energy.

Demand of energy for heating is a significant proportion of the energy consumption of the country, which has increased steadily and is proportional to the economic situation, such as the expansion of city and the community, tourism, industry, and agricultural sector that adapted to the agricultural industry. The targeted promotion of heat production was consider as the steps below

(1) The projected energy demand for heating. The energy demand for heat production was forecasted that it is at 68,413 ktoe in 2036 in line with the analysis of final energy demand from EEP2015, PDP2015 and fuel demand in the transport sector as an oil management plan.

(2) Assessment of the potential to produce heat. Renewable energy resources are based on four groups.

(2.1) production of heat from renewable feed stock such as residual waste, biomass and biogas as fuel remaining after deducting the estimated potential to produce a different type of energy now.

Table 3.3 Potential of Heat Production from the Remain Feedstock

Type of Resources	Unit	Remain Potential	Energy Production Potential (ktoe)		
			Electricity	Pyrolysis Oil	Heat
1. Solid Waste					
Landfill Waste	Million tons	30.8	-	-	24.64
Used tire	ton/year	547500	-	-	383250
MSW*	ton/day	68088	35000	4690	4500
2. Biomass					
Remain Biomass	Million ton/year	31.42	37.43	-	42.51
Additional Biomass	Million ton/year	48.52			
3. Biogas					
Amount of waste	MillionM^3/year	3411	1142	-	1245

* Energy produced from MSW has limited because there are no MSW treatment system in some city

(2.2) production of heat from fast growing trees, target was set by considering the potential of deteriorated soil area such as high deteriorated area and area of deterioration in crisis of the land for agricultural reform which was outside the main irrigation area. This make no impact or affect to the area of food crops. The analysis found that Thailand has high potential areas (about 640,000 hectares) for fast growing trees planting. The utilization of this area for 1/3 portion would be produced approximately 18 million tons of biomass per

year.

(2.3) production of solar heat, the target was set at 1,200 ktoe by assessing the potential solar energy to heat demand from the three available technologies, solar hot water systems, solar drying system, and solar heating and cooling systems.

- Solar hot water system, the goal is to install a solar hot water system at approximately 9.17 million square meters or 1,160 ktoe of heat equivalent. The target group are the hotels, resort and hospitals, which use hot water for serving guests or patients and to wash within the operation. The utilization of hot water industrial and residential is included.
- Solar Drying System, The goal is to promote the installation of solar drying of 75,000 square meters, equivalent to the production of thermal energy 5 ktoe. This will target on the household, small and medium dried product enterprises to improve of drying product standard because the product drying by natural sunlight are often damaged by insects, dust and moisture in the climate.
- Solar cooling systems, the target was to promote the use of solar cooling system for approximately 300,000 square meters or equivalent to Heat of 35 ktoe. In this system the solar hot water will be used as a heat source for the Absorption chiller in large buildings such as shopping centers, office buildings, hotels and hospitals, etc.

(2.4) the production of Heat by other source of renewable energy, this will be in the research and development of the technology that competitive in price in the near future such as geothermal etc.

Table 3.4 Status and Target to Produce Heat by Type of Feedstock

Feedstock	Status at end of 2014 (ktoe)	Target at 2036 (ktoe)
1. MSW	98.10	495.00
2. Biomass	5,144.00	22,100.00
3. Biogas	528.00	1,283.00
4. Solar	5.10	1,200.00
5. Alternatives Heat Source*	-	10.00
Total	**5,775.20**	**25,088.00**
Total Heat Demand	33,419.54	68,413.40
Share of RE for Heat Production (%)	**17.28**	**36.67**

*Geothermal, Oil from tire, etc.

3.3 Renewable fuels for the transportation production target.

The promotional target of biofuels is determined by balancing energy demand in the transportation sector and the domestic biofuels production capacity. This was considered in steps below.

(1) predicted fuel demand in the transportation sector by analysis of the demand for fuel in the transportation of Oil plan, which indicates that demand for fuel in the transport sector by the year 2036 was at 34,798 ktoe.

(2) assessed the potential for biofuel production. Now, the biofuels ware produced from food crops. It is the first generation biofuels. The key raw materials in the production are sugarcane, cassava and palm oil. It is an important crop in the country. Therefore, the strategy of the Ministry of Agriculture was used to set implementation target for the biofuels promotion. The MOEN are encouraged to bring the waste from agricultural production to produce energy for balancing between energy crops and food, causing interest of the country. The potential is evaluated from 5 renewable resources as follow,

(2.1) biodiesel

The potential was determined from the Palm and Palm Oil strategy years 2015 - 2026 and assumption that the palm oil remaining from domestic consumption was expects to produce biodiesel. This make potential of renewable diesel is 14 million liters per day in 2036. This also did not take into account the export of palm oil.

Table 3.5 Palm Potential for Bio-diesel Production 2015 - 2036

Palm Oil Potential	2015[1]	2017[1]	2019[1]	2026[1]	2036[2]
Target of Palm Planting Area (Million Rai)	4.50	5.00	5.50	7.50	10.20
Palm Feedstock (Million tons/year)	14.34	15.40	16.66	21.40	29.46
Crude Palm Oil (Million tons/year)	2.58	2.93	3.17	4.28	5.89
Remained Crude Palm Oil (Million tons/year)[3]	1.56	1.85	2.03	2.93	4.24
Maximum Production of Bio-diesel (Million L/d)[4]	5.60	6.50	7.10	10.00	14.00

source: [1] Palm and Palm oil Strategy 2015-2026

[2] Assume production gained from appropriate planting area for the whole country

[3] CPO balance by not deducting the volume of exports.

[4] Calculated from Fatty Acid Methyl Esters (FAME) production process

(2.2) Ethanol

Information from cassava and cassava products strategy and sugar cane and sugar strategy indicates that the use of land with potential for cassava and sugarcane planting will be full capacity by the year 2026. So the increasing production efficiency is the way to increase cassava and sugar cane. There for, it assumed that yield rate of cassava and molasses production will be constant until 2036 and it assume that the domestic consumption is constantly increased.

Table 3.6 Casava and Molasses Potential for Ethanol Production 2015 - 2026

Potential	2015	2017	2019	2026
Casava				
Target Planting Area (Million rai)	8.50	8.50	8.50	8.50
Casava Yield (Million tons/year)	30.60	36.00	42.50	59.50
Used as Food Consumption (Million tons/year)	8.05	8.91	9.77	11.57
Remain cassava for Ethanol Production (Million tons/year)	2.00	2.42	2.93	5.71
Ethanol Production (Million l/d)	0.87	1.06	1.28	2.50
Molasses				
Target Planting Area (Million rai)	10			16
Sugar Cane Yield (Million tons/year)	112.00	135.00	152.00	182.00
Used as Food Consumption (Million tons/year)	1.01	1.02	1.05	1.13
Remain Sugar Cane for Ethanol Production (Million tons/year)	4.03	5.00	5.79	7.43
Ethanol Production (Million l/d)	2.65	3.29	3.81	4.88
Total Ethanol Production (Million l/d)	3.52	4.35	5.09	7.38

source: Casava and Casava products strategy and Sugar cane and Sugar Strategy 2015 – 2026

In the case of molasses, the preliminary assessment expected that Thailand has the potential to produce ethanol from molasses about 4.8 million liters per day. In the case of cassava, it is implied that the use of cassava increased by 10 percent per year since 2026 so the country has the potential to produce ethanol from cassava, has about 6.5 million liters per day. Therefore in the year 2036, it is expected that the total potential of ethanol production to replace gasoline will be 11.3 million liters per day.

(2.3) The pyrolysis oil

It is expected that the remaining of municipal solid waste from the production of electricity and heat is about 4690 tons per day. Therefore, the plastic waste will be produced the pyrolysis oil at approximately 700 tons per day.

(2.4) Compressed Bio-methane Gas; CBG

The MOEN has introduced the concept of the biogas purification to be bio-methane and used as the option to replace of petroleum fuel in the area far away the natural gas pipeline. The promotion of CBG will encourage entrepreneurs to invest the CBG Stations and make public easier to access the fuel infrastructure. The study of potential areas for energy crop biogas to produce CBG in areas of 13 provinces that have 300 kilometers far from the gas pipeline indicated that there are 1 million rai (160,000 hectares) potential areas for energy crops. This can produce CBG at approximately 10,000 tonnes per day. AEDP2015 targeted the utilization of CBG at 4,800 tons per day, or about 2,000 ktoe in 2036.

(2.5) The alternatives feedstock

Alternative feedstock used in the production of renewable fuels for the transportation in the future are biofuels from biomass (second generation biofuels) such as bio-oil and Bio-fuel production from algae (Third generation biofuels) as well as hydrogen which is still under technology and cost-competitive development.

Table 3.7 status and target of renewable energy production for transportation sector

Type of Fuels	Status at end of 2014		Target at 2036	
	M l/d	ktoe	M l/d	ktoe
1. Bio-diesel	2.89	909.28	14.00	4,404.82
2. Ethanol	3.21	872.88	11.30	2,103.50
3. Pyrolysis Oil			0.53	170.87
4. CBG (ton/d)			4,800.00	2,023.24
5. Alternative Fuels*				10.00
Total (ktoe)		**1,782.16**		**8,712.43**
Total Fuel Consumption in Transportation		26,801.00		34,798.00
RE share in Transportation Sector (%)		**6.65**		**25.04**

* Bio-oil, Hydrogen and Others

The MOEN has set a target of AEDP2015 to increase the share of renewable energy either in the form of electricity, heat and biofuels to be 30 percent of final energy consumption in 2036, as summarized in Table 3.8.

Table 3.8 Target of AEDP2015

Type of Energy	Target by 2036	
Electricity	**Ktoe** **MW**	**5,588.24** **19,684.40**
1. MSW	**MW**	500.00
2. Industrial Waste	**MW**	50.00
3. Biomass	**MW**	5,570.00
4. Biogas (WW/SW)	**MW**	600.00
5. Small Hydro	**MW**	376.00
6. Biogas (Energy Crop)	**MW**	680.00
7. Wind	**MW**	3,002.00
8. Solar	**MW**	6,000.00
9. Large Hydro	**MW**	2,906.40
Heat	**Ktoe**	**25,088.00**
1. MSW	**Ktoe**	495.00
2. Biomass	**Ktoe**	22,100.00
3. Biogas	**Ktoe**	1,283.00
4. Solar	**Ktoe**	1,200.00
5. Alternative Renewable Energy	**Ktoe**	10.00
Biofuel	**Ktoe**	**8,712.43**
1. Bio-Diesel	Million L/d	14.00
2. Ethanol	Million L/d	11.30
3. Pyrolysis Oil	Million L/d	0.53
4. Compress Bio-methane Gas	Tons/d	4,800.00
5. Alternative Fuel	**Ktoe**	10.00
RE consumption (ktoe)		**39,388.67**
Final Energy Consumption (ktoe)		**131,000.00**
Share of RE in Final Energy Consumption (%)		**30**

4. Strategies to promote the development of renewable energy

The strategy to promote the development of renewable energy in the years 2015 - 2036 are as follows.

Strategy 1: preparation of raw materials and renewable energy technologies.
Aims To develop the production capability and the Management of raw material supply chain with the appropriates technology.
Tactic 1.1 Development of alternative raw materials and potential areas for renewable energy production.
Tactic 1.2 Development of the high efficient renewable raw materials management and utilization model
Tactic 1.3 Promote the development of appropriate technology for generation and utilization energy.
Tactic 1.4 Improve infrastructure to support the production of renewable energy appropriately.

Strategy 2: Increasing renewable energy production, utilization and market potential
Aims Enhancing renewable energy production and consumption capability
Tactics 2.1 Support people and a community to participate in the production an utilization of Renewable Energy
Tactic 2.2 Support the investment on renewable energy to manufacturers and consumers both domestic and international
Tactic 2.3 Promote the reducing of production costs and make renewable energy market more performance
Tactic 2.4 Develop the renewable energy law and rules to to encourage the development of renewable energy appropriately

Strategy 3: Create awareness and access to knowledge and facts of renewable energy
Aims To raise awareness and understanding on the efficient and sustain of production and consumption of renewable energy
Tactic 3.1 Develop renewable energy databases and information management systems
Tactic 3.2 Publicize information, knowledge and statistical data on renewable energy
Tactic 3.3 Capacity building both in theory and practice to make more ability in utilization of renewable energy
Tactic 3.4 Development of renewable energy and its related networks and encourage the participation of the whole network both nationally and international level.

4.1 The driven of renewable energy development strategy

Strategy 1:	**preparation of raw materials and renewable energy technologies.**		
Aims	**To develop the production capability and the Management of raw material supply chain with the appropriate technology.**		
Tactic	**Electricity**	**Heat**	**Bio-Fuels**
Tactic 1.1 Development of alternative raw materials And potential areas for renewable Energy production.	- Defined areas (Zoning) promoting the use of crops for renewable raw materials. - Develop and promote the use of other materials as fuel sources, such as agricultural residues, waste from the manufacturing process in the industry by integrating with various agencies.		
			Research and develop Non-food crop as alternate feedstock to produce biofuel such as rice, sweet rice, cellulose and algae, and so on.
Tactic 1.2 Development of the high efficient renewable raw materials management and utilization model	- Encourage the systematic management of renewable energy raw materials such as transportation systems and contract farming. - Development and standardization renewable fuel for commercial such as briquettes, pellet and pyrolysis oil, etc.		
	- Promotion the production of renewable energy products for use as fuel or co-use with another fuel such as biomass pellet or Bio-coke.		
Tactic 1.3 Promote the development of appropriate technology for generation and Utilization of energy.	- Promoting the use of domestically parts or technology - Develop spare part, equipment and a new renewable energy technologies with suitable for use In each area and can be reproduced for commercial purposes. - Standardize for material, equipment, installation and system performance testing of renewable energy technologies		
	- R&D in energy storage	- Develope high performance energy technology	- Study and develop automobile technology to use more proportion of biofuel - Develop high quality biofuel such as H-FAME and BHD etc. - develop the CBG production system
Tactic 1.4 Improve infrastructure to support the production of renewable energy appropriately	Develop renewable energy technology and equipment testing center.		
	- restructuring Transmission System to accommodate Electricity from RE	- Promote the centralize MSW treatment center	- increase biofuel station

Strategy 2: Increasing renewable energy production, utilization and market potential Aims: Enhancing renewable energy production and consumption capability			
Tactic	**Electricity**	**Heat**	**Bio-Fuels**
Tactics 2.1 Support people and a community to participate in the production and utilization of Renewable Energy	- Support community and other government agencies electricity system in remote areas - Support groups Green Communities Enterprise (Distributed Green Generation: DGG) - Promote RE electricity for Self-consumption in Government agency, businesses and household buildings. - Development of appropriated hybrid electricity system such as combine wind with solar power to generate electricity etc.	- Promote the high efficiency heat generator equipment for household sector - Promote the user friendly RE technology for the household sector - promote the RE utilization in Industrial sector	- Promote community to produce and consume biofuel

<table>
<tr><td colspan="4">Strategy 2: Increasing renewable energy production, utilization and market potential
Aims: Enhancing renewable energy production and consumption capability</td></tr>
<tr><th>Tactic</th><th>Electricity</th><th>Heat</th><th>Bio-Fuels</th></tr>
<tr><td rowspan="2">Tactic 2.2
Support the investment on renewable energy to manufacturers and consumers both domestic and international</td><td colspan="3">Promoted renewable energy investment with tax and appropriate financial measures</td></tr>
<tr><td>- Support electricity trade by competitive bidding measure
- Support electricity self-consumption by Net metering
- Revised Power purchase rate in accorded the situation</td><td>- Study and set measure to promote the RE Heat production
(Renewable Heat Incentive)</td><td>- Set up appropriate incentives price structure to reflect the true cost of production.
- Encourage the use of biofuels in government agencies with serious and concrete
- Promoting production and distribution automotive engine technology that consume high RE portion biofuels.</td></tr>
<tr><td>Tactic 2.3
Promote the reducing of production costs and make renewable energy market more performance</td><td colspan="3">- Promote the improvement of production efficiency.
- Support RE production from waste and residual from the manufacturing process.</td></tr>
<tr><td>Tactic 2.4 Develop the renewable energy law and rules to encourage the development of renewable energy appropriately</td><td colspan="3">- Develop the Renewable Energy Act
- Revise government rule to facilitated the production, transportation and utilization for RE development</td></tr>
</table>

Strategy 3:	**Create awareness and access to knowledge and facts of renewable energy**		
Aims	**To raise awareness and understanding on the efficient and sustain of production and consumption of renewable energy**		
Tactic	**Electricity**	**Heat**	**Bio-Fuels**
Tactic 3.1 Develop renewable energy databases and information management systems	- develop the high performance renewable energy database and connect with the relevant authorities		
Tactic 3.2 Publicize information, knowledge and statistical data on renewable energy	- Promote the activities or projects, such as renewable energy contest - Public relation on RE information and knowledge through various media, such as Websites, print media, radio, television, etc. - Develop and update information paper and make statistical information up to date		
Tactic 3.3 Capacity building both in theory and practice to make more ability in utilization of renewable energy	-Develop new RE course for enterprise and education institute - Training, knowledge transfer on renewable energy application		
Tactic 3.4 Development of renewable energy and its related networks and encourage the participation of the whole network both nationally and international level.	- Establish the RE learning center for the community or region. - Develop renewable energy network or support community network to gain acceptance and to reduce the resistance. - Developing and enhancing an international cooperation on renewable energy		

5. The expected results

The goal AEDP2015 is to increase the proportion of renewable energy in the form of electricity, heat and biofuels for 30 percent of final energy consumption by 2036. This RE would replace the use of fossil fuels for approximately 39,388 ktoe, which is estimated value for 590,820 million baht (price 1 ktoe = 15 million baht). It will reduce the greenhouse gas emission for about 140 million tons of carbon dioxide equivalent (tCO2e).