The Renewable and Alternative Energy Development Plan for 25 Percent in 10 Years (AEDP 2012-2021)

1. Justification for Development of the National Renewable Energy

Thailand has to mainly rely on energy import. Finding from the 2011 data that over 60 percent of primary commercial energy demand derived from importation. Oil import took a high proportion at 80 percent of a total domestic oil consumption with increasing trend since not capable to increase domestic petroleum production to meet the demand. Substance development on energy will reduce dependency and import of oil and other energy resources, additionally help sharing the risk in providing fuel for power generation which previously depended on natural gas at over 70 percent. Renewable energy would be counted as target fuel expected to significantly substitute natural gas for power generation, especially solar energy, wind energy by type of wind turbine farm, micro hydro, biomass, biogas and waste/garbage. Just in case such those renewable energy technologies would cost lower and getting broaden acceptance that could be developed as major energy for Thailand power generation in the future.

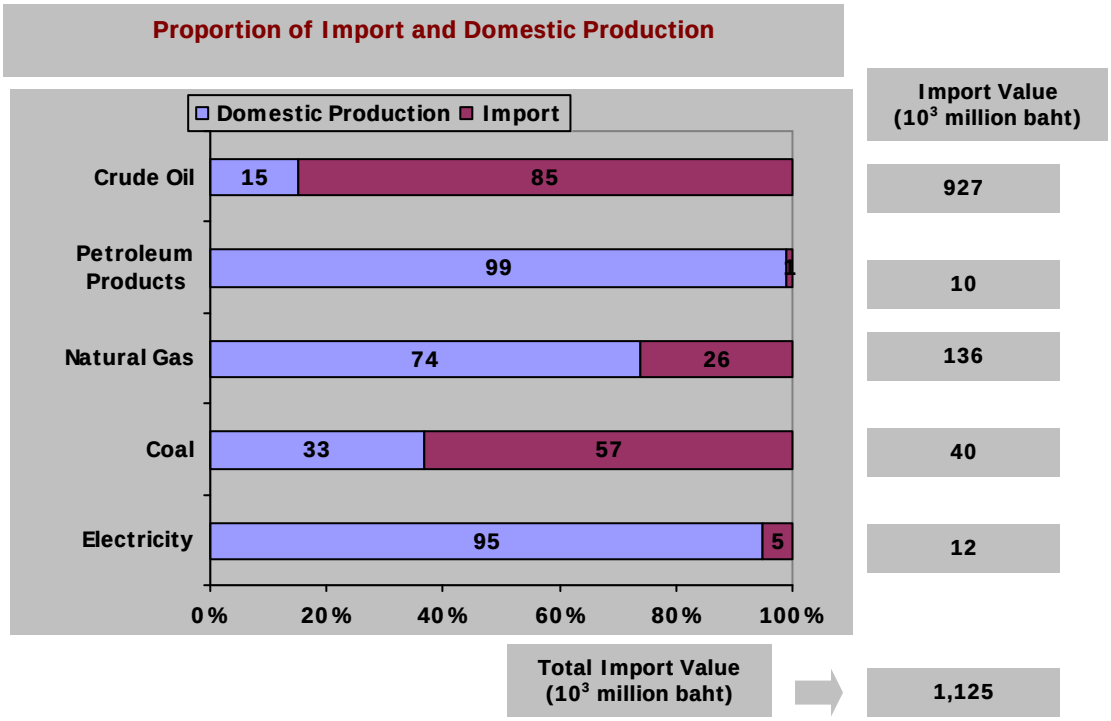


Figure 1 Thailand Energy Production and Import in 2011

Global warming problem causing from GHGs (*Greenhouse Gases*) release is the problem currently getting the worldwide attention and speeding up to find restriction measures where trade barrier is one measure with a trend to widely use in the future. Although Thailand is not yet enforced presently by such that measure but we should conduct the renewable energy development and promotion as a measure to reduce GHGs release. This would be an initial point to step into the **Low Carbon Society** and be exemplary for the world society to cite Thailand as the country with strong intent in using renewable energy.

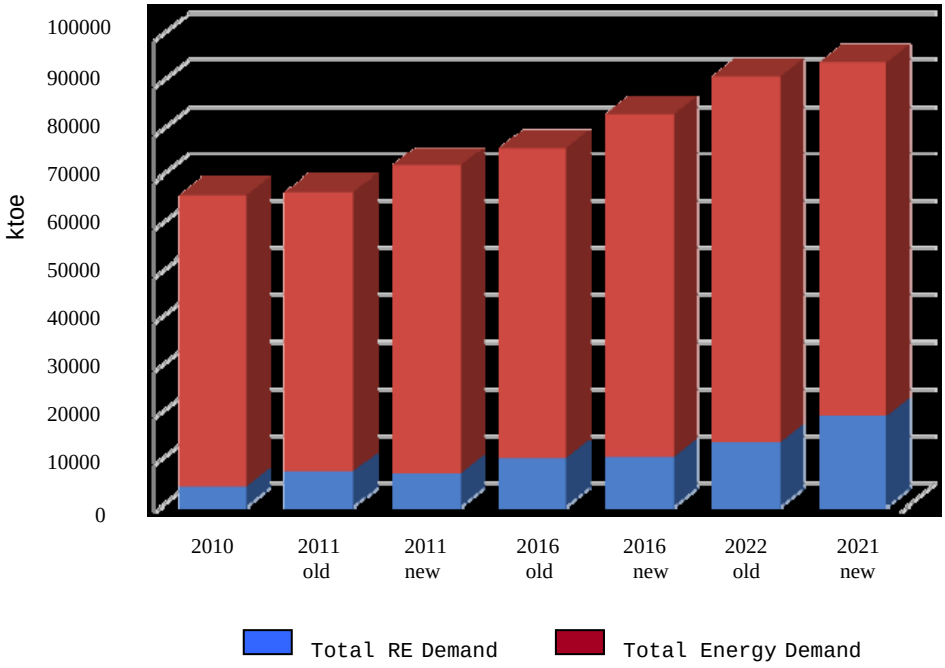
Agricultural products in capable use as feedstock in producing energy are either biomass, biogas including bio-diesel and ethanol, and after processing from food industry, the waste/residues would be used as energy from garbage/ MSW (*Municipal Solid Waste*). Moreover, in Thailand there are potentials of natural energy resources, as ex: solar energy with its solar radiation averaged at 18.2 MJ/m^2/day and some

parts/regions are with good wind energy potentials. These make Thailand renewable energy potentials be at very good level with opportunities to be promoted as energy sources and create the promising country energy security.

The government therefore, assigned Energy Ministry to establish Renewable and Alternative Energy Development Plan for 25 percent in 10 years, *so-called as* ***AEDP 2012-2021***, to identify the framework and direction of Thailand renewable energy development.

2. Framework of Renewable & Alternative Energy Development Plan for 25 percent in 10 Years

Thailand energy demand forecasted by Energy Ministry that, an expected demand in 2021 would be at 99,838 ktoe growing from presently of 71,728 ktoe. The PDP (*Power Development Plan*) of 2011-2030 and RE &AE (*Renewable Energy* and *Alternative Energy*) Development Plan for 2012-2021 determined the renewable energy share increasing from 7,413 ktoe in 2012 to 25,000 ktoe in 2021 or 25 percent increase of total energy consumption.

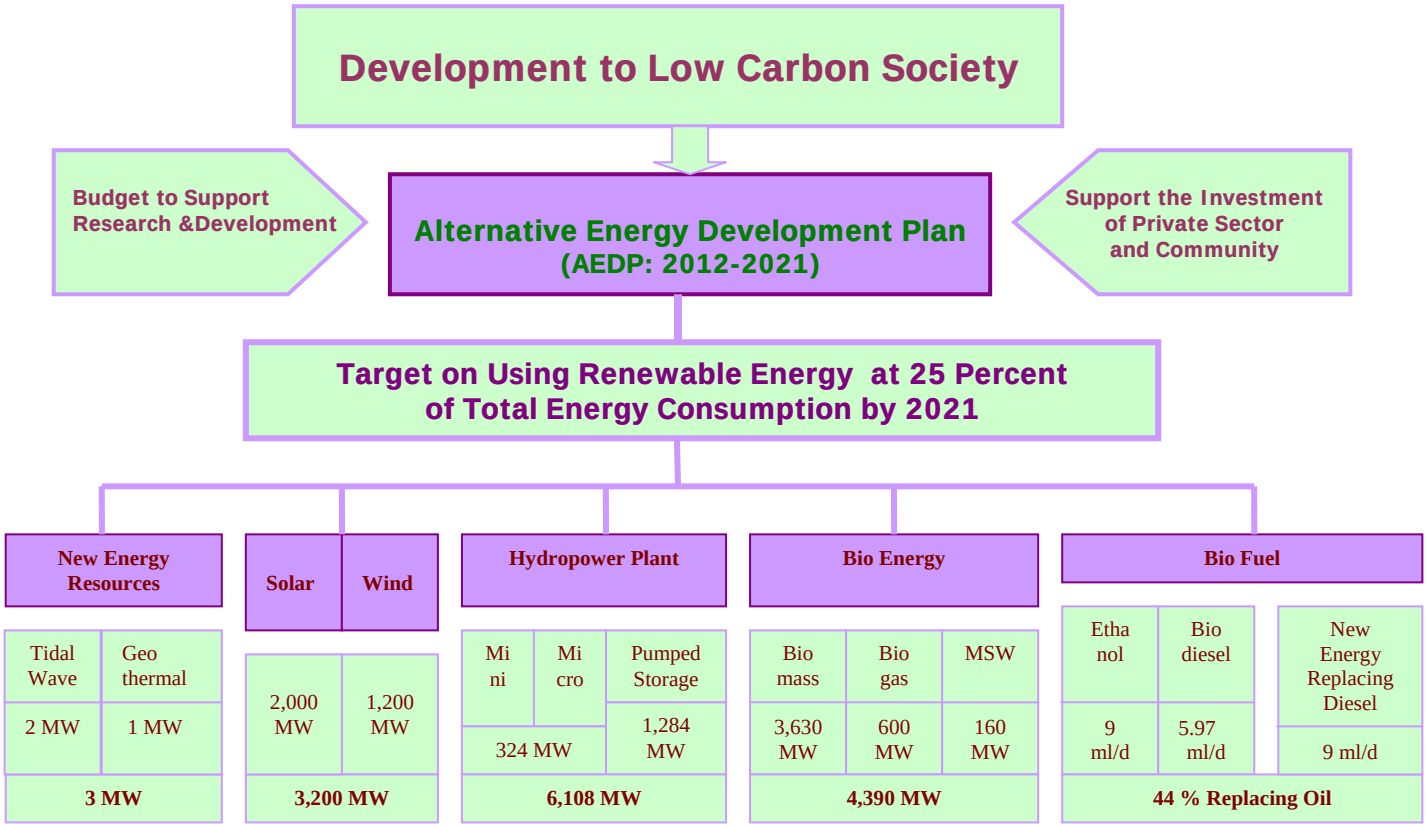


Source: Renewable & Alternative Energy Development Plan for 25 percent in 10 Years

3. Substances of Renewable & Alternative Energy Development Plan for 25 percent in 10 Years

3.1 Objectives

1) To capably develop renewable energy as one of the country major energy sources in sustainable replacing of fossil fuel and oil import for the future. This plan will not cover the NGV development plan (*Natural Gas for Vehicles in transport sector*).
2) To strengthen the country energy security.
3) To create using renewable energy at community level as of integrated green community.
4) To support the domestic renewable energy technology production industry.
5) To research, develop and promote Thailand renewable energy technology for competitive capability in the international market.



3.2 Strategy to promote renewable and alternative energy development for 25% in 10 years

Ministry of Energy established the roadmap as strategy to promote renewable and alternative energy development for 25 percent in 10 years (***AEDP: 2012-2021***) through the following six strategic issues, i.e.

1. Promoting the community to collaborate in broaden producing and consuming renewable energy.
2. Adjusting the incentive measure on investment from private sector appropriated with the situation.
3. Amending the laws and regulations which do not benefit to renewable energy development.
4. Improving the infrastructure as system of transmission line, power distribution line, including a development towards Smart Grid System.
5. Public relations and building up comprehensive knowledge for the people.
6. Promoting the research work as mechanism to develop the integrated renewable energy industry.

4. Driving by Technologies

4.1 Renewable energy for power generation

4.1.1 <u>Solar energy</u>: target in 2021 is 2,000 MW with a current total generating capacity at 75.48 MW. Focussing on development as AEDP framework for the following substances.

1. <u>Promoting community to collaborate in broaden production and consumption of renewable energy</u>

* Promote the small system project capably installing at household and community level, *including Solar PV Rooftop*, for 1,000 MW in 10 years. Consideration may cover the system installed in

1) Houses in general and community
2) Office buildings and factory roof
3) Housing projects or condominiums
4) Government buildings

2. Adjusting incentive measures for investment from private sector appropriated with the situation

* Adjust the Adder to be Feed-in Tariff (FIT) system.

3. Amending laws and regulations which do not benefit to renewable energy development

* Push up the amendment of laws and Industrial Act, 1992 (B.E. 2535).

4. Improving infrastructure system

* Asking the three Electricity Authorities (*EGAT, PEA, MEA*)[1] for preparation in extension and increasing the transmission system to support the rising renewable energy, includes preparing a development towards Smart Grid system.

5. Public Relations and building up comprehensive knowledge of people

* Promote the civilian sector or any sectors concerning to gain knowledge in using solar power generation system by various types.

6. Promoting research work as mechanism in development of integrated renewable energy industry

* Promote integrated upstream industry of solar panel production, for ex: silicon wafers plant.

4.1.2 Wind energy: target in 2021 is 1,200 MW where a present total generating capacity is 7.28 MW. Development would be focused on:

1. Promoting community to collaborate in broaden production and consumption of renewable energy

* Wind turbine in co-generation with other power generating systems in remote community and non-electrified island.

* Wind turbine for agriculture especially, wind turbine for water pumping and traditional waterwheel for consumption.

2. Adjusting incentive measures for investment from private sector appropriated with the situation

* Facilitating the people to capably request for land utilisation and installing wind turbine in remote area.

3. Amending laws and regulations which do not benefit to renewable energy development

* Push up amendment of laws and regulations which do not benefit in wind energy development, for examples:

1) Regulations or codes of practice of Ministry of Natural Resource and Environment for a request on land utilisation for wind project development.

2) Asking for exempt of 1-B area with no forestation left and difficult to restore in some area so that private sector can request to utilise the land for development of wind energy project.

3) Amend the Industry Act, 1992 (B.E.2535)

4. Improving infrastructure system

* Establish the extension plan for transmission system and energy storage system, for instances: pumped storage system in area with high wind energy potential as in the northeast.

5. Public Relations and building up comprehensive knowledge of people

* Promote establishing the network of wind energy users and producers

6. Promoting research work as mechanism in development of integrated renewable energy industry

* Encourage to emerge industry for electricity storage devices and integrated wind power generation system.

* Develop the wind turbine type appropriated with Thailand wind speed.

4.1.3 Hydropower: the 2021 target is at 1,608 MW where the current capacity is 86.39 MW (excludes the existing EGAT pumped storage system at Lam Takong unit 1-2, *each of 250 MW*, at total of 500 MW). Development would be focused on:

1. Promoting community to collaborate in broaden production and consumption of renewable energy

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1 ***EGAT*** *is the Electricity Generating Authority of Thailand,* ***PEA*** *refers to the Provincial Electricity Authority and* ***MEA*** *is the Metropolitan Electricity Authority*

* Generate the hydropower at village level for the non-electrified households by not connecting to transmission system (Off Grid)

* Support the construction of hydropower plant project at community level, let the local administrative organisation or local people to collaborate as project owner and capable for their future self-management and maintenance.

2. Amending laws and regulations which do not benefit to renewable energy development

* Solving the problems and barriers in micro hydropower project development that might be located in sensitivity area, as areas of: river basin at the floor 1-B, national park or wide animal preserved zone for examples.

3. Improving infrastructure system

* Assign the Department of Alternative Energy Development and Efficiency (DEDE) and Electricity Generating Authority of Thailand (EGAT) to develop small hydropower system of downstream irrigation dam and mini hydropower system at generating capacity of 200 - 6,000 kW.

* Assign EGAT to develop the new pumped storage system project in 2 areas, i.e. Lam Takong Pumped Storage (unit 3-4) at 500 MW and Chulabhorn Dam Pumped Storage Project at capacity of 784 MW to support the renewable energy development in the Northeast.

4. Public Relations and building up comprehensive knowledge of people

* Disseminate and conduct public relations on information and advantages of hydropower project.

5. Promoting research work as mechanism in development of integrated renewable energy industry

* Conduct research and develop the Micro Hydro Turbine of Run-of River (*Water Flow*) Type.

* Study and develop hydro turbine of low-head type (ex: Banki, Kaplan, Propeller).

4.1.4 Energy from waste: MSW *(Municipal Solid Waste)* : The 2021 target is 160 MW where a total capacity is currently at 1.45 MW. Development would be focused on:

1. Promoting community to collaborate in broaden production and consumption of renewable energy

* Promote and support producing energy from MSW in the medium and small sizing Local Admin Organisations.

* Promote and support producing energy from MSW in small communities, for instances: schools, temples, communities, local organisations.

2. Amending laws and regulations which do not benefit to renewable energy development

* Speed up the amendment of Joint Venture (*Allowing the Private Sector for Co-working or Implementing the Government Enterprises*) Act B.E 2535 to benefit for private sector to co-invest with Local Admin Organisation in producing energy from MSW by all types, especially RDF (*Refuse-Derived Fuel*) type, then to co-generate heat and power in factory, includes promote producing oil derived from plastic waste.

3. Public Relations and building up comprehensive knowledge of people

* Build up the collaboration in targeted area for establishment of waste to energy system, conduct campaign to educate children and juveniles in the detailed waste management for energy and environment at local level.

4. Promoting research work as mechanism in development of integrated renewable energy industry

* Study the RDF (*Refuse-Derived Fuel*) management

* Research, develop the domestic production of incinerator and the small waste to energy system at capacity not over 50 t/day.

* Develop the standards and appliances for producing oil from plastic waste

4.1.5 Biomass: The 2021 target is 3,630 MW with a total current capacity is at 1,751.86 MW. Development would be focused on:

1. Promoting community to collaborate in broaden production and consumption of renewable energy

* Promote establishment of ‘‘Distributed Green Generation (DGG)’’ as for community energy station by the local energy enterprise group as owner to integrated manage the station.

* Promote planting the fast growing trees in any wilderness/wasteful land or non-utilised area, and to process for distribution as fuel to DGG in order to extend using in electricity generation.

2. Adjusting incentive measures for investment from private sector appropriated with the situation

* Consider to require supportive measures as adder or FIT and RHI (*Renewable Heat Incentive*) specially for DGG project at community level in particular.

* Prepare the financial support measure on efficiency improvement of the old biomass power plants for changing any low pressure boilers to high pressure boilers.

3. Improving infrastructure system

* Assign EGAT and PEA (the *Provincial Electricity Authority*) to consider extending the transmission and distribution lines to support the development of biomass power plant project, especially in area with high potential of energy from biomass, such as at the South.

4. Public Relations and building up comprehensive knowledge of people

* Build up the collaborative process in target area to install the biomass-derived energy system, campaign to educate children and juveniles in the detailed biomass management for energy and environment at local level.

* Establish the network of biomass energy entrepreneurs.

5. Promoting research work as mechanism in development of integrated renewable energy industry

* Develop the production, consumption and standard of Biomass Pallet as for the future biomass fuel.

* Develop the technologies of Gasifier and Gas Engine, including theirs extended industrial plants for domestic production.

* Develop the Biomass-to Liquid technology.

4.1.6 Biogas: The 2021 target is 600 MW. A total capacity is 138 MW at present.
Development would be focused on:

1. Promoting community to collaborate in broaden production and consumption of renewable energy

* Promote and support biogas production at household level, especially rural community to benefit using in their households.

* Promote and support development of biogas network for connecting to system with excess capacity for sharing in community through mechanism of community self management.

2. Adjusting incentive measures for investment from private sector appropriated with the situation

* Promote biogas production/consumption as CBG (*Compress Bio-Methane Gas*) for transportation through price mechanism that reflects cost to support using biogas for CBG production.

3. Amending laws and regulations which do not benefit to renewable energy development

* Study and develop laws and regulations for Biogas Safety Standard.

4. Public Relations and building up comprehensive knowledge of people

* Conduct public relations via media to disseminate knowledge and news and to create good image of investment in producing and utilising of biogas safely *(**Biogas Safety Campaign***).

5. Promoting research work as mechanism in development of integrated renewable energy industry

* Research and develop producing biogas from mixed wastes (Co-Digestion), especially digesting of biomass resources as water hyacinth, corn cob to mix fermenting with animal manures.

* Develop using biogas as CBG for transportation at higher efficiency.

4.2 New energy for power generation

Energy Ministry by DEDE had the study work on new energy resources capable for electricity generation with an expected potential in commercial development for the future, i.e.

4.2.1 Geothermal energy: a target in 2021 is 1 MW with a present capacity of 350 kW.

1. Problems and barriers of geothermal development and promotion

* Restriction in development of geothermal source for power generation since most domestic sources are not at high heating value.

* Building up comprehensive understanding of community in using geothermal for energy production.

* Need to rely on overseas technology.

2. Direction and trend to develop the geothermal energy

* Develop the potential map of national geothermal sources and technologies.
* Assess the feasibility in development of geothermal sources by appropriate technologies.
* Evaluate the cost effectiveness and impacts on community, environment and public health from energy production.
* Try adopting technology which utilises geothermal energy at not high temperature.
* Follow up any technologies suitable for potentials and geography.

4.2.2 Energy from wave and tidal current

The target is at 2 MW but no power generation at the present.

1. Problems and barriers in development and promotion of energy from ocean wave and tidal current

* Lack of data and assessment on wave and tidal energy potentials.

2. Direction and trend to develop tidal and wave energy

* Speed up the study to capably identify the sources and technology types to be applied for energy from Thailand sea. It is expected primarily that potential areas are at under the Sarasin Bridge in Phuket and surrounding areas of Koh Sa Mui – Pa Ngan and Koh Tan for examples.
* Capably assess the development potential and readiness preparation to develop the pilot project.

4.2.3 Hydrogen Energy and energy storage system

1. Problems and barriers to develop and promote of hydrogen energy and energy storage system

* Lack of putting an importance on planning the research and development.
* Need to rely on overseas technologies
* Domestic research and development are not yet broaden and lack of continuous budget support.
* No incentive measure in development and utilising hydrogen energy in power generation industry and to develop hydrogen as energy storage system.

2. Direction and trend to develop hydrogen energy and energy storage system

* Study the appropriate raw material sources of hydrogen production in Thailand
* Research and develop technologies of domestic production, storage and related devices.
* Research and develop hydrogen production process at high efficiency with low cost.
* Research and develop technology of hydrogen application in energy storage system, including to research and demonstrate other types of potential energy storage system, for examples: Vanadium Redox Flow Technology and Lithium-Ion Battery Technology, etc.

4.3 Renewable energy for transport sector (to substitute oil use)

4.3.1 Ethanol (as fuel to substitute benzene): the 2021 target is at 9 ml/day where a total capacity is at 1.3 ml/day at the present. Development will be focussed on two aspects, i.e.

1. Supply side

1.1 Increase the national average production per rai per year of cassava and sugarcane at yielding not less than 5 and 15 t/rai/yr. in 2021 as follows:

Feedstock/ Raw material	Planting area (million rai)	Average Production (t/rai)	Annual Production (mt/yr)
Cassava	7	5	35
Sugarcane	7	15	105

1.2 Promote other alternative crops commercially such as: sweet sorghum, etc.

2. <u>Demand side</u>

2.1 Prepare to terminate using of 91 benzene, ending by October 2012.

2.2 Make the price differentiate of E20 at 3 baht/l lower than 95 gasohol and prompt setting the marketing value of E20 to higher than 91 gasohol at not less than 0.50 baht/l as incentive to encourage the extension of E20 service stations.

2.3 Support the budget on research, testing and building up incentive to raise ethanol demand, as: applying conversion kit for any old cars and motorcycles to capably fuelled by E85 or tuning - modifying the diesel engines for fuelling by ED 95 (*Ethanol blended with additives or a blend of 95% ethanol and 5% ignition improver and is used in modified diesel engines*), for examples.

2.4 Continuously campaign the public relations to create understanding on the E10, E20 and E85 gasohol.

2.5 Support the manufacturing of Eco-Car and E85 Car in general, by reducing excise tax to car makers for 50,000 baht per each E85 Car and 30,000 baht for each of Eco-Car.

2.6 Propose the requirement on E85 cars procurement for official vehicles.

2.7 Amend the laws and regulations to support the Ethanol Free Trade in the future, such as: requiring an exemption in Liquor Act for not enforcing ethanol production for fuelling and amend the Excise Tax Act to support ethanol export and as a readiness preparation to support the Multi-Dispenser Technology, etc.

4.3.2 Bio Diesel (as fuel to substitute diesel): the 2021 target is at 5.97 ml/day where a total capacity is at 1.62 ml/day at the present. Development will be focussed on two aspects, i.e.

1. <u>Supply side</u>

Promote growing palm trees in appropriate areas not competing with any food crops.

1.1 Support palm plantation area of 5.5 million rai and getting a total palm yielding of 5.3 million rai by 2021.

1.2 Increase production capacity of crude palm oil at not less than 3.05 mt/yr.

1.3 Set the production or yielding target at not lower 3.2 t/rai/yr in proportional to oil content not less than 18 percent

2. <u>Demand side</u>

2.1 Manage the proportion of bio diesel blending relevant to the domestic palm oil production.

2.2 Do the pilot fuelling of B10 or B20 in Fleet Trucks or proper Fishery Boats.

2.3 Prepare to develop the bio diesel standard of FAME to gain the blending share up to 7 percent in diesel oil.

3. Integrated management: start from growing the oil palm trees, oil extraction, vegetable production for consuming, bio diesel production and its extended industrial plants, import, export and R&D to reduce cost and increase value added at maximum to the country.

4.3.3 New fuel for the future diesel substitution : the 2021 target is at 25 ml/day.

1. Since the present planning of using ethanol to substitute benzene can be made efficiently in the country. But on a reverse, planning to use biodiesel for diesel oil substitution still faces lots of restrictions, especially the insufficient feedstock of Thailand for producing biodiesel. Therefore, R&D on "**The Future New Fuel for Diesel Substitution** " would be much important to identify the new fuel development trend in seven ways comprising the two ways of new energy crop development, i.e. jatropha and micro algae ; the three ways on using ethanol for blending to substitute diesel oil, i.e. FAEE (*Fatty Acid Ethyl Ester*), ED95 (*Ethanol blended with Additives*) and diesohol; and another two ways on development of oil conversion technology, i.e. BHD (*Bio Hydrofined Diesel*) and BTL (*Biomass to Liquid*). The action plan (2012-2016) was already established to promote research work on the Future New Fuel for Diesel Substitution through an integration in collaborative working between Energy Ministry and Ministry of Science and Technology. Such the integrated task may be concluded as follows.

- **Jatropha :** develop the jatropha variety for yielding high productivity, develop
- machinery for jatropha cycle, and test the long-run operation of engine.
- **Seaweed-Algae**: develop the varieties and commercial production.

- **FAEE** : test its operation in cars and requiring the quality testing standard.
- **ED95**: develop the additives and technology for modifying the old engine.
- **Diesohol**: test for ethanol proportion appropriated to blend with diesel blended of 3-5
- % biodiesel and test the engine operation.
- **BHD**: test its operation in engine and establish the quality testing standard.
- **BTL**: produce at pilot scale to test its operation.

2. An extension of commercial production (long term: 2017-2021) will be prepared next step on establishment of action plan after the research work is accepted. It is expected of extension to all refineries in Thailand.

Development Scheme of the Future New Fuel for Diesel Substitution

Development Plan	Indicator	Phase 1	Phase 2
1. Research Plan 1.1 ED95 1.2 Diesohol 1.3 FAEE 1.4 BHD 1.5 Seaweed/Algae 1.6 Jatropha 1.7 BTL	- Study result of new fuel development in the future is clear enough to make decision on policy and ready to implement the Pilot Project and commercial development respectively.	2014: ED 95, Diesohol 2015: FAEE, BHD 2016: Seaweed/Algae, BTL, Jatropha	
2. Pilot Project and Trial Fleet Test	- Emerge the Pilot Project and Trial Fleet Test. - Decide to select the most optimal new fuel.	2014-2016 - Pilot Project for ED95 or Diesohol or FAEE 2015-2017 - Pilot Project for seaweed, Jatropha + BHD 2015-2017 - Pilot Project for BioJet, BHD	
3. Commercial Development	- Emerge the commercial production plants with a total capacity of 2 ml/d in 2018. - Increase capacity to 25 ml/d in 2021.		Commercial Production Capacity (ml/d) 2018: 2 2019: 6 2020: 15 2021: 25

4.4 Renewable Heat (*RE for Heat Generation*)

* Manage to develop the RHI (*Renewable Heat Incentive*) measure to promote using renewable energy resources, for ex: biomass, MSW, biogas and solar, etc. to be converted to heat for industrial sector to replace fossil fuels, i.e. LPG, heavy oil, coal/lignite, etc. as follows.

4.4.1 Solar energy: the 2021 target is at 100 ktoe where a total capacity is 1.98 ktoe at present.

* Promote the system installation of solar heating/ cooling, government buildings might be installed as the pilot scheme.
* Develop the solar hot water system for households at low cost.
* Develop the compulsory mechanism such as: Building Energy Code to enforce large buildings for installing the Solar Hot/ Cool Water System.
* Promote the solar drying system for SMEs and local enterprises (OTOP)

4.4.2 Biogas: the 2021 target is 1,000 ktoe with a total capacity presently at 379 ktoe.

* Implement the Compress Biogas (CBG) Project as supplement part and support the promotion on using natural gas in transport sector or NGV (*Natural Gas for Vehicles*) with a target to raise NGV system by 5 percent.

4.4.3 Biomass: a target in 2021 is 8,200 ktoe where total capacity at present is 3,286 ktoe.

* Promote the production system of biomass pallets.

* Promote the co-generation system of CHP or *Combined Heat and Power* (electricity and thermal) or Biomass Co-generation System for broaden use.

5. Target Values by Renewable and Alternative Energy Development Plan for 25 % in 10 Years

Table 1: the AEDP Renewable Energy Consumption Target

Energy Resource	Unit	Old Target	New Target	
Electricity		ktoe	ktoe	GWh
1. Wind Energy		89	134	1,283
2. Solar Energy		56	224	2,484
3. Hydropower		85	756	5,604
4. Biomass		1,933	1,896	14,008
5. Biogas		54	270	1,050
6. MSW		72	72	518
7. New Energy		1 (Hydrogen)	0.86	10
Total		**2,290**	**3,352.86**	**24,956**
Proportion to Substitute Electricity	**%**	**6%**	**10.1%**	
Thermal	**Unit**	**Old Target**	**New Target**	
1. Solar Energy	ktoe	38	100	
2. Biomass	ktoe	6,760	8,200	
3. Biogas	ktoe	600	1,000	
3.1 Biogas			797	
3.2 CBG (5 % of NGV)			203	
4. MSW	ktoe	35	35	
Total	**ktoe**	**7,433**	**9,335**	
Biofuel				
1. Ethanol	ml/d	9.0	9.0	
2. Biodiesel	ml/d	4.5	5.97	
3. New Fuel for Diesel Substitution	ml/d	_	25	
Total	**ml/d**	**13.5**	**39.97**	
Proportion to Substitute Oil	**%**	**14%**	**44%**	
Proportion of Renewable Energy to the National Final Energy Consumption		**12% (excluding NGV)**	**25%**	

Table 2: Target on Renewable Power Generation for Driving and Monitoring

Energy Resource	Power Generation Target in 2021 (GWh)	Accumulated Installing Capacity in 2021 (MW)
1. Wind Energy	1,283	1,200
2. Solar Energy	2,484	2,000
3. Hydropower	5,604	1,608
		* EGAT Pumped Storage 1,284 MW
		* Small Hydro 324 MW
4. Biomass	14,008	3,630
5. Biogas	1,050	600
6. MSW (Municipal Solid Waste)	518	160
7. New Energy	10	3
		* Geothermal 1 MW
		* Wave or Tidal 2 MW
Total	**24, 956 GWh**	**9,201 MW**

6. Benefit Gain for Thailand

	the 15-Year REDP (*old plan*)	AEDP for 25 % in 10 Years (*new plan*)
Energy Aspect		
* Percentage of Fossil Substitution	12 % (20 % including NGV)	25 % (excluding NGV)
* Power Generation from Renewable Energy	5,604 MW	9,201 MW
* Thermal Generation (ktoe)	7,433	9,333
* Biofuel (ml/d)	13.5	39.97
* Percentage of Oil Substitution	14%	44%
Economic Aspect (unit: million baht/year)		
* Reducing Oil Import	460,000	574,000
* Promoting Investment from Private Sector	382,240	442,000
Environmental Aspect		
* CO_2 Reduction	42 mt/yr in 2013	76 mt/yr in 2012
* Revenue Gained from Selling Carbon Credit	14,000 million baht/yr	23,000 million baht
Innovation and Technology Development		
* Research Work Plan	none	with a definite Action Plan for 2012-2016

Source: DEDE AEDP 2012-2021 presented on DEDE Website at http://www.dede.go.th/dede/images/stories/aedp25.pdf in Thai version. English by Dr Renu Cheokul (April 2012)