Department of Alternative
Energy Development and Efficiency
MINISTRY OF ENERGY

Thailand Alternative Energy Development Plan (AEDP 2015) and Progress

Miss Jariya Budnard
Engineer Professional Level, Bureau of Energy Research

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Topic

- Energy situation in Thailand
- Alternative Energy Development Plan (AEDP2015) and Supporting Measures
- Performance on Alternative Energy Policy 2016
- Development of Energy Storage for the Expanding RE supply

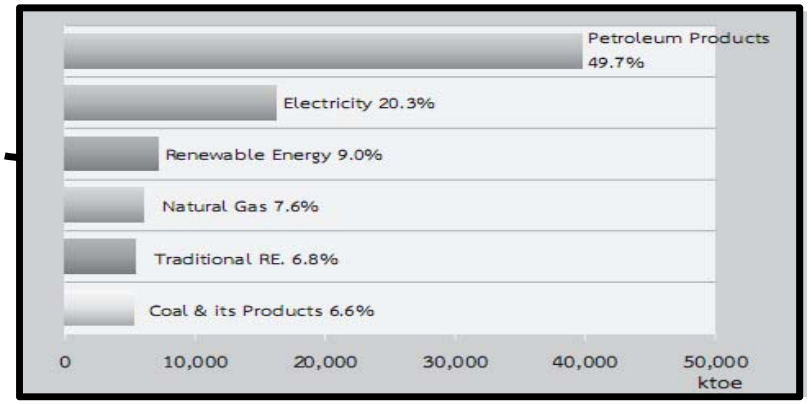
1. Energy situation in Thailand

Thailand final energy consumption, by fuel type

2014-2016 (*Unit: ktoe*)

FINAL ENERGY CONSUMPTION BY FUEL TYPE	QUANTITY (ktoe)			GROWTH (%)	
	2014	2015	2016[P]	2015	2016[P]
Final Energy Consumption	75,804	77,881	79,929	2.7	2.6
• Commercial Energy	61,075	63,844	67,296	4.5	5.4
- Petroleum Products	36,570	37,981	39,714	3.9	4.6
- Electricity	14,371	15,455	16,233	7.5	5.0
- Coal & its products	4,629	4,403	5,313	(4.9)	20.7
- Natural Gas	5,505	6,005	6,036	9.1	0.5
• Renewable Energy	5,775	6,979	7,182	13.9	9.2
• Traditional RE.	8,954	7,458	5,451	(16.7)	(26.9)

- In 2016, Thailand's final energy consumption **was 79,929 ktoe**, an increase of **2.6% from the previous year**.
- The total value of final energy consumption was **856 Billion Baht**
- **Commercial energy consumption shared 84.2%** of the total final energy consumption while the rest 9.0% and 6.8% were renewable energy and traditional energy respectively.



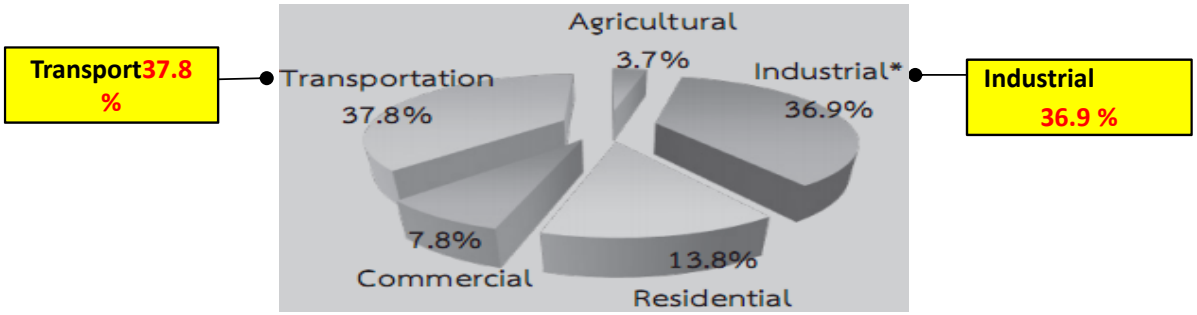
SOURCE: Energy Balance of Thailand 2016 by DEDE (www.dede.go.th)

1. Energy situation in Thailand

Thailand final energy consumption by Economic Sector,2014-2016

(Unit: ktoe)

FINAL ENERGY CONSUMPTION BY ECONOMIC SECTOR	QUANTITY (ktoe)			GROWTH (%)	
	2014	2015	2016P	2015	2016P
1. Agricultural	3,957	3,891	2,987	(1.7)	(23.2)
2. Industrial*	28,117	27,946	29,466	(0.6)	5.4
3. Residential	11,459	11,591	11,071	1.2	(4.5)
4. Commercial	5,470	5,952	6,215	8.8	4.4
5. Transportation	26,801	28,501	30,190	6.3	5.9
Total	75,804	77,881	79,929	2.7	2.6



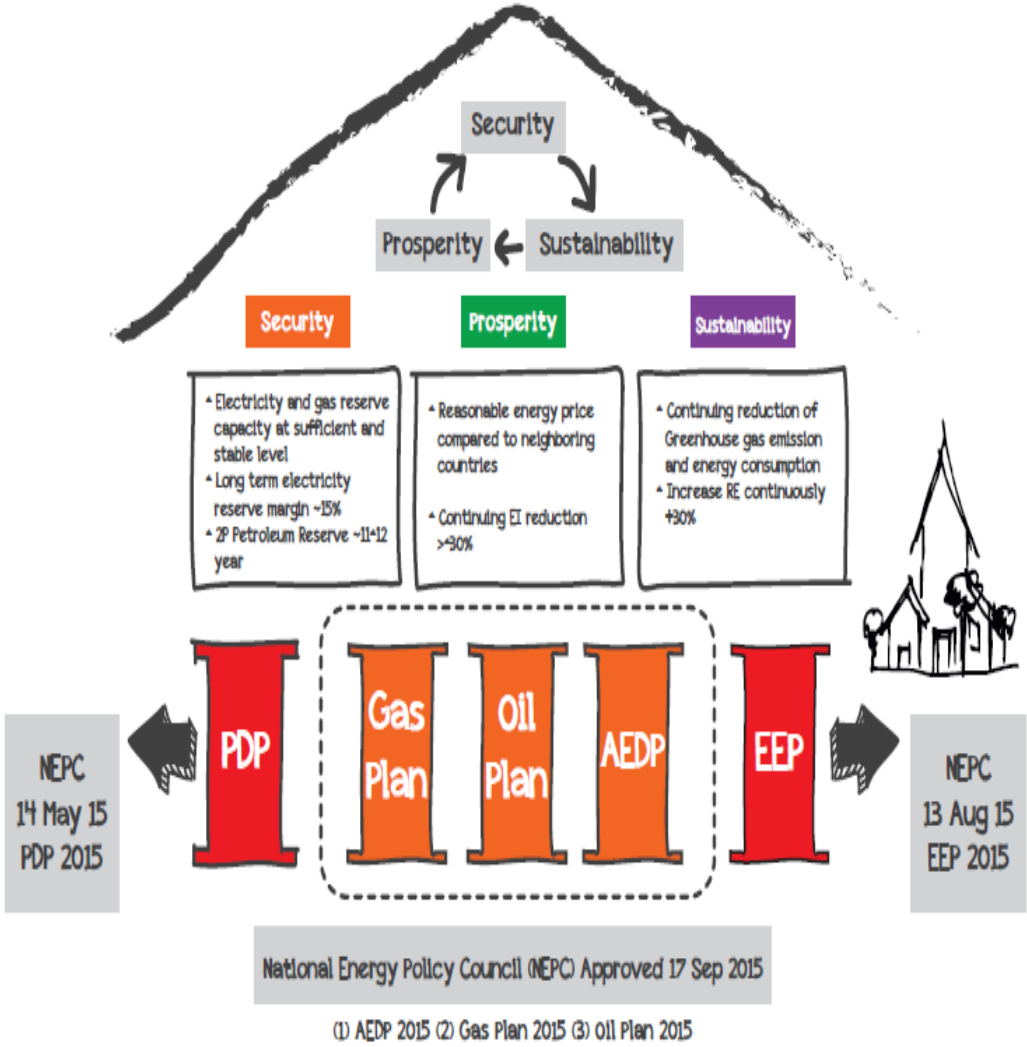
- **Since 2014, the transportation and industrial sector have shared the largest source of energy consumption.**
- Additionally, **In 2016 transportation sector shared the largest portion or 37.8% of the final energy consumption,** followed by industrial sector, residential sector, commercial sector and agricultural sector in sharing 36.9%, 13.8%, 7.8% and 3.7% respectively.

* Including manufacturing (29,206 ktoe), mining (128 ktoe) and construction (132 ktoe).

SOURCE: Energy Balance of Thailand 2016 by DEDE (www.dede.go.th)

2. Alternative Energy Development Plan (AEDP2015)

Thailand's Integrated Energy Blueprint or TIEB



The TIEB includes five individual national energy plans, which are aligned under the same timeframe **(2015-2036)** and focuses on suitable energy balance.

The five individual energy plans under TIEB include

- **Power Development Plan – PDP 2015**
- **Energy Efficiency Plan – EEP 2015**
- **Alternative Energy Development Plan – AEDP 2015**
- **Oil Plan – 2015 • Gas Plan – 2015**

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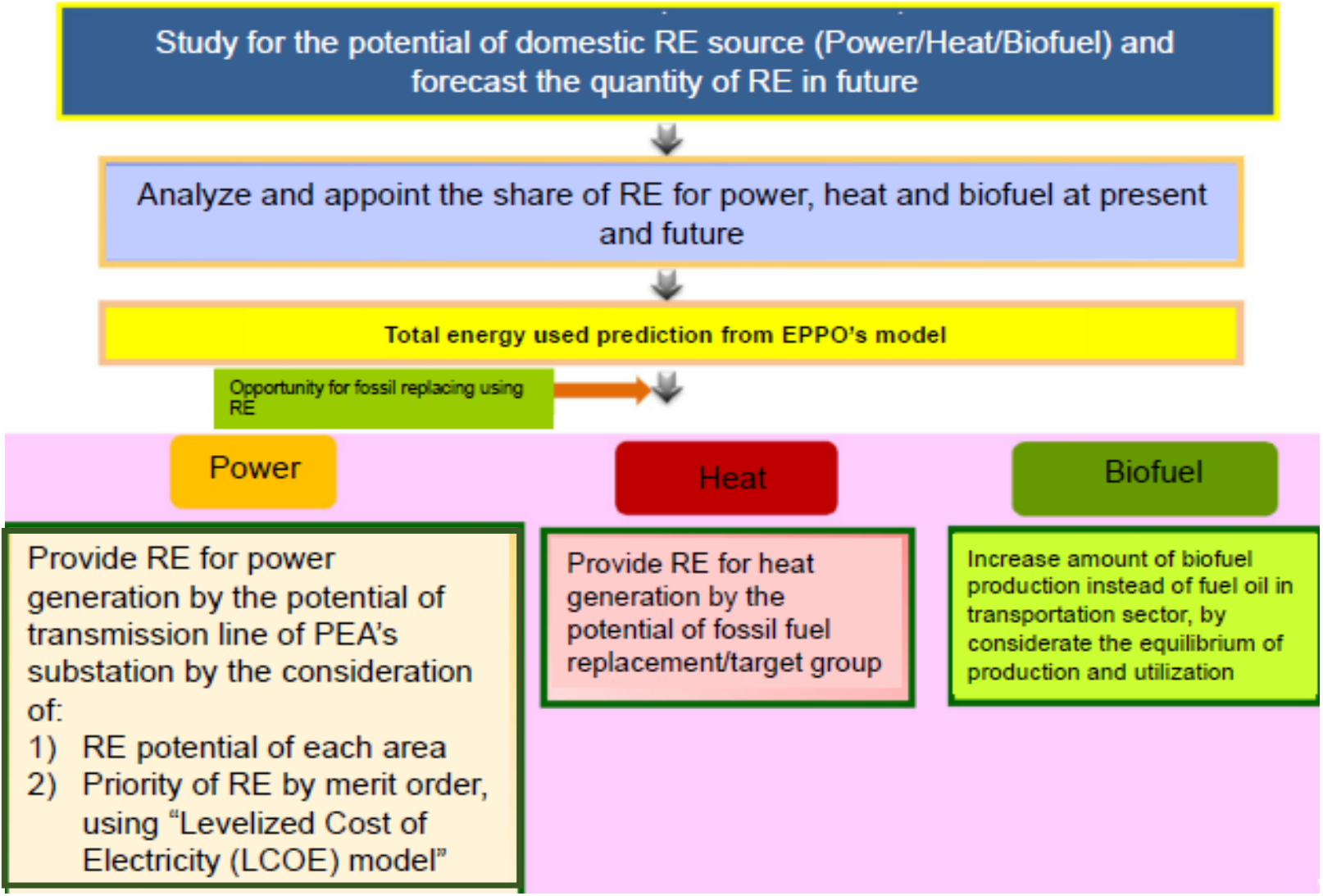
2. Alternative Energy Development Plan (AEDP2015)

Initial concepts for AEDP 2015



1) **Promotion on power generation from MSW, biomass and biogas, to benefit both farmer and community.**
2) **Set up target of the provincial RE development by zoning of electricity demand and RE potential**
3) **Power generation from solar and wind if the investment cost will be able to compete with power generation using LNG**
4) **Incentives by using the competitive bidding, and promote the utilization by energy consumption reduction (Net Metering Or Self-Consumption)**

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2. Alternative Energy Development Plan (AEDP2015)

Committed to the development of low-carbon society

Government Funding On R & D Activities

Alternative Energy Development Plan (AEDP : 2015-2036)

Encouraging Private-Led Investment

Target 30 % of RE in Total Energy Consumption By 2036

Solar	Wind	Hydro	Bio Energy			Biofuels	Others
			Biomass	Biogas	MSW/Ind.Waste		
6,000 MW	3,002 MW	• Small+Mini Hydro 376 MW • Large hydro 2,906.40 MW	5,570 MW	• Industrial /Animal Waste 600 MW • Energy crops 680 MW	• MSW 500MW • Industrial Waste 50 MW	• Ethanol 11.3 Million L/d • Biodiesel 14.0 Million L/d •Pyrolysis 0.53 Million L/d • Compress Bio-methane Gas (CBG) 4,800 tons/d	Alternative RE :Tidal wave/ Geothermal /Used Tire 10 ktoe (Heat) Alternative Fuel 10 ktoe
1,200 ktoe (Heat)			22,100 ktoe (Heat)	1,283 ktoe (Heat)	495 ktoe (Heat)		

RE consumption	**39,388.67 ktoe (By 2036)**
Electricity	**19,640.40 MW (5,588.27 ktoe)**
Heat	**25,088 ktoe**
Biofuel	**8,712.43 ktoe**

2. Alternative Energy Development Plan (AEDP2015)

SPP Hybrid Firm and VSPP Semi-Firm target

The principle of FiT determination for SPP Hybrid Firm and VSPP Semi Firm

	SPP Hybrid – Firm	VSPP – Semi Firm
Condition of participation	Only new power plants, all kind of fuel type	Only new power plants, Type of biomass, biogas (sewage/waste) and biogas (energy crops)
Contracted capacity	10 – 50 MW	< 10 MW
Firm model	Firm all year* (*In Accordance to ERC's definition)	Semi Firm for 6 months (Covering Mar-Jun) Other 6 months are Non-firm
Characteristic of Firm-model	Peak 100% and Off-peak 65%* (*In accordance to ERC's definition)	Peak 100% and Off-peak 65%* (*In accordance to ERC's definition)
Mix-sources (Hybrid)	≥ 1 type(s) Trading at the same meter / UMM required (fossil fuel supplement is allowed only for start-up the power plant)	Only 1 type (fossil fuel supplement is allowed only for start-up the power plant)
proportion of Hybrid	No proportion determined	no Hybrid
Installation of ESS	Installation of ESS is allowed	Installation of ESS is allowed
SCOD	Within 2020	Within 2019-2020
Purchased price mechanism	single FiT rates for all kind of fuel type with competitive bidding mechanism	FiT rates by each type of fuel With competitive bidding mechanism (FiT Premium only for Firm-duration).
Fuel supply plan	There must be a plan to procure fuel, and energy crops must be involved, by defined proportion.	There must be a plan to procure fuel, and energy crops must be involved, by defined proportion.
Guarantee of Firm	✔	✔

Note: fuel type according to AEDP's plan

Announced by Energy Policy and Planning Office, Ministry of Energy

NEPC's resolution on 17 FEB 2017

- Approved FiT rate for SPP Hybrid Firm, and Semi-Firm and assigned ERC to announced regulations of SPP Hybrid Firm and VSPP Semi-Firm
- EPPO has studied the policy concept to promote PPA with various sources of renewable energy geration electricity (Hybrid)
  - To increase the security of power system
  - To reduce the variation of intermittent energy sources
  - To reduce the fuel supply demand in each type of RE
- Approved purchasing target sequentially as follows
  SPP Hybrid Firm 300 MW
  VSPP Semi-Firm 269 MW
  - **Biomass energy 125 MW**
  - **Biogas energy 96 MW**
  - **Energy crop energy 47 MW**
- Assigned ERC and DEDE to determine the purchasing quantity by region
- Announced FiT rate for SPP Hybrid Firm and VSPP Semi-Firm by ERC

Note:
1) NEPC is an abbreviation of the National Energy Policy Commission
2) EPAC will determine the installed capacity and area that will be opened for the next purchase.

SOURCE: Energy Policy and Planning Office, Ministry of Energy
(http://www.eppo.go.th/images/Infromation_service/NEWS/2017/06Jun/08Jun/PPT-NEPC-hybrid-englishUBM2.pdf)

2. Alternative Energy Development Plan (AEDP2015)

Strategies to promote the development of Renewable energy

Strategy Roadmap of AEDP 2015

30% share of renewable energy consumption by 2036

Strategy 1
Preparing for RE law RE feedstock and technology readiness

Target
Increase production capability, RE feedstock management with appropriate technology development

Strategy 2
Accelerating the potential of RE generation, consumption and market

Target
Accelerate RE production potential and demand

Strategy 3
Creating public awareness and access to RE knowledge and updates RE statistic information

Target
Create public awareness, knowledge base and understanding of efficient and sustainable RE production and consumption

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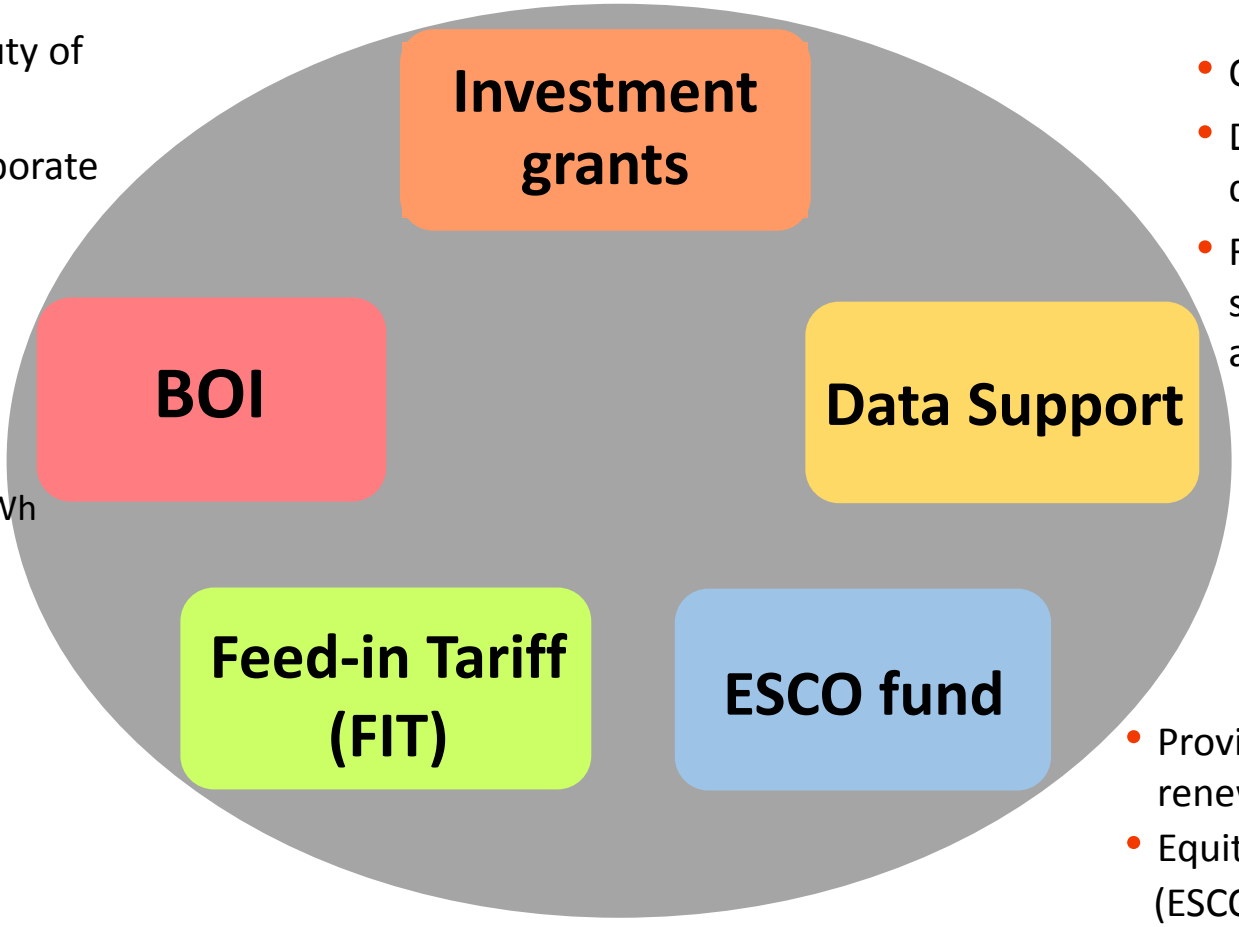
2. Alternative Energy Development Plan (AEDP2015)
Supporting Measures

- Exemption of imported duty of equipment or machines
- Exemption of income-corporate taxes resulting from selling RE or saving energy for periods up to 8 years



- One stop service center
- Data on renewable development progress
- Resource data maps, such as solar ,wind, biomass, biogas and MSW

- Biomass : 4.24-5.34 THB/kWh
- Biogas: 3.76-5.34 THB/kWh
- MSW: 5.08-6.34 THB/kWh
- Wind: 6.06 THB/kWh
- Hydro: 4.90 THB/kWh
- Solar: 5.66-6.85 THB/kWh
- SPP Hybrid Firm: 3.66 THB/kWh
- VSPP Hybrid Firm: 3.76-5.34 THB/kWh

- Provides lower risk capital to renewable focused businesses
- Equity investment (ESCO venture capital)
- Equipment leasing
- Credit guarantee facility

2. Alternative Energy Development Plan (AEDP2015)

Feed-in Tariff (FIT)

Capacity (MW)	FiT (THB/kWh)			Period of Subsidy (Year)	FiT Premium (THB/kWh)	
	FiT_F	$FiT_{V,2017}$	$FiT^{(1)}$		Biofuel Project (8 years)	Project in Southern Territory Area (Throughout Project Period)
1) MSW (Hybrid Management)						
Existing Capacity ≤ 1 MW	3.13	3.21	6.34	20	0.70	0.50
Existing Capacity > 1-3 MW	2.61	3.21	5.82	20	0.70	0.50
Existing Capacity > 3 MW	2.39	2.69	5.08	20	0.70	0.50
2) MSW (Sanitary Landfill)	5.60	-	5.60	10	-	0.50
3) Biomass						
Existing Capacity ≤ 1 MW	3.13	2.21	5.34	20	0.50	0.50
Existing Capacity > 1-3 MW	2.61	2.21	4.82	20	0.40	0.50
Existing Capacity > 3 MW	2.39	1.85	4.24	20	0.30	0.50
4) Biogas (Waste Water/Sewage)	3.76	-	3.76	20	0.50	0.50
5) Biogas (Energy Crop)	2.79	2.55	5.34	20	0.50	0.50
6) Hydropower						
Existing Capacity ≤ 200 kW	4.90	-	4.90	20	-	0.50
7) Wind	6.06	-	6.06	20	-	0.50

Remarks

(1) This FiT rate applies to a project that delivers power into the grid in the year 2017. After 2017, the FiTv rate will be increased based on the core inflation rate. This only applies to waste (integrated waste management), biomass and biogas (energy plants) projects.

(2) Projects located in Yala, Pattani, Narathiwat and 4 Sub-districts in Songkla (Jana Sub-district, Tepha Sub-district, Sabayoi Sub-district and Natawee Sub-district) only.

2. Alternative Energy Development Plan (AEDP2015)

Feed-in Tariff (FIT)

Installed Capacity (MWp)	FiT Rate for 2014-2015		
	Fit Rate (THB/kWh)	FiT Rate (USD/kWh)	Support Period
PV Ground mount			
≤ 90 MWp	5.66	0.16	25 Years
PV Rooftop (Household)			
≤ 10 kWp	6.85	0.20	25 Years
PV Rooftop (Commercial/Factory)			
> 10 – 250 kWp	6.40	0.18	25 Years
> 250 – 1,000 kWp	6.01	0.17	25 Years
PV Ground mount (Government site and Agriculture Cooperative)			
≤ 5 MW	5.66	0.16	25 Years

*Exchange rate 1USD=35 THB

September 26, 2016, The NEPC meeting approved New FiT (Feed-in Tariff) rate for VSPP solar power stations at 4.12 Baht/unit. Subsidy period is for 25 years.

2. Alternative Energy Development Plan (AEDP2015)

Feed-in Tariff (FIT)

Feed-in Tariff rate for SPP Hybrid Firm

Installed capacity(MW)	FiT (THB/kWh)			Period (years)
	FiT_F	$FiT_{V,2560}$	$FiT^{(1)}$	
SPP Hybrid Firm				
Installed capacity >10-50 MW	1.81	1.85	3.66	20 years

Note : FiT rates will be applied for projects that COD within 2017. After that, FiT Variable rates will continuously increase by core inflation.

Feed-in Tariff rate for VSPP Hybrid Firm

Installed Capacity (MW)	FiT (THB/kWh)			Period (years)	FiT Premium (THB/kWh)	
	FiT_F	$FiT_{V,2560}$	$FiT^{(1)}$		Firm period not exceeding 6 months (project lifetime)	Projects in the southern border provinces (2) (project lifetime)
1) Biomass						
- Installed Capacity ≤ 3 MW	2.61	2.21	4.82	20 years	0.40	0.50
- Installed Capacity > 3 MW	2.39	1.85	4.24	20 years	0.30	0.50
2) Biogas (sewage/waste)	3.76	-	3.76	20 years	0.50	0.50
3) Biogas (energy crops)	2.79	2.55	5.34	20 years	0.50	0.50

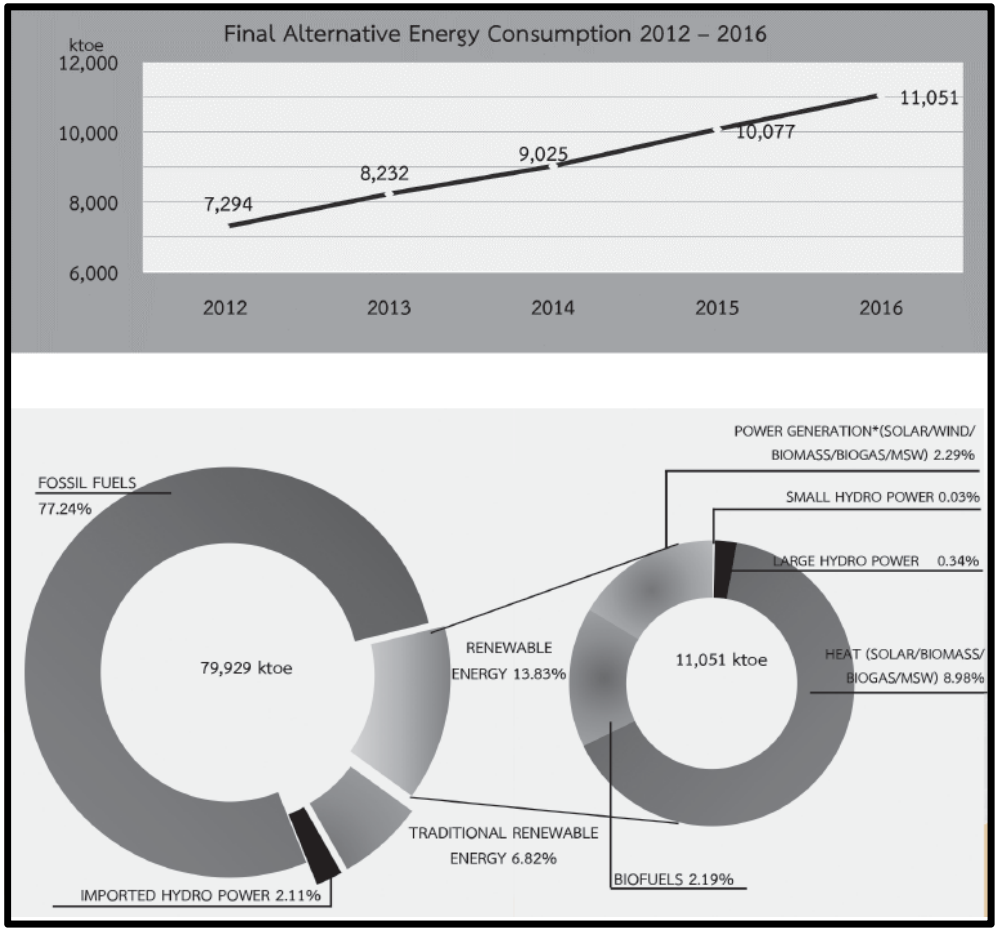
Note:

(1) FiT rates will be used for projects that COD within 2017. After 2017, FiT Variable rates will continuously increase by core inflation.

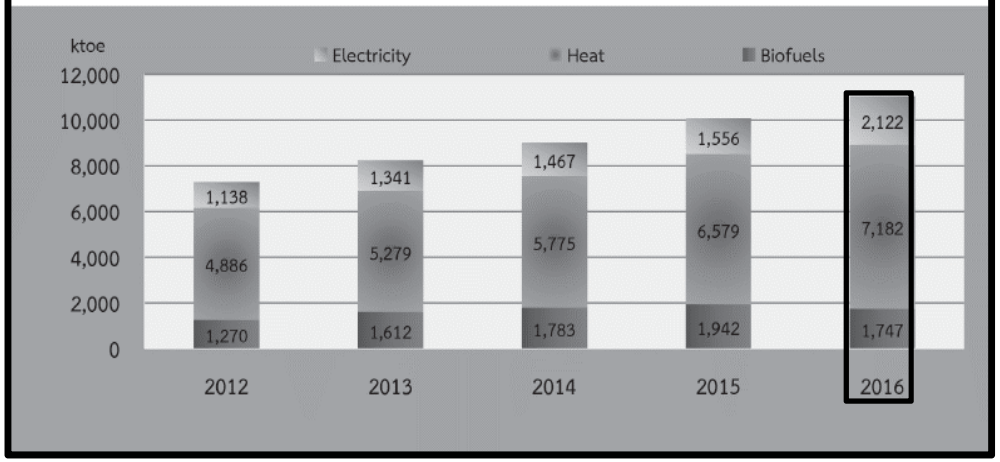
(2) 2) Projects in province Yala, Pattani, Narathiwat and 4 districts in Songkhla, i.e. Chana, Tepa, Saba Yoi and Nathawee District

3. Performance on Alternative Energy Policy 2016

Final Alternative Energy Consumption



Alternative Energy	Consumption (ktoe)					Growth rate (%)
	2012	2013	2014	2015	2016	2015-2016
1. Electricity [1/2/] (Solar, Wind, Small Hydro Power, Large Hydro Power, Biomass, MSW and Biogas)	1,138	1,341	1,467	1,556	2,122	36.4
2. Heat (Solar, Biomass, MSW and Biogas)	4,886	5,279	5,775	6,579	7,182	9.2
3. Biofuels	1,270	1,612	1,783	1,942	1,747	(10.0)
- Ethanol	430	707	874	879	684[3/]	(22.2)
- Biodiesel	840	905	909	1,063	1,063	-
Total	7,294	8,232	9,025	10,077	11,051	9.7



SOURCE: Thailand Alternative Energy Situation 2016 by DEDE (www.dede.go.th)

3. Performance on Alternative Energy Policy 2016

The total installed capacity of Electricity and Heat Generation by using AE

Alternative Energy	Installed capacity (MW)					Growth rate (%)
	2012	2013	2014	2015	2016	2015-2016
Solar	376.7	823.5	1,298.5	1,419.6	2,446.1	72.3
Wind	111.7	222.7	224.5	233.9	507.0	116.8
Small Hydro Power	101.8	108.8	142.0	172.1	182.1	5.8
Biomass	1,959.9	2,320.8	2,451.8	2,726.6	2,814.7	3.2
Biogas	193.4	265.7	311.5	372.5	434.9	16.8
MSW	42.7	47.5	65.7	131.7	145.3	10.3
Large Hydro Power	2,906.4	2,906.4	2,906.4	2,906.4	2,906.4	-
Total	5,692.6	6,694.9	7,400.4	7,962.8	9,436.5	18.5

Alternative Energy	Heat (ktoe)					Growth rate (%)
	2012	2013	2014	2015	2016	2015-2016
Solar	3.5	4.5	5.1	5.7	6.7	17.5
Biomass	4,346	4,694	5,144	5,990	6,507	8.6
Biogas	458	495	528	495	593	19.6
MSW	78	85	98	88	75	(14.8)
Total	4,886	5,279	5,775	6,579	7,182	9.2

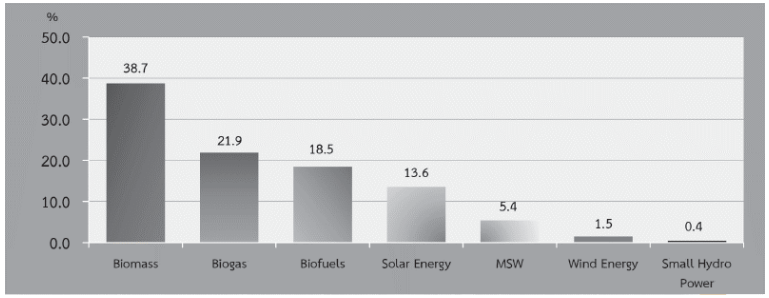
SOURCE: Thailand Alternative Energy Situation 2016 by DEDE (www.dede.go.th)

3. Performance on Alternative Energy Policy 2016

Biofuels consumption (Ethanol and Biodiesel) and Alternative Energy investment

Alternative Energy	Biofuels (million litres/day)					Growth rate (%)
	2012	2013	2014	2015	2016	2015-2016
Ethanol	1.4	2.6	3.2	3.5	3.7	5.7
Biodiesel	2.8	2.9	2.9	3.4	3.4	-
Total	4.2	5.5	6.1	6.9	7.1	2.9

Alternative Energy Investment (million Baht)	Solar Energy	Wind Energy	Samll Hydro Power	Biomass	Biogas	MSW	Biofuels	Total
	13,739.4	1,510.2	278.0	39,048.8	22,090.4	5,468.3	18,685.1	100,820.2

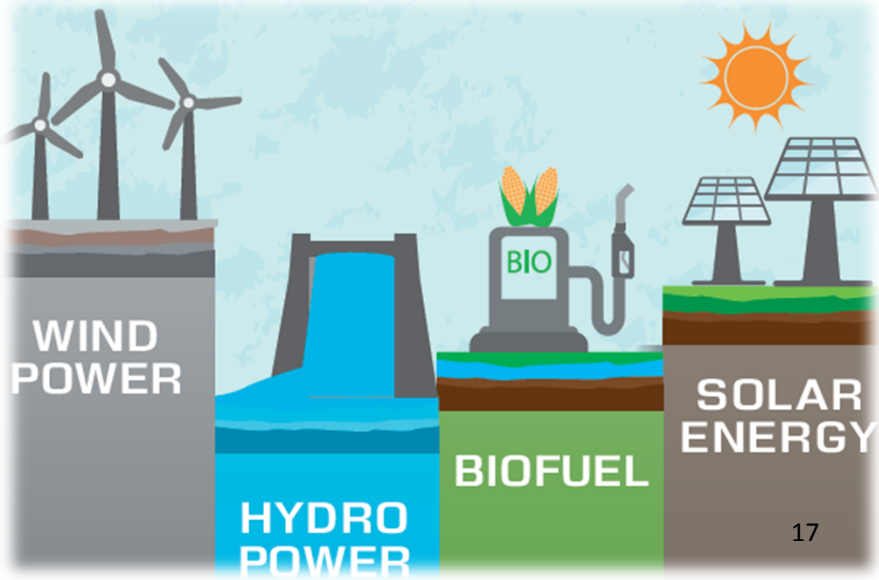


SOURCE: Thailand Alternative Energy Situation 2016 by DEDE (www.dede.go.th)

3. Performance on Alternative Energy Policy 2016

Alternative Energy	Unit	Target 2036	Performance	
			2016	2017 (Jan-Jul)
Electricity	**MW**	**19,640**	**9,436.52**	**10,013.29**
	Ktoe	**5,588.29**	**2,122**	**1,489.56**
Solar	MW	6,000	2,446.12	2,656.26
Wind	MW	3,002	507.04	627.82
Small Hydro Power	MW	376	182.12	182.28
Biomass	MW	5,570	2,814.70	3,004.68
Biogas	MW	1,280	434.86	464.41
MSW	MW	550	145.28	171.44
Large Hydro Power	MW	2,906.40	2,906.04	2,906.40
Heat	**Ktoe**	**25,088**	**7,182**	**4,157.96**
Solar	Ktoe	1,200	6.7	5.23
Biomass	Ktoe	22,100	6,507	3,775.00
Biogas	Ktoe	1,283	593	346.72
MSW	Ktoe	495	75	31.01
Alternative Heat	Ktoe	10	-	-
Biofuels	**Ktoe**	**8,712.79**	**1,747**	**1,087.18**
Ethanol	Million L/day	11.30	3.67	3.90
Biodisel	Million L/day	14.00	3.37	3.64
Pyrolysis Oil	Million L/day	0.53	-	-
Compressed Bio-methane Gas	tons/day	4,800	-	3
Alternative Energy Consumption (ktoe)		**39,389**	**11,051**	**6,734.71**
Final Energy Consumption (ktoe)		**131,000**	**79,929**	**46,683**
% of Alternative Energy Consumption		**30**	**13.83**	**14.43**

SOURCE from DEDE : Percentage of Alternative Energy Policy: Jan – Jul 17
As of 27 September 2017
Data sorm : EGAT, MEA, PEA, ERC, DEDE, and DOEB
Notes :
1/ Including off grid power generation.
2/ Including on grid power generation with capacity ≤ 1 MW & ≥ 1 MW.
3/ Including hydro power plants ≤ 12 MW & hydro power plant using the water downstream.
4/ Including waste water / waste dumping and energy crops.
5/ Including municipal solid waste and industrial waste.
6/The existing installed capacity.
7/ Based on M2 installed from solar collector.
8/ Including geothermal and oil from used tires
9/ Including bio-oil and hydrogen .



3. Performance on Alternative Energy Policy 2016

Target and current status in power sector

Alternative Energy proportion in power sector

19,684.40 MW
(10,013.29 MW)

- **MSW** 550 MW (171.44 MW)
- **Biomass** 5,570 MW (3,004.68 MW)
- **Small Hydro** 376 MW (182.28 MW)
- **Wind** 3,002 MW (627.82 MW)
- **Large Hydro** 2,906.40 MW (2,906.40 MW)
- **Industrial waste** 50 MW (- MW)
- **Biogas from (WW/SW)** 600 MW (464.41 MW)
- **Biogas from energy plant** 680 MW (- MW)
- **Solar** 6,000 MW (2,656.26 MW)

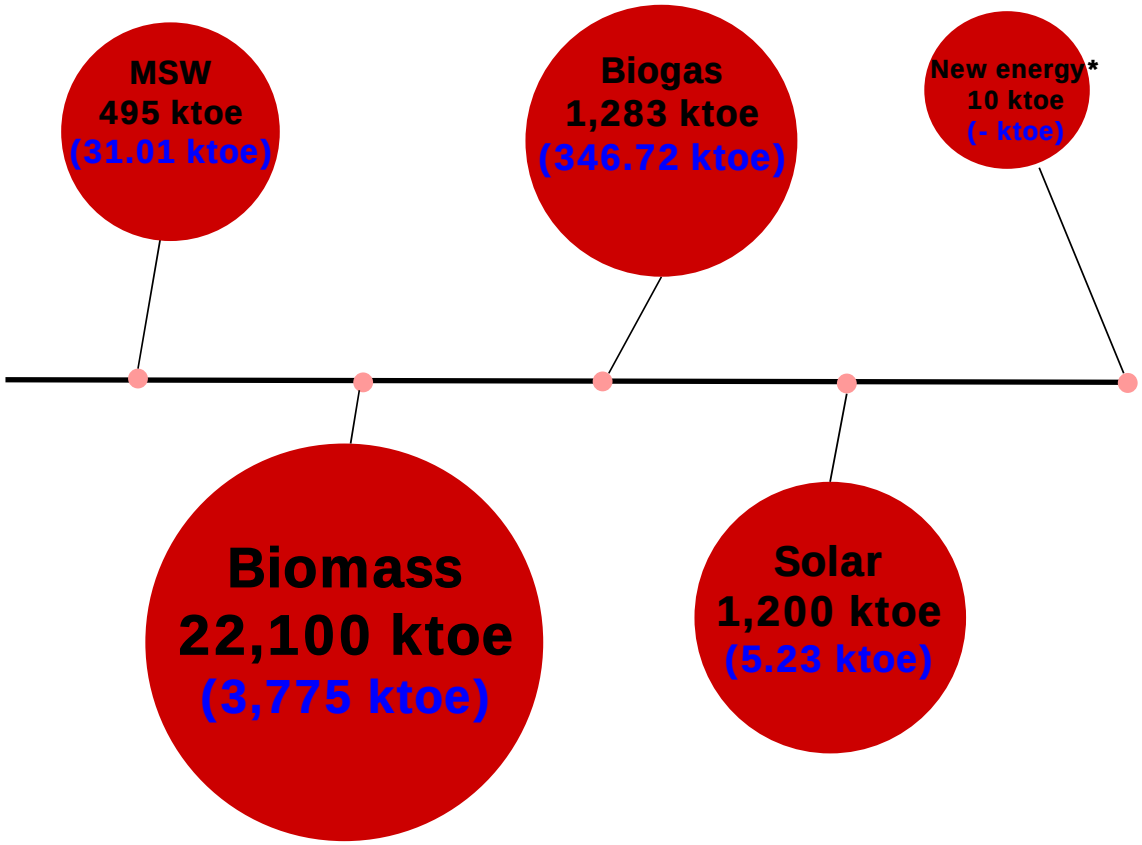
Note : Jan – Jul 2017

3. Performance on Alternative Energy Policy 2016

Target and current status in heat sector

Alternative Energy proportion in heat sector

25,088.00 ktoe
(4,157.96 ktoe)



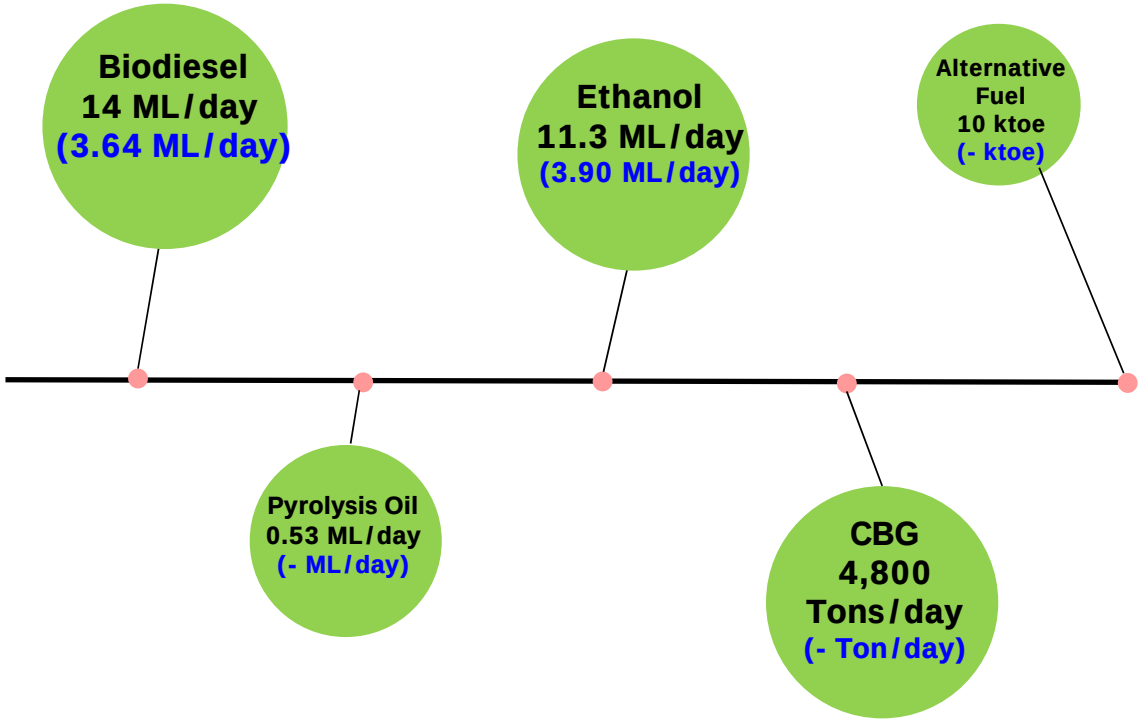
Note : Jan – Jul 2017

3. Performance on Alternative Energy Policy 2016

Target and current status in bio-fuel sector

Alternative Energy proportion in biofuel sector

25.83 ML/day
(7.54 ML/day)
4,800 Tons/day
(- Ton/day)
10 ktoe
(- ktoe)



Note : Jan – Jul 2017

4. Development of Energy Storage for the Expanding RE supply

Thailand 4.0

Thailand 4.0 to Energy 4.0

Goal
To get out of middle-income trap
(Increase the average income from 190,000 to 450,000 baht/year)

Thailand 4.0 Model
Focusing on becoming a value-based economy driven by innovation

Mechanisms for "Thailand 4.0"

"Security, Prosperity, Sustainability"

"Productive growth engine"
Using innovation and technologies
High-income Country

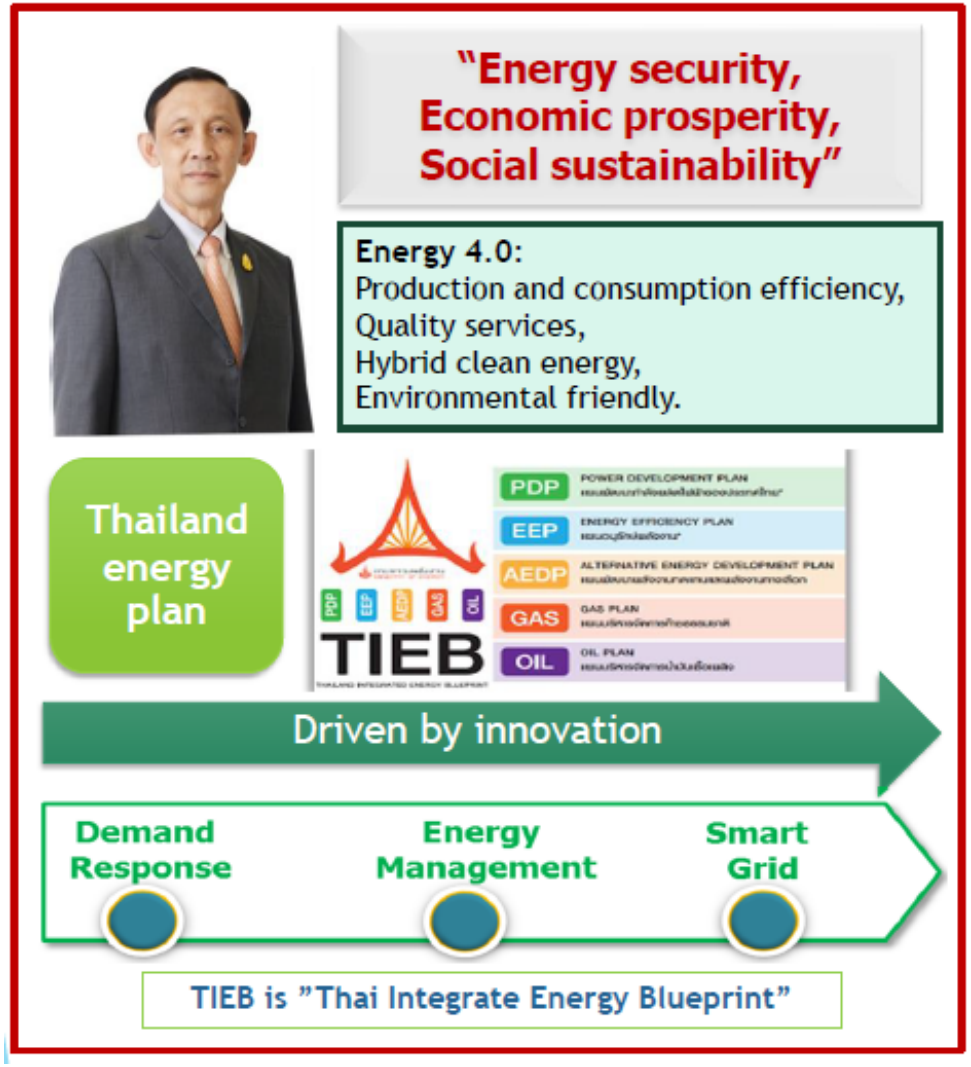
"Inclusive growth engine"
Economic development
Distributing income, opportunity and wealth to the community

"Green growth engine"
Using environment-friendly technology
Focusing on renewable energy and "Green" manufacturing process

SOURCE: Energy Policy and Planning Office and Commissioner of Energy Regulatory Commission of Thailand, Ministry of Energy

4. Development of Energy Storage for the Expanding RE supply

Energy 4.0



Energy 4.0

CONCEPT

"Raise the **standard** and improve the **efficiency** of energy usage by using **clean energy** and protecting environment in order to create the effective energy usage without side effects on the **environment** and improve the **quality of life** of people"

MAIN TASKS

✓ Promote the use of **Electric Vehicles** (EV) in Thailand

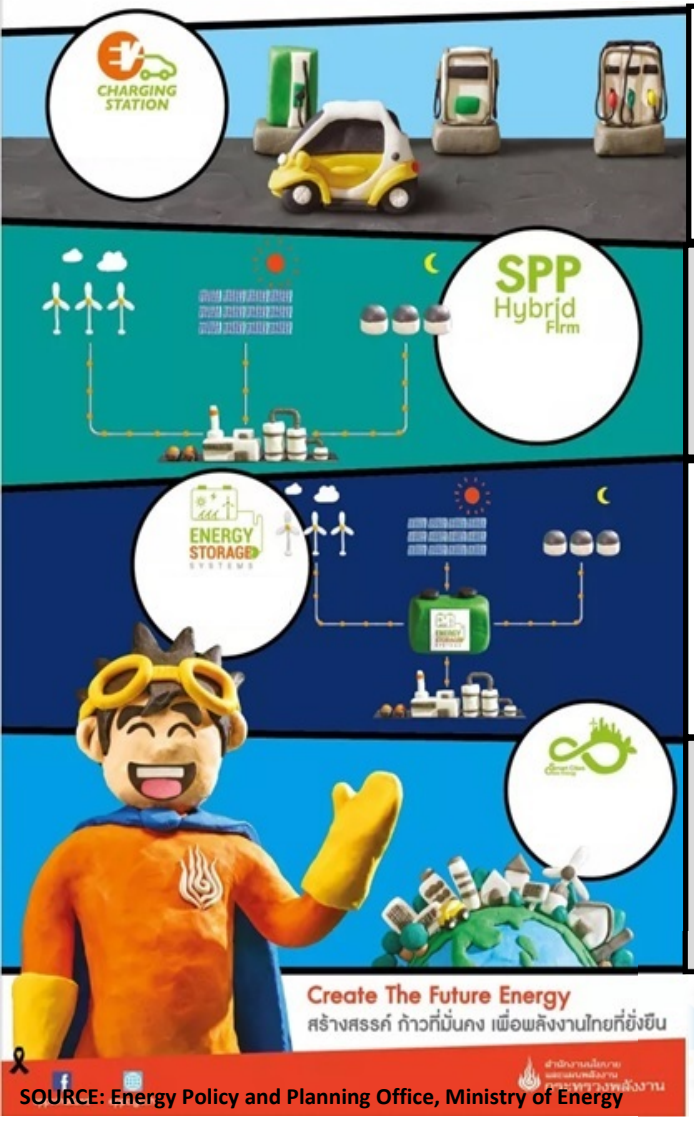
✓Create **Smart Cities** - Clean Energy projects

✓Support R&D on **Energy Storage**

✓ Drive **Bio Economy** for Thailand

SOURCE: Energy Policy and Planning Office and Commissioner of Energy Regulatory Commission of Thailand, Ministry of Energy

Energy 4.0 Policy



Goal in 2036

❖ **1.2 Million EVs and 690 charging stations**

NEPC's resolution on 17 FEB 2017: Approved FiT rate and purchasing target for SPP Hybrid Firm (- SPP Hybrid Firm 300 MW - FiT rate = 3.66 THB/kWh - Contract : 20 years)

The Energy Conservation Fund (ENCON Fund) 's resolution on 3 Aug 2017 : Granting the fund of 765 million THB to support the research projects in relation to Energy storage systems

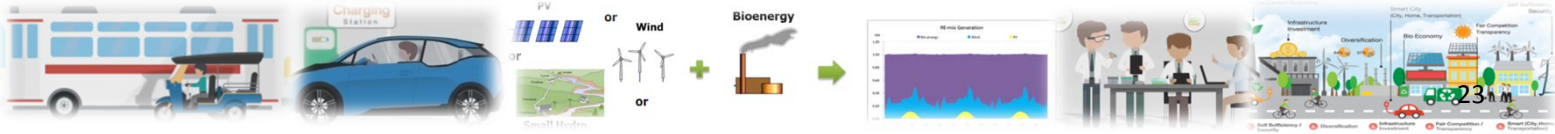
❖ **As of 17 Mar 2017, Approved 32 projects, 300 million THB.**

7 Concepts of Smart City

Smart Mobility | **Smart Economy**

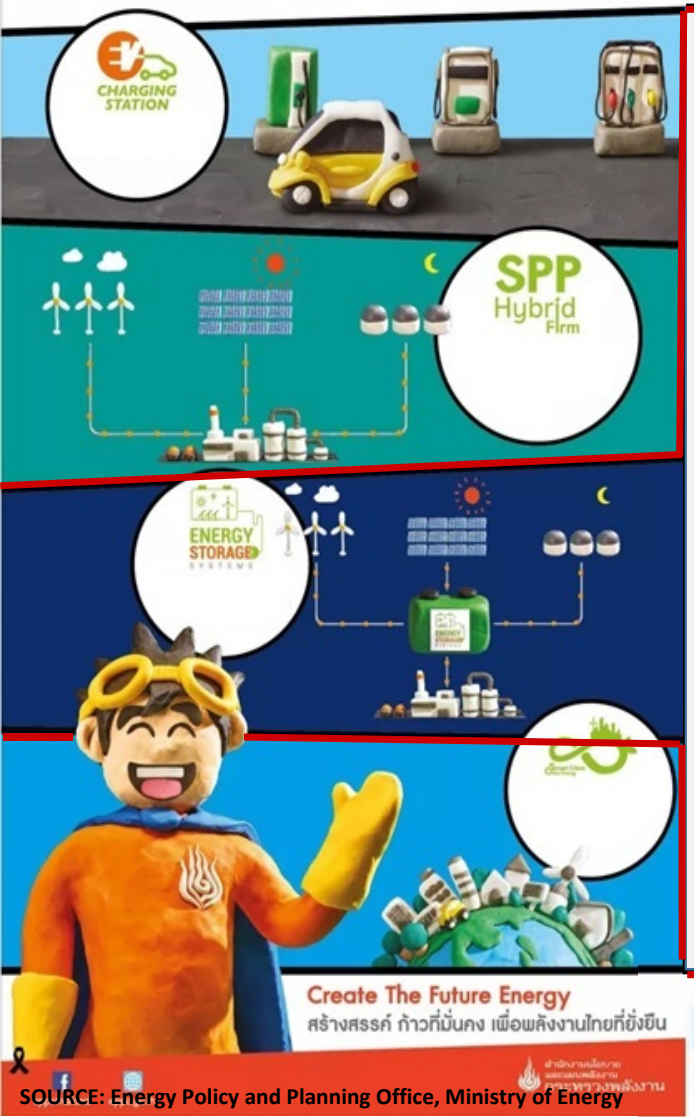
Smart Environment | **Smart Energy** | **Smart Community**

Smart Building | **Smart Governance**



SOURCE: Energy Policy and Planning Office, Ministry of Energy

Energy 4.0 Policy

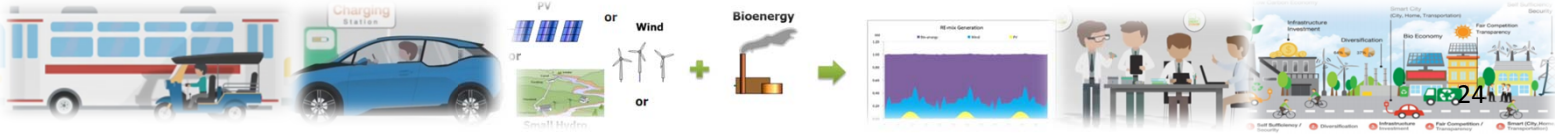


The Energy Conservation Fund (ENCON Fund) 's resolution on 3 Aug 2017

❖ **Granting the fund of <u>765 million THB or 23 million USD</u> to support the research projects in relation to Energy storage systems.**

❖ **As of 17 Mar 2017, 32 projects were approved with the total amount of <u>300 million THB or 9 million USD</u> .**

Remark: USD = 33 THB



SOURCE: Energy Policy and Planning Office, Ministry of Energy

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

4. Development of Energy Storage for the Expanding RE supply

Research Frameworks for Energy Storage Systems

Group 1
Research for practical technology application

Framework 1
For national security and natural disaster management

Framework 2
For industrial estate, renewable energy and / or remote area

Framework 3
For automotive industry

Development of energy storage system technology

Group 2
Research and development

Framework 4
On material elements (system package), and fuel cell as energy storage system

Framework 5
On power electronics controls / system integration

The preparation of "20-year strategy for the development of Thailand's energy storage system technology"

Research and development

Thank you for your attention

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