



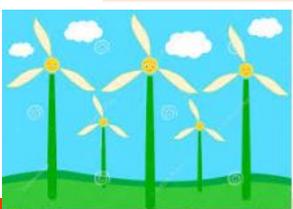
Alternative Energy Development Plan 2015-2036 (AEDP 2015)

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30 March 2017

Thailand Science Park Convention Center, Pathumthani



The Nation's Long Term Master Plan for the Energy Sector in Next Two Decades



THAILAND INTEGRATED ENERGY BLUEPRINT
 5 Master Plans as Pillars of Energy Development



Energy Security

- Promote **energy security** of Thailand
- Support the 11th National Economic and Social Development Plan

Economy

- Establish **sustainable** whole-chain energy business
- Promote long-term country development

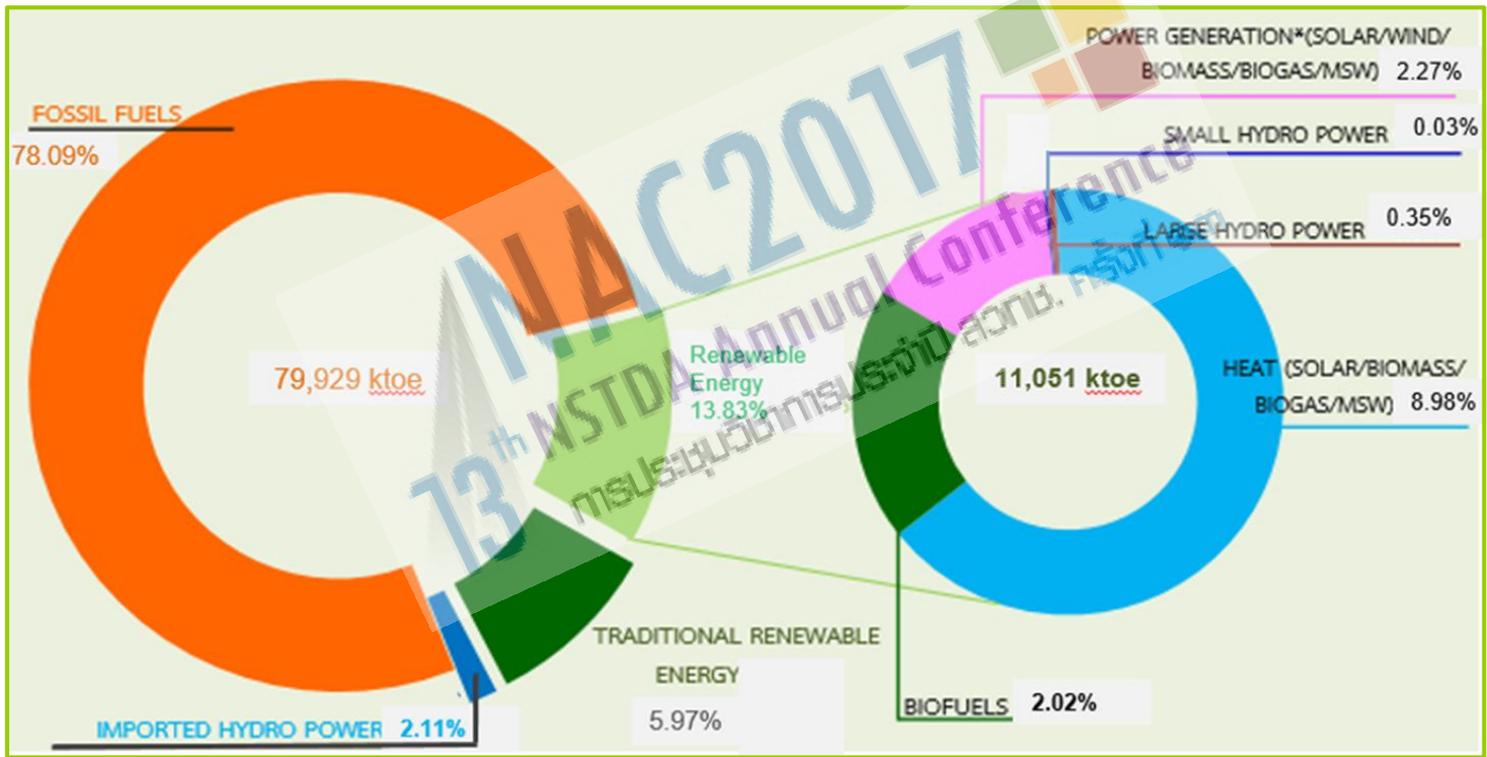
Ecology

- Increase renewable energy usage
- Reduce negative impacts to the environment



Final Energy Consumption

Alternative Energy Consumption





Study for the potential of domestic RE source (Power/Heat/Biofuel) and forecast the quantity of RE in future

Analyze and appoint the share of RE for power, heat and biofuel at present and future

Total energy used prediction from EPPO's model

Opportunity for fossil replacing using RE

Power

Heat

Biofuel

Provide RE for power generation by the potential of transmission line of PEA's substation by the consideration of:

- 1) RE potential of each area
- 2) Priority of RE by merit order, using "Levelised Cost of Electricity (LCOE) model"

Provide RE for heat generation by the potential of fossil fuel replacement/target group

Increase amount of biofuel production instead of fuel oil in transportation sector, by considerate the equilibrium of production and utilization



Main Activities

Electricity



- Area-based RE power generation target must be related to RE potential (RE Grid Capacity)
- Develop and support for power generation from unutilized fuel (e.g. agricultural waste, industrial waste, fast growing crop)
- Support competitive bidding for power purchasing system

Heat



- Promote and support RDF transformation for municipal waste management
- Promote and support biomass-derived fuel (e.g. biomass pellet, bio-coal)
- Support biogas generation from waste water or solid waste
- Promote heat utilization in building by building code establishing

Biofuel



- Promote utilization of B10, B20 in both transportation and industrial sector
- Promote gasohol utilization
- Promote CBG utilization for vehicle and industry
- Promote biofuel production efficiency improvement

Commitment to the development of a low-carbon society

Facilitator:
Private-led investment

Strategy: Alternative Energy Development Plan 2015-2036

Facilitator:
Government funded on R&D

Goal: Target 30% renewables in Total Energy Consumption by 2036

Bio-Energy			Bio-Fuel		
Biomass	Biogas	MSW + Industrial Waste	Ethanol	Biodiesel	Pyrolysis Oil
5,570 MW	1,280 MW	550 MW	113 ML/Day	14 ML/Day	0.53 ML/Day
22,100 ktoe	1,283 ktoe	495 ktoe			
6,720 MW Power 23,878 Ktoe Heat			CBG	Alt. Fuels*	
			4,800 t/Day	10 ktoe	

Solar

6,000 MW

1,200 Ktoe

Wind

3,002 MW

Hydro

Large Hydro 2,906.40 MW	Small Hydro 376 MW
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New-Energy

Geothermal, Used Tire Oil, etc.

10 ktoe

9,002 MW Power | 1,200 Ktoe Heat

3,282.40 MW

* Alternative fuels = Bio-oil, Hydrogen, and Others



Goal: Target 30% renewables in Total Energy Consumption by 2036

Target	ktoe
RE Consumption (ktoe)	39,388.67
Final Energy Consumption (ktoe)	131,000
RE share (%)	30%

Renewable Energy		Unit	2012	2013	2014	2015	2016
Electricity*		MW	2,786	3,788	4,494	7,962.79	9,139.65
		ktoe	1,138	1,341	1,467	1,556	2,122
1. Solar		MW	376.72	823.46	1,298.51	1,419.58	2,149.25
2. Wind		MW	111.73	222.71	224.47	233.90	507.04
3. Small Hydro		MW	101.75	108.80	142.01	172.12	182.12
4. Biomass		MW	1,959.95	2,320.78	2,451.82	2,726.60	2,814.70
5. Biogas		MW	193.40	265.23	311.50	372.51	434.86
6. MSW		MW	42.72	47.48	65.72	131.68	145.28
7. Large Hydro Power		MW	-	-	-	2,906.40	2,906.40
Heat			4,886	5,279	5,775	6,579	7,182
1. Solar		ktoe	3.50	4.50	5.10	5.70	6.72
2. Biomass		ktoe	4,346.00	4,694.00	5,144.00	5,990.0	6,507.3
3. Biogas		ktoe	458.0	495.0	528.0	495.0	593
4. MSW		ktoe	78.20	85.00	98.10	88.00	75.08
Bio-fuel		Million liter/d	4.20	5.50	6.10	6.80	7.04
		ktoe	1,270	1,612	1,783	1,942	1,747
Ethanol		Million liter/d	1.40	2.60	3.21	3.50	3.67
Bio-diesel		Million liter/d	2.80	2.90	2.89	3.30	3.37
RE Consumption (ktoe)			7,294	8,232	9,025	10,076	11,050
Final Energy Consumption (ktoe)			73,316	75,214	75,804	77,881	79,929
Share of RE in Final Energy Consumption (%)			9.95	10.94	11.91	12.94	13.83
As of February 22nd, 2017							

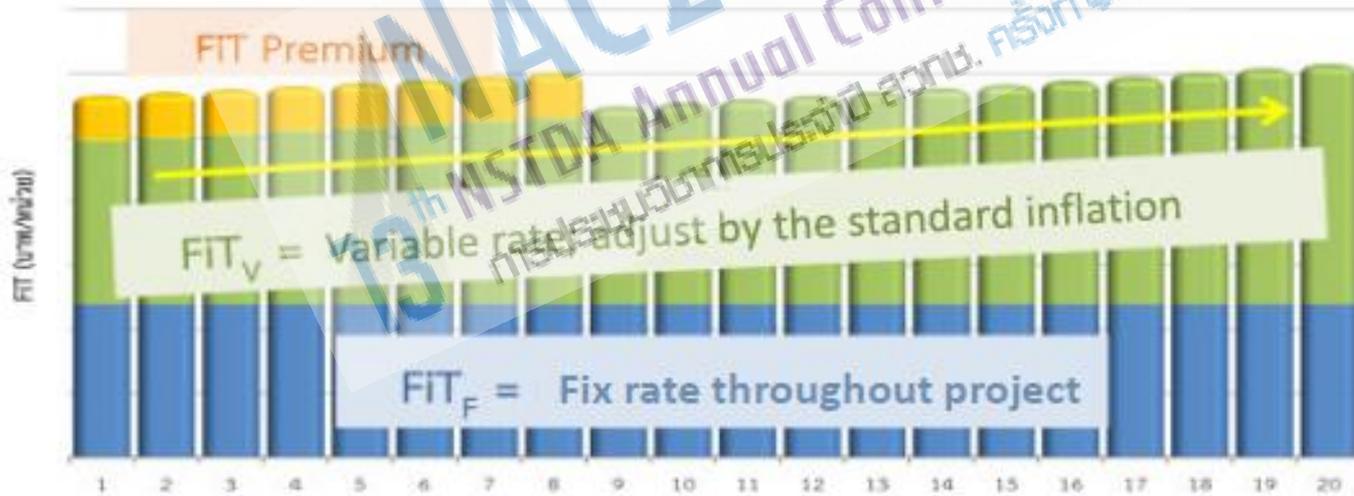
*Including off grid power generation and on grid power generation with capacity ≤ 1 MW & ≥ 1 MW



Feed in Tariffs Scheme

$$\text{FIT}_i = \text{FIT}_F + \text{FIT}_{V,i-1} \times (1 + \text{Core Inflation}_{i-1}) + \text{FIT Premium}$$

i = year of power purchasing





Feed-in Tariff (FiT) for VSPP in 2015

Installed Capacity (MW)	FiT (THB/kWh)			Supporting Period (years)	FiT Premium (THB/kWh)	
	FiT _F	⁽¹⁾ FiT _{V,2560}	FiT		Biobased Fuel (for the first 8 yrs)	special Southern zones ⁽²⁾ (for project lifetime)
Waste-to-Energy						
≤ 1 MW	3.13	3.21	6.34	20	0.70	0.50
> 1-3 MW	2.61	3.21	5.82	20	0.70	0.50
> 3 MW	2.39	2.69	5.08	20	0.70	0.50
Landfill organic waste	5.60	-	5.60	10		0.50
Biomass						
≤ 1 MW	3.13	2.21	5.34	20	0.50	0.50
> 1-3 MW	2.61	2.21	4.82	20	0.40	0.50
> 3 MW	2.39	1.85	4.24	20	0.30	0.50
Biogas from wastewater/manure	3.76	-	3.76	20	0.50	0.50
Biogas from energy crops	2.79	2.55	5.34	20	0.50	0.50
Small hydro						
≤ 200 kW	4.90	-	4.90	20	-	0.50
Wind	6.06	-	6.06	20	-	0.50

⁽¹⁾ FiT_V is subjected to be adjusted by core inflation

⁽²⁾ Includes 3 Southern provinces (Yala, Pattani, Narathiwat) and 4 districts in Songkhla province



Preparation of raw materials and renewable energy technologies



- Development of alternative raw materials and potential areas for renewable energy production
- Development of the high efficient renewable raw materials management and utilization model
- Promote the development of appropriate technology for generation and utilization of energy
- Improve infrastructure to support the production of renewable energy appropriately



Increasing renewable energy production, utilization and market potential

- Support people and a community to participate in the production and utilization of renewable energy
- Support the investment on renewable energy to manufactures and consumers both domestic and international
- Promote the reducing of production costs and make renewable energy market more performance
- Develop the renewable energy law and rules to encourage the development of renewable energy appropriately

Create awareness and access to knowledge and facts of renewable energy



- Develop renewable energy databases and information management systems
- Publicize information, knowledge and statistical data on renewable energy
- Capacity building both in the theory and practice to make more ability in utilization of renewable energy
- Development of renewable energy and its related networks and encourage the participation of the whole network both nationally and international level



Key success factors

WTE



- Effective waste management/waste sorting system
- Effective collaboration among relevant WTE responsible parties

Biomass



- Successful improvement of biomass supply chain system
- Successful improvement of biomass logistic/collection system
- Successful development of community-scale biomass energy technology

Energy Crop



Successful development of energy crop pilot project that can be used as business model

Solar PV



Advancement of solar PV technology development to the stage in which its LCOE cost can be competitive with fossil fuel cost

Wind



Successful development of wind turbine technology that is suitable for low wind speed potential in Thailand

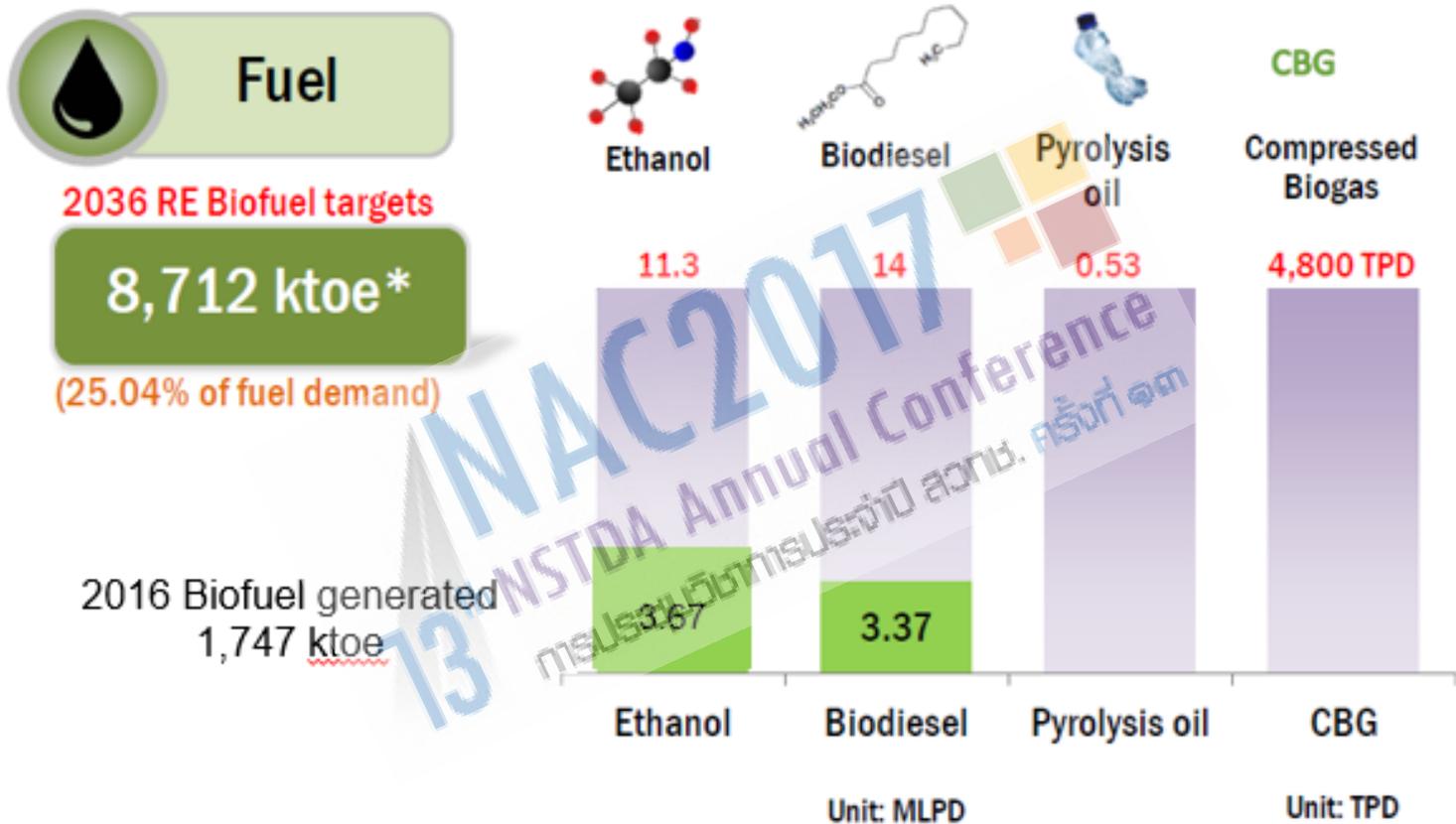
Smart Grid



Successful development of smart grid system to improve the power demand-supply management via smart technology and thus allow more RE integration into the national grid



AEDP 2015 Targets : Biofuel



Remark : * ktoe equivalent of biofuel



Biodiesel Bureau of biofuel development (DEDE)

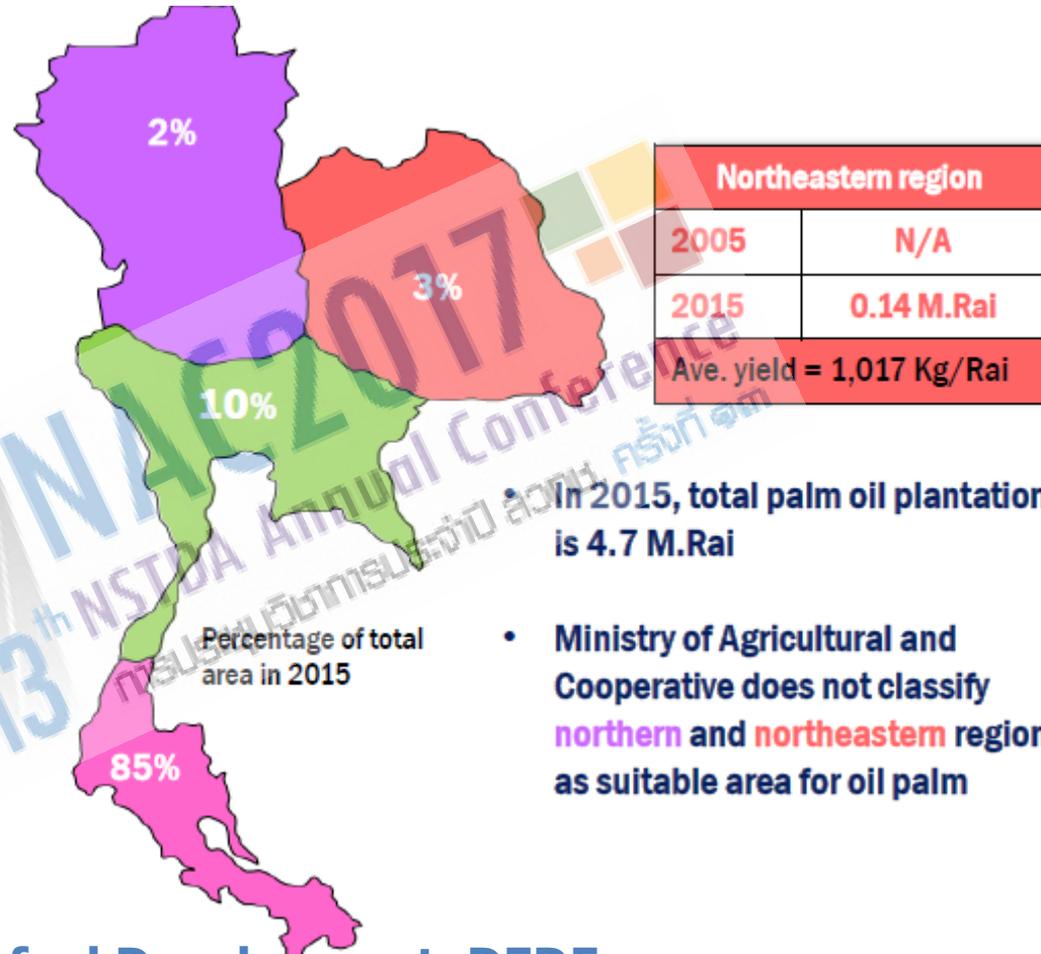


Oil Palm Plantation Area

Northern region	
2005	N/A
2015	0.07 M.Rai
Ave. yield = 811 Kg/Rai	

Central region	
2005	0.20 M.Rai
2015	0.48 M.Rai
Ave. yield = 2,246 Kg/Rai	

Southern region	
2005	2.54 M.Rai
2015	4.01 M.Rai
Ave. yield = 2,675 Kg/Rai	



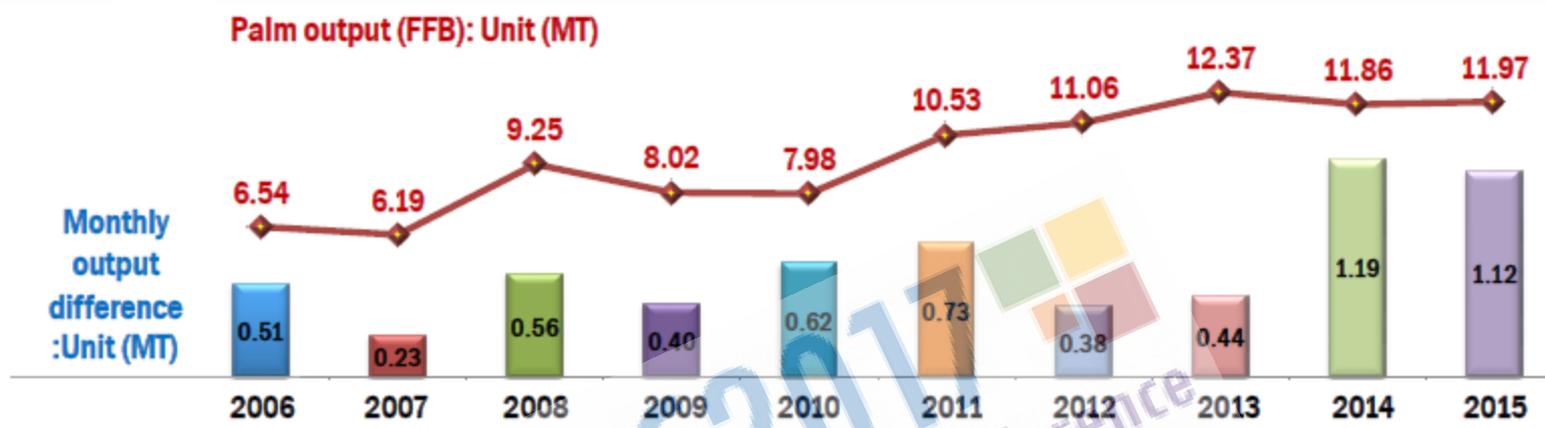
Northeastern region	
2005	N/A
2015	0.14 M.Rai
Ave. yield = 1,017 Kg/Rai	

- In 2015, total palm oil plantation is 4.7 M.Rai
- Ministry of Agricultural and Cooperative does not classify northern and northeastern regions as suitable area for oil palm

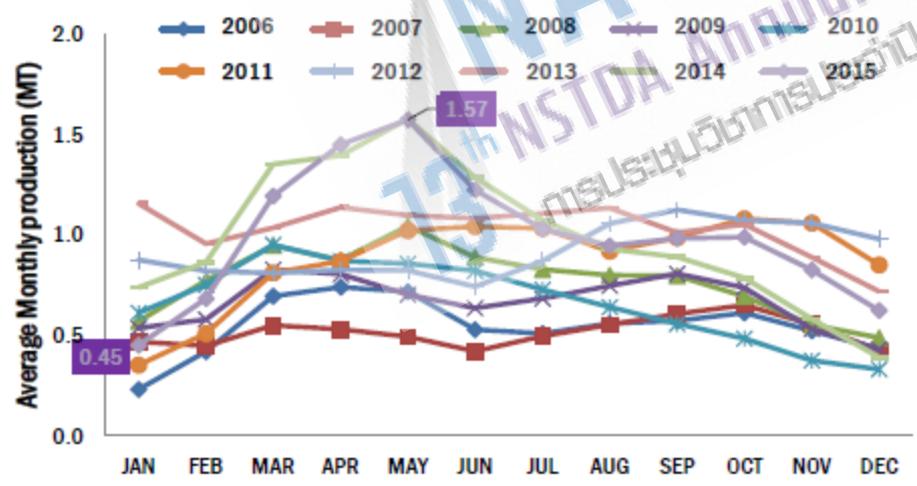
Source: Bureau of biofuel Development, DEDE



Oil Palm Production and Yield



The bar chart shows the maximum average monthly difference in the year: Unit (MT)



Palm oil output is increasing. In 2015, total output is 11.97 MT.

- Season fluctuation remains strong
- Production in May was the highest and production in January is the lowest. The difference between those two months was 1.12 MT FFB or 0.2 MT CPO

Source: Bureau of Biofuel Development, DEDE



Biodiesel B100 (Reference Price)

1 Kg of biodiesel produced from 0.94 Kg of Crude Palm Oil

$$\begin{array}{cccccc} \text{Biodiesel cost} & = & (\text{CPO price} \times \text{production ratio}) & + & 0.1 \times \text{Methanol price} & + & \text{production cost} \\ (\text{THB/L}) & & (\text{THB/Kg}) & & (\text{TH/Kg}) & & \text{THB/Kg} \\ & & (0.94 \text{ Kg/Kg}) & & & & 3.82 \text{ THB/Kg} \end{array}$$

1 Kg of biodiesel produced from 0.86 Kg of Palm stearin

$$\begin{array}{cccccc} \text{Biodiesel cost} & = & (\text{CPO price} \times \text{production ratio}) & + & 0.09 \times \text{Methanol price} & + & \text{production cost} \\ (\text{THB/L}) & & (\text{THB/Kg}) & & (\text{TH/Kg}) & & \text{THB/Kg} \\ & & (0.86 \text{ Kg/Kg}) & & & & 2.69 \text{ THB/Kg} \end{array}$$

1 Kg of biodiesel produced from 0.93 Kg of RBD palm oil

$$\begin{array}{cccccc} \text{Biodiesel cost} & = & (\text{CPO price} \times \text{production ratio}) & + & 0.1 \times \text{Methanol price} & + & \text{production cost} \\ (\text{THB/L}) & & (\text{THB/Kg}) & & (\text{TH/Kg}) & & \text{THB/Kg} \\ & & (0.93 \text{ Kg/Kg}) & & & & 2.63 \text{ THB/Kg} \end{array}$$

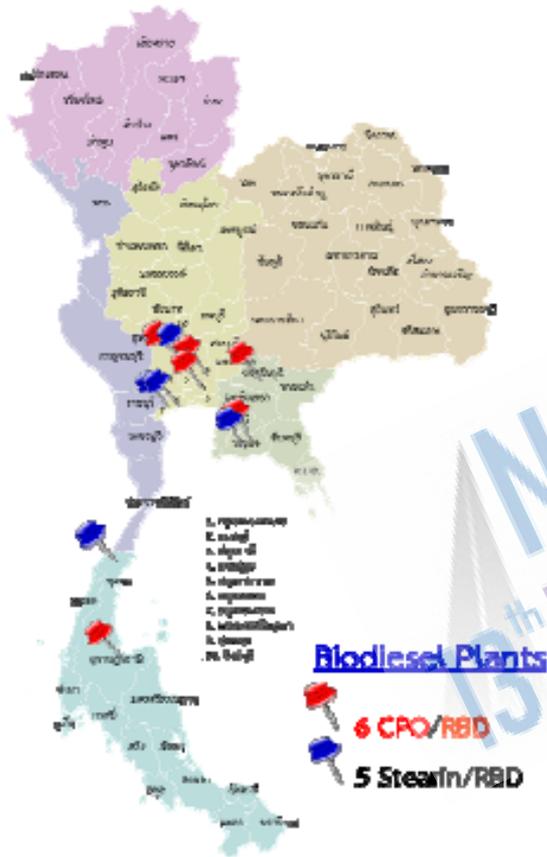
Biodiesel reference price calculated from monthly weighted average price

Source - Energy planning policy office

Bureau of biofuel development (DEDE)



Biodiesel Production Capacity



Feedstock	Registered capacity	
	No. of factories	Capacity (ML/day)
CPO/RBDPO/Palm Stearin	6	3.5
Palm Stearin	5	1.4
Total	11	4.9

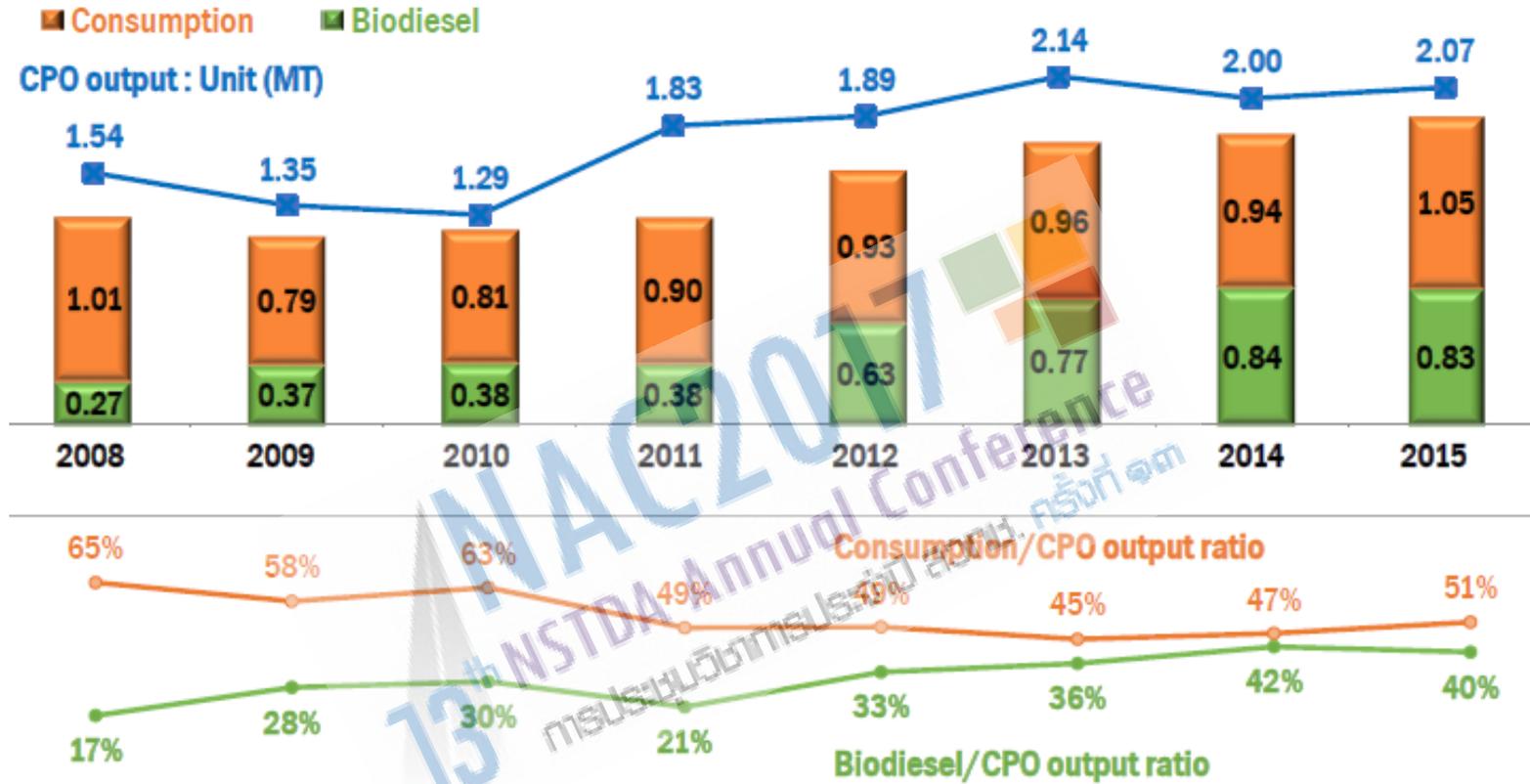
Department of Energy Business , August 2015



Source: Bureau of Biofuel Development, DEDE



CPO Supply and Demand

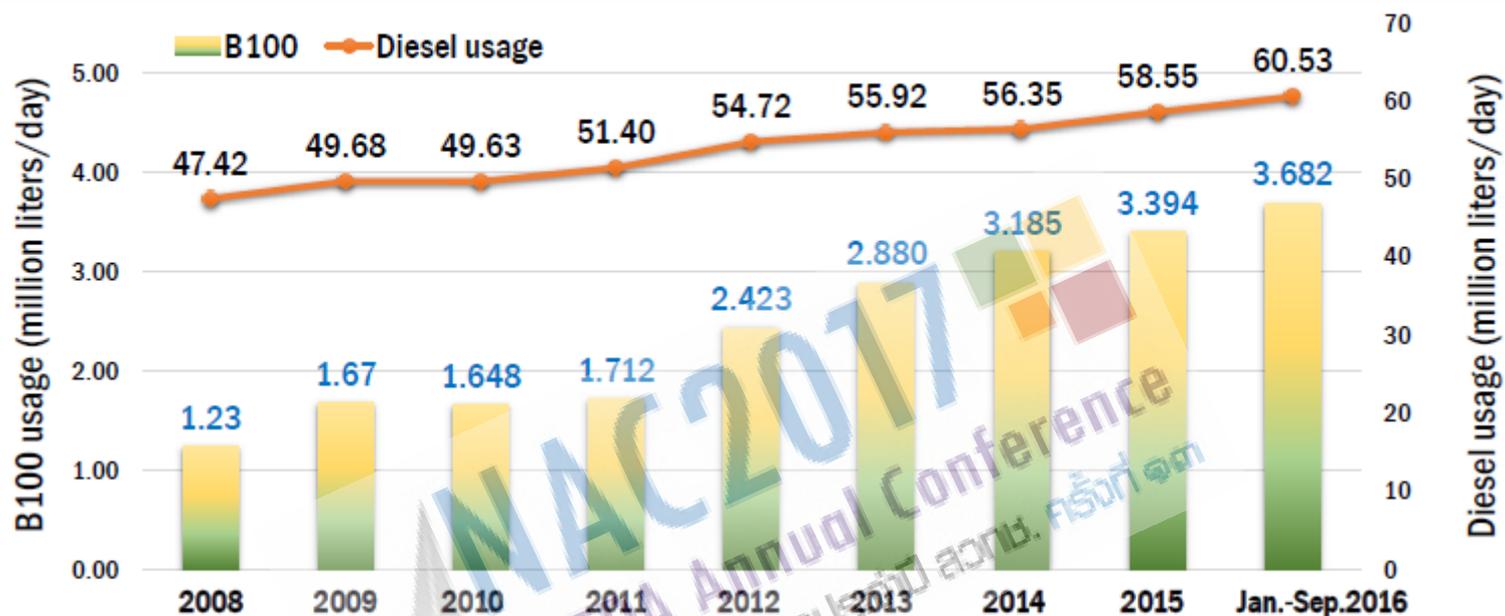


- CPO output varied based on agricultural conditions such as temperature and water supply
- Domestic consumption of CPO remains relatively constant over the year (0.8 – 1 MT annually)
- Biodiesel share of CPO produced has an upward trend from 17% in 2008 to 40% in 2015

Source: Bureau of Biofuel Development, DEDE



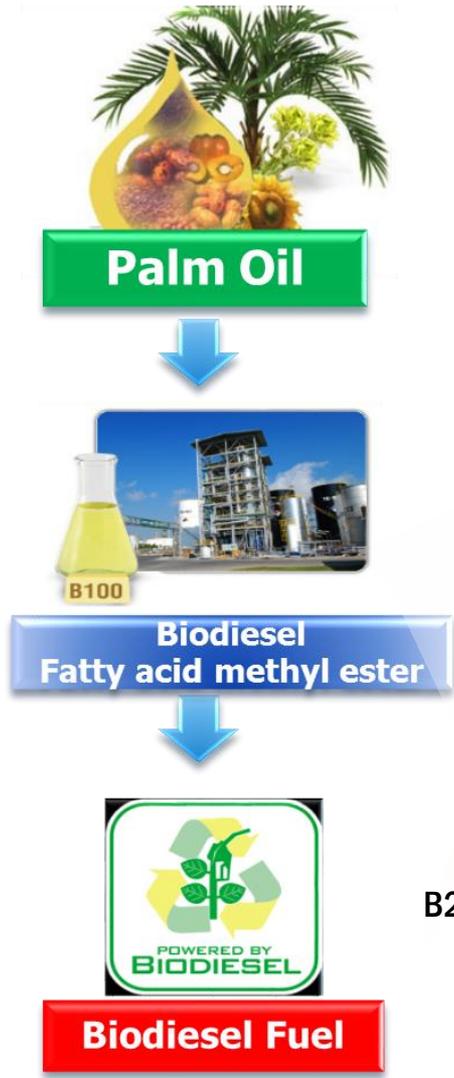
Biodiesel Usage



- Jan. 1, 2014 - Thailand diesel mandate biodiesel blending between 6 - 7%
- Due to domestic palm oil shortage, the blending range was extend lower to 3.5 - 7%
 - Feb. 17 - May. 13, 2014
 - Jan. 20 - Apr. 15, 2015
- Aug. 3, 2016 - Thailand diesel mandate biodiesel blending between 6.5 - 7%
- Aug. 25, 2016 - Thailand diesel mandate biodiesel blending between 3 - 7%
- Nov. 25, 2016 - Thailand diesel mandate biodiesel blending between 5 - 7%

Thailand Biodiesel History

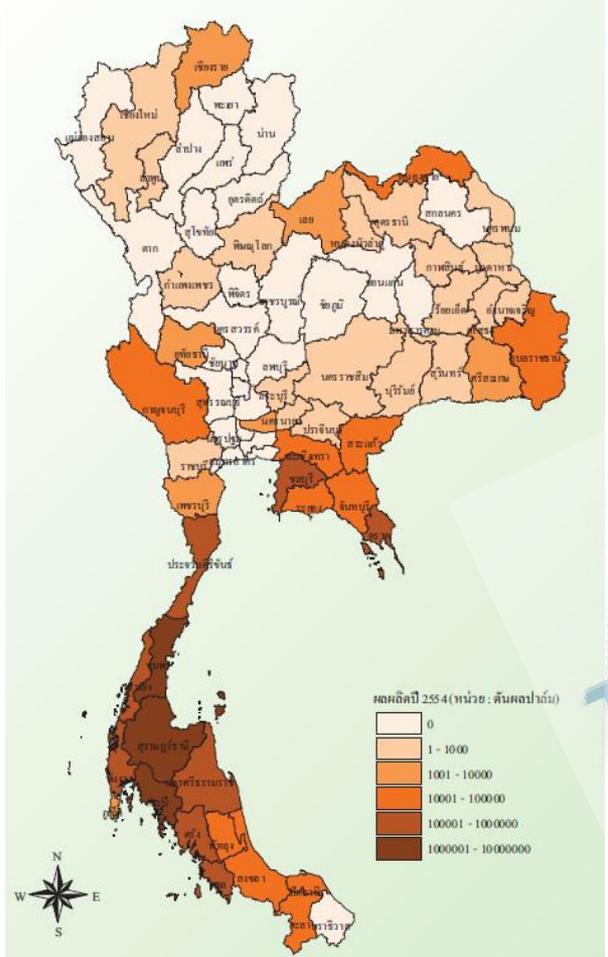
History of biodiesel blend in Thailand



Ministry of Energy has announced the biodiesel B7 blend mandate since January 2014



Thailand Palm Situation

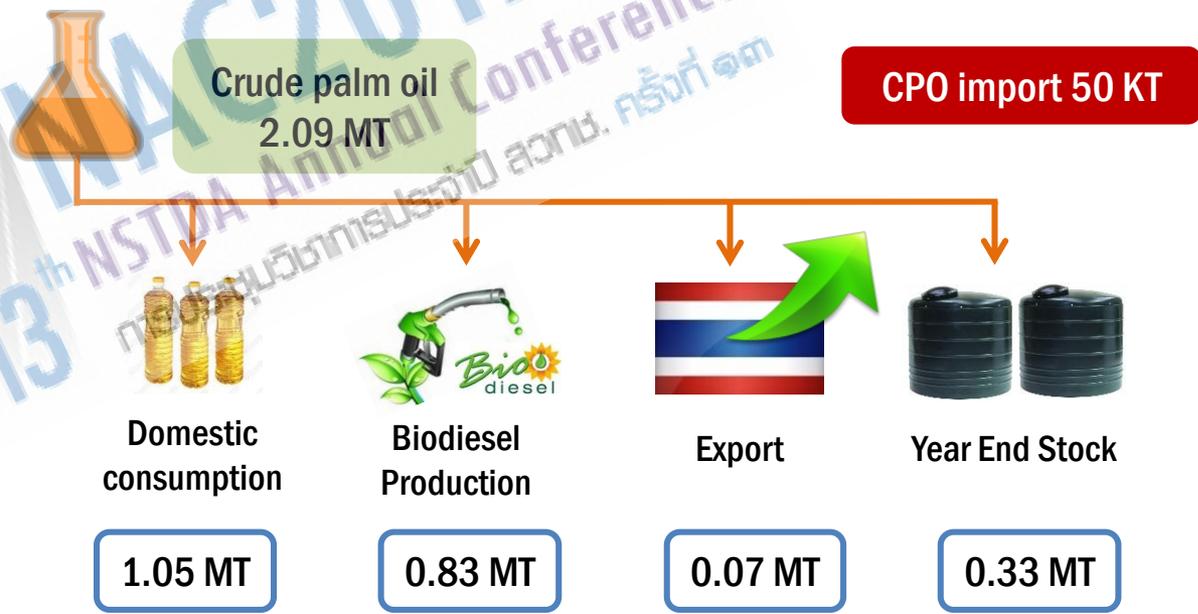


Oil palm plantation in Thailand

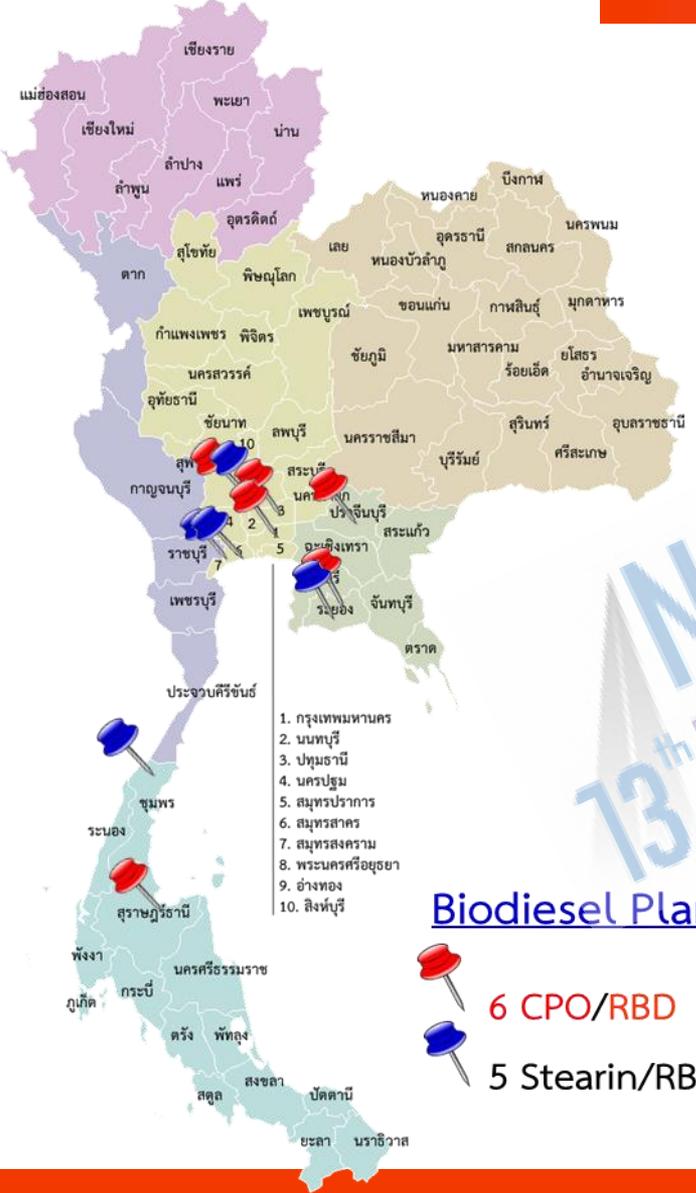
There are only some certain areas suitable for oil palm plantation in Thailand (eg. Southern and Eastern)

Oil palm plantation area : 4.70 M.Rai

1 Hectare = 6.25 Rai



Average (2015) B100 consumption : 3.39 ML/day



Feedstock	Registered capacity	
	No. of factories	Capacity (ML/day)
CPO/RBDPO/Palm Stearin	6	3.5
Palm Stearin	5	1.4
Total	11	4.9

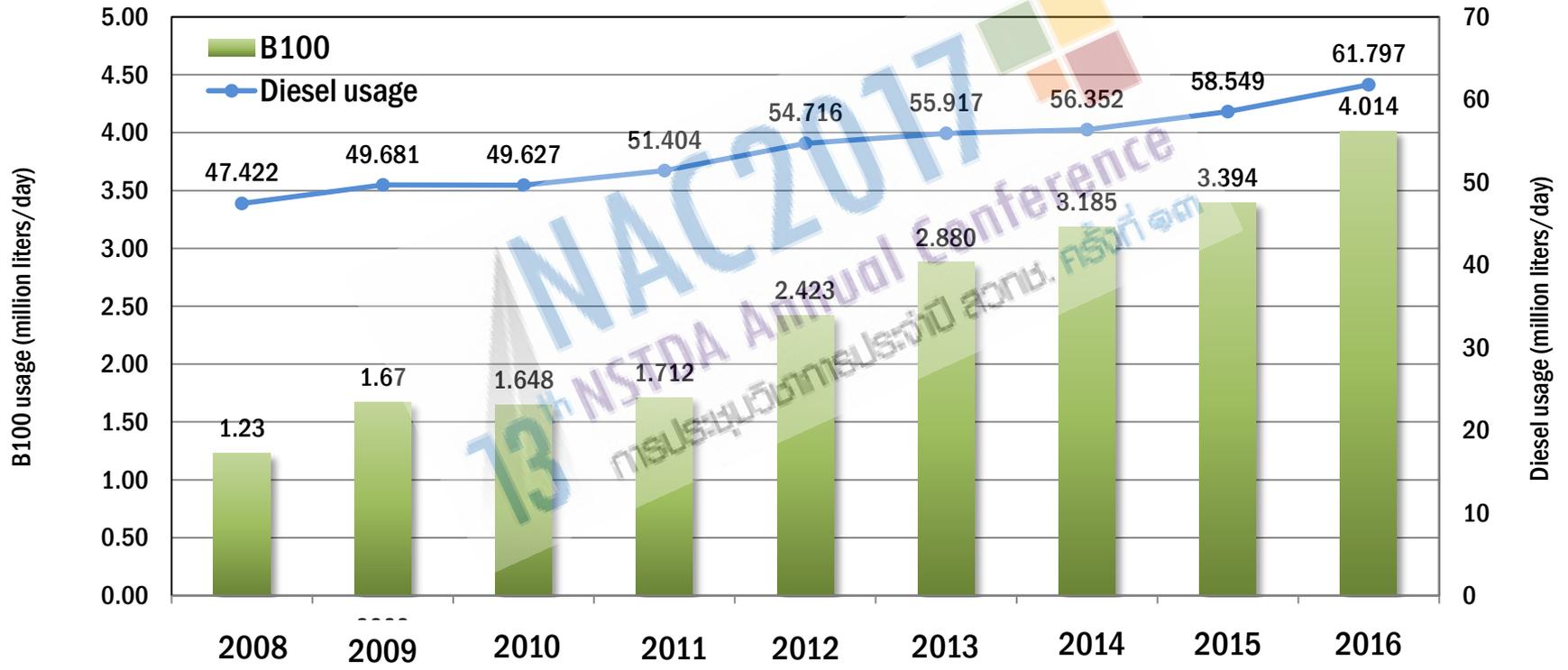
Department of Energy Business , August 2015



Biodiesel Usage



Thailand mandated 7% biodiesel (B7) blend for every liter of diesel sold since Jan 2014



Related Policies



2016 Phase2 Thailand excise tax scheme for B10 diesel eco-car
 Excise tax rate at 12% starting from 1st Jan 2016



2018 Completion of double-track railway infrastructure



- Develop diesel-substitution fuel (both traditional and advanced) in terms of both **feasibility** and **economically**
- Develop higher %biodiesel compatible vehicles

- Develop and improve new feedstock
- Promote production of advanced biofuel that can be commercially blended in higher percentage

- Promote **B10** as an optional alternative fuel (Price incentive/Service coverage/Quality control)
- Tax incentives for vehicles that use high % biofuel (2026)
- Mandate **B10** (2026)

- Promote consumption of **higher-blend biodiesel** as an optional alternative (Service coverage/Quality Control)
- Excise Tax incentives for vehicles that use high % biofuel

- Promote **B10** usage in transport and industrial sectors
- Promote **B100** usage in agricultural machineries

- Promote consumption of biofuel-blended fuel in both transport and industrial sectors



Thank you

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Bureau of Energy Research, DEDE

