R&D on biomass and policy in Thailand

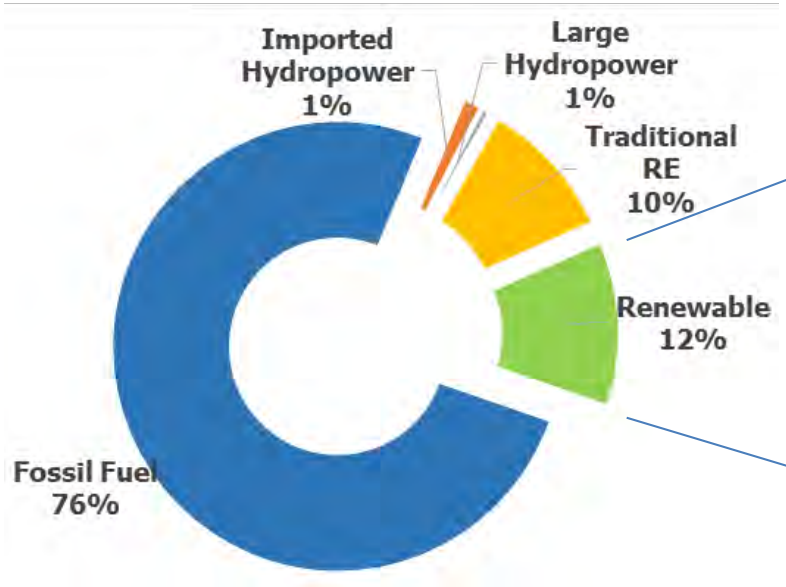
Dr. Boonrod Sajjakulnukit
JGSEE, KMUTT

JASTIP kick-off workshop
Feb.29 NSTDA, TSP

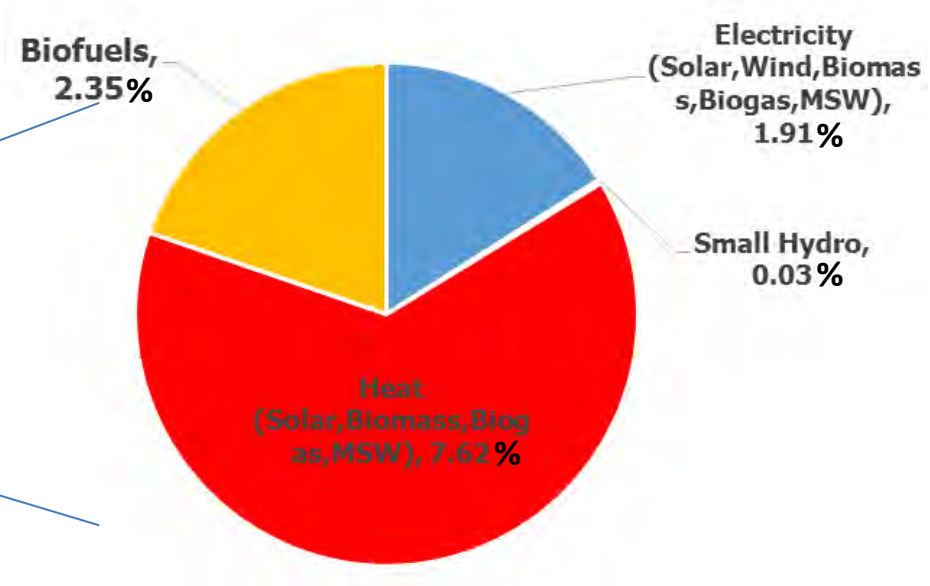
Thailand's Energy Situation

Thailand Final Energy Consumption 2014

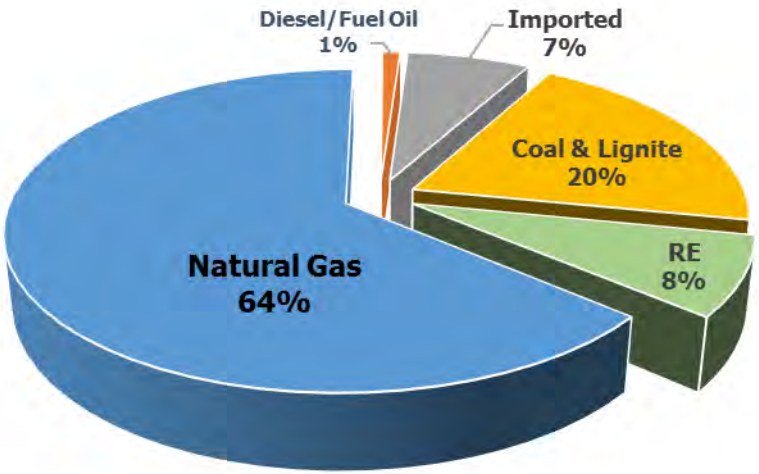
Final Energy Consumption

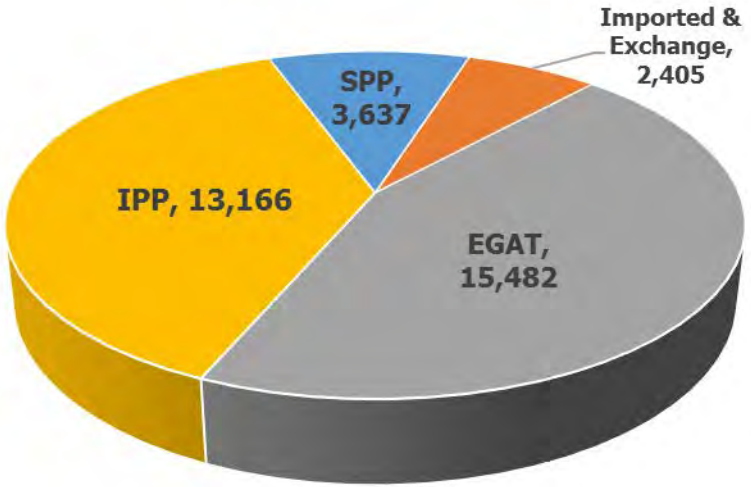


Renewable Energy Consumption



Power Generation by Fuel Type in 2014





Unit : MW

Power Generation by Fuel Type

Power Generation by Producer

Energy Policy

Thailand's Energy Policies

General Prayuth Chan O-cha
Prime Minister

✓ Secure Thailand Energy supply
- Exploration and production of natural gas and crude oil both in the sea and on land
- More new power plant by government agencies and private organizations
- Increase the use of renewable energy
- International energy development cooperation

✓ Fair Energy Pricing
- Energy price restructure
- Appropriate tax between different types of oil

✓ Energy conservation
- More efficient use of energy
- Awareness of consumer

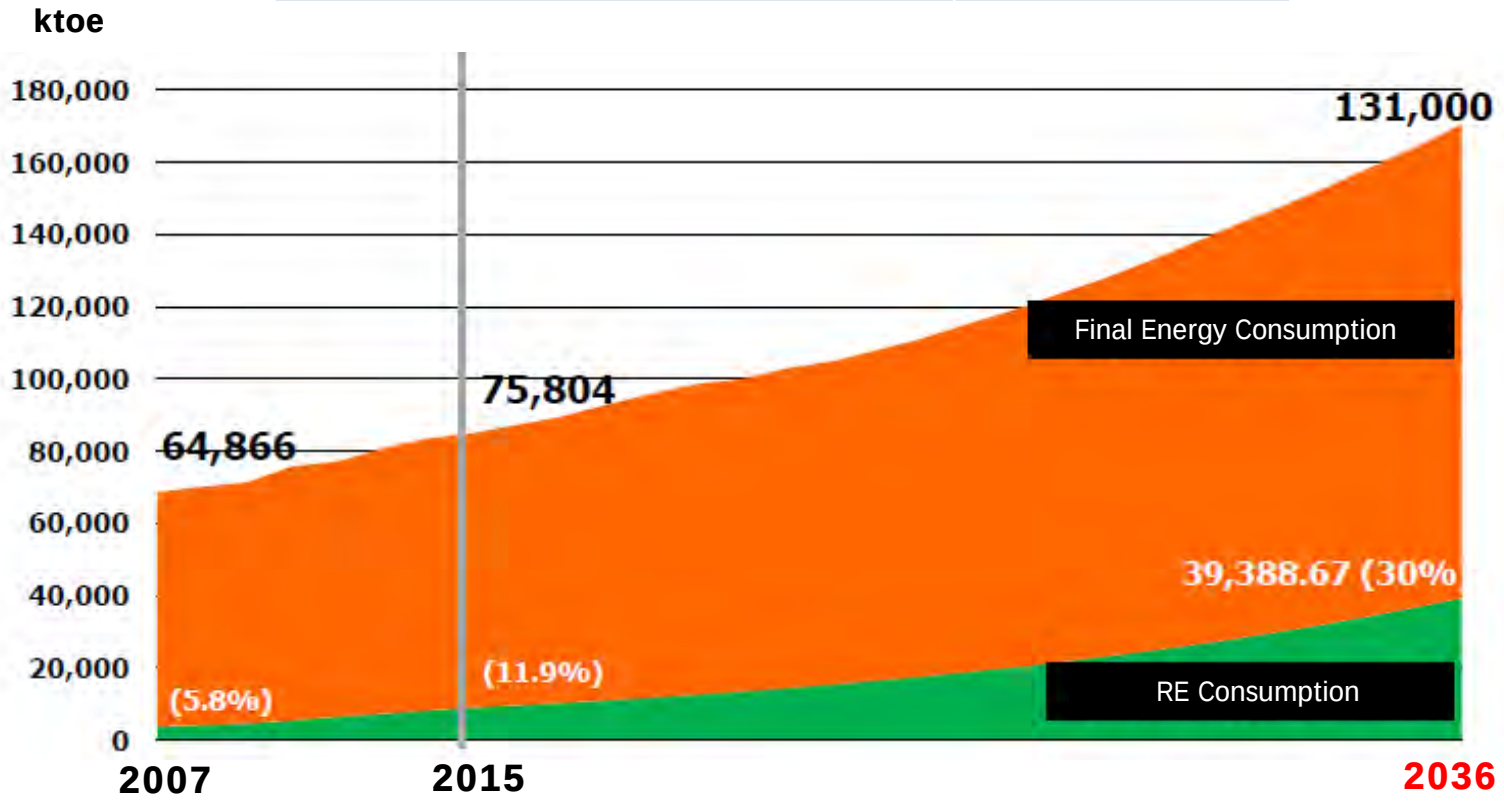
Department of Alternative
Energy Development and Efficiency
MINISTRY OF ENERGY

Alternative Energy Development Plan (AEDP) 2015-2036

Alternative Energy Development Plan (AEDP) 2015-2036

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%



Alternative Energy Development Plan (AEDP) 2015-2036

Foundation: Commitment to the development of a low-carbon society

Facilitator: *Private-led investment*

Strategy: Alternative Energy Development Plan 2015-2036

Facilitator: *Government funded RD&D*

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

Bio-Energy

Biomass	Biogas	MSW + Industrial Waste
5,570 MW	1,280 MW	550 MW
22,100 ktoe	1,283 ktoe	495 ktoe

6,720 MW Power | 23,878 Ktoe Heat

Bio-Fuel

Ethanol	Biodiesel	Pyrolysis Oil
11.3 ML/Day	14 ML/Day	0.53 ML/Day

CBG	Alt. Fuels*
4,800 t/Day	10 ktoe

Solar

6,000 MW

1,200 Ktoe

Wind

3,002 MW

9,002 MW Power | 1,200 Ktoe Heat

Hydro

Large Hydro 2,906.40 MW	Small Hydro 376 MW

3,282.40 MW

New-Energy

Geothermal, Used Tire Oil, etc.

10 ktoe

* Alternative fuels = Bio-oil, Hydrogen

Power Generation Sector: Status & target

RE Technology	Year 2014 (MW)	Target in 2036 (MW)
1. MSW	65.7	500
2. Industrial Waste	-	50
3. Biomass	2,451.8	5,570
4. Biogas	311.5	600
5. Small Hydro Power	142	376
6. Biogas from Energy Crops	-	680
7. Wind	224.4	3,002
8. Solar PV	1,298.5	6,000
9. Large Hydro Power	-	2,906.4
Total	**4,494**	**19,684.4**
RE Share in Power Sector	**9%**	**20%**

Heat Sector: Status & target

RE Technology	Year 2014 (ktoe)	Target in 2036 (ktoe)
1. MSW	98.1	495
2. Biomass	5,184	22,100
3. Biogas from Wastewater/Animal Manure	488.1	1,283
4. Solar	5.12	1,200
5. Others*	-	10
Total	**5,775**	**25,088**
RE Share in Heat Sector	**17%**	**30-35%**

* Other RE sources such as geothermal energy, etc.

Transportation Sector: Status & target

RE Technology	Year 2014 (ML/day)	Target in 2036 (ML/day)	Target in 2036 (ktoe)
1. Biodiesel	2.89	14	4,404.8
2. Bioethanol	3.21	11.3	2,103.5
3. Pyrolysis-Oil	-	0.53	170.8
4. Compressed-Biomethane Gas (tons/day)	-	4,800	2,023.2
5. Other Alternative Fuels*	-		10
Total	**6.1**		**8,712.4**
RE Share in Transportation Sector	**7%**		**20-25%**

* Other alternative fuels such as hydrogen, bio-oil, etc.

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

Feed-in Tariff Scheme

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

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Biomass Energy Promotion

Biomass Potential

Biomass potential data	Remain Biomass (at year 2014)			Remain Biomass incl. Agri. Plan		
Type of biomass	Ton/y	ktoe	Existing (MW)	Ton/y	ktoe	Existing (MW)
Rice husk	432	0.14	0.05	432	0.14	0.05
Rice straw	4,124,630	1,204	461	4,124,630	1,204	461
Sugar cane and leaf	2,928,140	1,073	411	5,265,619	1,929	738
Bagasse	-	-	-	21,280,000	3,712	1,421
Corn cob	80,889	18	7	80,889	18	7
Corn trunk	3,369,690	784	300	3,369,690	784	300
Cassava rhizome	2,838,125	369	141	3,372.560	439	168
Cassava trunk	1,052,636	388	149	2,084,755	769	294
Oil palm frond	14,606,671	2,265	867	33,586,191	5,208	1,993
Oil palm fiber	-	-	-	2,944,803	795	304
Oil palm shell	-	-	-	619,959	248	95
Oil palm empty fruit bunch	606,541	104	40	1,402,455	240	92
Para wood root	1,411,834	287	110	1,411,834	287	110
Coconut shell	79,678	31	12	79,678	31	12
Coconut fiber	71,875	27	10	71,875	27	10
Coconut bunch and frond	249,026	91	35	249,026	91	35
Total	31,420,166	6,642	2,542	79,944,394	15,783	6,040

Biomass Plan

Promote the community scale biomass power generations by

- establishing community enterprises to co-manage the operation and fuel supply;
- identifying suitable technologies, for example gasifiers, for community scale power generation; and
- formulating necessary incentives for promotion of their uses.

Promote R&D on Biomass technologies, i.e

- plantation of fast growing plants;
- harvesting and collection;
- transformation and logistics such as pellets and briquetting.

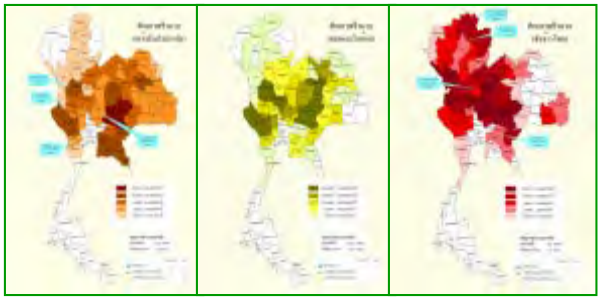
Promote biomass power development by

- providing new incentives to developers such as different rate Adder based on technology and size;
- expansion of national grid; and
- Creation of public participation.

Next Step for Biomass

Encourage biomass utilization

- substitute fossil fuel in local industry and in community
- increase the utilization of unused biomass
- improve the energy efficiency in agro industry



Promotion & Support

- update and provide biomass potential map
- develop biomass excellent center
- financial support and co-promote CDM activities
- develop the biomass collection and transportation system

R&D

- encourage biomass transformation : pellet
- biomass to liquid technology
- high efficiency biomass technology

Renewable energy class detail: *Biomass*

Development initiatives

- Promote **plantation of fast growing trees** that can be used as feedstock for power/heat generation
- Develop **production and standard of biomass pellets** for future biomass fuel
- Develop **advanced gasifier and gas engine technology** as well as **biomass-to-liquid** (BTL) technology
- Promote **use of high pressure boilers** to improve efficiency of power generation from biomass
- Promote Distributed Green Generation (DGG) – **community level biomass** energy
- Coordinate with EGAT to develop necessary **transmission and distribution infrastructure**

Promote and Support for Establishing of Distributed Green Generation (DGG) Project

Promote and Support for Establishing of Distributed Green Generation (DGG) Project

Project initiatives

- Farmer in the northeast area of Thailand have cultivated a great deal of fast growing tree, such as Eucalyptus, Acacia, etc., and communities have high potential to establish for cooperative.
- Limitation of national transmission line.

Project objectives

- To promote and support high potential communities to be established as a distributed green generation station
- To demonstrate DGG model, and determine the method for model distribution to other efficient communities.

Promote and Support for Establishing of Distributed Green Generation (DGG) Project

Target Demonstration Sites

1. Community DDG Station: Jaturas District, Chaiyaphoom
2. Community DDG Station: Phu Wieng District, Khon Kaen
3. Sum-Soong Community DDG Station: Sum-Soong District, Khon Kaen
4. Bann None Sawang Community DDG Station: Muang District, Nong Bua Lamphoo
5. None Sanguan Community DDG Station: Sri Boonruang District, Nong Bua Lamphoo
6. Green Energy Crop Community Enterprise DDG Station: Sri-Tart District, Udon Thani
7. Phai Sub-district DDG Station: Muang District, Kalasin
8. Poh-Sri DDG Station: Poh-Chai District, Roi-Et
9. Kam Kuen Kaew DGG Station: Sirindhorn District, Ubon Rachathani
10. Seesuk-Seelakor Community Enterprise DGG Station: Chakkarat District, Nakhon Ratchasima

Promote and Support for Establishing of Distributed Green Generation (DGG) Project

Example of DGG management concept

Site: None Sanguan DDG Station: Nong Bua Lamphoo Province




Fast growing tree

Fast growing tree

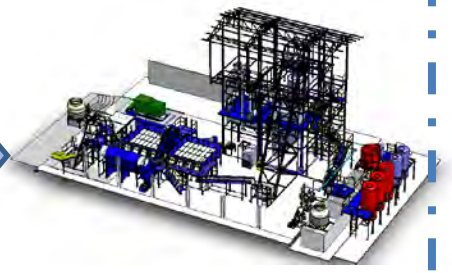
Fast growing tree

Cassava Rhizome

50 ton-fuel/day

1 Trailer
2 Trucks
3-4 Small Trucks

DGG Station
25% moisture
fuel storage

1 MW Gasification
Power Plant

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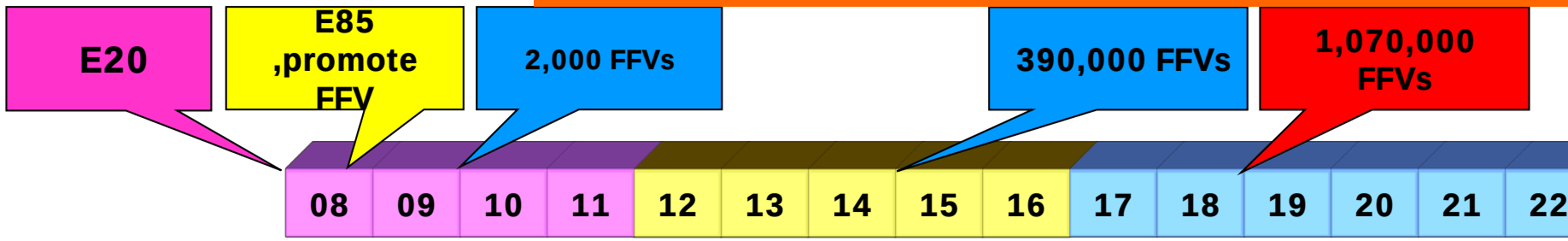
Ethanol Development Plan 2008 - 2022



Ethanol Demand (ML/day)**	1.24	1.34	2.11	2.96	6.2	9.0
Budget (MB)	-	28	60	30	160	280

Ethanol Market	**Sustainable ethanol production** R&D and promote ethanol logistic , ethanol depot for export
Ethanol Production	Promote ethanol production from molasses and cassava Promote ethanol production from sugar cane Promote by-product utilization from ethanol production ex. Acetic acid
Feed Stock	R&D yield of cassava 3.5 to 4.5 ton/rai/yr in 2012 R&D yield of sugarcane 11.8 to 15 ton/rai/yr in 2012 **Sustainable feed stock for ethanol production**
R&D	R&D 2nd generation of ethanol production (Cellulosic) Promote 2nd generation of ethanol production value added ex. sawage study E85

Thailand Ethanol Feedstock - 2014

Sugarcane
- Area 8.46 MRai
- Yield 12.3 T/Rai/Year
- Output 104 MT

Molasses 4.7 MT

Sugarcane Juice

Cassava
- Area 8.7 MRai
- Yield 3.6 T/Rai/Year
- Output 31 MT

Used to produce ethanol 0.9 MT

66 ML

62% of molasses

Used to produce ethanol 2.90 MT

694 ML

6% of cassava

Used to produce ethanol 1.9 MT

298 ML

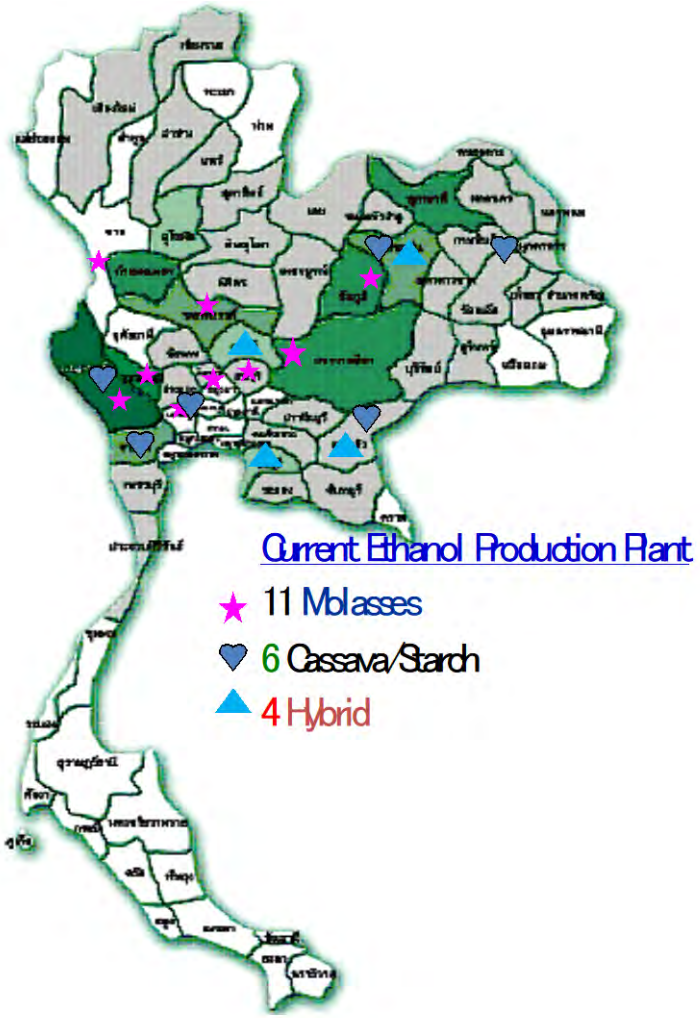
Ethanol
1059 ML

(3 ML/day)

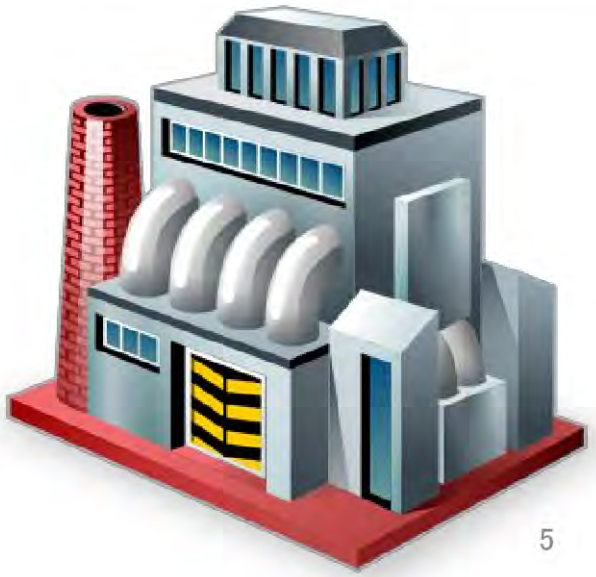
1 Hectar = 6.25 Rai

Sources –DEDE

Ethanol production capacity



Feedstock	No. of plants	Total cap. (M/day)
Molasses	10	2.26
Cassava	7	1.455
Molasses and Cassava	5	1.25
TOTAL	22	4.965

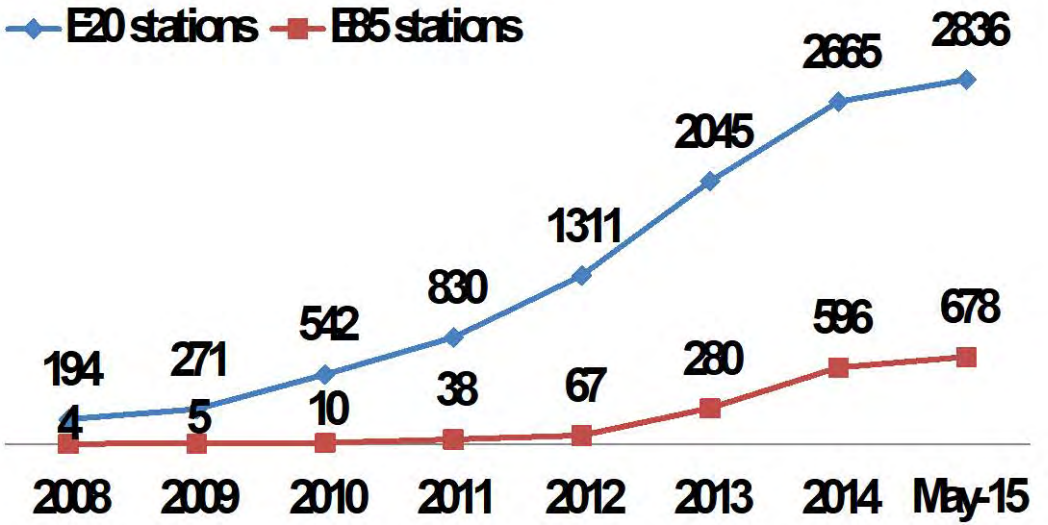


Sources – DEDE

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Gasohol fuel stations and vehicles

E10 stations are well spread over Thailand



Sources – DOEB

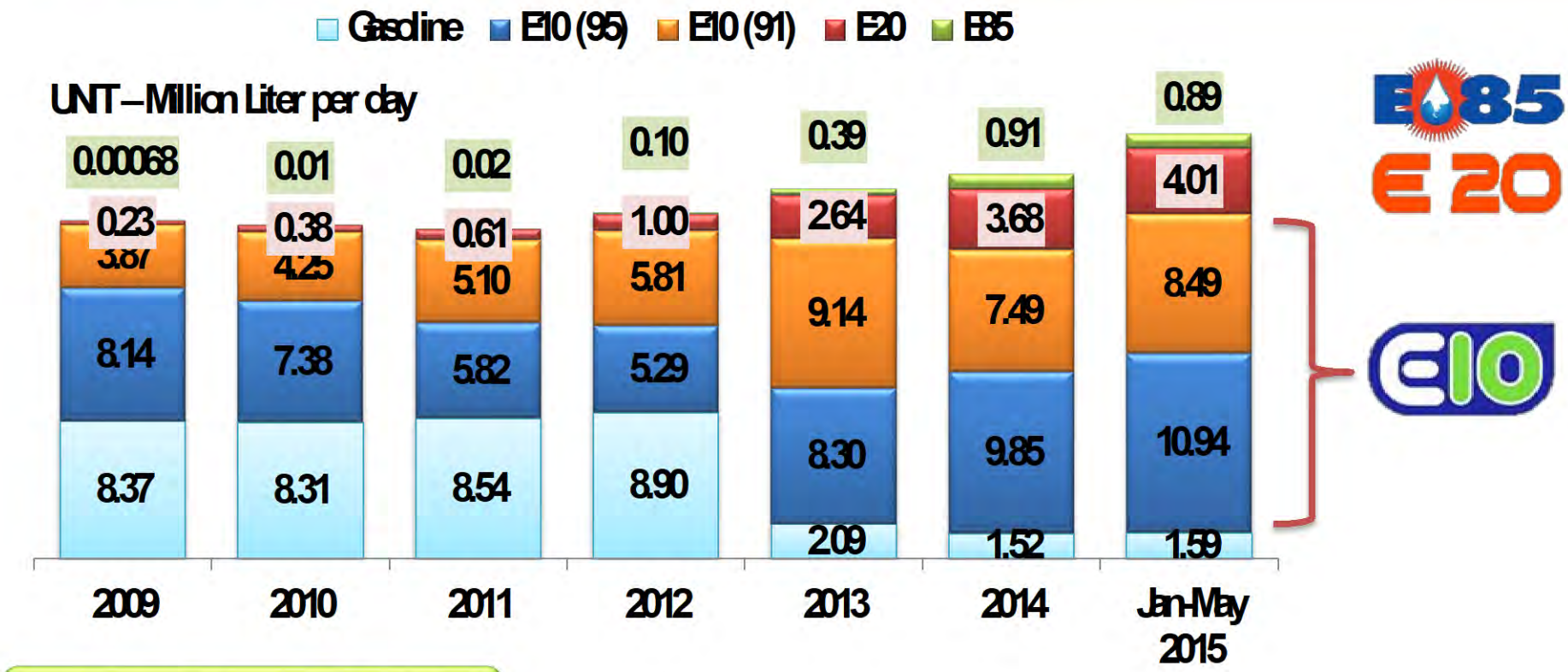
E10 Most cars manufactured since 1995

E20 Most cars manufactured since 2008

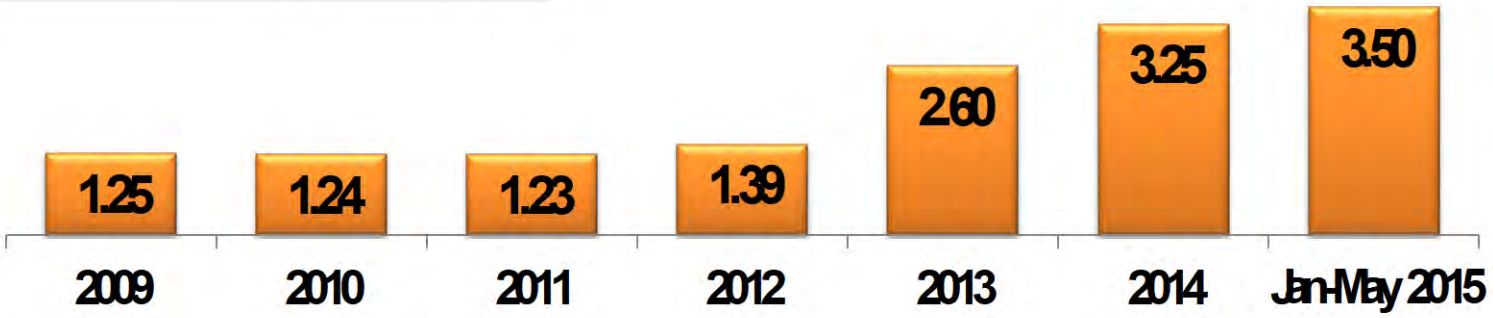
E85 All Flex fuel cars (FFV)

CHEVROLET HONDA mazda MITSUBISHI MOTORS TOYOTA VOLVO

Ethanol uses



Ethanol usage ML/day

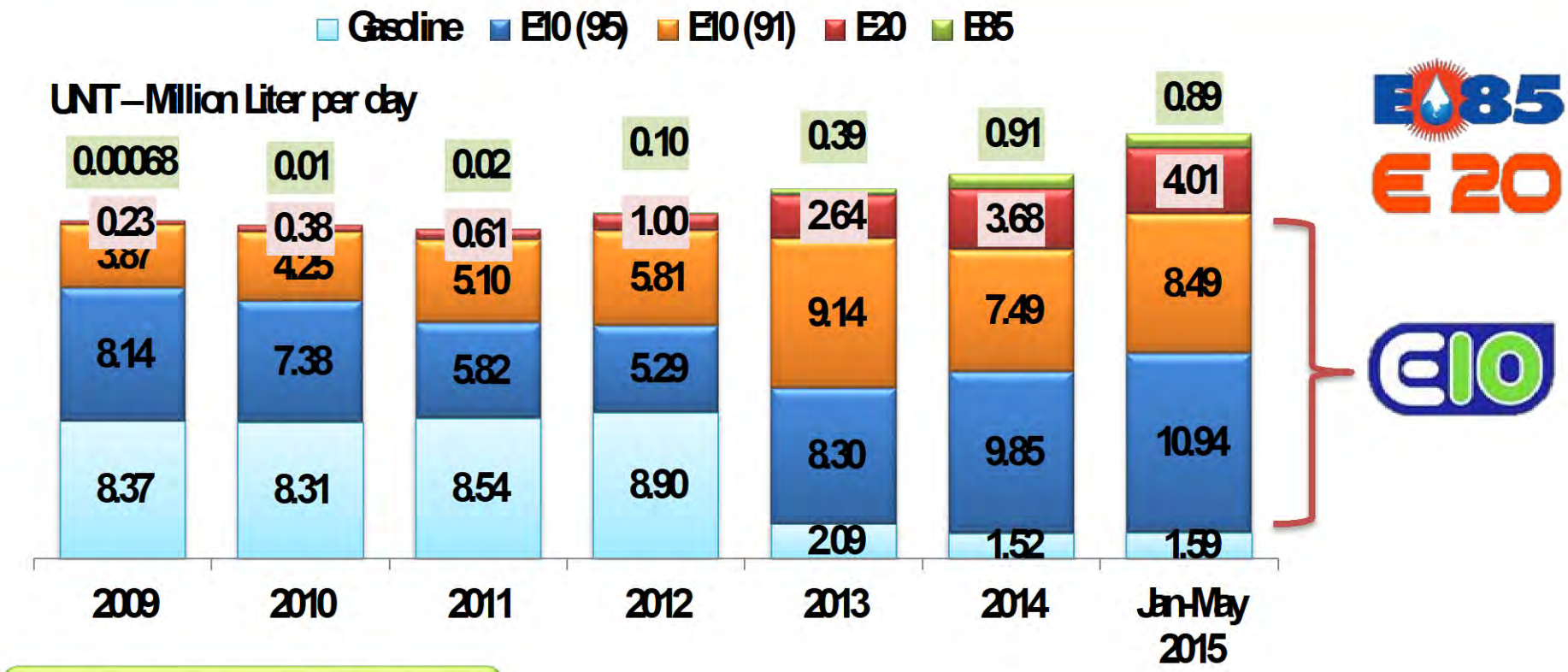


10%

replacement of Gasoline

Sources – DOEB

Ethanol uses



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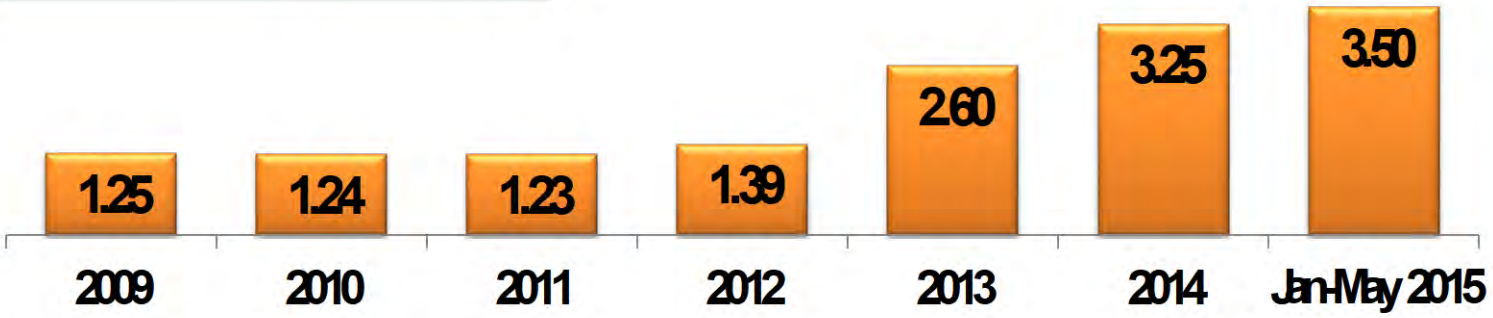

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Sources – DOEB

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Biodiesel Development Plan 2008 - 2022

Research on Biodiesel with fish boat Engines

B5 nationwide, B10 optional

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
Demand B100 (ML/day)	1.35	1.35	1.35	3.02	3.64					4.50					
Budget (MB)	129.75	37.4	29.4	19.4	450					330					

B100 Marketing	Enforcement B2 → Enforcement B5 Optional B5 → Optional B10 **Sustainable B100 production**
B100 Production	Biodiesel production from CPO and Sterine R&D production / Community usage Biodiesel standard development
Feedstock	Expanding Palm oil cultivation areas 2.5 million rai R&D Yield of palm 2.8 to 3.2 ton/rai/yr **Sustainable CPO production**
R&D	R&D and promote value added of gycerline/small CPO extraction unit R&D BTL / BHD → Promote BTL and/or BHD, seaweed R&D biodiesel production from seaweed → **R&D Alternative feed stock for biodiesel production** ZERO waste of Jatropha for biodiesel production

Biodiesel

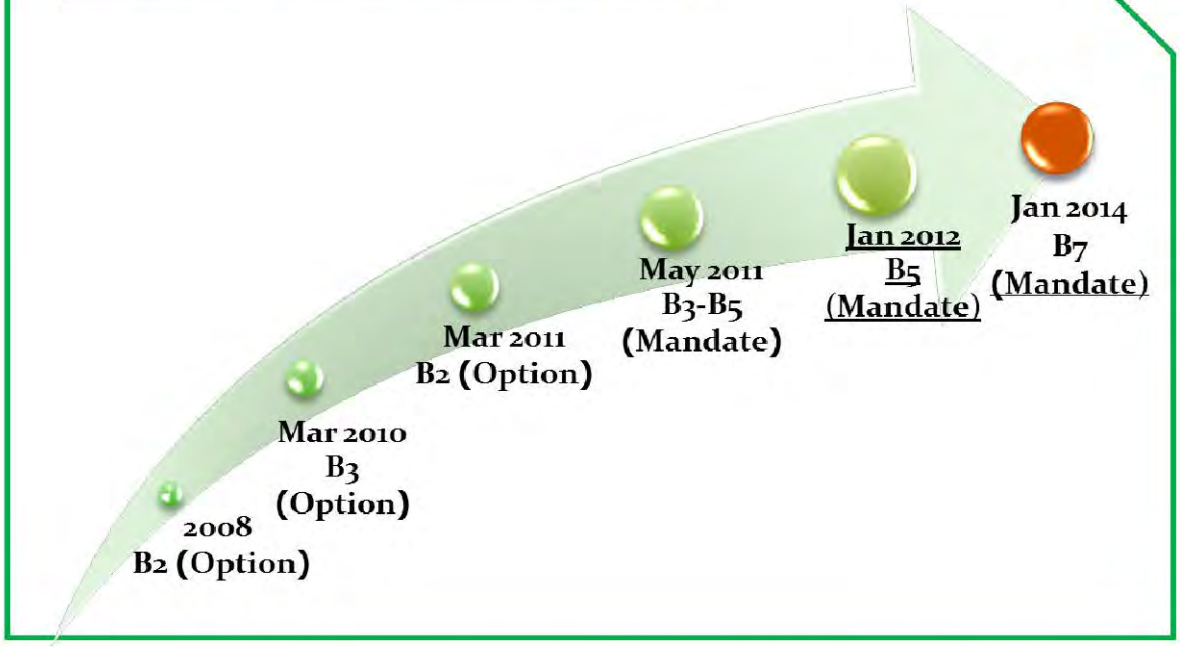
Palm Oil

Biodiesel
Fatty acid methyl ester

Biodiesel Fuel

Historically implemented policies

Biodiesel consumption policy



Dept. of Energy Business has announced policy
⇒ Biodiesel B7 (7% B100 blended)
⇒ since January 2014

Biodiesel

Palm Oil

Biodiesel
Fatty acid methyl ester

Biodiesel Fuel

Historically implemented policies

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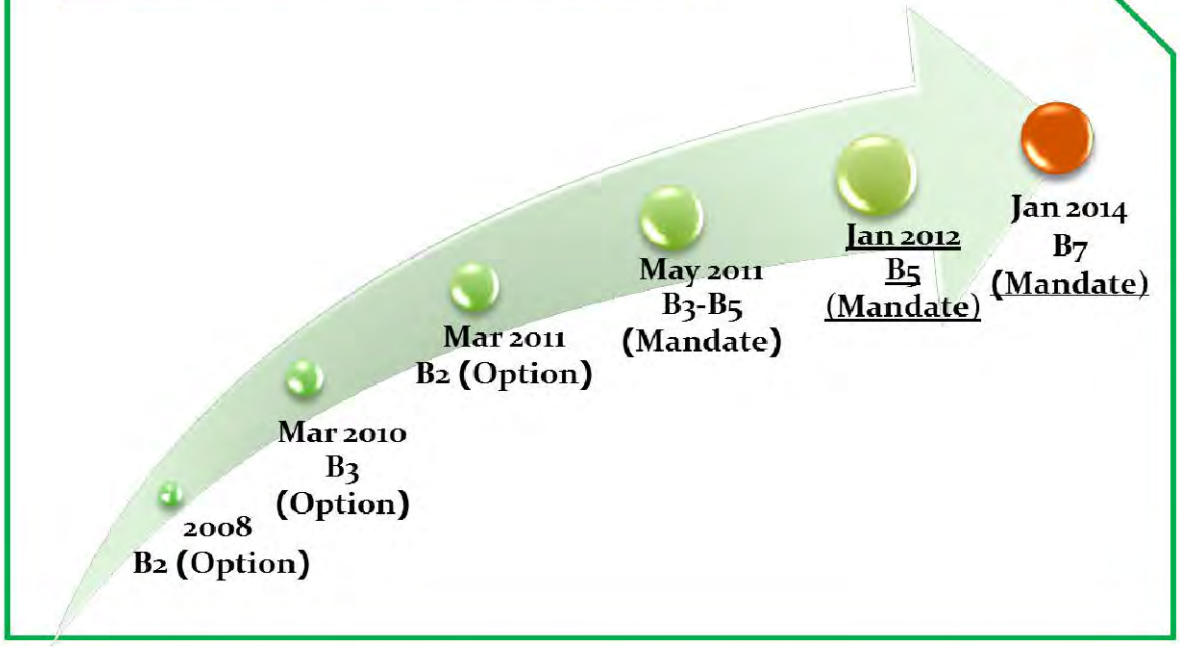

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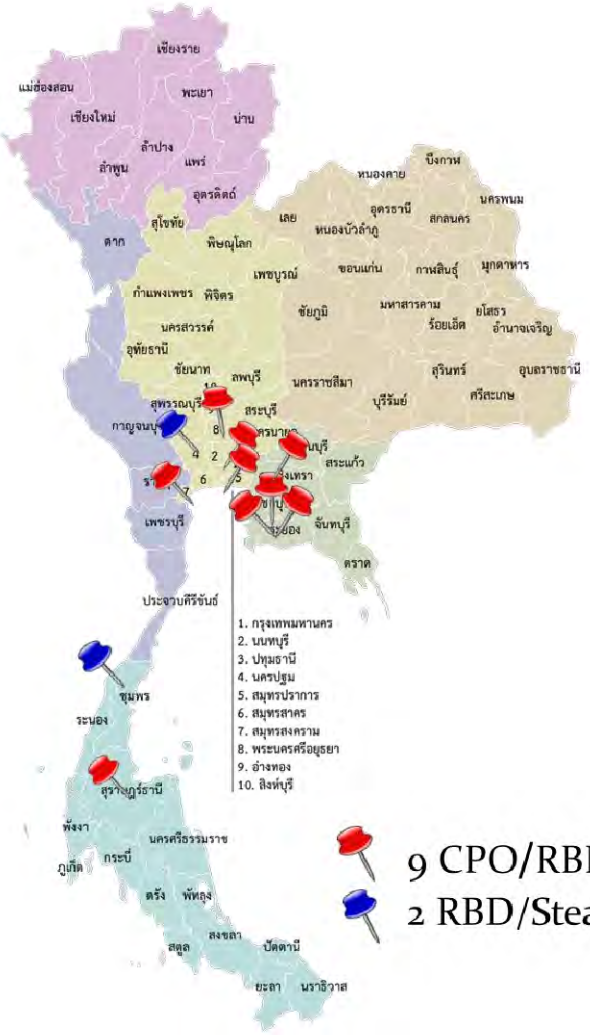
Biodiesel production capacity

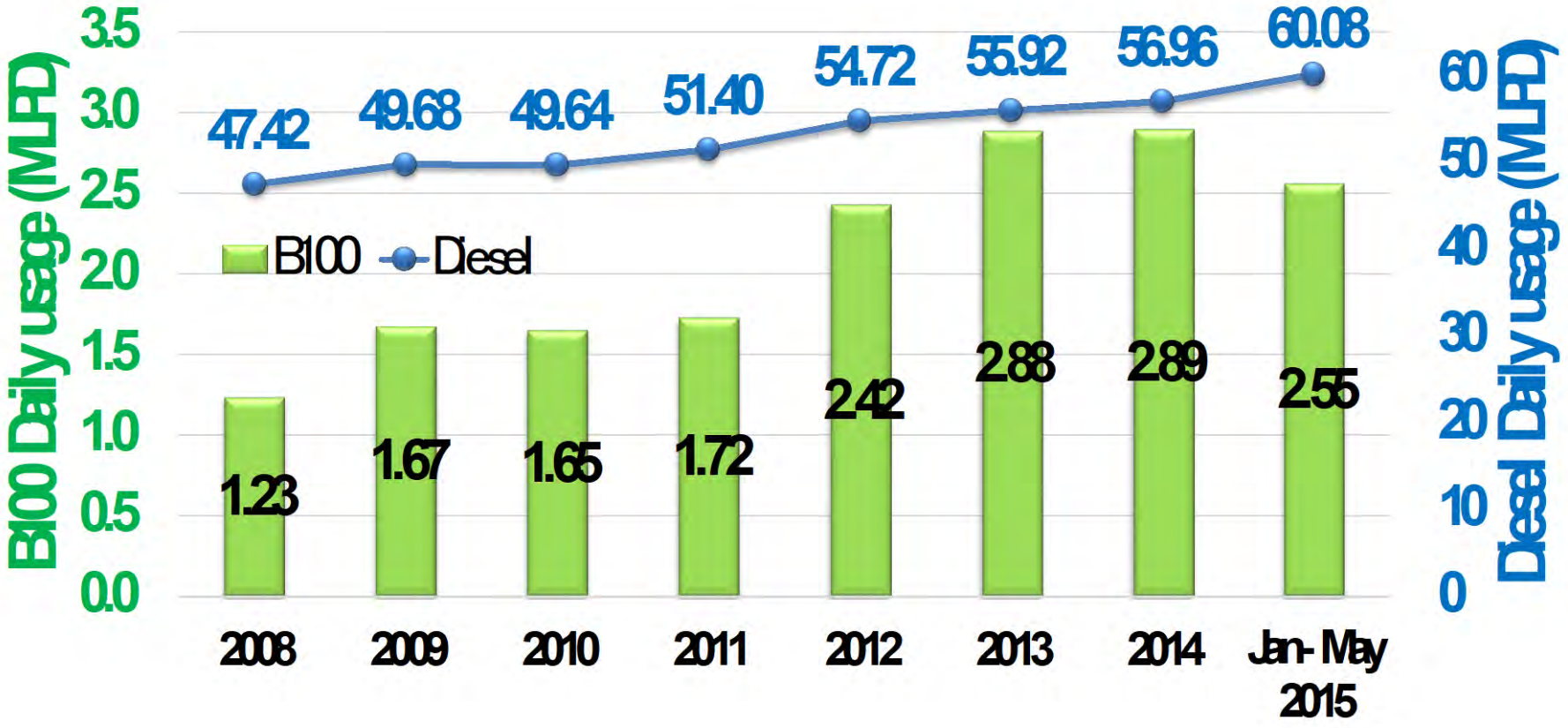


9 CPO/RBD/Stearine
2 RBD/Stearine

Feedstock	Registered capacity	
	No. of factories	Capacity (ML/day)
CPO/RBDPO/Palmstearin	9	4.56
Palmstearin	2	0.40
Total	11	4.96

Biodiesel usage

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



Source - DOEB

Conclusion on Biomass and Biofuels R&D

MOU between MOST and MOEN

Biomass

- Characteristics
- Logistic
- Property Improvements
  - Size reduction
  - Drying
  - Torrefaction
  - Densification; Briquette, Pellet

- Technology Development, Small Scale
  - Co-fuels combustion
  - Gasification, both for heat and power

<u>Biogas</u>

- Efficiency Improvement
- Co-digestion
- Cleaning equipment
- Upgrading to CBG

Biofuels

- Yield improvement of raw materials
- Logistic of raw materials
- Cost reduction on conversion process
  - Yeasts, Enzyme, Catalysts, Energy Use, Retention time.
- Added values for wastes or coproducts.
- Logistic of products.
- Development of small scale production for Biodiesel.
- Sustainability Criteria and LCA.
- Advance Biofuel Technologies.

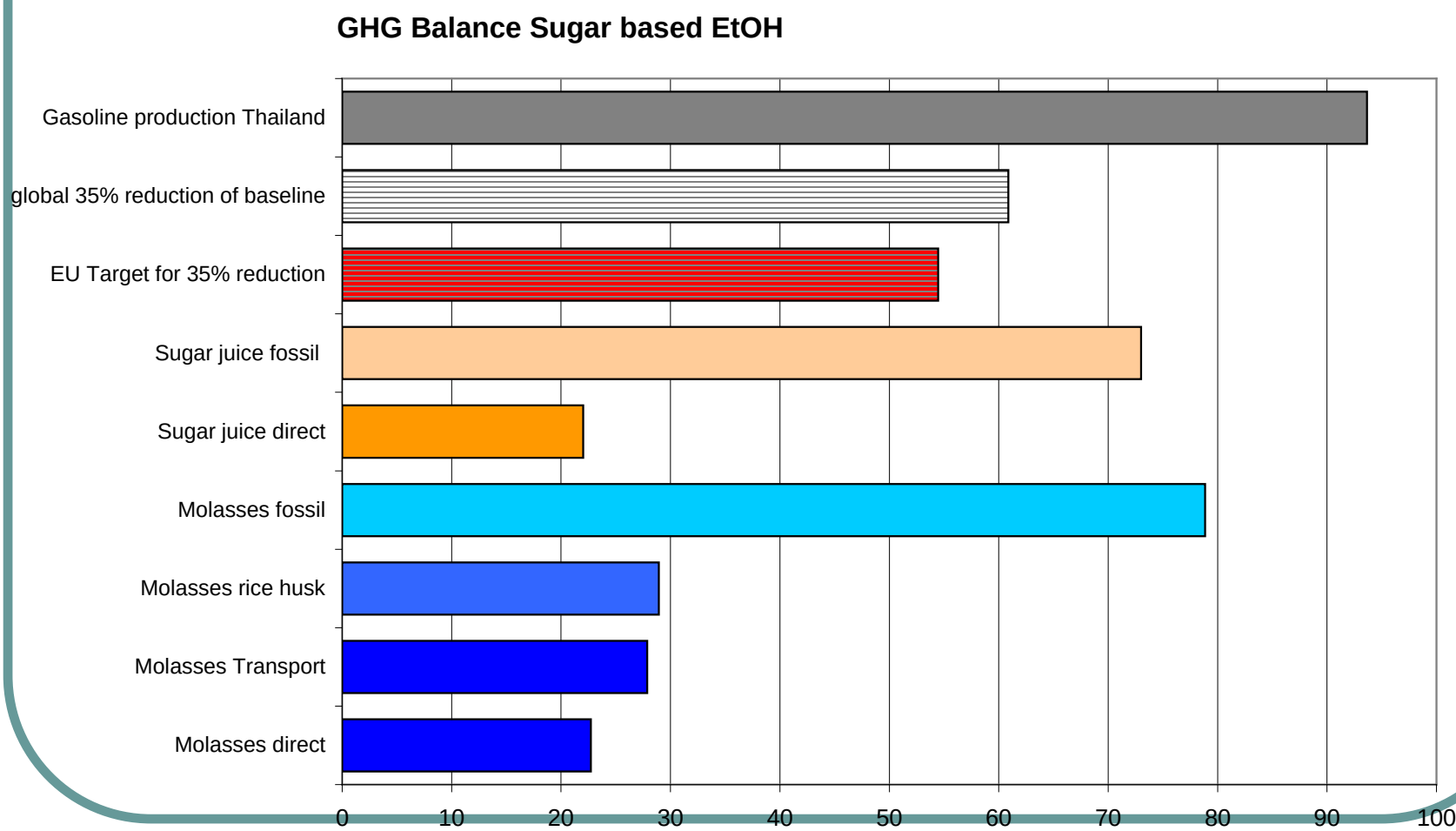
Thank You

Any Question?

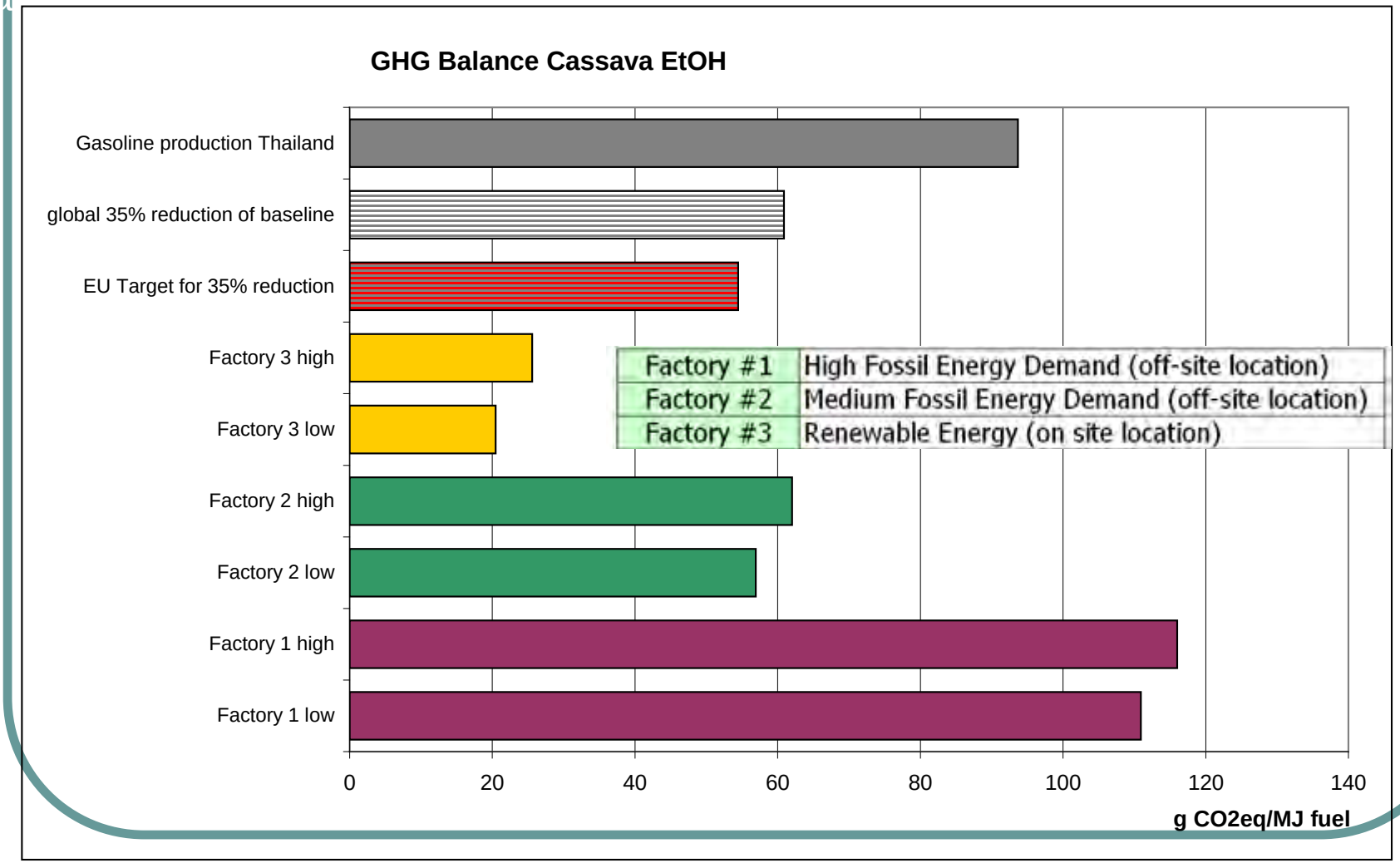




GHG emissions results



GHG emissions results for final bioethanol*



* Final values in g CO2eq per MJ of cassava-ethanol for agriculture, transport, processing and refining but without CC or LUC

GHG emissions results

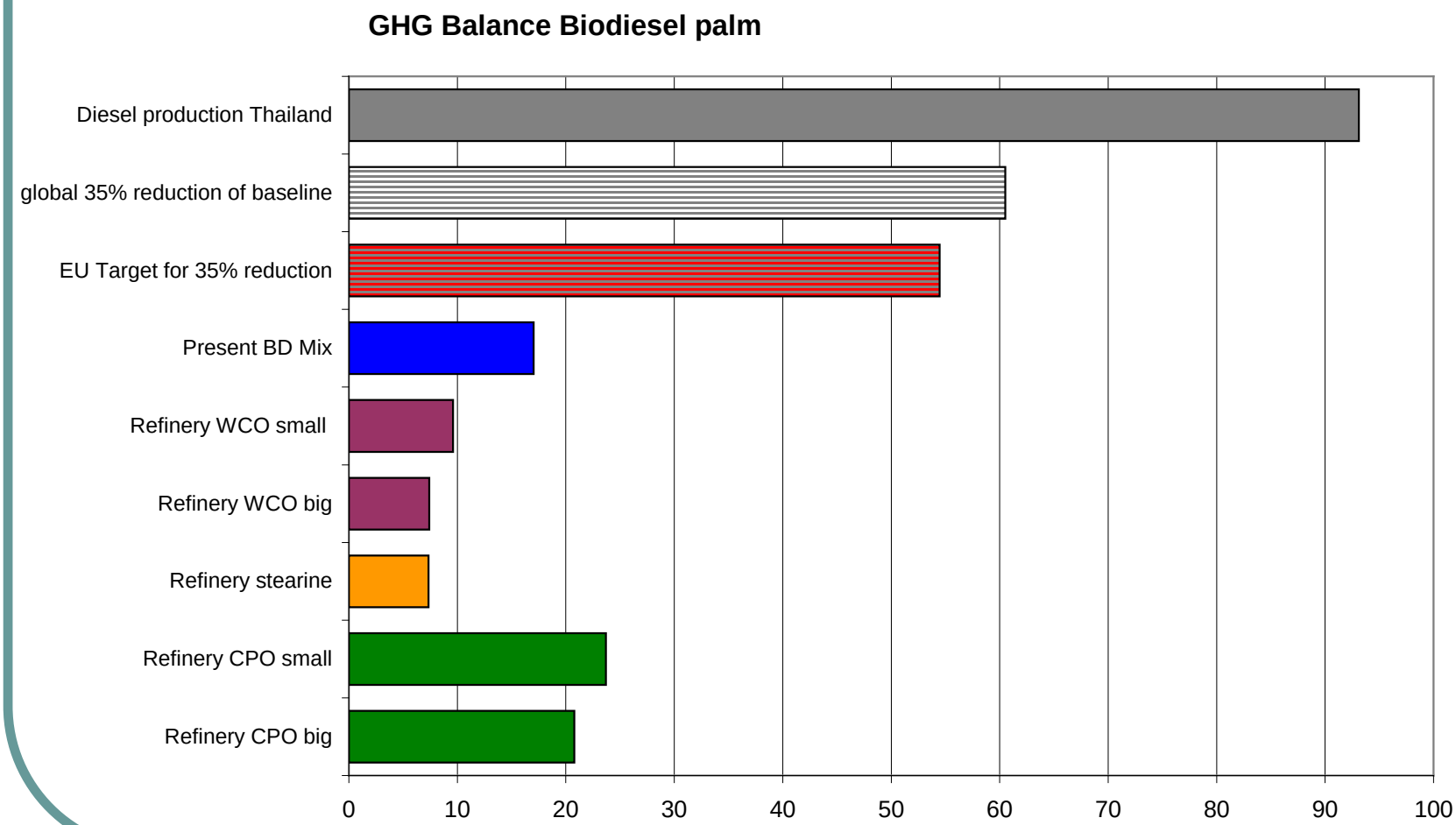


Table 2: Land-use efficiency of different biofuel crops and expected yield improvements (global averages)

Biofuel type	*Yields, 2010 (litres/ha)*		*Average improvement per year, 2010-50*	*Resulting yields in 2050 (Lge or Lde/ha)*	*Main co-product, 2010 values, (Kg/L biofuel)*
	nominal	*Lde or Lge*			
Ethanol - conventional (average yield of feedstocks below)	3 300	2 300	0.7%	3 000	
Sugar beet	4 000	2 800	0.7%	3 700	Beet pulp (0.25)
Corn	2 600	1 800	0.7%	2 400	DDGS (0.3)
Ethanol - cane	4 900	3 400	0.9%	4 800	Bagasse (0.25)
Cellulosic-ethanol - SRC*	3 100	2 200	1.3%	3 700	Lignin (0.4)
Biodiesel - conventional (average yield of feedstocks below)	2 000	1 800	1.0%	2 600	FAME: Glycerine (0.1)
Rapeseed	1 700	1 500	0.9%	2 100	Presscake (0.6)
Soy	700	600	1.0%	900	Soy bean meal (0.8)
Palm	3 600	3 200	1.0%	4 800	Empty fruit bunches (0.25)

	Yield (gross) Giga joule per hectare per year	**Required agricultural land** - To replace a quarter of the current global demand for transportation fuels (2) - In percentage points of what is available globally (3)
Sugar cane	104	17
Sugar beet	90	20
Palm oil	81	22
Maize	54	33
Wheat	45	40
Barley	20	91
Rape	20	91
Sunflowers	16	111
Soy beans	9	200

(1) from: Biomass for food or fuel: Is there a dilemma? Louise O. Fresco. Amsterdam University. The Duisenberg Lecture, Singapore 19 September, 2006

(2) 45 EJ/year

(3) 2.5 billion ha

Table 2.2 Indication of land required for the production of biomass (1) (Cramer 2007).

Crop	kg oil/ha	litres oil/ha	lbs oil/acre	US gal/acre
corn (maize)	145	172	129	18
cashew nut	148	176	132	19
oats	183	217	163	23
cotton	273	325	244	35
hemp	305	363	272	39
soybean	375	446	335	48
linseed (flax)	402	478	359	51
hazelnuts	405	482	362	51
pumpkin seed	449	534	401	57
mustard seed	481	572	430	61
camelina	490	583	438	62
sesame	585	696	522	74
safflower	655	779	585	83
sunflower	800	952	714	102
cocoa (cacao)	863	1,026	771	110
peanuts	890	1,059	795	113
rapeseed (Canola)	1,000	1,190	893	127
olives	1,019	1,212	910	129
castor beans	1,188	1,413	1,061	151
jojoba	1,528	1,818	1,365	194
jatropha	1,590	1,892	1,420	202
macadamia nuts	1,887	2,246	1,685	240
Brazil nuts	2,010	2,392	1,795	255
avocado	2,217	2,638	1,980	282
coconut	2,260	2,689	2,018	287
oil palm	5,000	5,950	4,465	635

Table 2.1 - Yields for Various Vegetable Oil Sources (Wikipedia 2007)