Palm Biodiesel – An Overview

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Presentation Outline

1. Global Energy Outlook.
2. Global Warming & Climate Change
3. Understanding Biodiesel
4. Biodiesel Specifications & What they mean
5. Global Biodiesel Scenario
6. Key Drivers for Biodiesel Mandates
7. The Malaysian Palm Biodiesel Story
8. Challenges to the Palm Biodiesel business
9. Status of Palm Biodiesel in Malaysia/Indonesia
10. Summary & Conclusions

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GLOBAL ENERGY OUTLOOK

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Global Energy outlook

- World energy demand is predicted to rise by 30% by 2040
- 80% of global energy comes from burning fossil fuels
- 13.8% of the world's primary energy supply comes from renewable energy
- Liquid biofuels constitute only 4.1% in the Renewable energy portion
- Liquid Biofuels grew at 10.4% from 1990 to 2014 as compared to Solar PV at 46.2%

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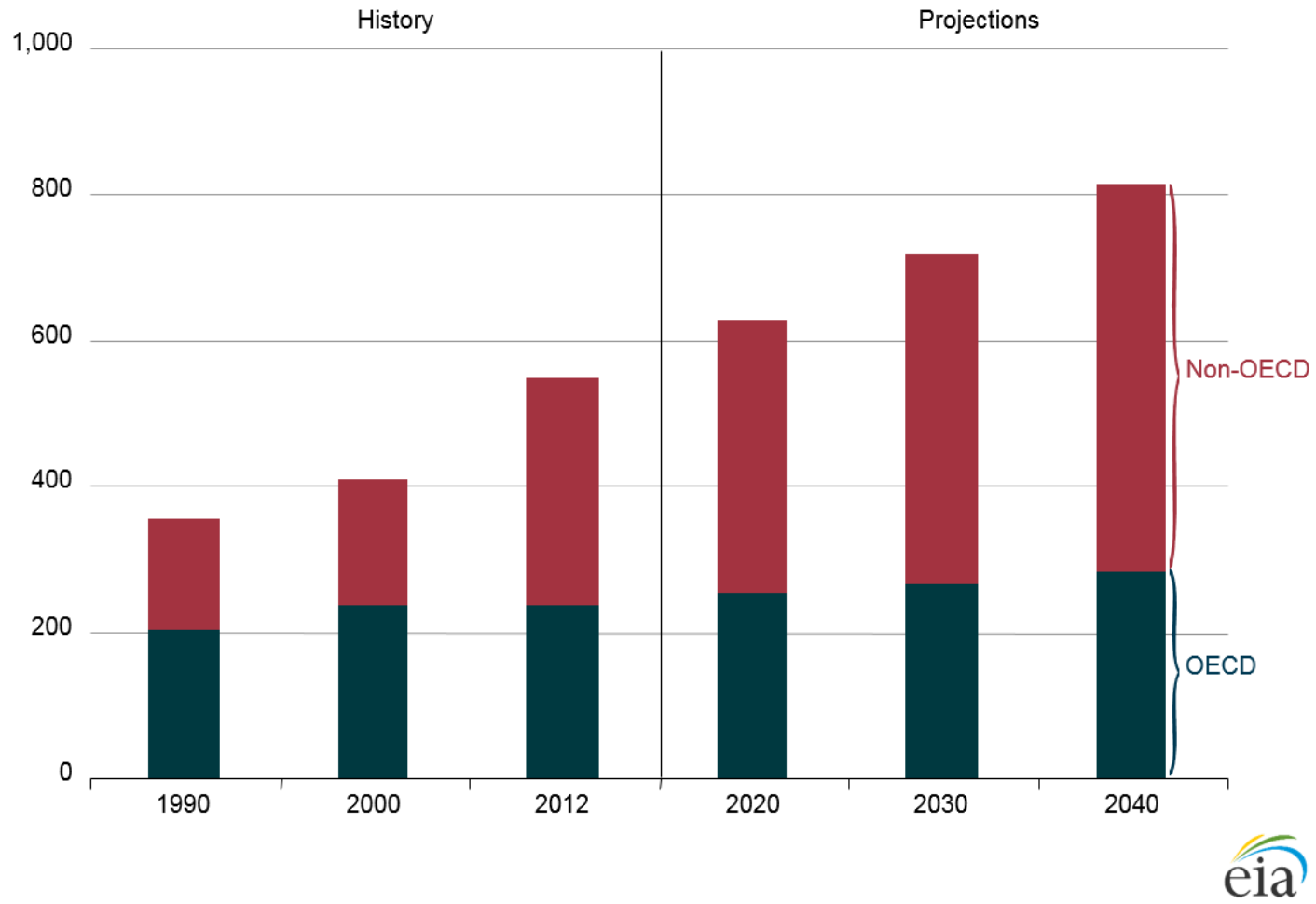

World Energy Consumption, 1990-2040, Quadrillion Btu

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World Primary Energy Demand by Fuel and Scenario (Mtoe)

		New Policies		Current Policies		450 Scenario	
	2012	2020	2040	2020	2040	2020	2040
Coal	3 879	4 211	4 448	4 457	5 860	3 920	2 590
Oil	4 194	4 487	4 761	4 584	5 337	4 363	3 242
Gas	2 844	3 182	4 418	3 215	4 742	3 104	3 462
Nuclear	642	845	1 210	838	1 005	859	1 677
Hydro	316	392	535	383	504	392	597
Bioenergy*	1 344	1 554	2 002	1 551	1 933	1 565	2 535
Other renewables	142	308	918	289	658	319	1 526
Total	13 361	14 978	18 293	15 317	20 039	14 521	15 629
Fossil fuel share	*82%*	*79%*	*74%*	*80%*	*80%*	*78%*	*59%*
*Non-OECD share***	*60%*	*63%*	*70%*	*63%*	*70%*	*63%*	*68%*

2444

4665

3135

6335

* Includes traditional and modern uses of biomass. ** Excludes international bunkers.

Source: Richard Vietor, Harvard Business School, 2016

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GLOBAL WARMING AND CLIMATE CHANGE

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CO_2 and Climate Change

- Emissions are still rising, especially in developing countries
- Concentrations are still rising, towards 450ppm CO_2
- Temperatures are also rising
- Energy sector contributed 2/3rd of the GHG emissions

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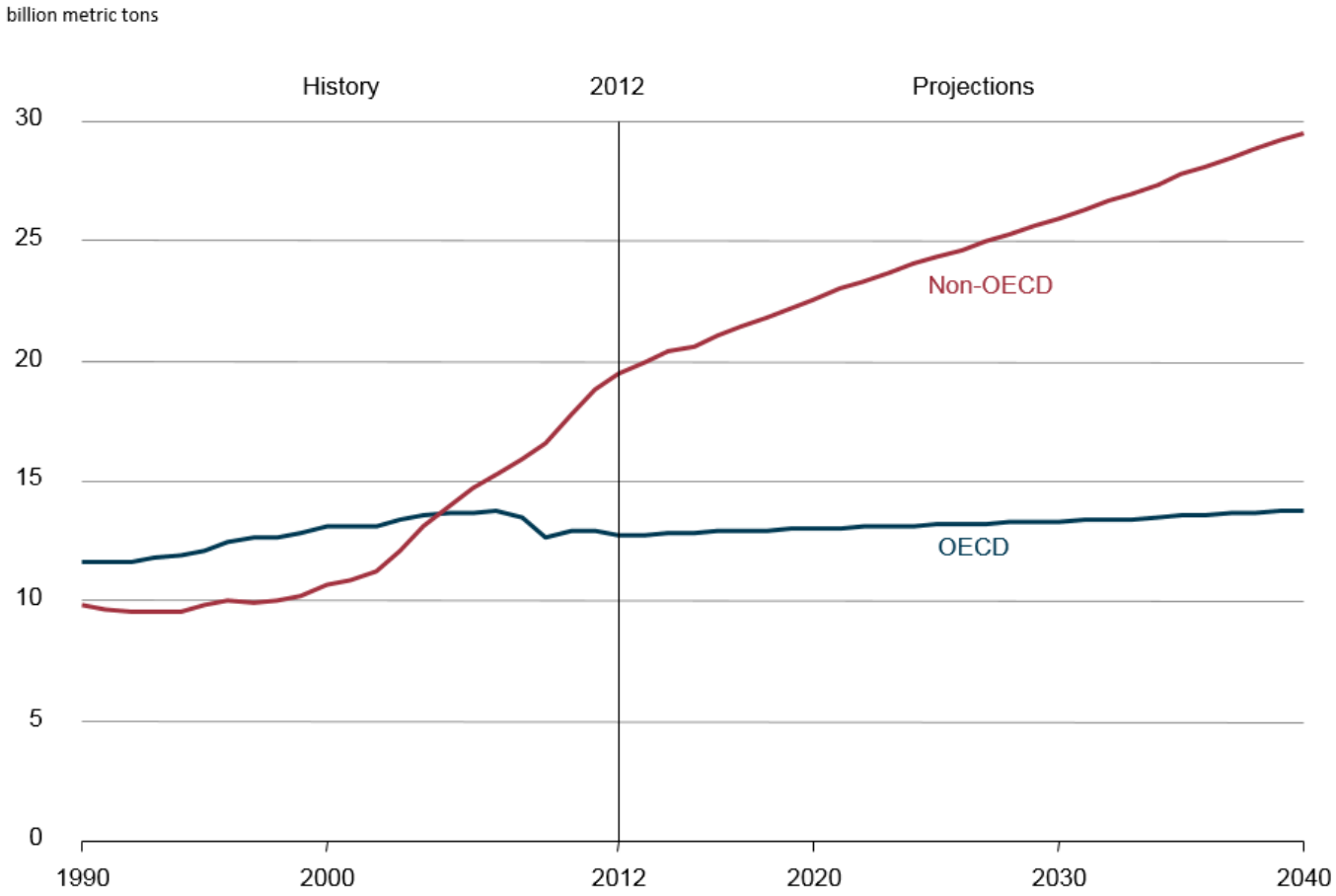

Carbon Dioxide emissions, 1990-2040

eia

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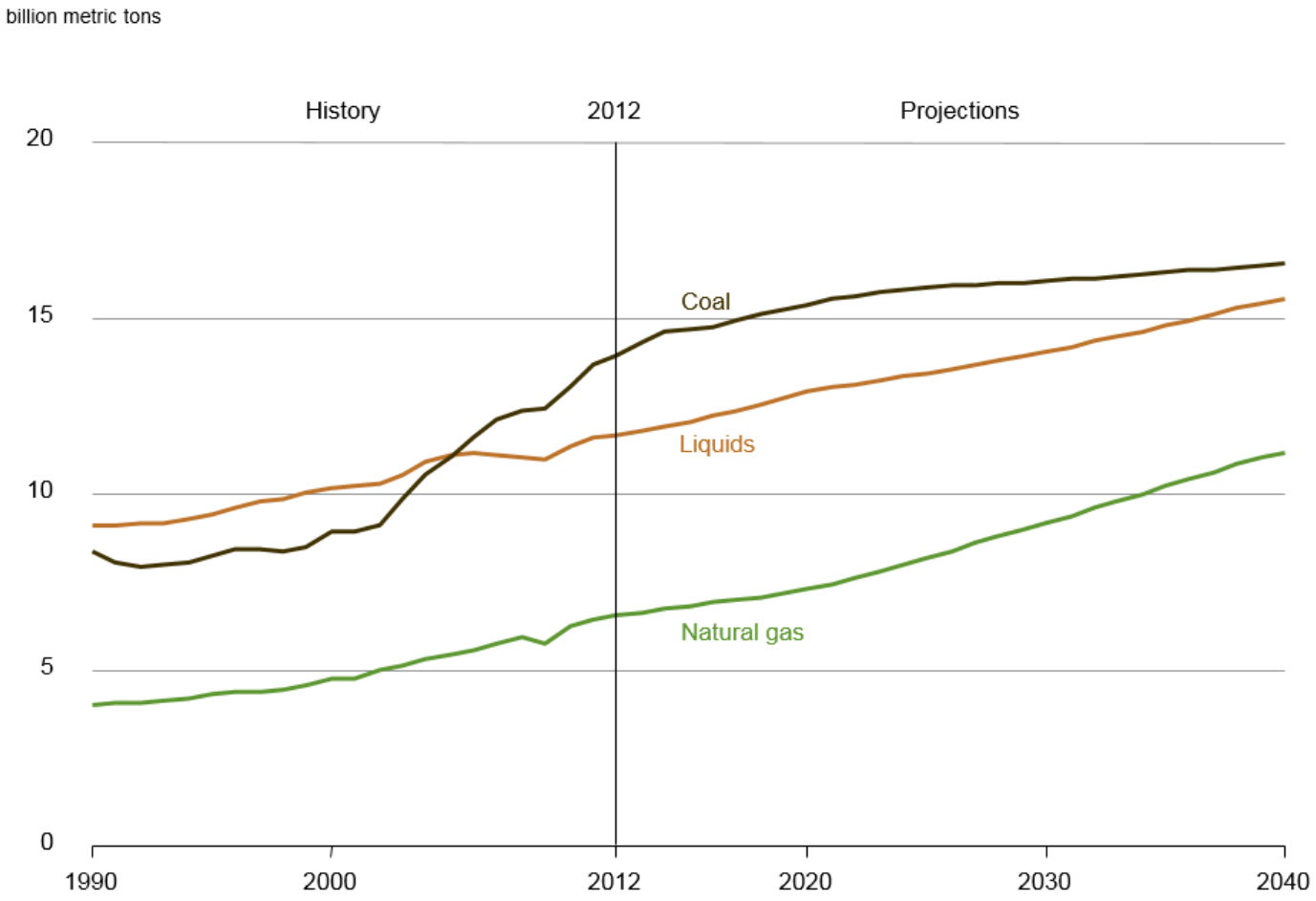

Carbon Dioxide emissions by Fuel type, 1990-2040

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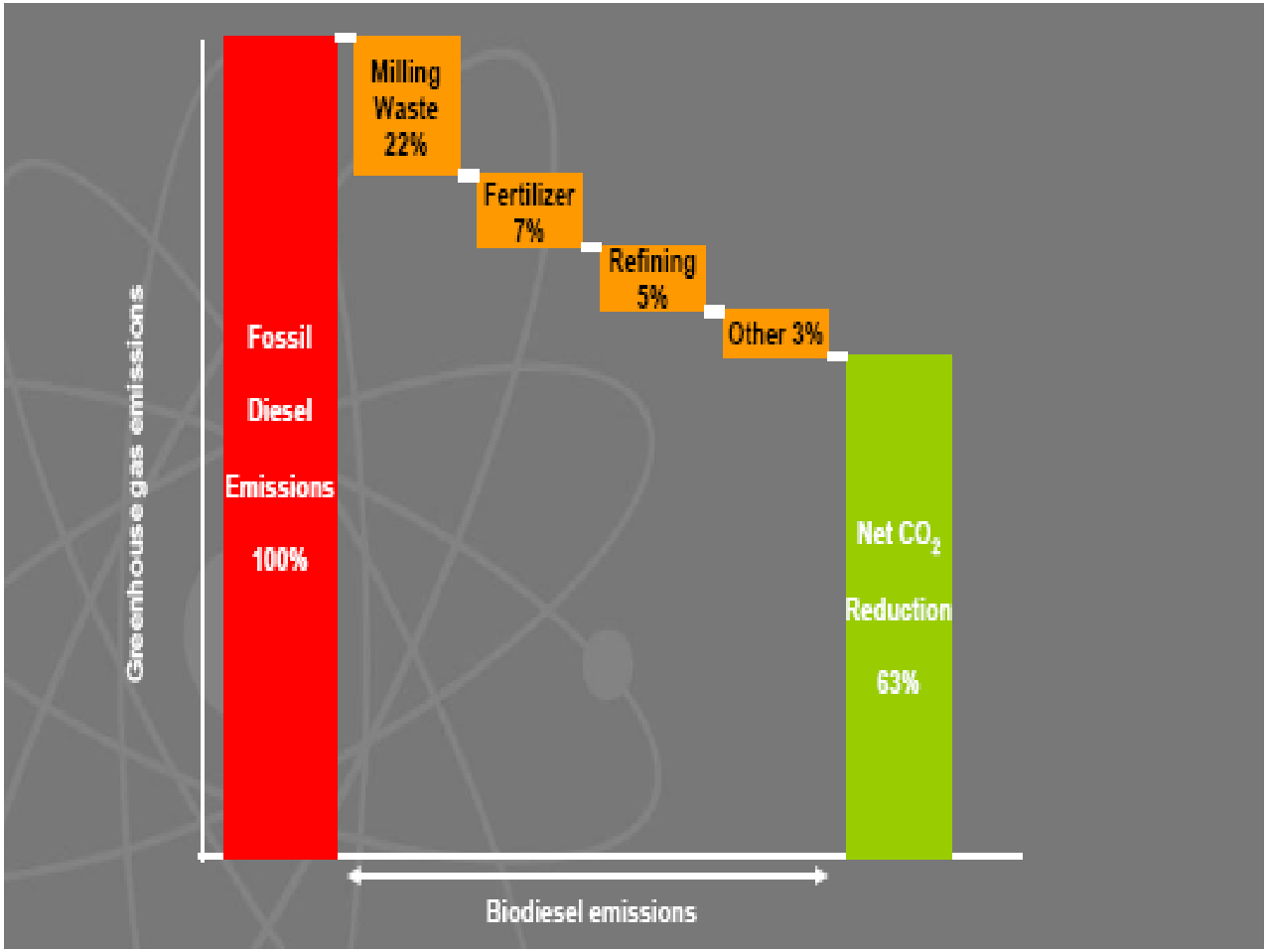
GHG Reduction with Palm Biodiesel



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UNDERSTANDING BIODIESEL

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BIODIESEL

- Introduction
- Advantages and Drawbacks
- B100(100% Biodiesel)
- Specifications
- Other sources of biodiesel

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History

- The concept of using vegetable oil as a fuel dates back to 1895 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil.
- Diesel demonstrated his engine at the World Exhibition in Paris in 1900 using peanut oil as fuel.

Rudolf Diesel

"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as the petroleum and coal tar products of the present time"
Rudolph Diesel, 1912

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What is Biodiesel?

- Biodiesel is a renewable fuel manufactured from vegetable oils, animals fats and recycled cooking oils

- The manufacturing process converts oils and fats into chemicals called mono-alkyl esters, also known as methyl esters or fatty acids methyl esters (FAME)

- The manufacturing process is known as “trans-esterification”.

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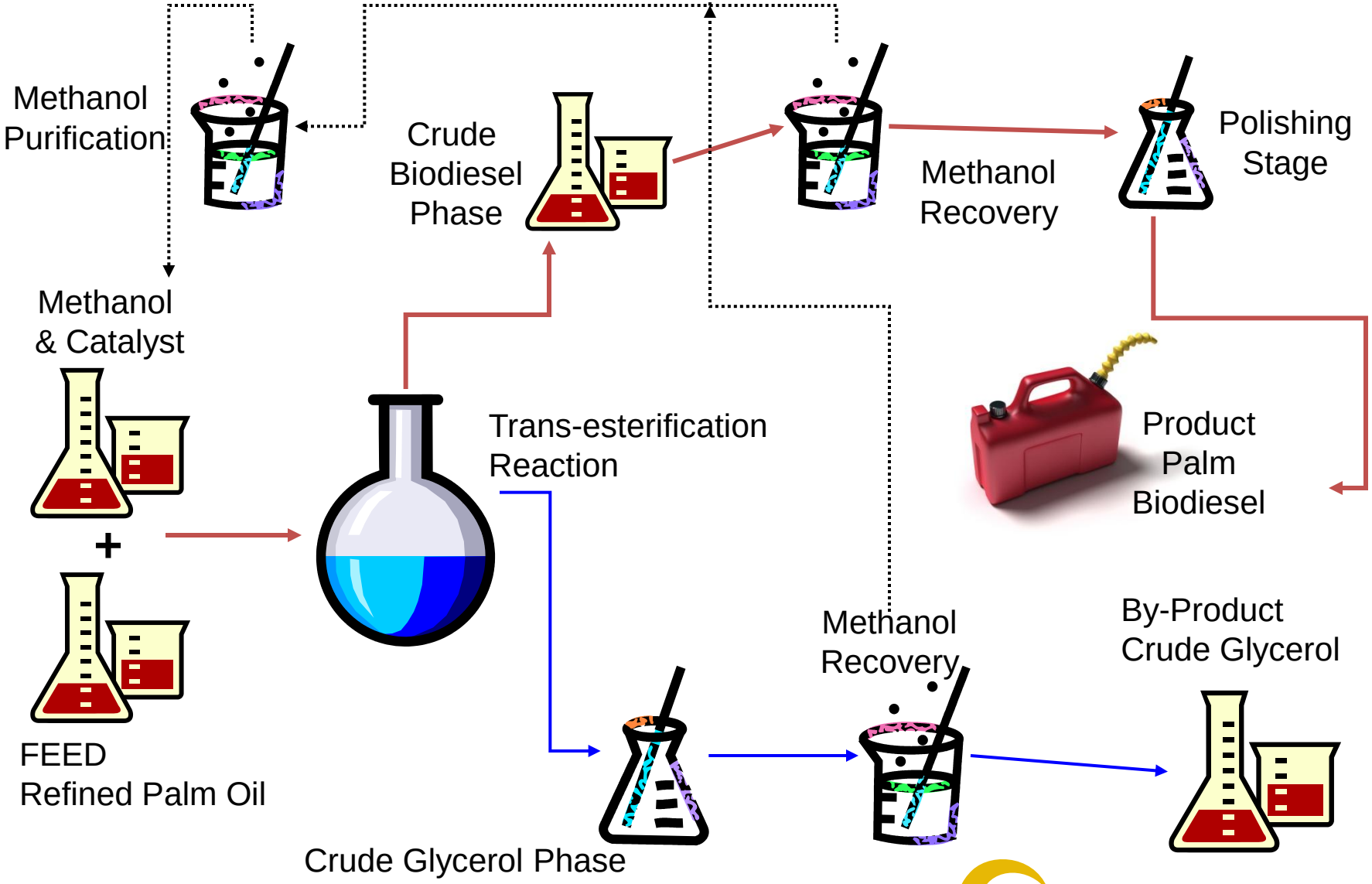
Understanding the Process



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Biodiesel Applications

- **Transportation/Freight**

  e.g. Buses, trucks, trains, diesel cars, boats, taxis
- **Agriculture**

  e.g. Harvester, tractor
- **Heavy Industry**

  e.g. Cranes, bulldozers,
- **Others**

  e.g. Generators, Furnace,

  Home/Office heating

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Advantages & Disadvantages of Biodiesel with Petroleum Diesel

Advantages	Disadvantages
Renewable	Less energy per unit weight/volume
Biodegradable – no spill hazards	Increase in NOx emissions
Non-toxic	Degrades rubber hoses and parts
High flash point – less hazardous	Higher pour point
High solvency – reduce carbon deposits	Not compatible with certain metals
High cetane number	Deforestation
Oxygenated fuel – cleaner burning	Monocrops – diminished ecological diversity
Reduce green house gas emissions	Potential competition for food production
High lubricity	
Low sulfur	
Adds diversity and security to fuel supply portfolio	
No aromatic compounds	

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Biodiesel

SPECIFICATIONS

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Biodiesel Standards & Quality Assurance

1. European Standard for Biodiesel (EN14214:2003)

2. American Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels (ASTM D6751-07)

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Typical Fuel Properties of Regular and Winter Grade Palm Biodiesel

Property	Unit	PME Regular	PME Winter Grade	EN 4214	ASTM D6751-06a
Ester Content	% mass	97-99	97-99	96.5 min	-
Density@ 15C	kg/L	0.87-0.88	0.87-0.89	0.86 – 0.90	-
Viscosity@ 40C	mm^2/s	4.4-4.5	4.4-4.5	3.5 – 5.0	1.9 – 6.0
Flash Point	C	170-180	170-180	120 min	130 min
Cloud Point	C	+17	-30 to 0	-	Report
Pour Point	C	+18	-33 to 0	-	-
Cold Filter Plugging Point	C	+15	-20 to 0	-	-
Sulfur Content	% mass	<0.0002	<0.0002	0.001 max	0.0015 min
Carbon Residue	% mass	0.02	0.02 to 0.03	0.3 max	0.05 max
Acid Value	mg KOH/g	0.3-0.4	0.3-0.5	0.5 max	0.5 max

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Typical Fuel Properties of Regular and Winter Grade Palm Biodiesel

Property	Unit	PME Regular	PME Winter Grade	EN 14214	ASTM D6751-06a
Sulfated Ash Content	% mass	<0.01	<0.01	0.02 max	0.02 max
Sediment & Water	% mass	<0.05	<0.05	0.05 max	0.05 max
Cetane Number	-	60-70	52-58	51 min	47 min
Copper Strip Corrosion(3h at 50 C)	Rating	1a	1a	1	3 max
Iodine Value	-	50-52	56 - 95	120 max	-
Content of Linolenic Acid Methyl Esters	% mass	<0.5	<0.5	12 max	-
Content of 4 db PUFA	% mass	<0.1	<0.1	1 max	-
Methanol Content	% mass	<0.2	<0.2	0.2 max	-
MG	% mass	0.4-0.8	0.4-0.8	0.8 max	-
DG	% mass	0.1-0.2	0.1-0.2	0.2 max	-
TG	% mass	<0.1	<0.1	0.2 max	-
Free Glycerol	% mass	<0.01	<0.01	0.02 max	0.02 max
Total Glycerol	% mass	0.1-0.24	0.1-0.24	0.25 max	0.24 max

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What do the Specifications Mean?

Flash Point

- This parameter is required for fire safety and to ensure that excess methanol has been properly removed in the manufacturing process

Water

- Water contamination leads to corrosion and provides an environment for micro-organisms
- It is tested together with fatty acids content and viscosity to determine level of oxidation.

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What do the Specifications Mean?

Viscosity

- A min value needed to reduce power loss due to injection leakage.
- Higher viscosity can cause fuel combustion problems which leads to deposit formation

Sulfated Ash

- Ash can be contributed by residual alkali catalyst
- High ash causes injector deposits and fuel system fouling

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What do the Specifications Mean?

Sulfur

- A limit is imposed to reduce sulfate or sulfuric acid pollutant emissions.

Copper Corrosion

- The test indicates potential difficulties when in contact with copper or bronze fuel system components
- Copper and bronze parts may not degrade in the presence of biodiesel, but prolonged exposure will cause fuel degradation and sediment formation

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What do the Specifications Mean?

Cetane Number

- Higher cetane number ensures good cold start properties and minimise the formation of white smoke

Acid Number

- Indicates level of free fatty acids
- The value can be elevated if biodiesel is not properly manufactured or has undergone oxidation.

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What do the Specifications Mean?

Free and Total Glycerine

- Measures levels of partially converted fats and by-product glycerine
- High levels will lead to storage tank, fuel system and engine fouling
- Fuels that exceed the limits will cause filter plugging

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What do the Specifications Mean?

Phosphorus

- Can cause damage to catalytic converters

Carbon Residue

- Indicate the tendency to form carbon deposits in an engine

T90 Distillation

- Ensure that fuels has not contaminated by high boiling point material like motor oil

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What do the Specifications Mean?

Cloud Point

- The temperature at which small crystals are first observed as the fuel is cooled

Cold Filter Plugging Point

- The temperature at which crystals have agglomerated to the extent of plugging test filter

Pour Point

- The temperature at which the fuel gels and no longer flows

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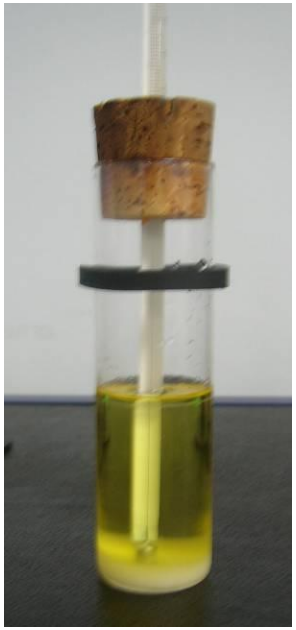
Cold Flow Properties

Cloud Point

- The temperature of fuel when crystals first appear.
- Most fuel can be used without any problems below cloud point but above CFPP.



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Cold Flow Properties

Cold Filter Plugging Point (CFPP)

- The temperature when the fuel crystals have sufficient amounts to cause a 45µm test filter to plug.
- CFPP is a better indicator of fuel cold flow behavior in an engine than Cloud Point or Pour Point.

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Cold Flow Properties

Pour Point

- The temperature when the surface of the fuel in the test jar no longer moves.
- Result is expressed as multiples of 3

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GLOBAL BIODIESEL SCENARIO

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Global Biodiesel Mandates

- Biodiesel is already widely in use around the world, in particular in countries which have strong agricultural economies based on oil seeds (e.g. palm, soya and rapeseed)
  - Almost all such countries have instituted use of biodiesel in the form of national mandates

- A number of countries/regions have already proceeded to use high blends of biodiesel (i.e. B10 and above.
  - Minnesota (USA) B10 (using soy biodiesel)
  - Argentina B10(using soy biodiesel)
  - Colombia B10 (using palm biodiesel)
  - Indonesia B20 (using palm biodiesel)

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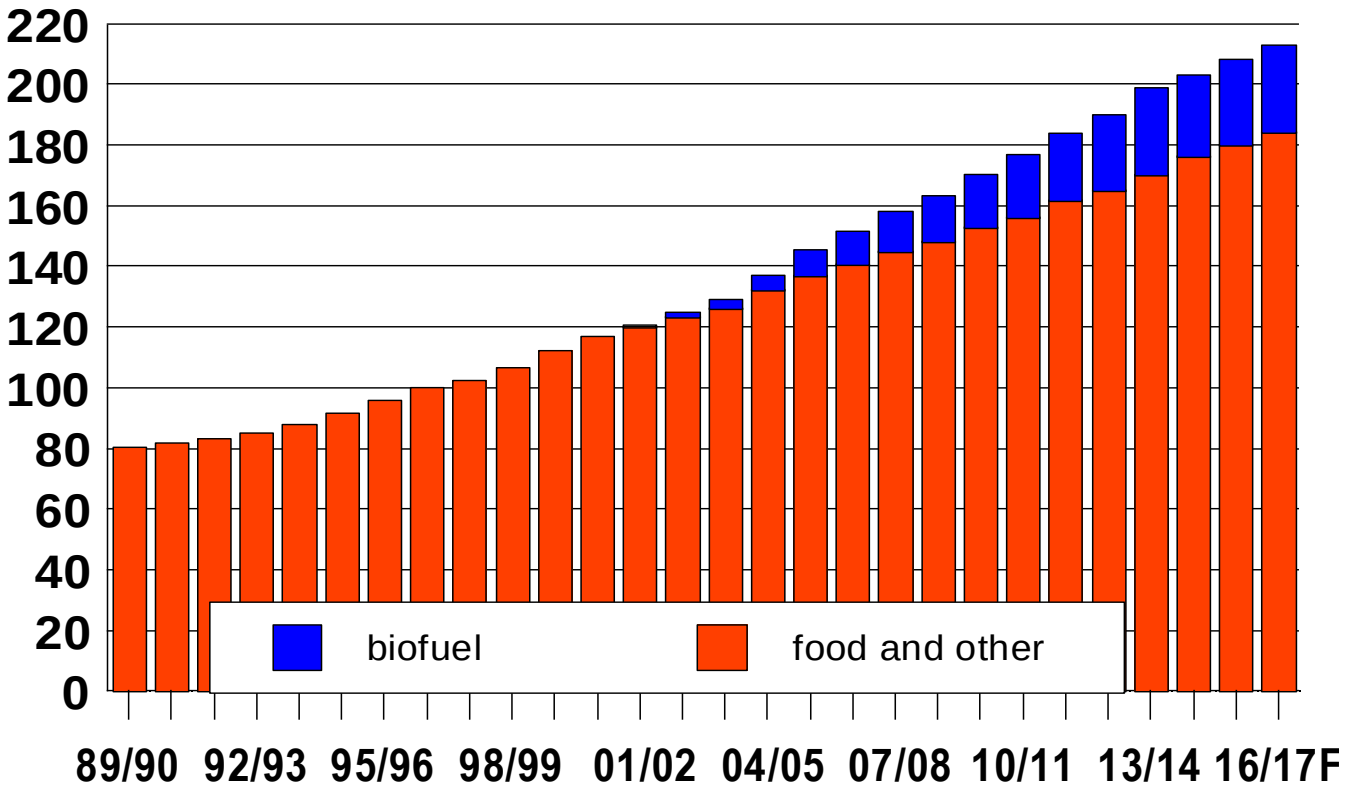
17 Oils & Fats : World Consumption

Total Usage in Mn T



Source: Oil World

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BIODIESEL: World Production by Country (Mn T)

January/December

	2017F	2016	2015	2014	2013
EU-28	12.40*	12.35*	12.37	12.20*	10.65
U.S.A.	6.20*	5.85*	4.90	4.80	4.72
Argentina	2.55*	2.63*	1.81	2.58	2.00
Brazil	3.80*	3.36*	3.46	3.00	2.56
Colombia	.49*	.45*	.51	.52	.50
Singapore	.88*	.86*	.82	.76	.79
Indonesia	3.20*	3.00*	1.16	2.92	2.60
Malaysia	.60*	.50*	.67	.60	.47
Thailand.	1.10*	.98*	1.03	.99	.93
Oth. ctries.	3.00*	2.94*	2.89	2.94*	2.65*
Total	**34.22***	**32.92***	**29.62**	**31.30**	**27.87**
Change in	*+1.30**	*+3.30**	*-1.68*	*+3.43*	*+3.29*

15% of Total Oils & Fats is used in Biodiesel

Source: Oil World

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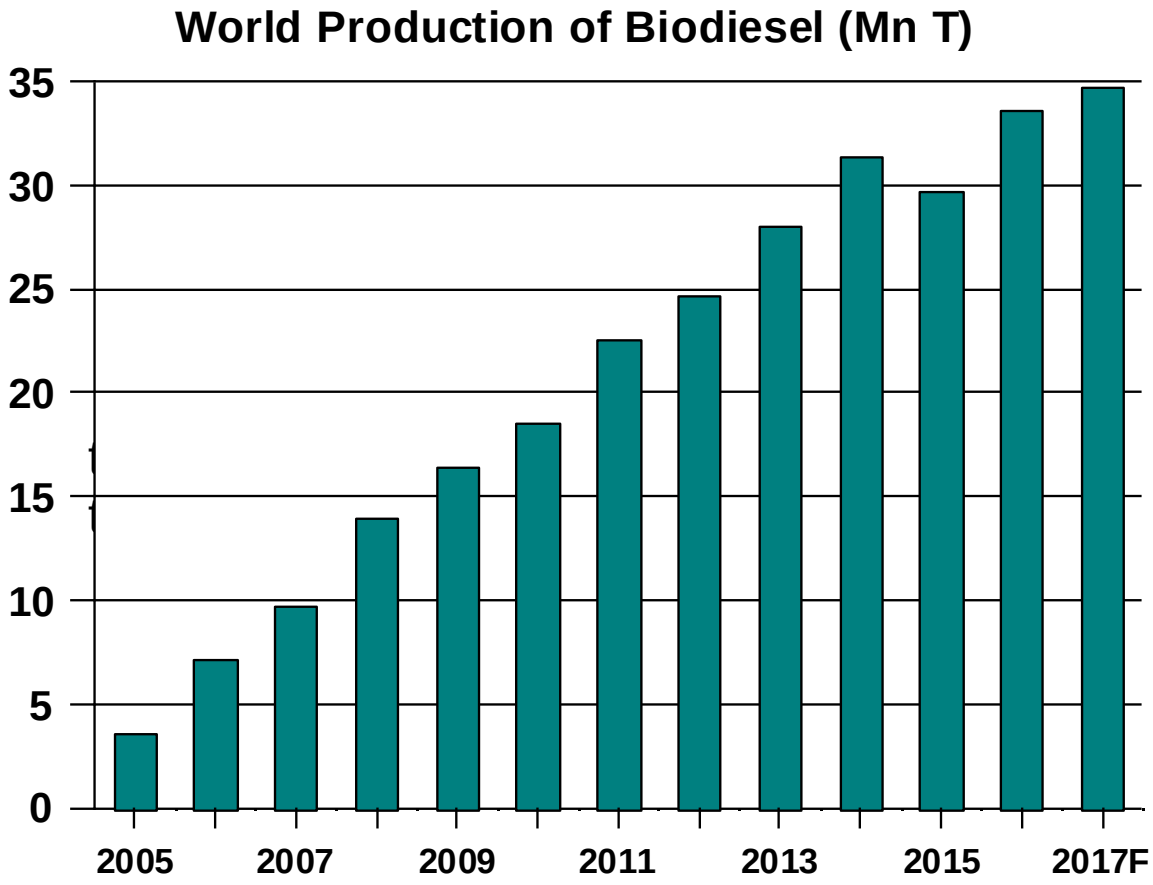

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EU-28	12.40*	12.25*	12.37	12.20	10.65
U.S.A.	6.30*	6.21	4.72	4.80	4.77
Argentina	2.55*	2.66	1.81	2.58	2.00
Brazil	3.75*	3.33	3.46	3.00	2.56
Colombia	.49*	.45*	.51	.52	.50
Singapore	.92*	.93*	.82	.76	.79
Indonesia	3.40*	3.15*	1.22*	2.92	2.60
Malaysia	.65*	.50*	.67	.60	.47
Thailand.	1.20*	1.16*	1.14	1.04	.94
Oth. ctries.	3.05*	2.97*	2.89	2.93	2.65
Total	**34.71***	**33.61***	**29.61**	**31.35**	**27.93**
Change in	*+1.10**	*+4.00**	*-1.74*	*3.42*	*3.35*

Source: Oil World

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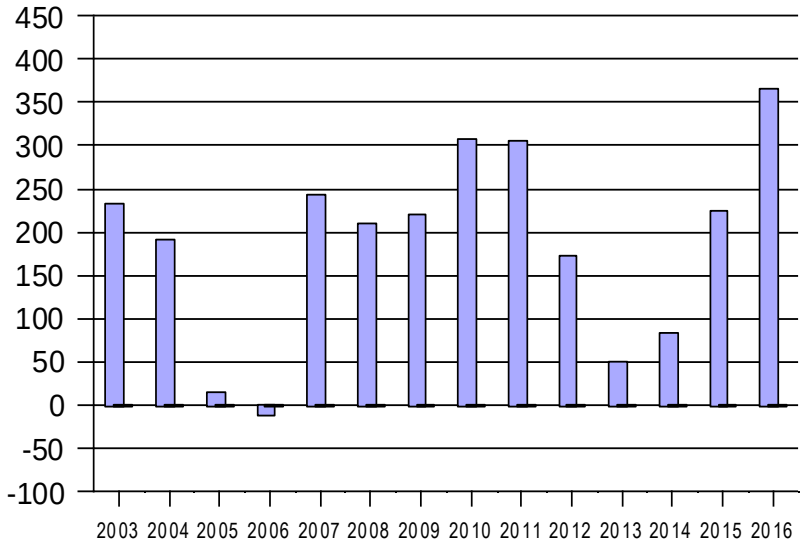
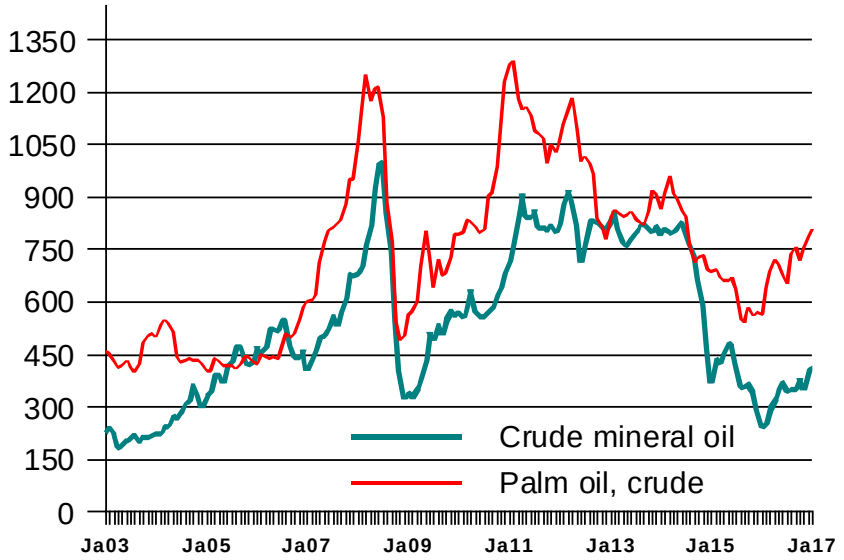
Annual Price Premiums Palm Oil vs Crude Mineral Oil (US-$/T)

nearest forward shipment



Annual average premiums/discounts from 2003 until 2016

Monthly Prices of Palm Oil & Crude Mineral Oil (US-$/T)



Monthly prices from Jan 2003 until Jan 2017

Source: Oil World

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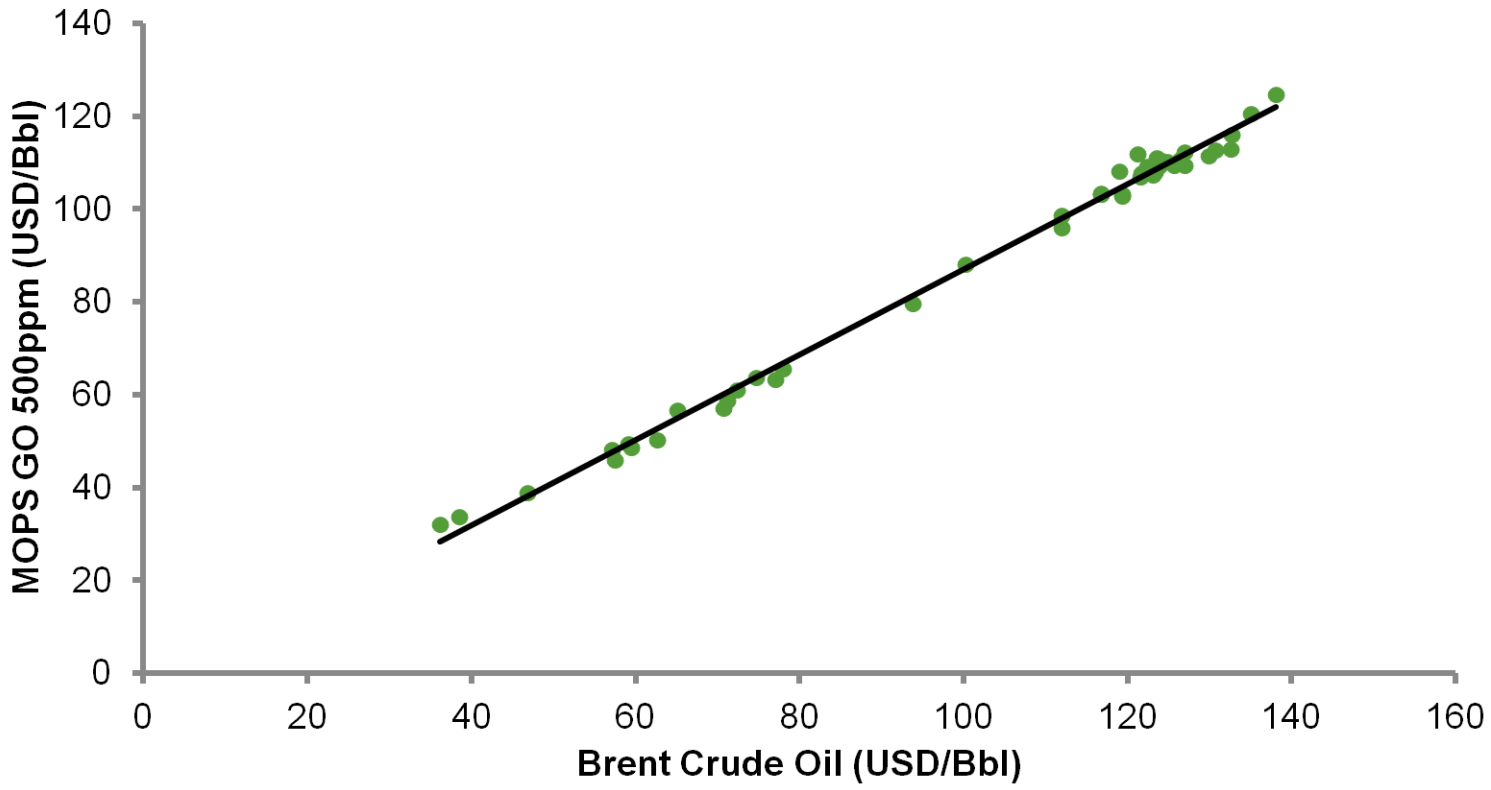
Brent Crude Oil vs MOPS Gasoil 500ppm



March 2016

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Global Biodiesel Mandates

- Biodiesel use is a world-wide phenomenon especially in countries with strong agriculture economies like Malaysia. High blends are an increasingly common feature

No.	Country	Blending %
1	USA[e]	Up to B10
2	Colombia[a]	B10
3	Argentina	B10, B20 by 2017
4	France	B8,
5	Brazil	B8, B9 2018, B10 2019
6	Poland	B7.1
7	Italy	~B5
8	U.K.	B4.75
9	Spain	~B4
10	China	Discretionary
11	Netherlands	B3.5
12	Germany[b]	3.5% GHG (min)

No.	Country	Blending %
1	Indonesia[c]	B20
2	Malaysia	B7 to B10
3	Thailand[d]	B7
4	Philippines	B5
5	South Korea	B2.5

(a) Colombia uses 60% of its 1m MT of CPO for biodiesel to improve livelihood of farmers. No problems experienced with B10 using palm biodiesel since December 2011
(b) From Jan 2015, German Govt has changed target to min 3.5% GHG reduction in diesel (4% in 2017 and 6% in 2020)
(c) With effect 2016
(d) With effect from April 2015
(e) B10 in Minnesota since July 2014

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KEY DRIVERS FOR BIODIESEL MANDATES

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Key Drivers for Biodiesel Mandates

1. Energy Security – depleting fossil fuel reserves
2. Climate Change- COP21 commitments
3. Price Support for Vegetable Oils- key strategy in major producing countries
4. Economic Development
5. Protectionism- led by the new US regime

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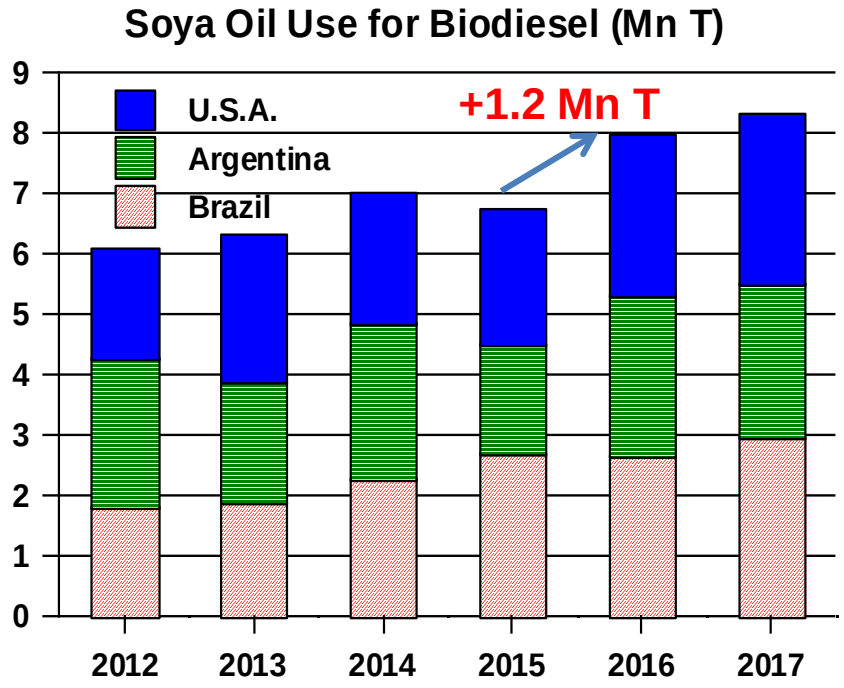
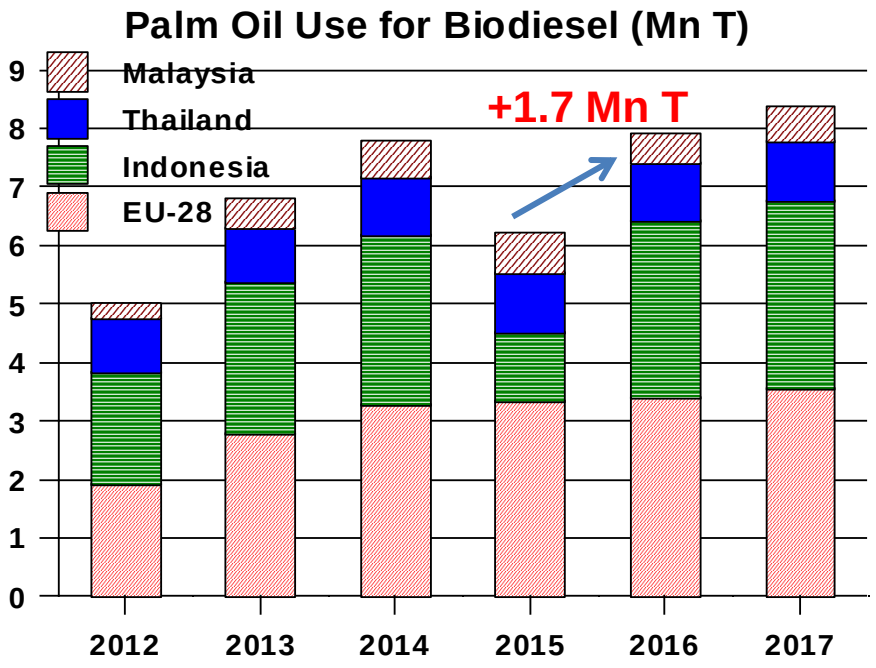
Policy Measures Boosting Use of Soya Oil & Palm Oil for Biodiesel Production in 2016





Source: Oil World

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Biodiesel – Cleaner Air

Biodiesel use reduces potential cancer causing compounds from petroleum emissions

	B100	B20
REGULATED		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48	-12
Particulate Matter	-47	-12
Nox	+10	+2
NON-REGULATED		
Sulfates	-100%	-20%
PAH	-80	-13
nPAH (nitrated)	-90	-50
Ozone potential of speciated HC	-50	-10

Source: National Biodiesel Board

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Biodiesel – GHG Reductions

The Palm Oil industry itself therefore could contribute as much as 1.78% of the GHG reduction target of Malaysia

Malaysia's GHG Emission Target by 2030	
Carbon Intensity Reduction Commitment by 2030 (COP21) from 2005 levels	45%
Carbon Intensity in 2005	1.07 $kgCO_2$/USD GDP
Forecasted GDP by 2030	USD 650 Billion
Projected GHG Emission WITHOUT Carbon Intensity Commitment by 2030	2.78 Billion $MtCO_2e$
Projected GHG Emission WITH Carbon Intensity Commitment by 2030	1.53 Billion $MtCO_2e$
GHG Emission Reduction Target by 2030	1.25 Billion $MtCO_2e$
Potential GHG Reductions	
Reduction of GHG Emission by using B20	6 Million $MtCO_2e$ (0.48% of GHG Reduction Target)
Reduction of GHG Emission Methane Capture in Palm Oil Mills	16.3 Million $MtCO_2e$ (1.3% of GHG Reduction Target)
Estimated Savings from Cost of CO_2 Mitigation	USD 1.1 – 2.2 Billion (MYR 4.6 – 9.6 Billion)

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THE MALAYSIAN PALM BIODIESEL STORY

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MALAYSIAN PALM BIODIESEL STORY

- **Malaysian Palm Oil Board (MPOB) commenced the Palm Biodiesel R&D Project in 1982.**
- **Field trials with Palm Biodiesel successful (1986-1994)**
- **Recovery of Co-Products: Phytonutrients**
- **Low Pour Point Technology developed**
- **Commercialization of R&D findings**

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From Concept to Commercialisation (1981-2006)

- The MPOB began R&D into palm biodiesel from the early 1980s – constructing pilot plants and conducting vehicle engine trials
- The first commercial palm biodiesel plant was built at Carotino with MPOB technology

MPOB Palm Biodiesel Pilot Plant

Source: MPOB

1981-1984

MPOB Starts palm biodiesel project, constructs first pilot plant

1984-1994

Palm biodiesel trials in taxis/buses

2000-2002

First commercial palm biodiesel pilot plant at Carotino

2006

First commercial palm biodiesel

Source: thestar.com.my

2008

Establishment of MBA

Palm Diesel Pilot Plant at MPOB (3,000 tonnes per year)

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Field Trials using Mercedes Benz (OM352) Diesel Engines Mounted on Passenger Buses (Each bus covered 300,000 km)

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TRIALS OF PALM BIODIESEL ON COMMERCIAL TRAINS

Trials conducted by Prignitzer Eisenbahn (PE)

Arrival in Germany, since September 2004

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Extraction of Neutraceuticals

Crude Palm Oil (CPO)

CPO Methyl Esters (Palm Bio Diesel)

Distillation

Distilled Methyl Esters (Palm Bio Diesel)

Phytonutrients Concentrate Containing Carotenes, Vitamin E, Phospholipids (Lecithin), Sterols, Coenzyme Q and Squalene

Excellent Qulaity Biodiesel & Feedstock for value-added oleochemical products

Carotenes
Vitamin E
Sterols
Squalene
Coenzyme Q
Phospholipids (Lecithin)

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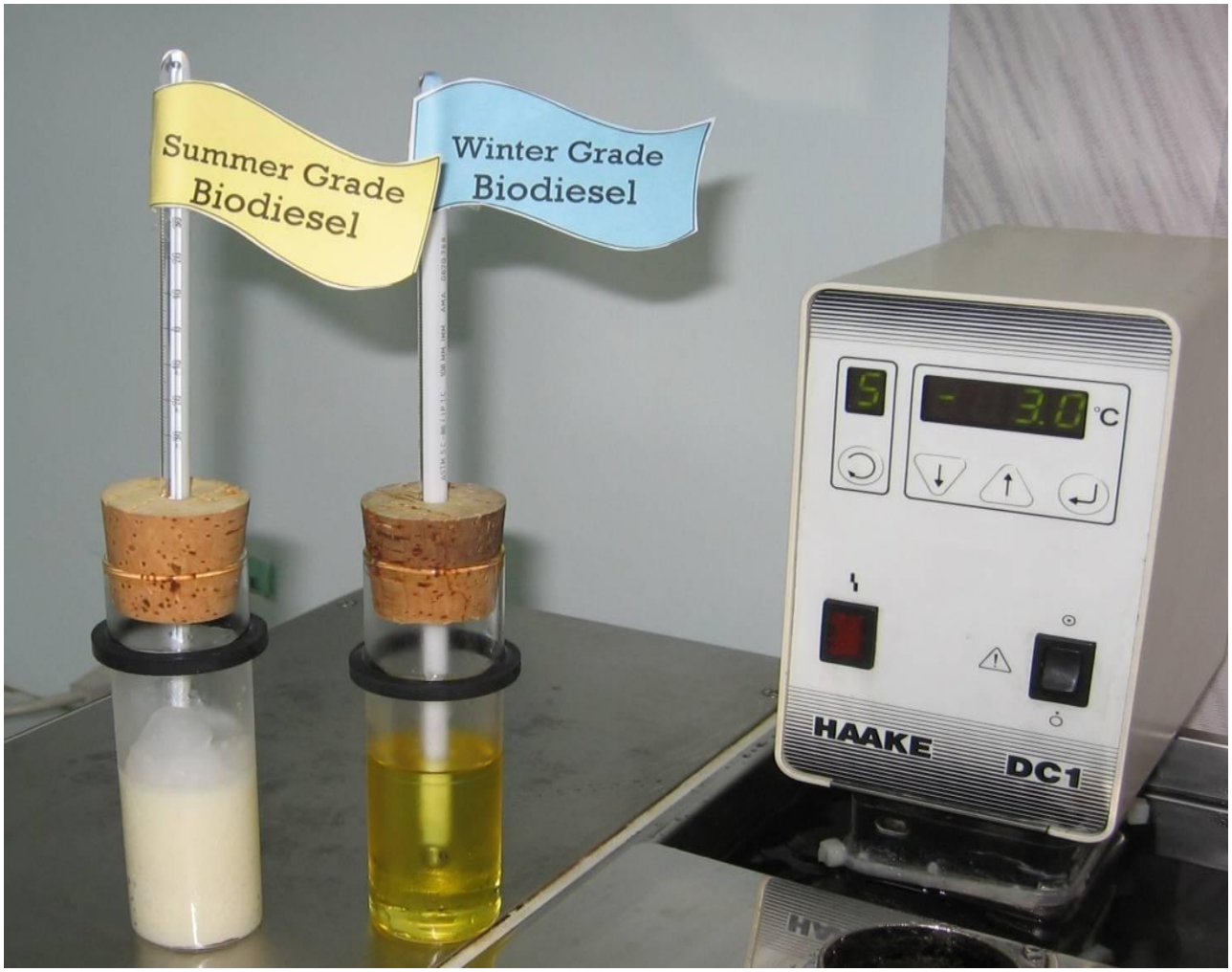
Regular & Winter Grade Palm Biodiesel



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Malaysian Biodiesel Mandate (2006-Present)

2008
Biofuel Industry Act 2007 comes into force

2011
Rollout of B5 Programme

2014
(November) Launch of B7

2016 (July) Launch of B10

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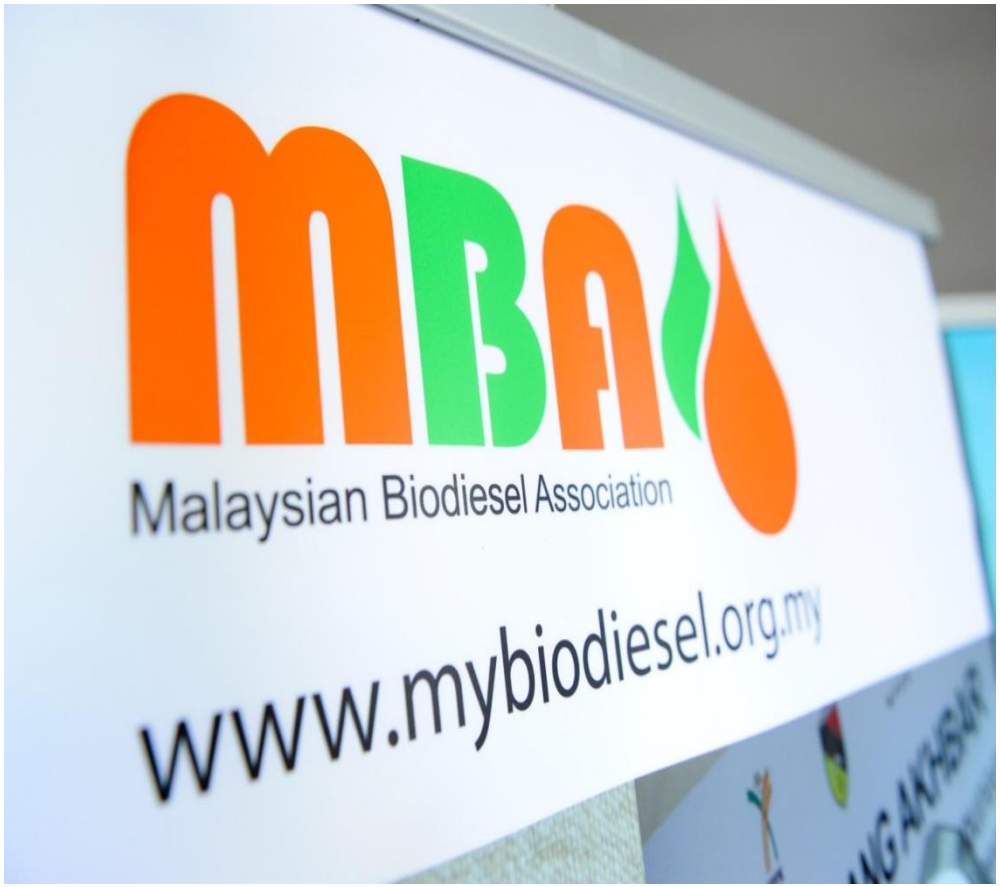

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STATUS OF PALM BIODIESEL IN MALAYSIA AND INDONESIA

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Implementation of Biodiesel Programme

B5/B7 Programme

- B7 was implemented **nation-wide** concurrently with East Malaysia in Dec 2014

Regions	States	%	Implementation Date
Central	Putrajaya, KL, Selangor, Melaka & Negeri Sembilan	B5	June – Nov 2011
Southern	Johor	B5	July 2013
Eastern	Pahang, Kelantan & Terengganu	B5	Feb 2014
Northern	Penang, Kedah, Perak & Perlis	B5	March 2014
East Malaysia	Sarawak, Sabah & Labuan	B7	Dec 2014

B10 – Cabinet Approval

B10 Programme

- The Cabinet decided that B7 that was implemented in the transport sector (retail, fisheries & other subsidized sectors) to be increased to B10 beginning June 2016 (and implementation of B7 in the industrial sector beginning June 2016)
- **Two (2) exemptions** are given **to address stakeholder concerns** that are still being looked at. These are:
  - **Exemption 1** – All Euro 5 diesel sold in retail stations be maintained at B7 blends. This will **provide consumers the choice of either B7 or B10**
  - **Exemption 2** - All diesel sold in **highlands stations** (such as Cameron Highlands and Genting Highlands in Pahang and Kundasang in Sabah) **will be allowed to continue supplying B7**

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Malaysia B10

- The rationale for proceeding to B10 following the successful implementation of B5, then B7, are strong for Malaysia and discussed in the following slides
- In planning for the implementation of B10, the Malaysian government embarked on an extensive multi-stakeholder consultation program over more than 2 years that **leveraged on more than 30 years of accumulated R&D from MPOB on the use of palm biodiesel**
  - Probably no research institution in the world has conducted more R&D than MPOB in Malaysia on palm biodiesel specifically
  - This is an important point as there are specific properties of palm biodiesel that sets it apart from other forms of biodiesel especially in its stability and high cetane number
- The MBA provided significant support in the consultation and helped in the messaging of the positive use of biodiesel in Malaysia

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Benefits of B10

- **Energy security** – reducing dependency on foreign imported fuel
- **GHG reduction** – helping to meet the national target. GHG reduction is also a KPI for industries in improving its image in export markets
- **No subsidies required** (if B10 is built into formula pricing)
- The **cost effectiveness** of biodiesel would be even better as Malaysia moves to more stringent Euro 5 standard for diesel with 10 ppm sulfur. Here, palm biodiesel will further improve lubricity at lower sulfur levels (hence saving on an additional lubricity additive which would raise the price of ULSD)
- **Create additional demand for CPO** and its likely positive price impact

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Biodiesel – Lubricity Enhancer

- A small amount of biodiesel can enhance lubricity of ULSD significantly
  - Tests performed on Ultra Low Sulfur Diesel (ULSD, less than 15ppm)
  - Based on ASTM Scuffing Load Ball On Cylinder Lubricity Evaluator (SLBOCE) test methods
  - Several diesel engine manufacturers have indicated that an SLBOCLE of 3100g provides adequate lubrication for a modern diesel fuel injection system.
- Results show that 5-10% blend would be sufficient to restore lubricity of ULSD to adequate levels. Certainly, a 10% blend would be more than sufficient in restoring lubricity in ULSD (Euro 5 diesel)

Blend Level	0%	2%	**4%**	**12%**
ULSD	1250g	2880g	**2950g**	**4200g**

Source: Beach, M. & Schumacher, L. 2004. Lubricity of Biodiesel Blends. University of Missouri, Columbia, MO, April 27, 2004

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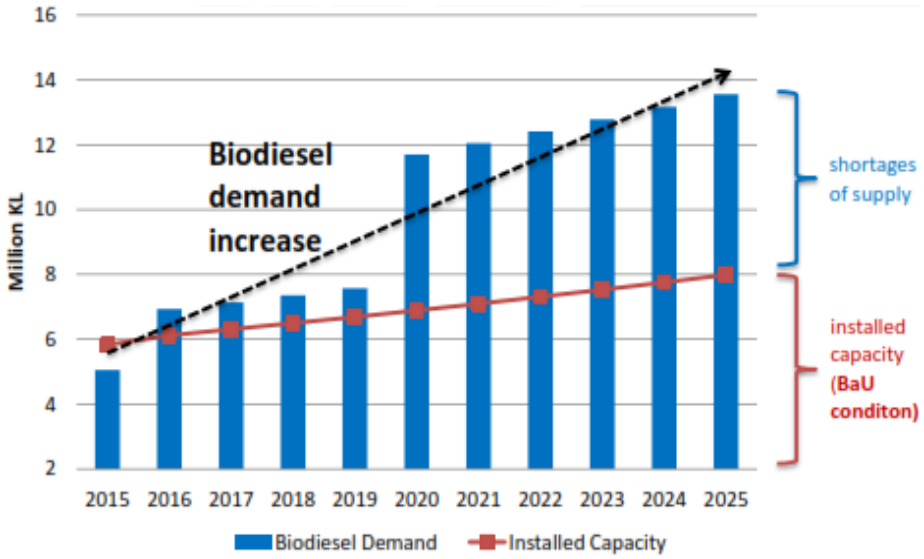
Indonesian's Biodiesel Production Trend & Forecast



Indonesia's Biodiesel Implementation Program

BIODIESEL (Minimum)				
SECTOR	April 2015	Jan 2016	Jan 2020	Jan 2025
Transportation Public Service Obligation (PSO)	15%	20%	30%	30%
Transportation Non PSO	15%	20%	30%	30%
Industry	15%	20%	30%	30%
Electricity	20%	30%	30%	30%

- It's a very ambitious target.
- Success depends on subsidy from palm oil fund.

Source: IECF, APROBI, Energy & Mineral Resources Minister Regulation No. 12, 2015

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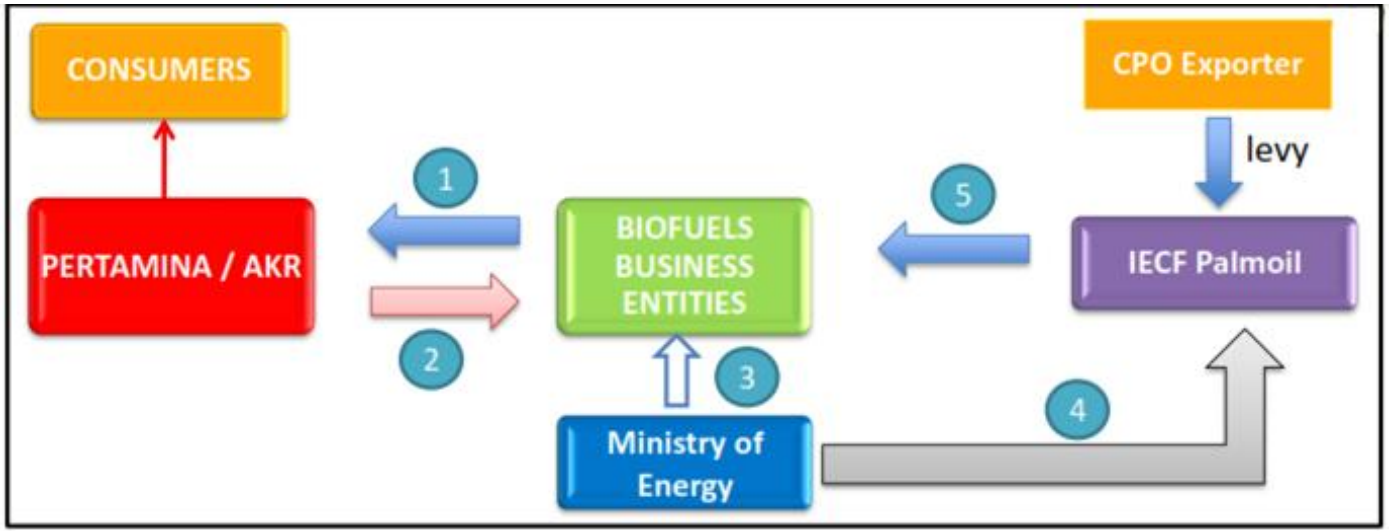
Indonesia's Biodiesel Support Fund



1. Biofuels Business Entities supply biodiesel to Pertamina / PT ANEKA KIMIA RAYA (AKR).
2. Pertamina / AKR will pay for the Biodiesel based on the Diesel Fuel Market Price Index assigned by the Director General of Oil and Gas, Ministry of Energy and Mineral Resources.
3. Ministry of Energy and Mineral Resources cq DG EBTKE verify the delivery of Biodiesel from Biofuels Business Entities to Pertamina / AKR
4. IECF will disburse the Biodiesel financing funds based on the verification results.
5. Biodiesel Support Funds = The difference between the Market Price Index of Biodiesel and Diesel Fuel Market Price Index determined by the Ministry of Energy and Mineral Resources.
6. As of December 2015, IECF disbursed 460 billion Rupiah.

Source: IECF, 2015

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Indonesian Biodiesel Mandate

Indonesian Biodiesel Mandate

- It's a very ambitious target
- The Indonesian Government subsidizes biodiesel implementation using CPO export duty of USD 50 / MT with effect from July 1, 2015

BIODIESEL (Minimum)							
Sector	**Sept 2013**	**July 2014**	**Jan 2015**	**Apr 2015**	**Jan 2016**	**Jan 2020**	**Jan 2025**
Transportation PSO Public Service Obligation	10%	10%	10%	15%	20%	30%	30%
Transportation, Non PSO	3%	10%	10%	15%	20%	30%	30%
Industry	5%	10%	10%	15%	20%	30%	30%
Electricity	7.5%	20%	25%	25%	30%	30%	30%

Source: Energy & Mineral Resources Minister Regulation No 20, 2014 & Regulation No 12, 2015

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CHALLENGES FACED BY THE PALM BIODIESEL INDUSTRY

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CHALLENGES

- Sharp drop in Crude Oil Prices affects the parity with PME.
- New Sustainability Criteria for Palm Biodiesel in the EU discriminates Palm Biodiesel.
- Export duty structure for vegetable Oils & Biodiesel creates another major distortion in the PME market.
- Wide fluctuations in US$/RM exchange rate
- There are several Technical challenges as well

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Drawbacks of Biodiesel

- Biodiesel has 8% less energy per volume or 12% less energy per weight than a typical petroleum diesel

	MJ/kg
Pet Diesel	45.6
Biodiesel	40.7

- The difference in power, torque and fuel economy would be about 1%-2% for B20
- The difference is not noticeable for B5 or less

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Drawbacks of Biodiesel

- Biodiesel has been shown to increase nitrogen oxides (NOx) emissions
- Biodiesel does not contain nitrogen
- NOx is created in the engine as nitrogen from the intake air reacts in the high combustion chamber temperatures

Biodiesel (B100)

- Palm B100 gels at 15 to 18°C.
- Heated fuel lines and tanks may be needed in moderate climates

Atego 6-cylinder Diesel Engine

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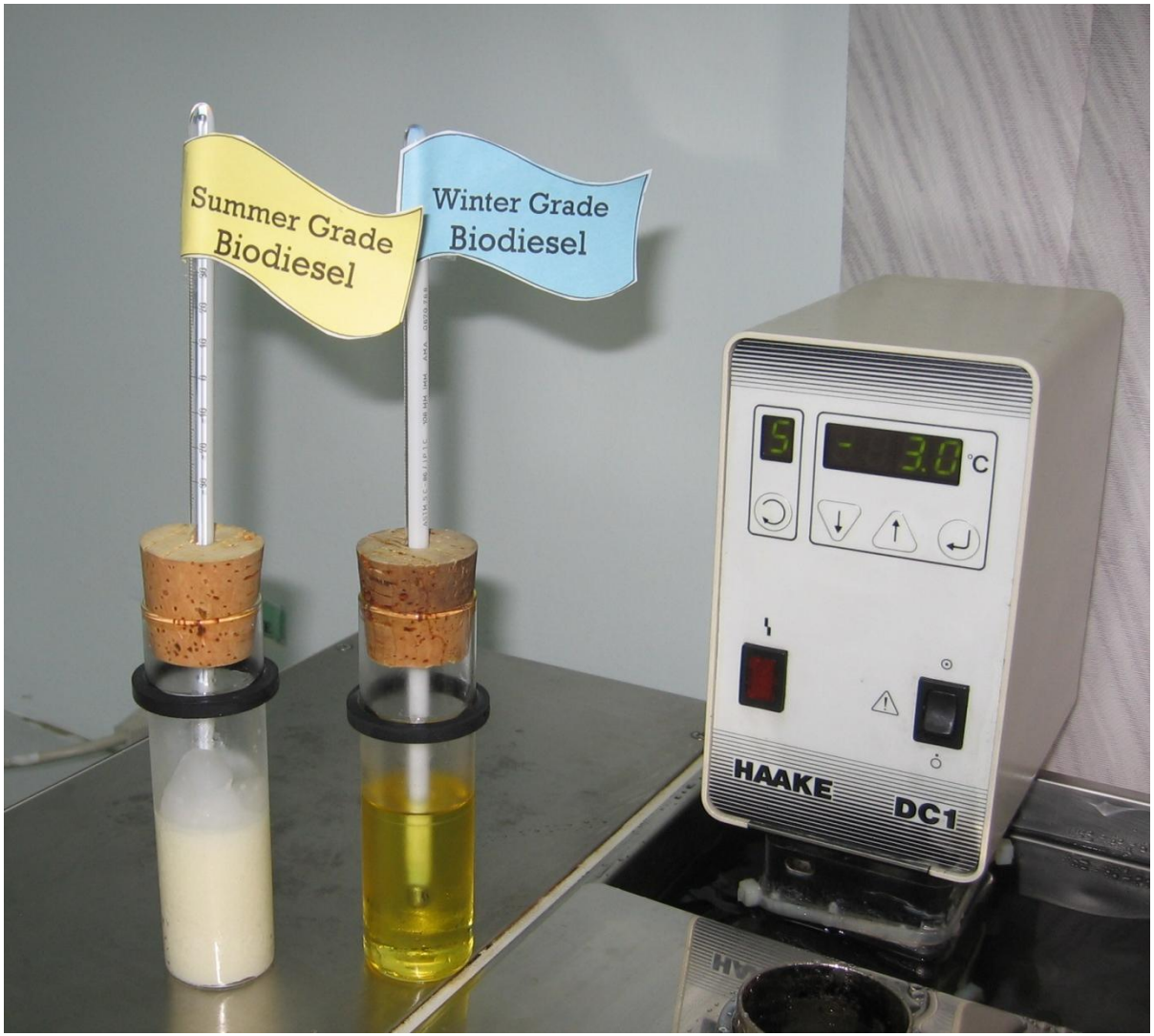
Winter Grade Palm Biodiesel



- Regular grade biodiesel is frozen at -3°C
- Winter grade Palm biodiesel is still in a fluid state at -3°C

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Commercially Available Winter Grade Palm Biodiesel

- CFPP +3° C max
- CFPP 0° C max
- CFPP –6° C max
- CFPP –15° C max
- CFPP –20° C max

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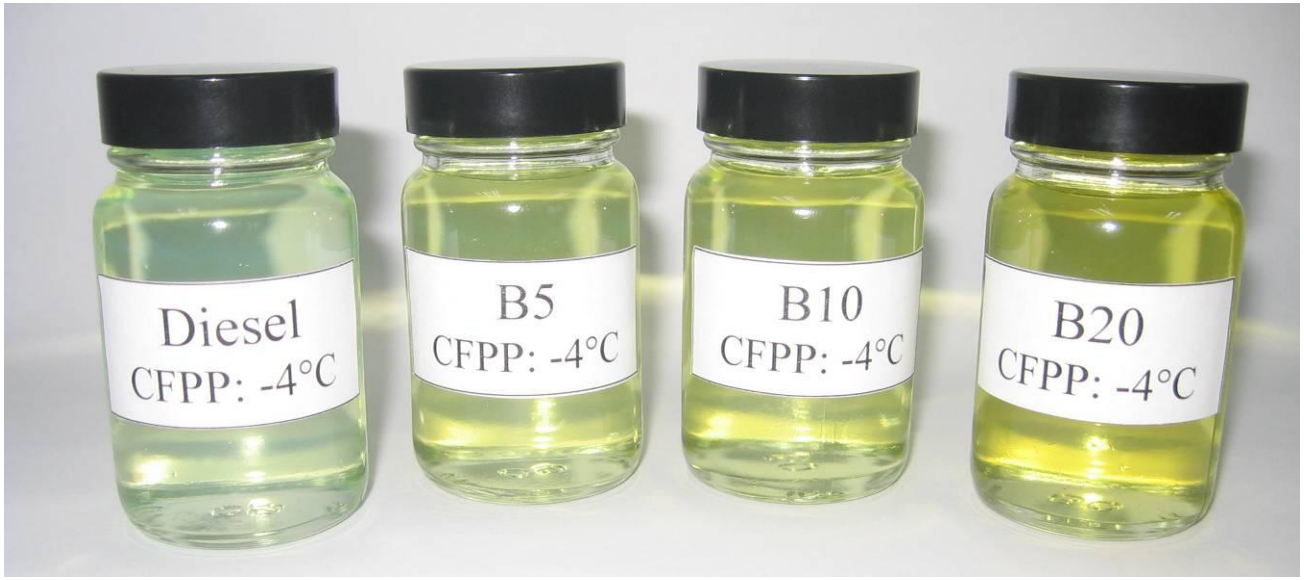

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Key Technical Considerations for B 10 in MY/INA

No.	Technical Issue	Solution	Remarks
1.	Oxidation	B100 to meet OS = 8 hours	Already built into MS2008:2014
2.	Precipitation	Field trial at Cameron Highlands underway	Final results awaited
3.	Solvent Effect	Educate consumers that there is no problem in moving from B7 to B10 and B20	No customer complaints thus far

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Technical Support For B10

- MPOB's extensive and exhaustive research trials has established and proven the efficacy of using **B100**:
  - PHASE 1 (1986-1989): 31 engines of various makes
  - PHASE II (1990-1994): 36 buses with Mercedes Benz engines
  - No modifications required
  - Good engine performance with cleaner exhaust gas emissions: substantial reduction of pollutants such as polycyclic aromatic hydrocarbons, CO, CO2 and SO2
  - High cetane number and lower ignition delay
- OEM engine manufacturers such as CASE IH, Deutz Ag, Fairbanks Morse and New Holland already support B100*
- The majority of the remaining OEMs such as Artic Cat, Buhler, Caterpillar, Fiat Chrysler, Daimler Trucks, Cummins, John Deere, Hino, Perkins, Yanmar, Volvo, etc. support B20*

* *Source: National Biodiesel Board (USA)*

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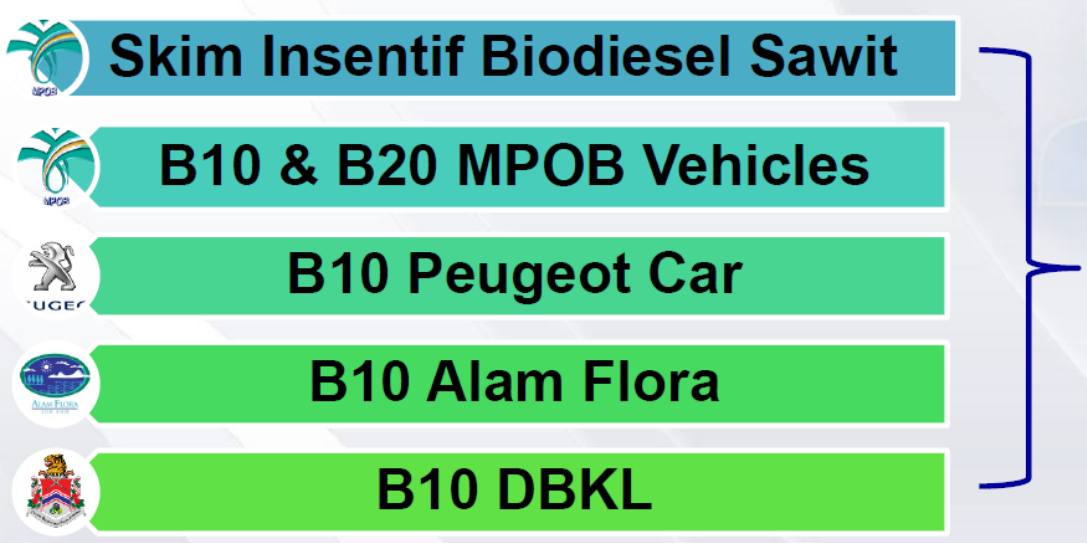
Current MPOB Field Trials



Source: MPOB

- MPOB field trial that began in January 2013 involving MPOB vehicles, Alam Flora vehicles and DBKL vehicles – altogether 76 vehicles
- CONCLUSION: POSITIVE. No specific issues on using B10 palm biodiesel – fuel filters, injector deposits, engine oil dilution/degradation were studied

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Summary Of Field Trials

- No modification of diesel engine required
- Good performance of engine: easy starting, no knocking, smooth running
- Cleaner exhaust gas emission:
  - Reduction of unburnt hydrocarbon (30%), CO (20%), CO2 (74%), SO2 content (99%)
  - More environment friendly
- Engine oil: still usable after recommended mileage
- Carbon build-up at the injector nozzles was normal. Deposits in the engine combustion chamber were normal
- No sludge formation was observed on all the engine parts in contact with the lubricating oil. This is very encouraging because Mercedes found that engines running on soy methyl ester encountered considerable sludging problems
- Cetane number / Diesel Improver (62.4 compared to 37.7 for petroleum diesel from Europe)
- Lower Ignition delay

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Technical Consultation With Stakeholders on B10

- The MPOB conducted extensive consultations with various stakeholders in the industry over a period of more than two years that included:
  - SIRIM – for setting the Malaysian Standard
  - JAMA – Japan Automobile Manufacturers Association
  - Petroleum Companies
  - Malaysian Automotive Association (MAA)
  - Malaysian Automotive Institute (MAI)
  - Various automakers
  - Malaysian Biodiesel Association

JAMA's Recommendations

- Extensive technical consultations (spearheaded by MPOB) were held with JAMA
  - JAMA's recommendations for implementation of B10 in Malaysia:
    - 1. Oxidative stability to 10 hours
    - 2. Monoglycerides to 0.7% max instead of 0.8%
    - 3. Water content to 300 ppm
    - 4. Field trials in highlands
    - 5. Communication to consumers on the benefit of B10
  - JAMA's recommendations were all accepted by MBA except for water content as the Euro 2M spec for water is already at 500ppm (>300ppm)

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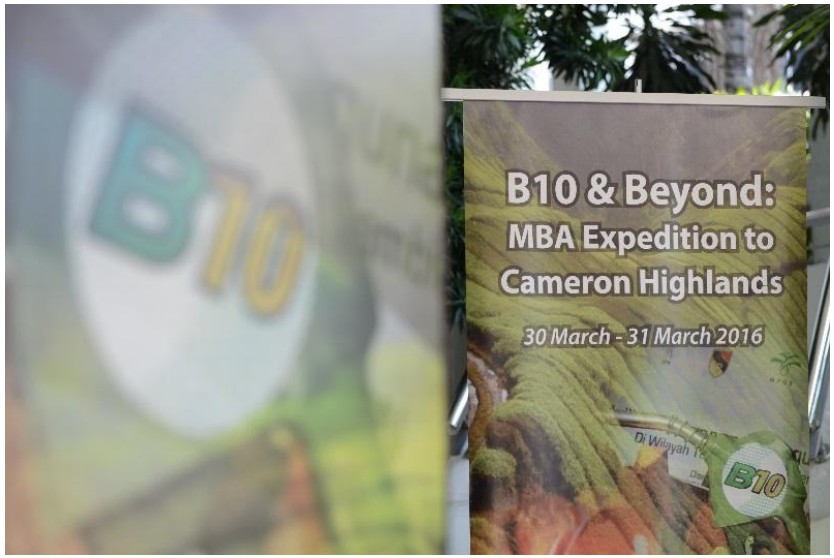
B10 – Malaysian Biodiesel Association(MBA) Helps Spread The Message

MBA has been helping with the messaging for the biodiesel mandate, and of late, with B10 specifically

- Organised a highly successful expedition from MPOB HQ to Cameron Highlands and back in various vehicles utilizing PME biodiesel in various blends with the message: **B10 and Beyond**



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From B10 to B100

- Various makes and types of diesel vehicles participated in the ~600km journey from MPOB HQ (Bangi) to Cameron Highlands and back (with a stay overnight for the vehicles to be subjected to the low temperatures of the highlands)
- Vehicles ran blends of B10, B20, B50 and B100

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Flawless Performance In Highlands

Each vehicle was fueled at MPOB HQ and driven to Cameron Highlands and subjected to overnight temperatures that fell to as low as 14C

- Every vehicle started flawlessly in the early morning and driven successfully

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Trans Borneo B10 Expedition

- On March 2nd, 2017 MPIC launched the B10 Trans Borneo expedition covering 1000 km through Sarawak, Brunei & Sabah ending in Kundasang, highlands in Sabah
- 14 Four wheel drive vehicles & 2 road tankers were used
- Once again no problems encountered with B10

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Data From B20 Field Trials in Indonesia

GAIKINDO

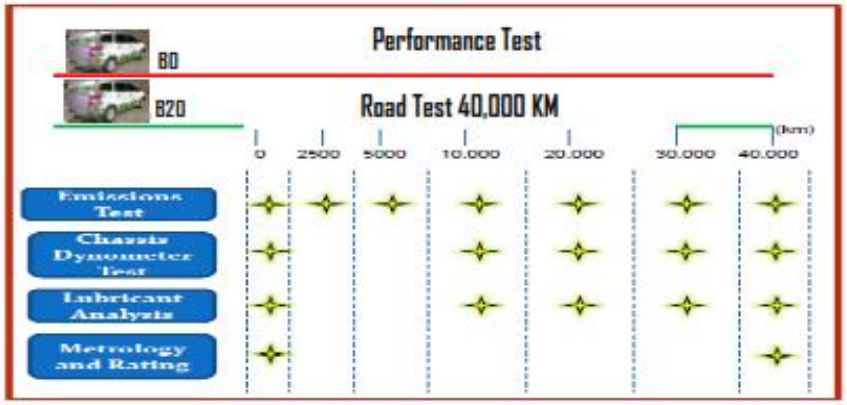
FIRST 40.000 KM ROAD TEST B-20 VEHICLES – (2014)

ROAD TEST PROGRAM :

Toyota "Innova"

Mitsubishi "Pajero"

Chevrolet "Spine"



One lap Cycle Road Test is 500 KM/day with stopping condition for Performance Test & Stay in)

Source: EBTKE / GAIKINDO, 2015

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Comparison of Components after Field Trial

B0	B20

Source: IECF, 2015

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Indonesia B20 – Safe for Use


kabarbisnis

SEMEN INDONESIA GROUP

Gaikindo nyatakan B20 aman untuk kendaraan berbahan bakar diesel

Multi-stakeholder support from automotive association to manufacturers to Petcos

- "SURABAYA, kabarbisnis.com: Indonesian Automotive Industry Association (Gaikindo) states that **the use of biodiesel fuel 20% (B20) is safe** for all types of motor vehicles with a diesel type fuel. This statement is based on the fuel system test conducted by Toyota and Denso Japan. As well as examined the readiness of diesel vehicles by EMR, Gaikindo, APROBI, BPPT, Pertamina and ITB followed by Toyota, Mitsubishi and Chevrolet up to the mileage of 100,000 kilometers."

Source: kabarbisnis.com

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Summary & Conclusions

1. Global Energy demand continues to grow.
2. Share of Renewables in the Energy Mix will increase in the years to come
3. Biodiesel is now an integral part of the Vegetable Oils market and a key Price determinant
4. Global Biodiesel Mandates will continue to be driven by Government policies
5. Palm Biodiesel has come a long way and has the largest share of Global Biodiesel production.
6. Technical challenges for Palm Biodiesel have been addressed well
7. Indonesia & Malaysia will further increase Palm Biodiesel share as a Price support mechanism for Palm Oil.
8. Palm Biodiesel industry can increase its competitiveness by value addition through better By-product utilization such as Phyto-nutrients & Crude Glycerine.
9. Palm Biodiesel Sustainability standards will improve further with mandatory Methane capture in Mills and establishment of MSPO
10. Palm Biodiesel will continue to be the best Price support mechanism for Palm Oil.

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THANK YOU

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