Indonesia's experience: The application of biodiesel in the transportation sector

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CONTENTS

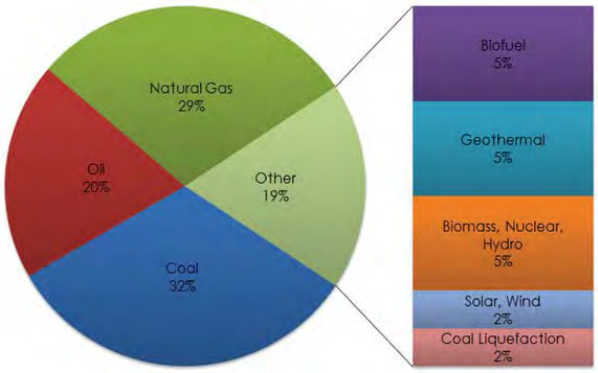
I. INTRODUCTION




Why Biofuel in Indonesia?

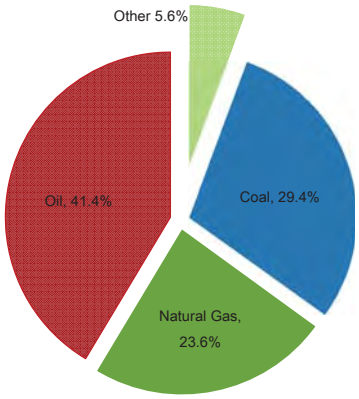
- ❖ BIOFUEL provides energy security and prevent global warming
- ❖ BIOFUEL reduces greenhouse gas emission in transportation sector
- ❖ BIOFUEL promotes industrial development, innovation and jobs creation
- ❖ Indonesia has various BIOFUEL feedstocks and land plantation
- ❖ Proven BIOFUEL technology by domestic potential (Engineering, Research and Development)

Indonesia Energy Diversity Planning



Energy Elasticity < 1

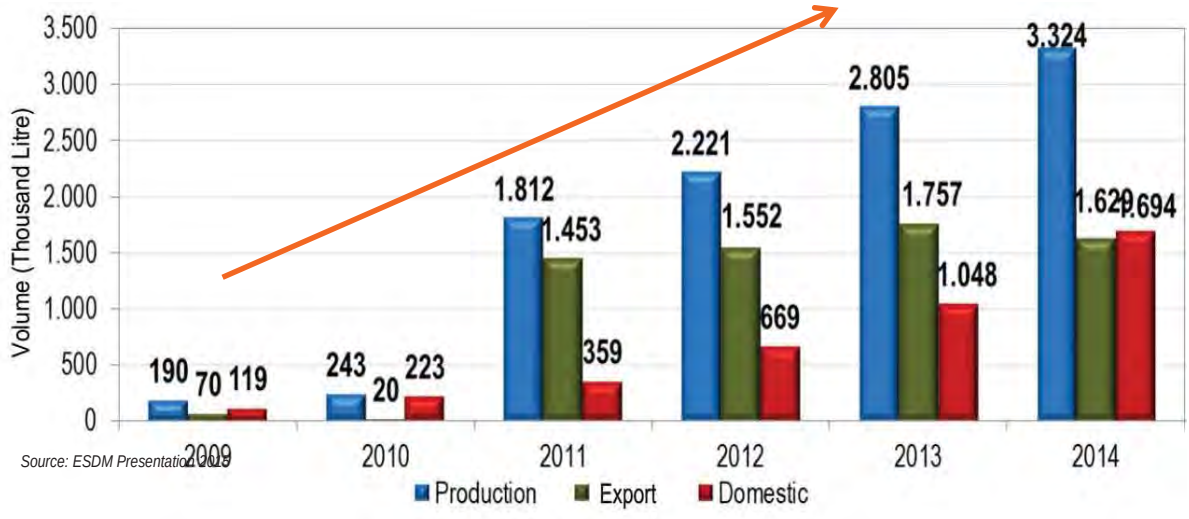
- **National energy mix target in 2025**
- **Presidential decree No. 5 / 2006**



Energy Elasticity < 1.65

- **National energy mix in 2013**
- **Average of increasing energy consumption: 7%/year**

Utilization Achievement of Biodiesel



Source: ESDM Presentation 2013

- The content of biodiesel/fame **(now 10%, B-10) will be increase to 20% (B-20) in 2016**
- Mandatory biofuel realization is around 1,69 billion kL in 2014 or increase of **62%** compared to 2013

Resources of Biofuel

- 46 type of plantations has been identified as potential resources in Indonesia .
- Considering cultivation area, production process and plant properties, the best 4 of plants are as follow:

Comparison of Biodiesel Raw Material

Raw Material	Production Area -ha (Prediction 2013)	Productivity (kg/ha)	Production Availability*)	Ease of Production*)
Palm	9.149.919	3.689	30 years	seed and pulp
Coconut	3.796.149	1.157	50 years	pulp
Jathropa	47.407	302	50 years	seed
Rubber	3.492.042	1.104	20 years	seed

Source: Statistik Perkebunan Indonesia 2009-2012, Ditjen Perkebunan, Kementan
**): Priyohadi Kuncahyo,2013*

- Indonesia is the biggest producer of palm oil in the world
- Palm is still the most potential as resource for biofuel !!!

Fatty Acids Composition

Composition	Palm	Coconut	Jatropha	Rubber
Kaproat Acid (6:0)	-	0 - 0.8	-	-
Kaprilat Acid (8:0)	-	5.5 - 9.5	-	-
Kaprat Acid (10:0)	-	4.5 - 9.5	-	-
Laurat Acid (12:0)	0 - 0.4	44 - 50	-	-
Miristat Acid (14:0)	0.6 - 1.7	13 - 19	-	-
Palmitat Acid (16:0)	41.1 - 47.0	7.5 - 10.5	14 - 15	7 - 8
Stearat Acid (18:0)	3.7 - 5.6	1 - 3	7	9 - 10
Arakhidat Acid (20:0)	-	0 - 0.45	-	0.5
Palmitoleat Acid (16:1)	-	0 - 1.3	1	-
Oleat Acid (18.1)	38.2 - 43.6	5 - 8	34 - 45	28 - 30
Linoleat Acid (18:2)	6.6 - 11.9	1.5 - 2.5	31 - 43	33 - 35
Linolenat Acid (18:3)	0 - 0.6	-	0.2	20 - 21

✓**Palm oil is dominated by palmitat acid : high cetane number**
✓**Palam oil has lower linolet acid content (good oxidation stability)**

II. BIODIESEL POLICIES




BIOFUEL POLICIES

CONSTITUTION NO. 30, 2007	Priority for providing and utilizing non fossil fuel (new and renewable energy/EBT) including biofuel
PERPRES NO. 79 , 2014	Biofuel target on 2015 is 5% for national energy mix
INPRES NO. 1, 2006	Instruction to related ministry, governor and municipal head to make an action to accelerate providing and utilization of biofuel
PERMEN ESDM NO. 32, 2008	Mandatory for utilization of biofuel on sectors of transportation, industry, commercial and electric power generation
PERMEN ESDM No. 25/2013 dan NO. 20/2014	Acceleration of biofuel mandatory from decree of ministry No 32 year 2008
KEPMEN ESDM NO.2185K/12/MEM/2014	Market price index of biofuel when its blended into certain fossil fuel/subsidized fuel
PERDIRJEN EBTKE	1. No.723 K/10/DJE/2013: Biodiesel refer to SNI 7182:2012 2. No.722K/10/DJE/2013: Bioethanol refer to SNI 7390:2012 3. No.903K/10/DJE/2013: CPO refer to SNI 7431:2008 4. No.830K/10/DJE/2013: Bio oil with partial transesterification

Source: ESDM Presentation 2015

Mandatory of Biofuel

BIODIESEL (Minimum)

Sector	July 2014	Jan. 2015	Jan. 2016	Jan. 2020	Jan. 2025
Transportation, Public Service Obligation (PSO)	10%	10%	20%	30%	30%
Transportation Non PSO	10%	10%	20%	30%	30%
Industry	10%	10%	20%	30%	30%
Electricity	20%	25%	30%	30%	30%

BIOETANOL (Minimum)

Sector	July 2014	Jan. 2015	Jan. 2016	Jan. 2020	Jan. 2025
Transportation, Public Service Obligation (PSO)	0,5%	1%	2%	5%	20%
Transportation Non PSO	1%	2%	5%	10%	20%
Industry	1%	2%	5%	10%	20%
Electricity	-	-	-	-	-

CPO (Minimum)

Sector	July 2014	Jan. 2015	Jan. 2016	Jan. 2020	Jan. 2025
Low and Medium Speed Engine in Industry	5%	10%	20%	20%	20%
Low and Medium Speed Engine in Marine Transportation	5%	10%	20%	20%	20%
Air Transportation	-	-	2%	3%	5%
Electricity	6%	15%	20%	20%	20%

Current priority of biofuel application is on land transportation

Goverment plan to do field testing on marine applications in 2016

Biodiesel standard

Specification of B100 (SNI 7182:2012)

No	Parameter	Value	Unit	Method
1	Density at 40 ° C	850-890	kg/m³	ASTM D-1298/D-4052/SNI 7182:2012
2	Kinematic Viscosity at 40 ° C	2.3-6.0	mm²/s	ASTM D-445//SNI 7182:2012
3	Cetana Number	51	Min	ASTM D-613/D-6890//SNI 7182:2012
4	Flash Point	100	° C, Min	ASTM D-93//SNI 7182:2012
5	Cloud Point	18	° C, Max	ASTM D-2500//SNI 7182:2012
6	Copper Strip Corrossion (3 hours at 50 ° C)	1	-	ASTM D-130//SNI 7182:2012
7	Carbon Residue			
	In Original Sample	0.05	% of mass, Max	ASTM D-4530/D-189//SNI 7182:2012
	In 10% of Distillation Waste	0.3		
8	Water and Sediment	0.05	% of vol, Max	ASTM D-2709//SNI 7182:2012
9	Distillation Temperature 90%	360	° C, Max	ASTM D-1160//SNI 7182:2012
10	Sulfuric Ash	0.02	% of mass, Max	ASTM D-874//SNI 7182:2012
11	Sulfur	100	mg/kg, Max	ASTM D-5453/D-1266/D-4294/D-2622/SNI 7182:2012
12	Phosphorus	10	mg/kg, Max	AOCS Ca 12-55//SNI 7182:2012
13	Acid Number	0,6	mg KOH/g, Max	AOCS Cd 3d-63/ASTM D-664/SNI 7182:2012
14	Free Glycerol	0,02	% of mass, Max	AOCS Ca 14-56/ASTM D-6584/SNI 7182:2012
15	Total Glycerol	0,24	% of mass, Max	AOCS Ca 14-56/ASTM D-6584/SNI 7182:2012
16	Ester Methyl Level	96,5	% of mass, Min	SNI 7182:2012
17	Iodium Number	115	% of mass (g-I2/100g), Max	AOCS Cd 1-25//SNI 7182:2012
18	Oxidation Stability			
	Induction Method Period	360	Minute, Min	EN 15751/SNI 7182:2012
	Rancimat or Petro Oxy Method	27		ASTM D-7545/SNI 7182:2012

Biodiesel standard

Specification of B6 – B20 (ASTM D7467-10)

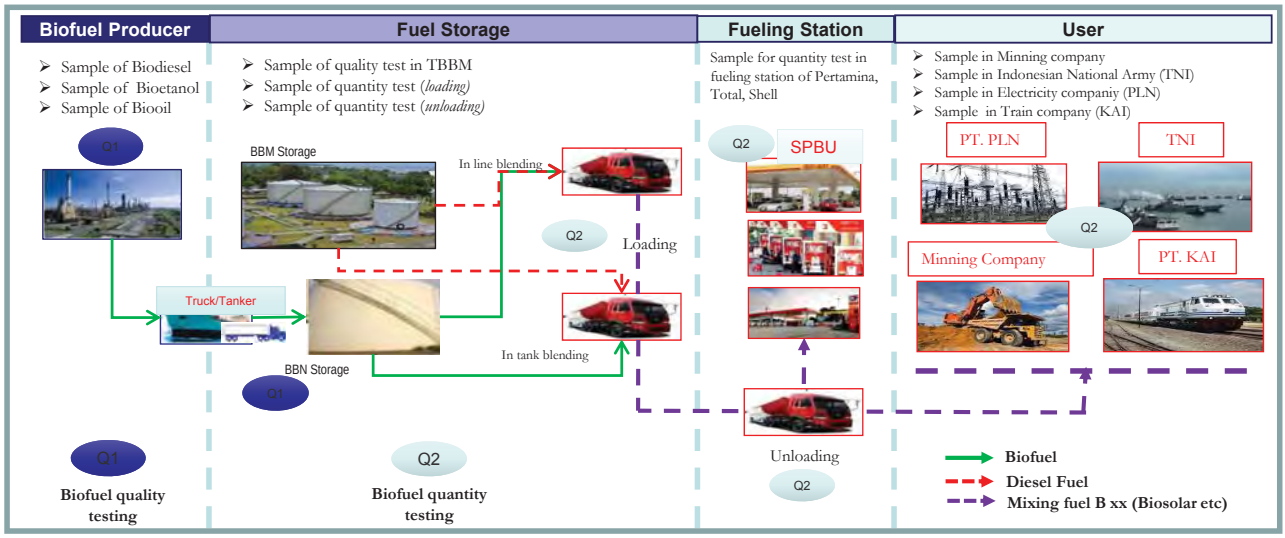
No	Parameter	ASTM Method	Restriction	Unit
1	Acid Number	D-664	Max 0.30	mg KOH/g, Max
2	Kinematic Viscosity at 40 °C	D-445	1.9-4.1	mm^2/s
3	Flash Point	D-93	Min 52	°C
4	Cloud Point	D-2500		°C
5	Sulfur			
	S15 Grade	D-5453	Max 0.0015 (15)	% of mass, ppm
	S500 Grade	D-5453	Max 0.05 (500)	% of mass, ppm
6	Physical Distillation T90	D-86	Max 650	°C
7	Ramsbottom Carbon Residue - 10% Residue	D-524	Max 0.35	% of mass
8	Cetana Number	D-613	Min 40	Min
9	Requirements			
	Cetana Index	D-976-80	Min 40	-
	Aromatic Compound	D-1319-03	Max 35	% of volume
10	Ash Content	D-482	Max 0.01	% of mass
11	Water and Sediment	D-2709	Max 0.05	% of volume
12	Copper Strip Corrossion	D-130	Max No. 1	
13	Phosphorus Content	D-4951	Max 0.001	% of mass
14	Oxydation Stability	EN-14112	Min 6	Hours
15	Biodiesel Content	D-7371	6-20	% of volume
16	Lubricity, HFRR at 140 °F	D-6079	Max 520	Micron

Automotive Diesel Oil, www.pertamina.com (accessed 19 June 2006)
SNI Biodiesel No. 04-7182-2006, based on ASTM D 6751 & EN 14214

III. BIODIESEL IMPLEMENTATIONS




Monitoring and Evaluation of Biodiesel Utilization



Biodiesel Quality

	Biodiesel Quality Test Result				
	2010	2011	2012	2013	2014
SNI	7182:2006	7182:2006	7182:2006	7182:2012	7182:2012
Total of samples	-	15	15	15	12

Biodiesel Blending Quantity (Volume)

	Blending Biodiesel with Diesel Fuel				
	2010	2011	2012	2013	2014
Total of samples	8	14	65	95	223
% Mandatory	5%	5%	7,5%	7,5% - 10%	10%
Average	6,08%	5,2	7,46%	9,61% *)	8,3%

Source: ESDM Presentation 2015

IV. CHALLENGES OF BIODIESEL

CHALLENGES

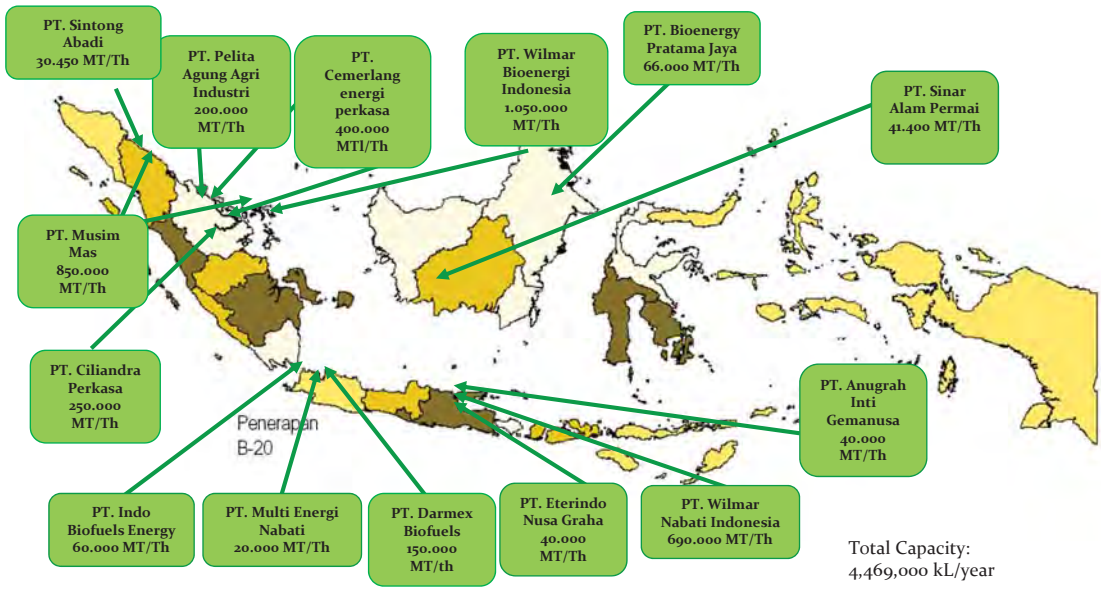
- **Improving quality of biofuel**
  Revision SNI: stability, glyceride content, acid number etc
  Development of HVO

- **Improving national technological capabilities on biofuel processing**
  Research and Development on biofuel process

- **The price of biofuel that has not yet competitive in compare with fossil fuel**
  Feedstock diversification and effective technology will decrease the price of biofuel ; subsidize

- **Land availability for biofuel development**
  Land availability inventory, synchronizing data among Forestry Department, National Land Affairs Agency and Regional Government

Biodiesel Issues



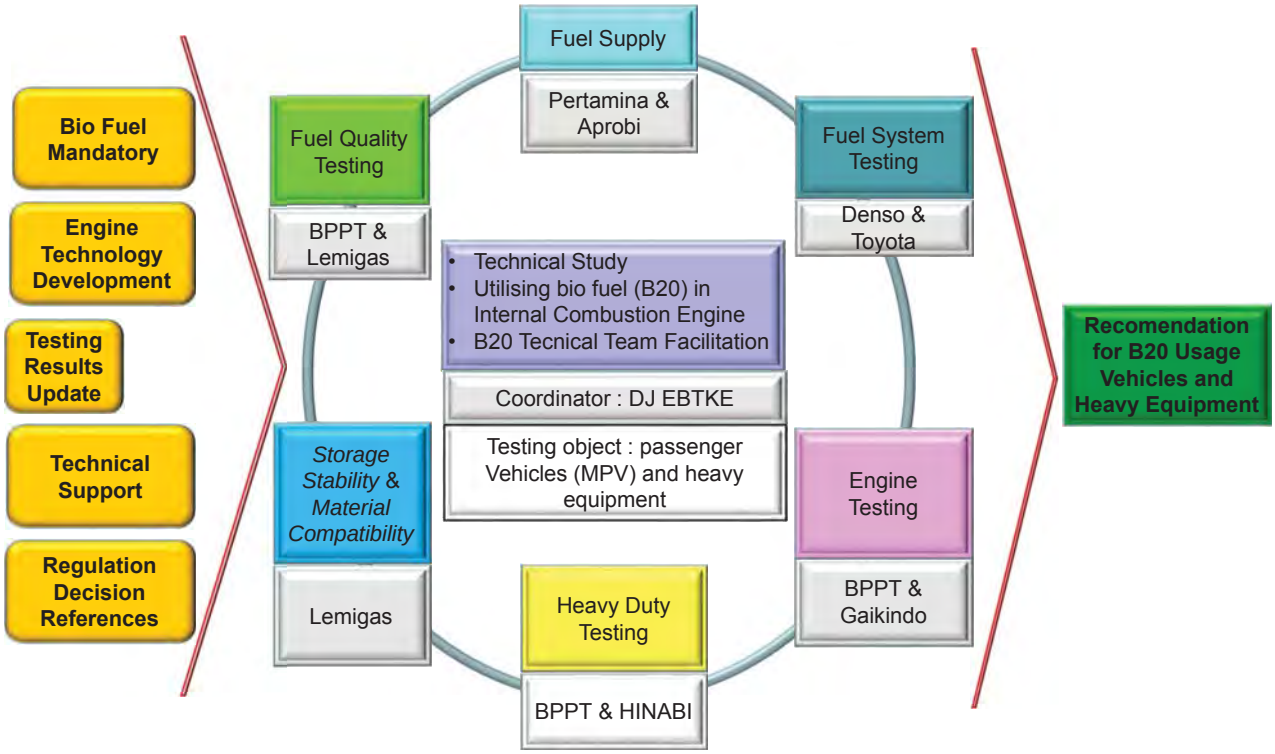
Total Capacity:
4,469,000 kL/year

- **Feedstock sustainability (volume and price)**
- **Automotive and heavy equipment industry readiness**
- **Support facilities and biodiesel production in east area of Indonesia**

V. RESEARCH AND DEVELOPMENT

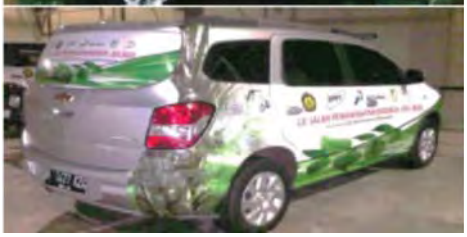


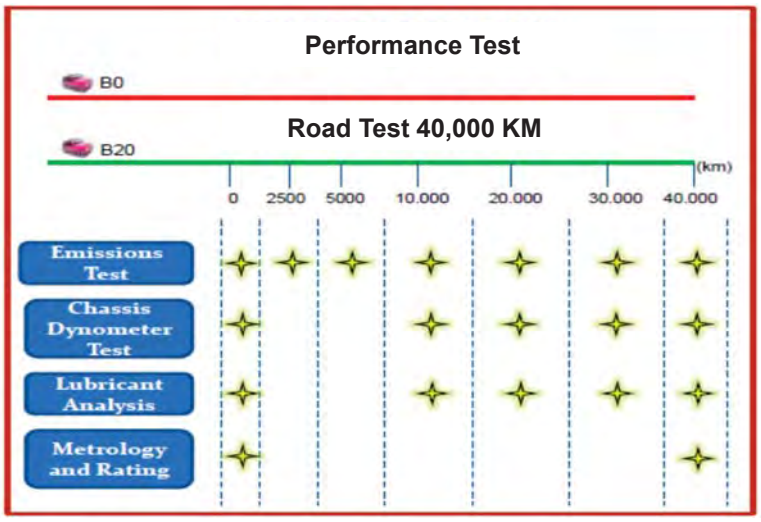

R&D Activities on B20 (2014-15)



Source: MEMR Presentation 2015

Field Testing of B20 on Vehicles



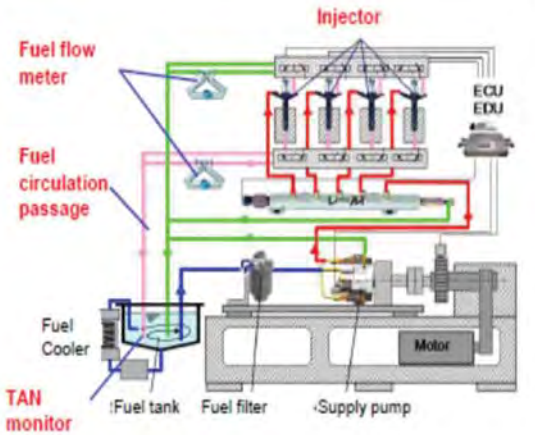


Road Condition	Distance (km)	Perc %
Highway (Asphalt+Concrete)	220	43,3
General Asphalt	81	15,9
Climbing-Down hill	195	38,4
City road	12	2,4
Total per day	508	

Fuel System Test of B20

■Test bench

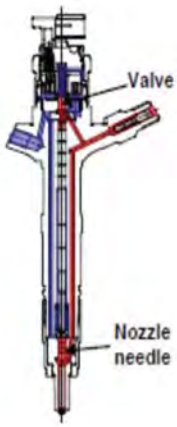
Operation Condition		Fuel Temperature	
Pump speed	2000rpm	Pump inlet	60℃
Injection pressure	200MPa	Injector return	150℃



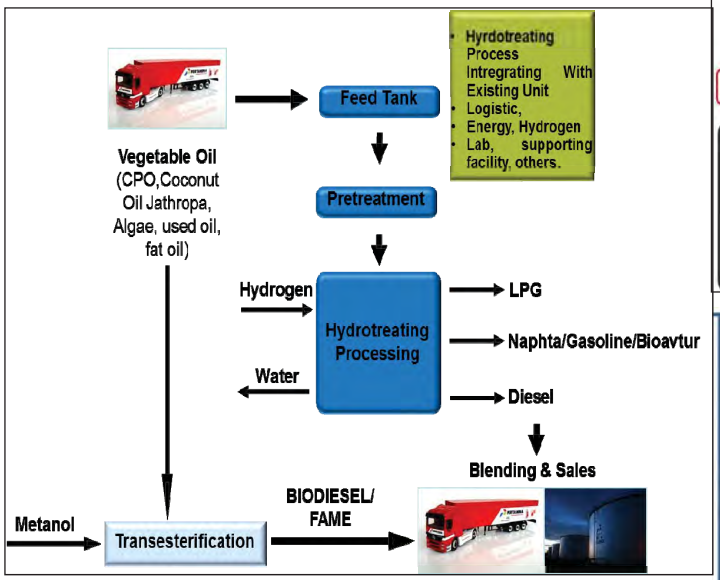
■Injector specification

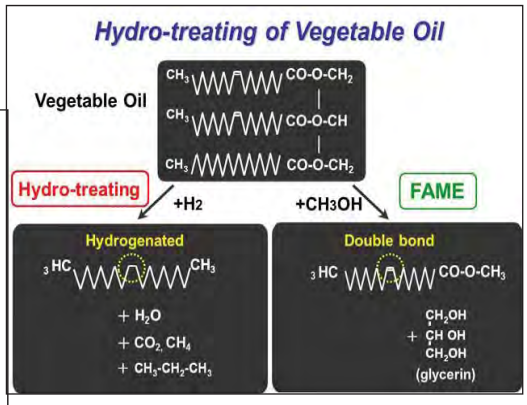
	DLC* coating	
	Valve	Nozzle needle
Injector A	No	No
Injector B	Yes	Yes

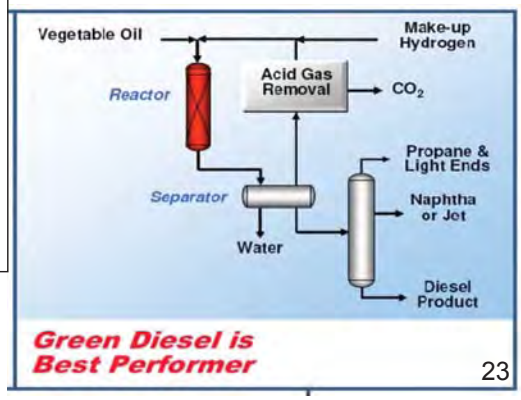
(DLC: Diamond Like Carbon)



Development Of HVO Process (PERTAMINA)







Source : Nippon Oil / TOYOTA JSAE Nov.29, 2006 & Pertamina

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VI. BIODIESEL TESTING RESULTS




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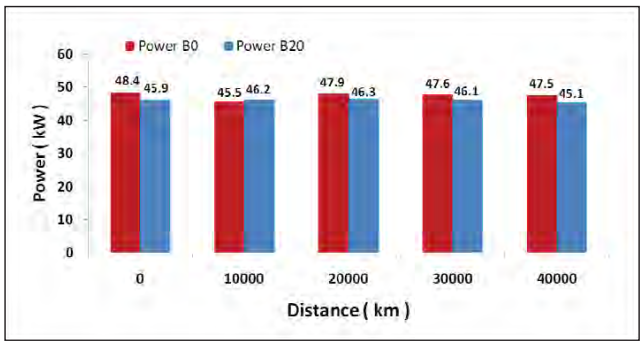
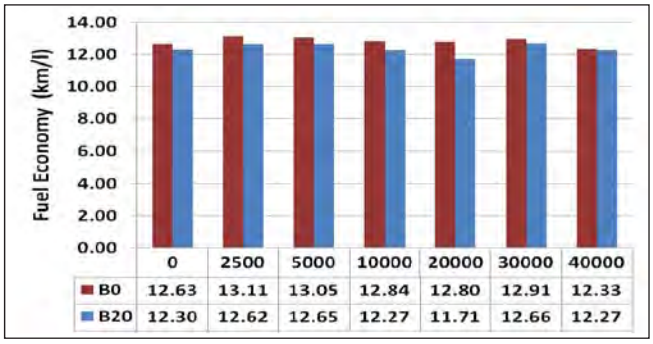
Rating of Engine Components (TOYOTA Innova)

Quantity of deposit, sludge & scratch between B20 and B0 were similar

Power & Fuel Economy

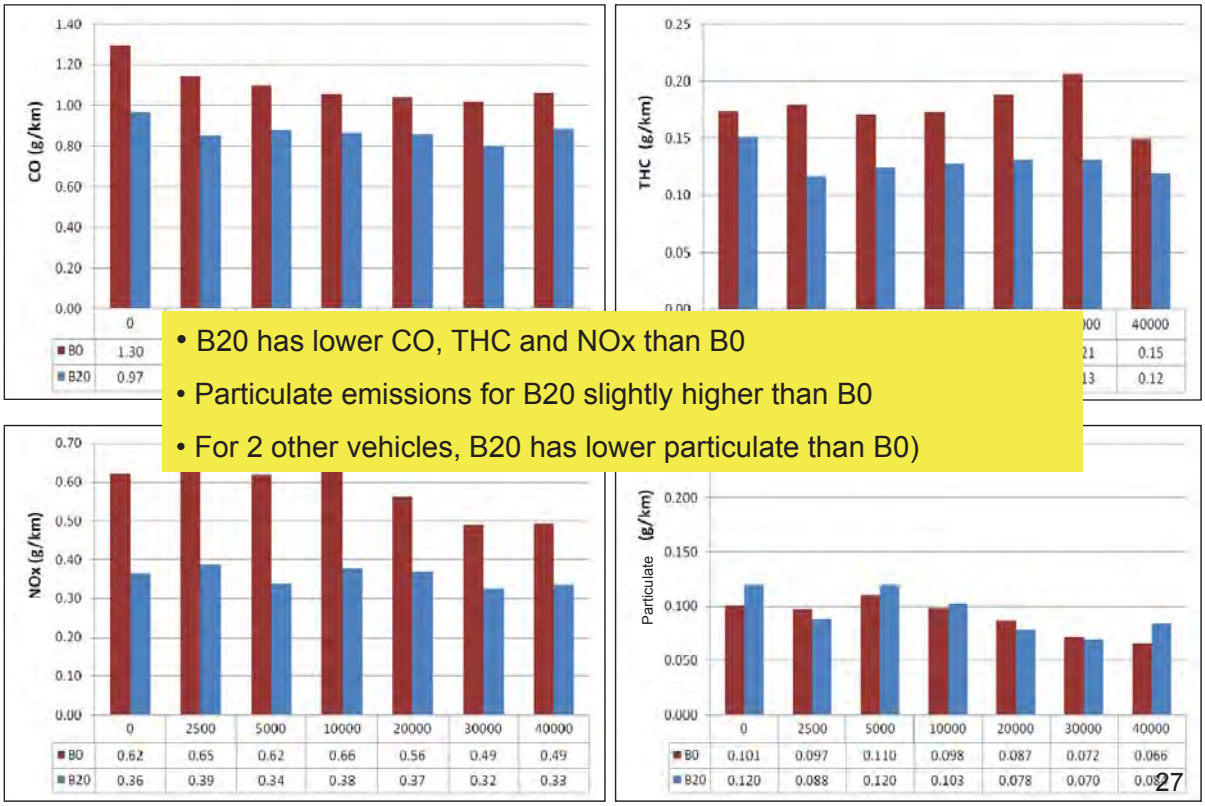




	0	2500	5000	10000	20000	30000	40000
B0	12.63	13.11	13.05	12.84	12.80	12.91	12.33
B20	12.30	12.62	12.65	12.27	11.71	12.66	12.27

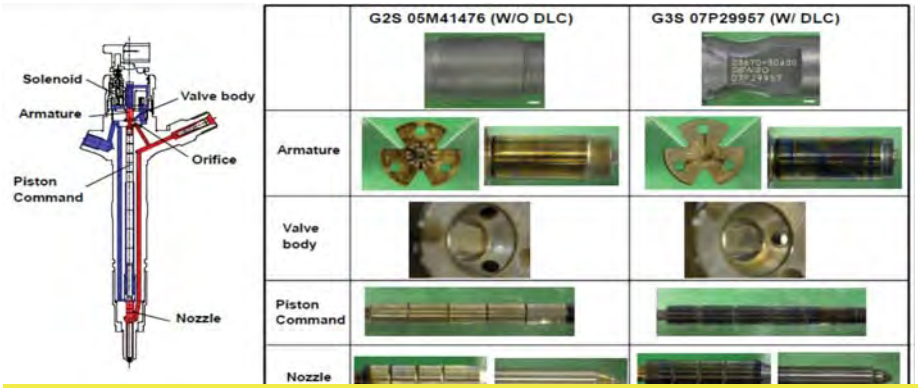
B20 has a slightly less Power and lower FE (km/l) compared to B0

Emissions of TOYOTA Innova

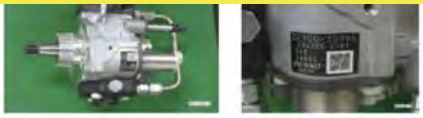


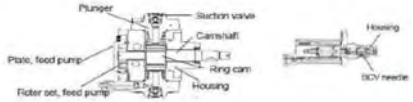
- B20 has lower CO, THC and NOx than B0
- Particulate emissions for B20 slightly higher than B0
- For 2 other vehicles, B20 has lower particulate than B0)

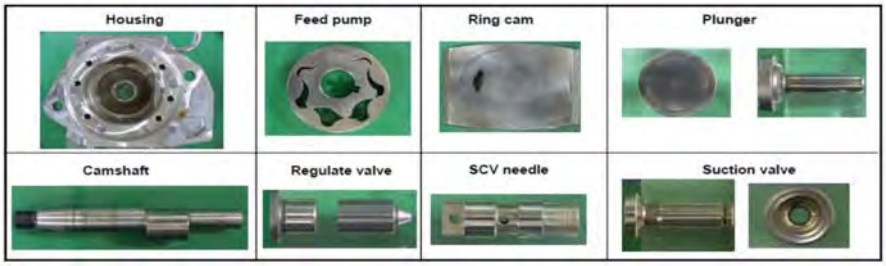
Rating on Fuel Injection parts (Denso)



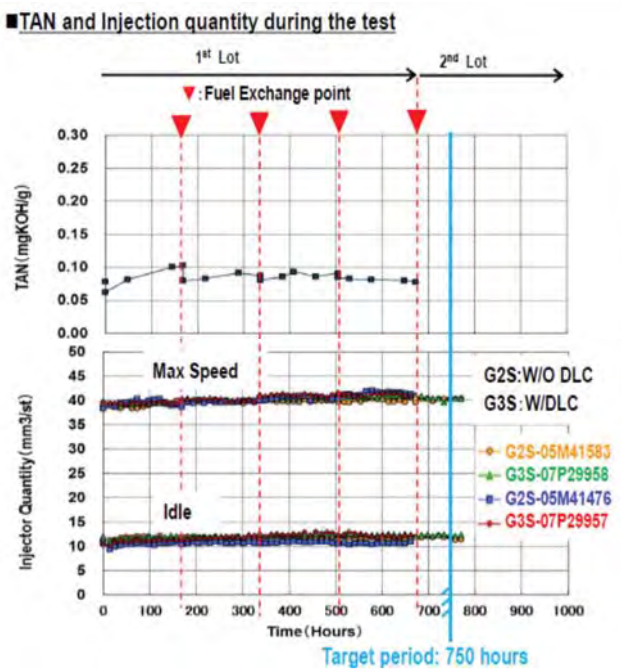
Utilization of B20 did not effect on fuel injection components

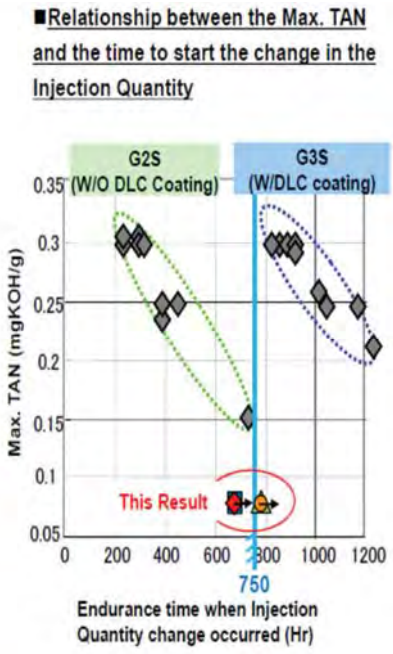






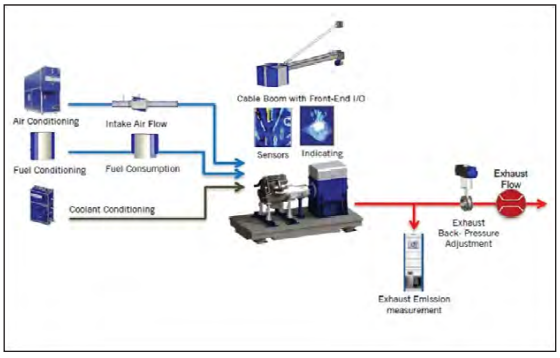
Fuel Injection Characteristics of B20 (Denso)

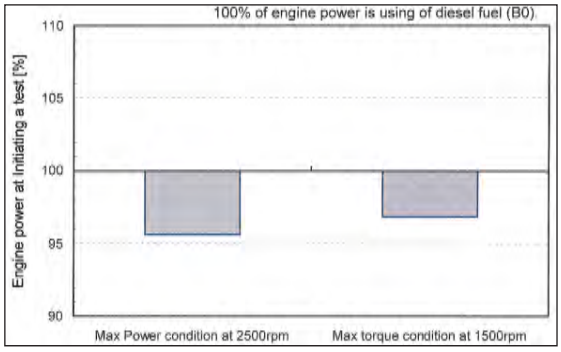


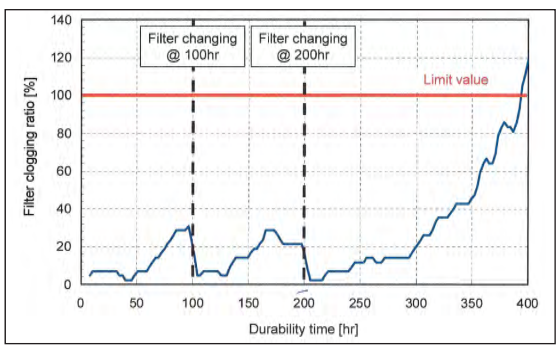


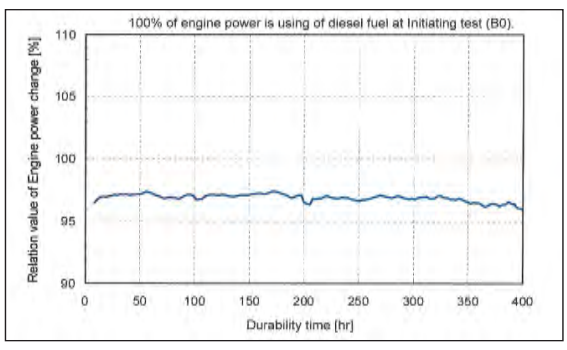
Injector shows constant injection quantity during 750 h durability test

Engine Durability Test (200 kW at BTMP)









- **Maximum power has slightly lower for B20**
- **Maximum power tends to decrease 3-5%**
- **Fuel filter is recommended to be changed earlier**

Hydrotreating of Vegetable Oil (Pertamina)

	Petroleum ULSD	Biodiesel (FAME)	Pertamina HBD	Commercial HBD
Oxygen Content, %	0	11	**0**	0
Specific Gravity	0.84	0.88	**0.776**	0.779
Sulfur content, ppm	<10	<1	**< 3**	< 3
Heating Value MJ/kg	43	38	**-**	
Cloud Point ° C	-5	-5 to +15		7
Pour Point, ° C			**+15 s/d +18**	
Distillation, ° C	200 to 350	340 to 355	**269 to 317**	269 to 313
Cetane Number	40	50-65		
Cetane Index			**65-67**	>56.5
Stability	Good	Marginal	**Good**	Good
Parrafin % wt			**100%**	100%
Total Aromatic	19		**0**	0.2
Ash Content wt%	<0.001		**<0.004**	<0.001
Flash Point C			**116**	99
Lubricity (HFRR) um	324		**200- 500**	360

Source : Renewable Energy Directorate of MEMR & Pertamina

Testing Results : Hydrotreated Biodiesel (HBD)

	CO (g/km)	HC (g/km)	NOx (g/km)	HC+NOx (g/km)	CO_2 (g/km)	Particulate (g/km)	FE km/litre
Based Market Diesel	**1,239**	**0,132**	**0,235**	**0,367**	**262,940**	**0,163**	**9,91**
Hydrotreated Biodiesel	**0,725**	**0,075**	**0,227**	**0,302**	**242,917**	**0,049**	**10,78**
Changes (%)	**- 41.5**	**-43,2**	**-3,4**	**-17.7**	**-7.6**	**-69.9**	**8,8**

- Higher Cetane Number and Low Sulphur Content
- Lower emissions than the best commercial diesel fuel in Indonesia
- Better fuel consumption
- Potential candidate as blending component for B30 & higher (FAME limitations)

Biodiesel Application on Marine Engine

- Engine for land transportation is commonly used as marine engine
- Very few research of utilization biodiesel on marine engine in Indonesia

- Testing results of biodiesel in NMRI will be valuable additional information for marine engine user in Indonesia and fuel quality standard

- More comprehensive study on marine application will be proposed to Ministry of Energy and Mineral Resources on 2016

Thank you for your attention