K Petro 한국석유관리원

석유기술연구소 Petroleum Institute of Petroleum Technology

Current Situation & Prospect of Bio-Fuels in Korea

2017. 5. 16

Content

Alternative fuels in Korea

1 Bio-fuels in Korea

2 Biodiesel(commercialized)

3 Bioethanol(feasibility test)

4 Biogas & Bio Power Fuel

5 Summary

Energy Situation in Korea

10th in Energy Consumption
* 9th in Petroleum Consumption, 9th in Power Consumption

97% Dependence on Foreign Energy

7th in GHG Emission

Energy Security

2nd Master Plan for National Energy('14)

Renewable Energy 11%(~'35)

확 대

신재생에너지 보급목표 11%('35)

	'12년	1st Plan('08)	2nd Plan('14)
풍력	2.18	13	18
태양광	2.68	4	4
태양열	0.30	6	8
지열	0.74	4	9

축 소

	'12	1st Plan('08)	2nd Plan('14)
폐기물	67.77	33	29
바이오	15.08	31	18
해양	1.11	5	1
수력	9.21	4	3

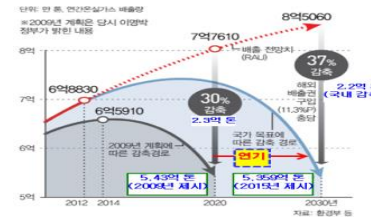
Bioenergy 18%

GHG Reduction

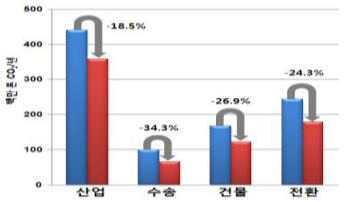
National GHG Reduction Target('09)

BAU 37%(~'30)

GHG Reduction Target (Unit : milion)



GHG Reduction Target by Sector



Need to Expand the Supply of Renewable Energy (RPS, RFS, RHO)

2nd Master Plan for National Energy (Renewable Energy)

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+ Increase Renewable Energy Target 11%(~'35)

	Result in 2012	Result in 2014	2nd Plan(~'15)
Wind	2.2	2.1	18
Solar Light	2.7	4.7	14
Solar Heat	0.3	0.2	8
Geothermal Heat	0.7	0.9	9

— Decrease

	Result in 2012	Result in 2014	2nd Plan('14)
Waste	67.8	59.8	29
Bio	15.1	24.5	18
Ocean	1.1	0.9	1
Water Power	9.2	5.0	3

4th Master Plan for New & Renewable Energy

Primary Energy

Target rate: 11.0% (2035)

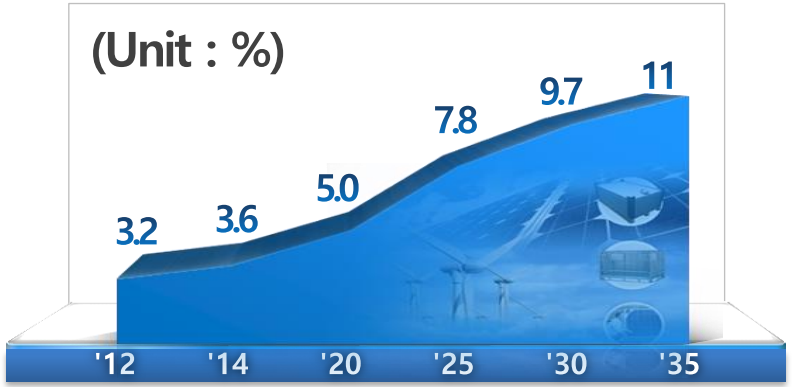
Annual NRE growth rate between 2014 and 2035: 6.3% > Annual demand rate of primary energy: 0.7%

Electricity

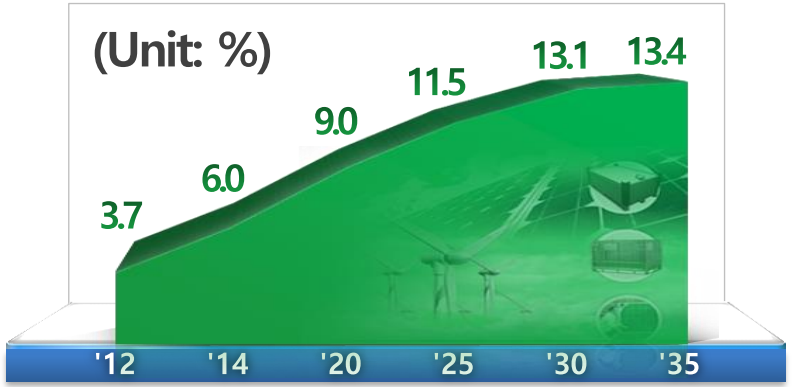
Target Rate: 13.4% (2035)

Annual NRE growth rate between 2014 and 2035: 5.8% > Annual demand rate of electricity: 1.8%

NRE share targets based on primary energy



NRE share targets based on power generation capacity



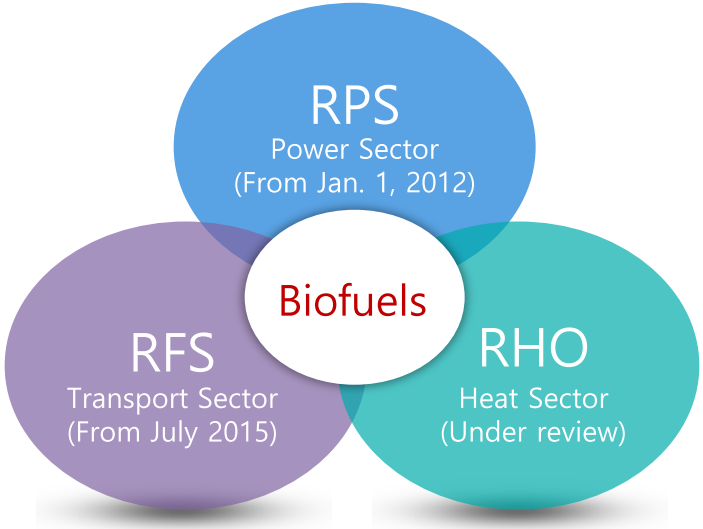
4th Master Plan for New & Renewable Energy

- While ratio of waste has decreased largely, the amount of shortfalls are expected to be replaced with Solar PV and Wind
  * Ratio per energy resource(%, '12→'35) : Waste(68.4→29.2), Wind(2.2→18.2), Solar PV(2.7→14.1)

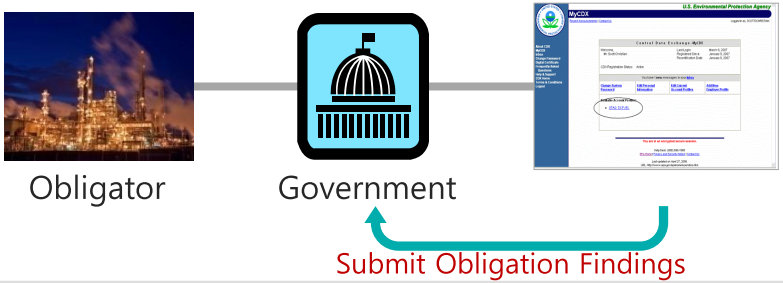
Ratio targets per energy resource compared to primary energy (Unit : %)

Areas	2012	2014	2020	2025	2030	2035
Solar Thermal	0.3	0.5	1.4	3.7	5.6	7.9
Solar PV	2.7	4.9	11.7	12.9	13.7	14.1
Wind	2.2	2.6	6.3	15.6	18.7	18.2
Bio	15.2	13.3	18.8	19.0	18.5	18.0
Water	9.3	9.7	6.6	4.1	3.3	2.9
Geo Thermal	0.7	0.9	2.7	4.4	6.4	8.5
Ocean	1.1	1.1	2.5	1.6	1.4	1.3
Waste	68.4	67.0	49.8	38.8	32.4	29.2

The Policy for the Promotion of Renewable Energy



Annual Supply X Obligatory Rate = Fulfillment



- Solid : Wood Chips, Wood Pellets, etc.
- Liquid : Biodiesel, Bioethanol, etc.
- Gas : Biogas, etc.

- RPS (Renewable Portfolio Standard) : Power Sector
- RFS (Renewable Fuel Standard) : Transport Sector
- RHO (Renewable Heat Obligation) : Heat Sector

System of RFS in Korea

Government

- Verification of Sustainability
- Impose obligatory amount
- Verification of findings
- Impose a penalty
- Quality inspection
- Check illegal fuels

Biofuel

- Diesel : BD, HBD, BtL etc.
- Gasoline : BE, Biobutanol etc.
- NG : Biogas
- LPG : BioDME etc.

Sustainability

- **LCA, Nonfood, Biological diversity etc.**

Weight Value

- **Promote potential fuels**

Obligator

- Refiners : SK Energy, GS Caltex, S-OIL , HDO, HW Total
- Importers : NH Chemical, EZ Petroleum etc.
- NG and LPG suppliers

Obligatory Rate

- **Blending rate**
- **Review triennially**

Fine

- **150% of average biofuel price**

Service Station

- Sale to consumer

Import

Domestic

SS

Obligatory Rate and Management System of RFS

Obligatory Rate

Implementation — 1st step — Review — 2nd step — Review

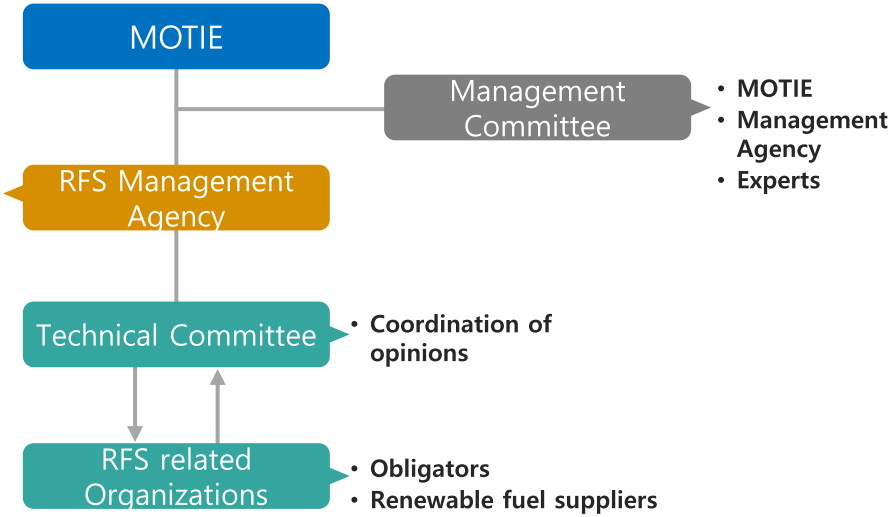
2015	2016	2017	2018	2019	2020
BD 2.5	BD 2.5	BD 2.5	BD 3.0	BD 3.0	BD 3.0

* Review the obligatory rate triennially

System

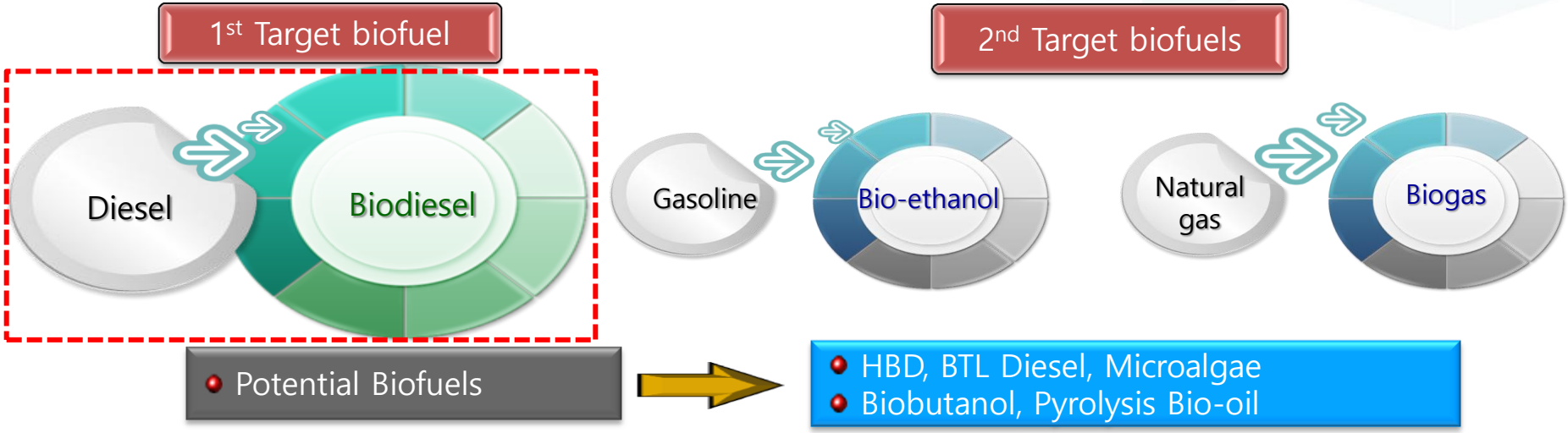
K-petro
- Verification of obligation findings
- Site inspection for verifying the findings
- Make a quality standard and inspect quality
- Site inspection of the production facility
- Clamp down on illegal renewable fuel
- Review technical standard and safety of fuel
- Management of working committee
- Approved work by minister

KNREC
- Verification of obligation findings
- Management of related informations
- Site inspection for verifying the findings
- Management of obligation standard
- Calculate obligatory amount and fine
- Management of working committee
- Management of RFS integrated management system



RFS Scheme – Biofuels

- It was applied biodiesel to blend in automotive diesel obligatorily in phase 2 from 2015.
- It will be introduced next biofuels with bioethanol and biogas to substituted road fossil fuel after consideration by demonstration project for commercialization.



Status of Petroleum Alternative Fuels in Korea

Petroleum and Petroleum Alternative Fuel Business Act
Article no. 5 (Types of alternative fuels)

- **Biodiesel**
  - Commercialized in 2006
  - Mandated 2~5vol% from 2012
  - To start RFS (July 2015~)
- **Bioethanol**
  - Feasibility study('06-'08)
  - Study on scheme of demonstration supply('13)
- **CTL**
- **Orimulsion (Bitumen)**
- **Emulsified fuel**
  - Commercialized but no sales record
  - **Bio-fueloil for power**
    - Feasibility study('13.12~'16.11)
    - Demonstration supply('14.1~'18.12)
- **GTL**
- **DME**
  - Feasibility step (Vehicle, Boiler etc.)
- **Biogas**
  - Partly commercialized (City gas, Bus, Taxi etc.)

Status of Biodiesel in Korea

Petroleum and Petroleum Alternative Fuel Business Act
Article no. 5 (Types of alternative fuels)

※ Revision('06.1.1) : Petroleum Business Act → Include 'Petroleum Alternative Fuel'

Revision('09.4.30)

- Biodiesel
- Bioethanol
- CTL
- Orimulsion (Bitumen)
- Emulsified fuel
- GTL
- DME
- Biogas
- Others

구 분		2002. 5 ~ 2005.12	2006.1 ~ 2006.6	2006.7~2011.12	2012. 1 ~	2015.7.31
BD5	Stage	-	-	Commercialization (First in Asia)	←	RFS implementation
	Blenders	-	Refiners/Importers	←	←	←
	Blending rate(vol%)	-	Max 5	0.5->1.0->1.5->2	2~5 (Quality spec.)	2.5 (~17)/3.0 (~20) (Obligatory rate)
	Target areas	-	The whole country	←	←	←
	Target vehicles	-	All diesel cars	←	←	←
BD20	Stage	Demonstration	←	Commercialization	←	←
	Blenders	SS/BD suppliers	BD suppliers	←	←	←
	Blending rate(vol%)	20±3%	←	←	←	←
	Target areas	Capital area, Jeolla-nam/buck do	The whole country	←	←	←
	Target vehicles	All diesel cars (Recommended for Buses/Trucks)	←	Buses, trucks, construction equipment and trains with their own repair shops and refueling facilities	←	←

Status of Transport Biofuels in Korea

Petroleum Products		Alternative Biofuels for transport	
Diesel	»	Biodiesel	Mandated
* HBD(Demonstration stage), Microalgae BD and BTL (under R&D)			
Gasoline	»	Bioethanol	Demonstration step
* 2nd generation bioalcohols (biobutanol, cellulosic alcohol etc.) R & D stage			
NG	»	Biogas	Partly commercialized
* Partly in use for city gas and transport(taxi, bus)			
LPG	»	Bio-DME	R&D step
* Bio-DME is considering as one of the alternative fuel for LPG to carry out the obligatory policy(RFS)			

Implementation Status of Petroleum Alternative Fuels

Year	Promotion Status
2002~2004	- BD 20 Demonstration Project(2002~2005) - BE, ETBE permitted as gasoline oxygenate(2004)
2006 ~ 2008	- BD commercialized(2006.07) - 1st BD Medium and Long Term Dissemination Plan(2007) : Voluntary agreement between the government and refiners(Tax free, BD 0.5%→2.0%) - BE Actual Assessment Project(2006~2008)
2009 ~ 2010	- Study on introduction of obligatory policy(RFS, Renewable Fuel Standard) in Korea
2011	- 2nd BD Medium and Long Term Dissemination Plan(2010) - Mandate requiring BD 2~5% in the diesel specifications from 2012 with taxation
2012 ~ 2013	- Study on RFS operation scheme('12.5~'13.3) /RFS proclamation('13.7.30) - Study on the detailed scheme of BE Demonstration Project('13.5~'13.12)
2014	- Pre-announcement of RFS sub-legislation(enforcement ordinance, enforcement regulation and notification) - Demonstration project of bio-fuel oil for power plant(2014.1.1 ~ 2015.12.31)
2015	- RFS implementation('15.7.31) - Extension period of demonstration project of bio-fuel oil for power plant('15.8.20) , ~ 018.12.31

Content

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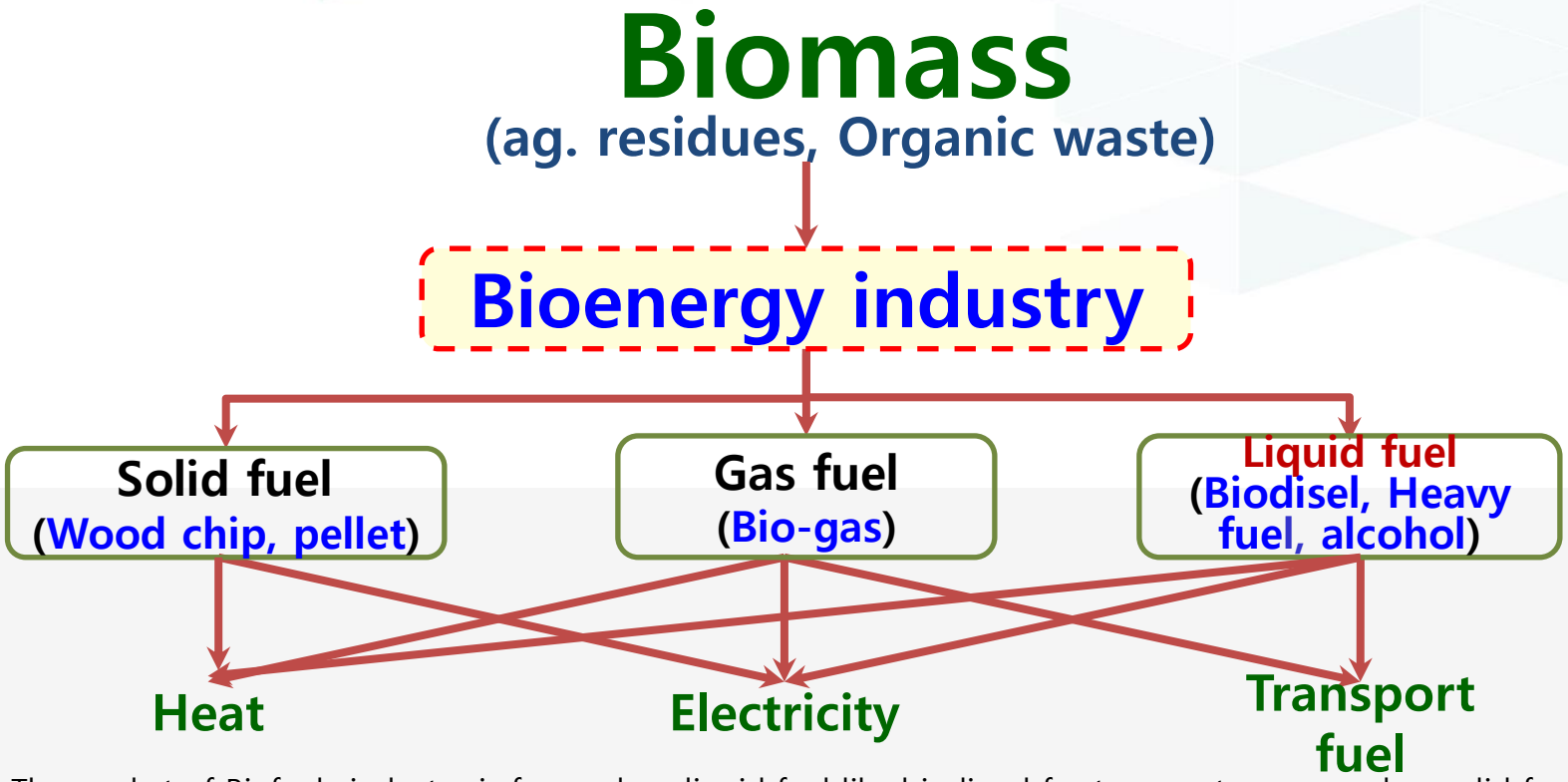
5 Summary

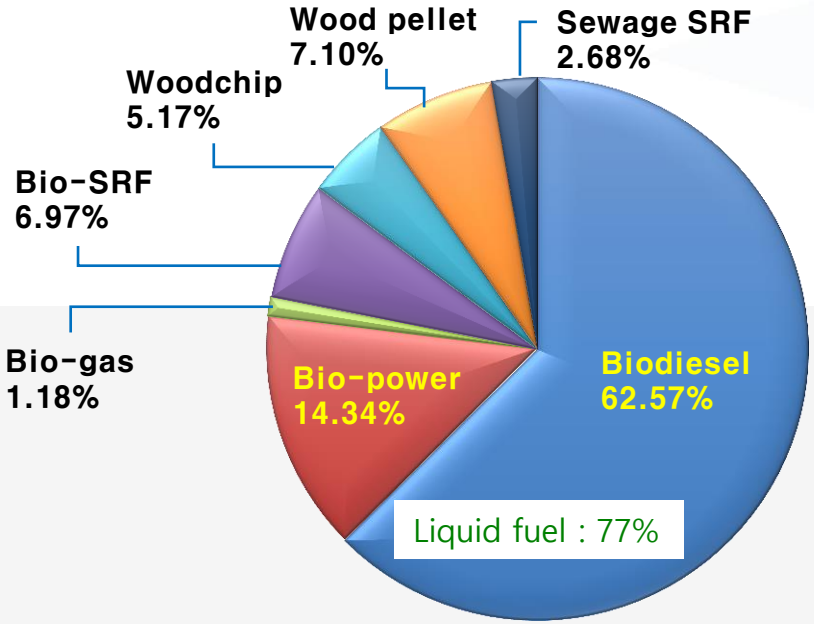
Biofuels Industry in Korea



- The market of Biofuels industry is focused on liquid fuel like biodiesel for transport, compared as solid fuel and gas fuel because of high value addition on economy in Korea

Status of Biofuels Market in Korea

Market size : $ 10.52 billion



Source : Statistics of NRE industry in Korea, 2016

Status of Biodiesel Industry – Distribution

- B2.5 is subject to diesel fuel specification, and supplied by refiners.
- B20 is used by bus and truck company on their own accord, and supplied by biodiesel suppliers.

BD suppliers(9)

B100

Refiners(4)

Diesel (B2.5)

Service Station

Diesel (B2.5)

Customer

B20
10% during winter season(11/1~3/31)

Bus, truck and construction equipment operators who are equipped with 'certified storage tank' and 'self-repair shop'

Status of Biodiesel Industry

No.	Biodiesel Company	Production Capacity (kL/year)	Main Feedstock
1	EMACBIO Corp.	50,000	Soybean, Waste cooking oil
2	M Energy Corp.	100,000	Waste cooking oil
3	Dansuk Corp.	113,068	Waste cooking oil, Palm oil
4	Eco-Solution Corp.	85,000	Waste cooking oil
5	SK Chemical Corp.	136,000	PFAD
6	Aekyung Petrochemical Corp.	130,000	Waste cooking oil, Palm oil
7	JC Chemical Corp.	120,000	Waste cooking oil, Animal Fat
8	GSBIO Corp.	120,000	Palm oil, Waste cooking oil
Total		854,068	

Status of Biodiesel Industry – BD Consumption

- 9 Domestic BD Companies (Production Capacity. : 914,068kL) in Korea
- From July 31, 2015, BD blending ratio was increased by 2.5% according to RFS regulation

BD

- **Since July 2006, Consumption of BD was about 3,083,000kL**

Items	2006.7~ 2006.12	2007	2008	2009	2010	2011	2012	2013	2014	2015
B100(1,000KL)	46	109	195	288	395	389	398	393	400	469.6
Blending Rate(%)	0.5	0.5	1	1.5	2	2	2	2	2	2.5

BD20

- **Since July 2006, Consumption of BD20 was about 5,600kL**

Items	2006.7~ 2006.12	2007	2008	2009	2010	2011	2012	2013	2014	2015
B100(1,000kL)	3.7	0.2	0.3	0.3	0.3	0.3	0.2	0.1	0.2	-
Blending Rate(%)	20 (10 for winter)									

Content

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2 Biodiesel(commercialized)

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Physical Properties of Bio-ethanol

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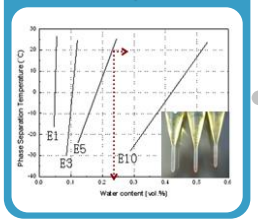
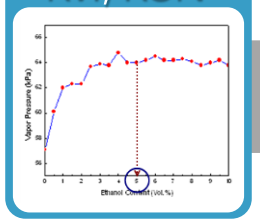
Corrosion

Phase Separation



RVP, RON



Research

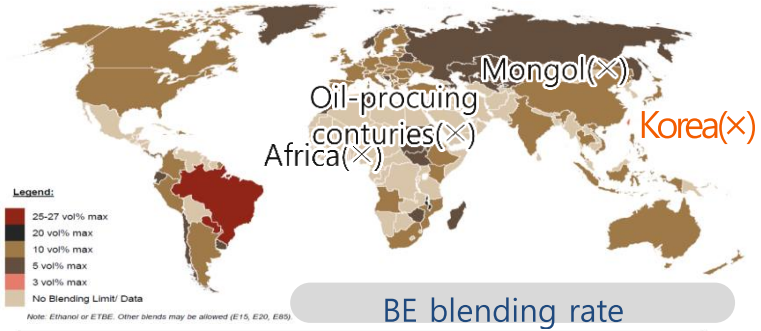
Bio-ethanol Distribution

- Improve qualities
- Evaluate vehicle compatibility
- Impossible to transport with pipe
- Need to blending facility in each oil reservoirs
- Need to control water in G.S

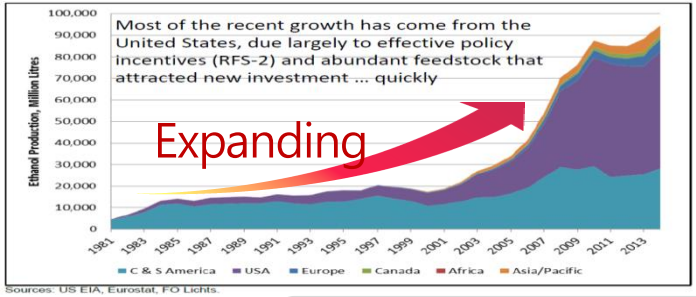
	O.N. (RON)	RVP (kPa)	Oxygen (wt%) (Calorie, kJ/kg)	Corrosiveness	Water solubility (Phase separation)	Price competitiveness	CO_2 Reduction	Technology level
Bio-ethanol	111	16 (Azeotrope)	34.7 (26.8)	★★★	100	★★	Carbon neutral	★★★
Bio-butanol	100	2	21.6 (-)	★★	9.1	★	Carbon neutral	★★
ETBE	118	30	15.7 (35.2)	★	1.2	★★	47%(BE) Carbon neutral	★★★
MTBE	117	55	18.2 (35.2)	★	2.1	★★★	Fossil fuel	★★★
Gasoline	91~94	49~92	0 (44.0)	★	Ignore	★★★	Fossil fuel	★★★

Status of Global Bio-ethanol Supply

BE blending ratio

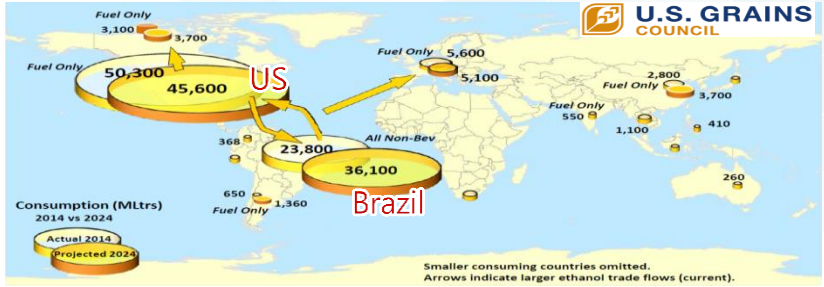


BE blending rate



World BE supply

Prospect of BE consumption(~2024)



Japan situation of BE supply

Goal : expand to 3% BE of gasoline by 2020

Demonstration	Government Incentive
• ENV(E3)/METI(ETBE) • E3 Okinawa, ETBE nationwide • Domestic BE, Imported ETBE	• Tax exemption • Support to infra construction • E3, 100 gas station • ETBE, nationwide

- Conventional BE has been mainly used in US and Latin American/Currently, trend of expanding non-food cellulosic BE
- Forecast the expansion of BE use according to the increase of gasoline use and obligation rate in Asia
- ETBE is commercialized in EU and Japan but GHG reduction effect is nearly half of BE

Status of Global BE Feedstocks

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Sugar

Sugar Cane / Molasses
(Brazil, India, Thailand, etc.)

Sugar Beet
(EU)

Sweet Sorghum
(Under developing)

Starch

Ground

Corn
(US, China)

Rice
(Beverage)

Barley
(EU)

Wheat
(EU, Russia)

Under ground

Cassava
(Southeast Asia, Africa)

Potato
(EU)

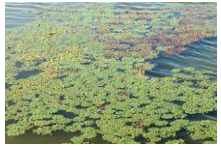
Sweet Potato
(Korea)

2 Generation

Agricultural Wastes

Forestal Wastes

3 Generation



Freshwater algae

Marine Macroalgae

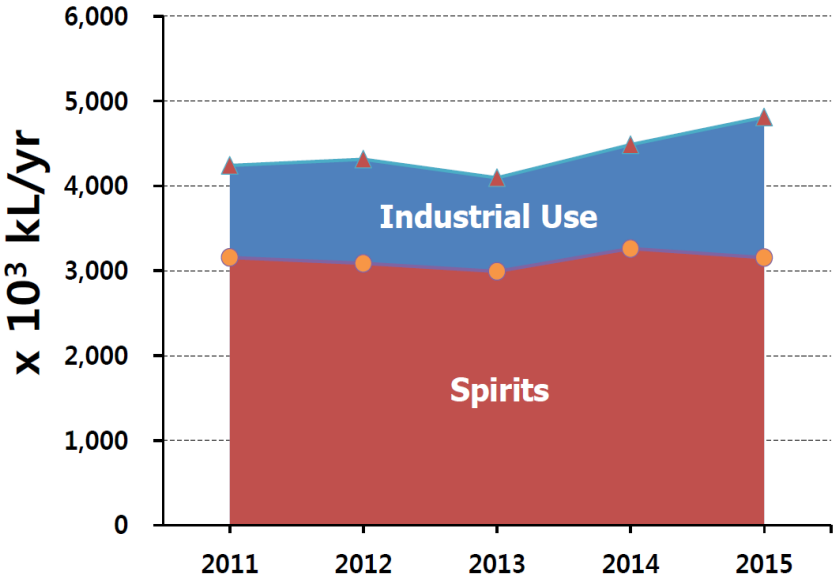
Potential Feedstocks for BE in Korea

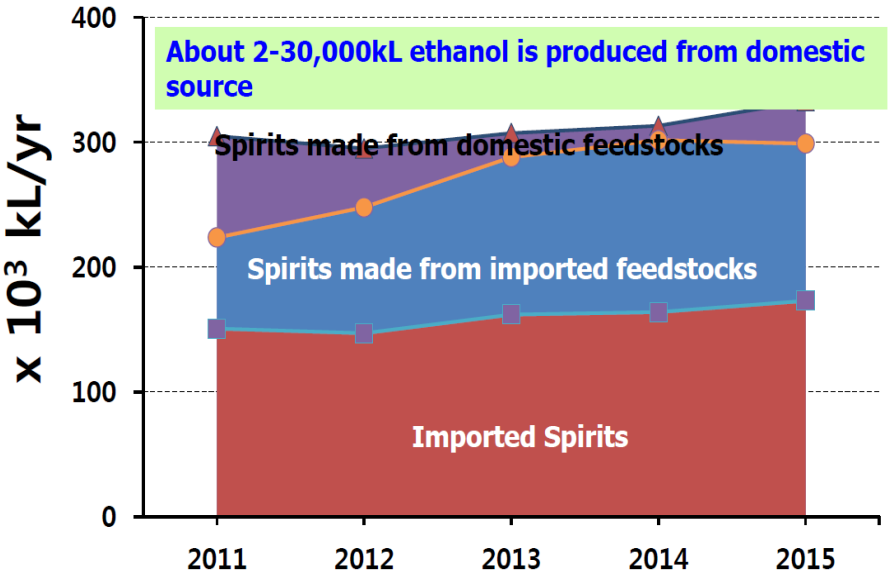
- The ranking of potential feedstock for BE is sugarcane BE from brazil > corn BE from US > cassava from Cambodia and Vietnam > domestic winter crop such as barley > domestic summer crop such as miscanthus > wastes of tangerine in Jeju.

Feedstocks		Amount	Price	Potential ranking	Note
BE(Brazil, US)		★★★★★	★★★★★	1	Recently, US BE has competitiveness
Cassava (Cambodia/Vietnam)		★★★	★★★	2	China became a big consumer and its price is increasing
Domestic	Barley seed	★★★	★★	3	Need a government support for using rest area
	Barley straw	★★	★★	3	Need to develop a technology for producing BE
	Miscanthus	★★	★★	3	Need a government support to cultivate it at large scale in reclaimed land
	Peel of tangerine	★	★★★	4	Need to develop technology for producing BE

Status of Bio-ethanol Industry

- Bio-ethanol for beverages is produced by 10 domestic companies(about 300,000kL), Bio-ethanol use amount for industries(cosmetics, medical, etc.) is about 150,000kL
- Imported alcohol count for 40~50% and the rest of alcohol is produced by domestic rice stock and imported cassava





Bio-ethanol Quality Specification

BE100 Specification(Draft)

Items	Value	Test Method
Ethanol(vol%)	92.7 min	ASTM D 5501
Water(vol%) (Karl Fischer)	0.30 max	KS M ISO 103369, 10337, ASTM E203, D6304
Methanol(vol%)	0.1 max	ASTM D 5501
Denaturant(vol%)	2.0 ~ 5.0	Managed by administrative quidance
Washed Gum(mg/100mL)	5.0 max	KS M 2041, ASTM D381
Electrical Conductivity(uS/m)	500 max	KS I ISO 7888, ASTM D1125
Sulfate(mg/kg)	4 max	ASTM D7318, D7319, D7328
Inorganic Chloride(mg/kg)	10 max	ASTM D7319, D7328
Copper(mg/kg)	0.1 max	KS I ISO 8288, ASTM D1688
Acidity(as acetic acid) (wt%)	0.0070 max	KS M ISO 1388, ASTM D1613
pHe	6.5 ~ 9.0	ASTM D6423
Phosphorous(mg/L)	0.50 max	KS M 2403, ASTM D3231
Sulfur(mg/kg)	10 max	KS M ISO 20846, ASTM D 5453
Appearance	Clear and Bright	Visual inspection

* Denaturant is gasoline satisfying the specification of 'petroleum and petroleum alternative fuel business act'

Gasoline Specification

Items		Regular	Premium
Octane No. (RON)		91 ~ 94	94 min
Distillation	10% T (℃)	70 max	
	50%T (℃)	125 max	
	90%T (℃)	170 max	
	End point (℃)	225 max	
	Residue(vol%)	2.0 max	
Water and Sediment(vol%)		0.01 max	
Copper Strip Corrosion(50℃, 3h)		1 max	
RVP(37.8℃, kPa)		44 ~ 82 {Summer : 44 ~ 65, Winter:44 ~ 96}	
Oxidation Stability(min)		480 min	
Washed Gum(㎎/100mL)		5 max	
Sulfur(㎎/kg)		10 max	
Color(visual)		Yellow	Green
Lead(g/L)		0.013 max	
Phosphorous(g/L)		0.0013 max	
Aromatic Compounds(vol%)		24(21) max	
Benzene(vol%)		0.7 max	
Olefin(vol%)		16(19) max	
Oxygen(wt%)		2.3 max	
Methanol(wt%)		0.1 max	

* Oxygenates : MTBE, ETBE, TAME(Tertiary Amyl Methyl Ether) and Bio-ethanol

Major R&D in Korea _ BE feasibility test (2005, 2008)

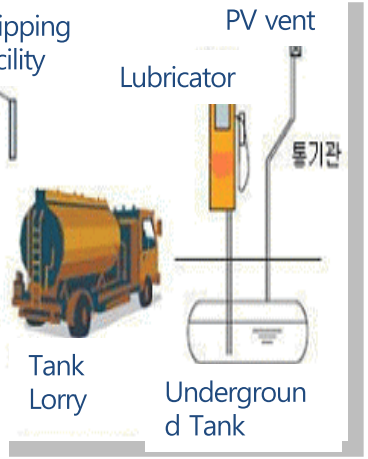
- Feasibility study for the implementation of bio-ethanol as fuels in Korea(2005.7~2005.12, KIER)
- Actual Assessment Study on domestic infrastructure was conducted (2006.8~2008.7, Kpetro)
  - Found that the bio-ethanol blended fuels(E3, E5) are possible to introduce in Korea

  * Participants : Kpetro(supervision), 4 oil fineries(SKE, GS-Caltex, HD-Oilbank, S-OIL), 1 alcohol company(changhae ethanol)

Distribution Infrastructure (production/transport/use)

Anhydrous bio-ethanol (changhae)

Suboctane gasoline (oil refiners)



1 » E3, E5 → 2 » Transport → 3 » 4 Gas Stations

Gas Stations

SK 인천정유 — Blend E3, E5

CHANGHAE ETHANOL — Produce Anhydrous BE

GS 칼텍스 — Honam(E3)

Gyeonggi (E5)

Chungcheong(E5)

Yeongnam (E3)

Fleet users — 587 of public officials and teachers

Major R&Ds in Korea _ Plan of BE demonstration project (2013)

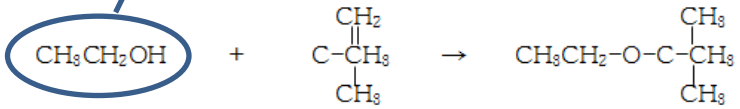
- This study('Study on plan of BE demonstration project in Korea') supported by MOTIE and carried out by Kpetro

- Comparison by distribution types

Blending types	BE direct mix(E3, E5)	ETBE
	Alcohol companies prefer	Oil refiners prefer
Quality	• Prone to phase separation and corrosion	• Similar to MTBE
Facilities and Infrastructures	• Impossible to transport with pipe • Need a blending facility in oil reservoirs • Need a production facility of anhydrous BE	• Possible to transport with pipe • Need a facility of ETBE production(BE+Isobutene) (remodel a MEBE process)
CO_2 Reduction	• Carbon neutral	• Half of the BE CO_2 reduction(42.37%) • CO_2 is generated during its production process
Foreign Case	• Worldwide(E3~E27, E85, E100)	• Japan(ETBE 7%), Europe(France, Spain, etc.)

In case of MeOH, MTBE is produced

ETBE outline

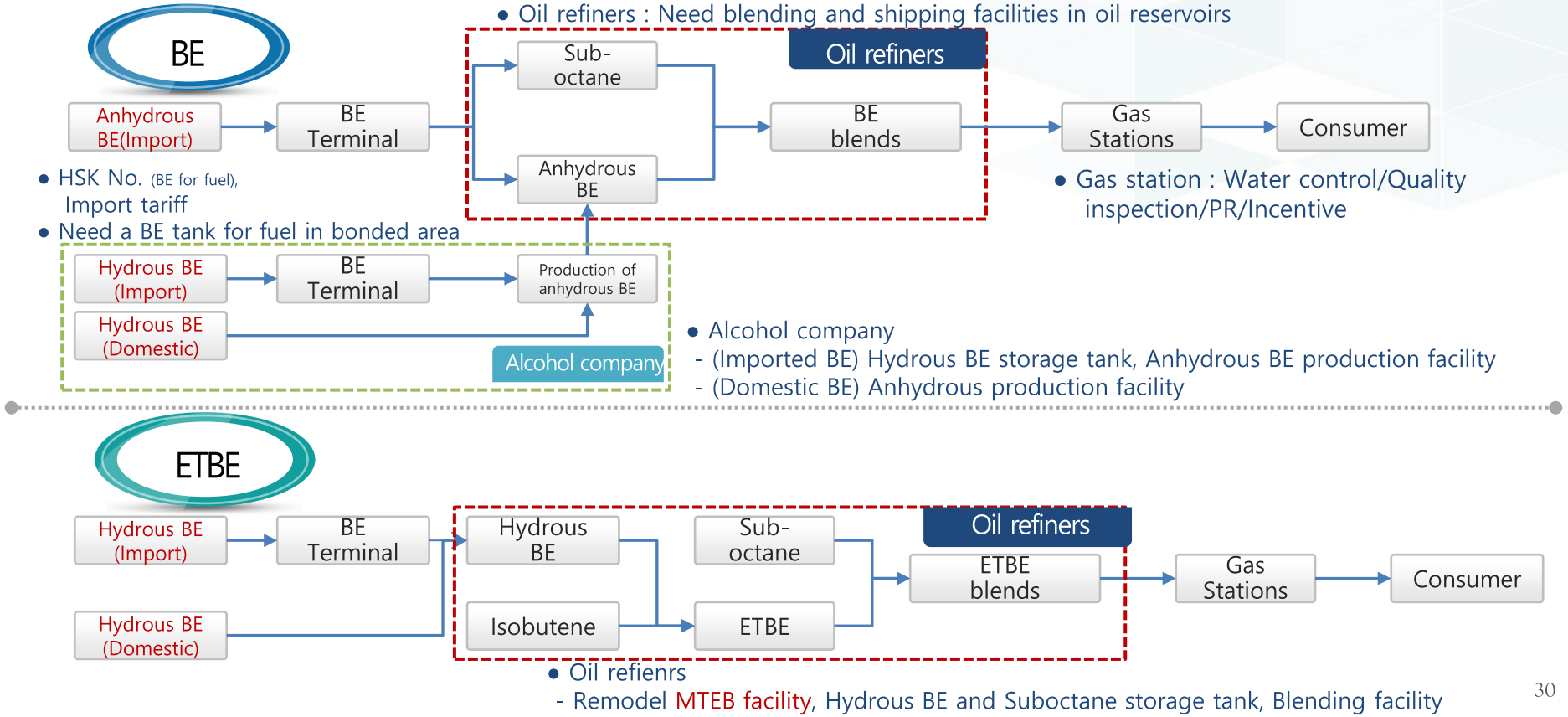


Bio-ethanol **Isobutene** **Bio-ETBE**

✓MTBE facilities in oil refiners (total 10,600B/D)
- SKE : 1,500B/D
- GS-Caltex : 2,500B/D
- S-OiL : 2,000B/D
- HD-Oilbank : 4,600B/D

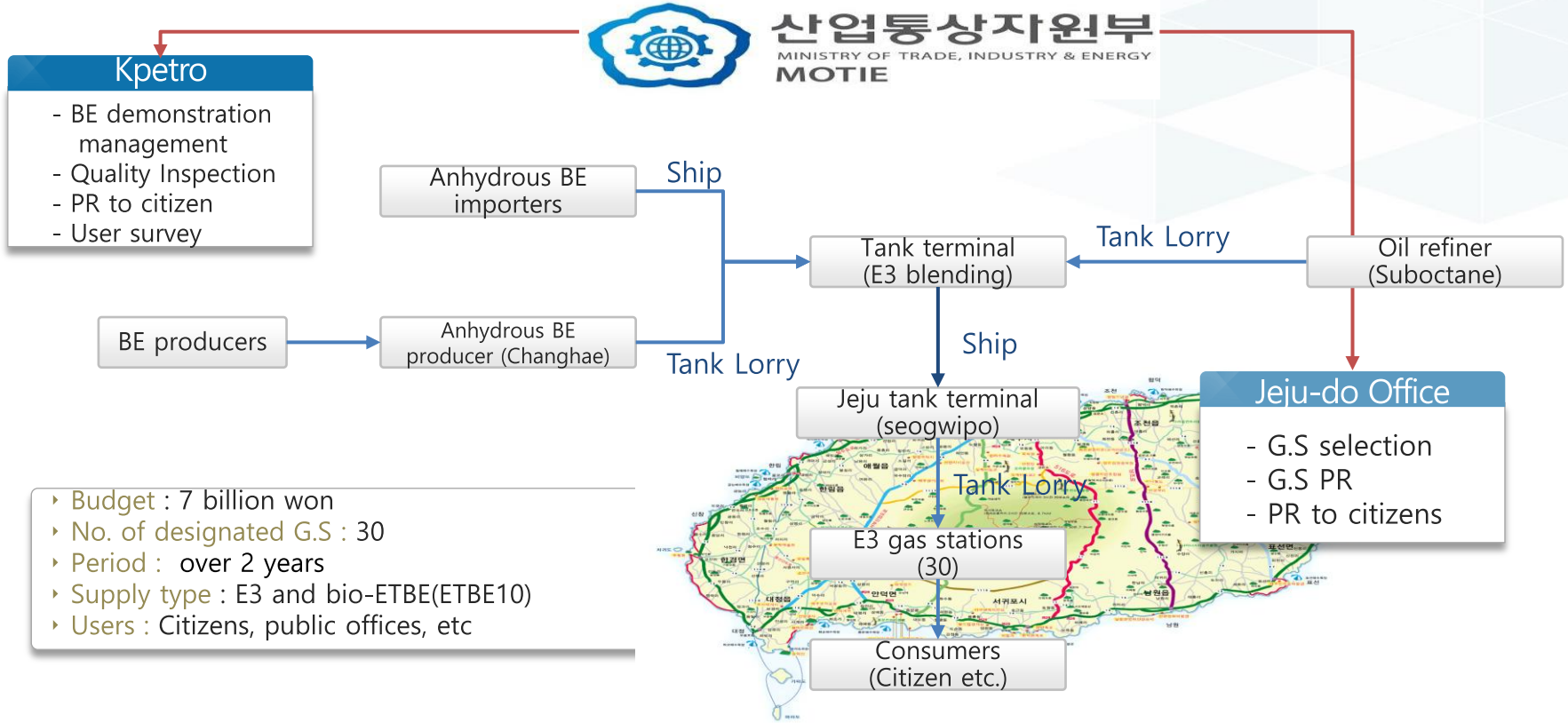
Major R&D in Korea _ Plan of BE demonstration project (2013)

- A possible distribution structure of bio-ethanol and ETBE in Korea



Major R&D in Korea _ Plan of BE demonstration project (2013)

- Suggested the scheme of demonstration with E3 and ETBE in Jeju-do



- Budget : 7 billion won
- No. of designated G.S : 30
- Period : over 2 years
- Supply type : E3 and bio-ETBE(ETBE10)
- Users : Citizens, public offices, etc

Major R&D in Korea _ Vehicle and Infra Evaluation of E3 (2016)

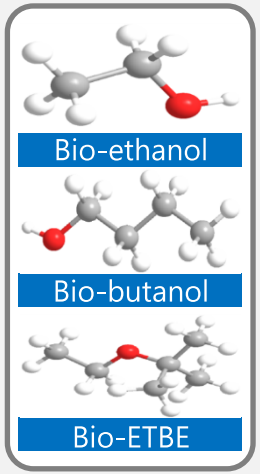
- Supported by MOTIE(2016.5 ~ 2019.4 (3 years))

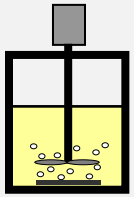
  * Participants : Kpetro (management), GS-Caltex, Changhae, KATECH, COAVIS, SNU

Goal

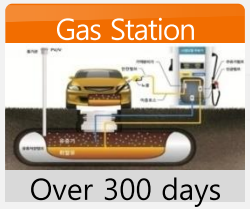
- ✔ Development of distribution technologies for introducing bio-alcohol in Korea
- ✔ Development of element technologies for introducing bio-alcohol in Korea

Main works

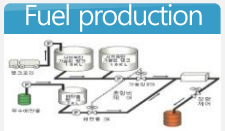


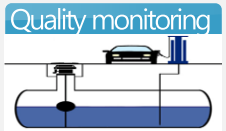


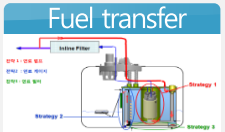
Supply

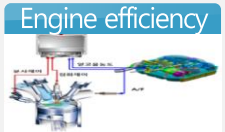


Use

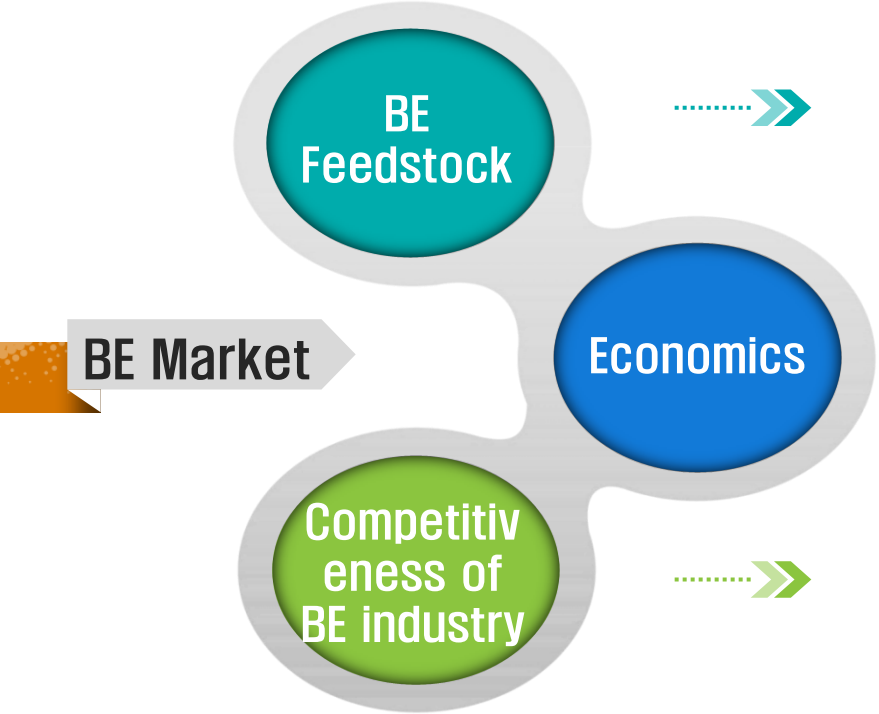








Issues of BE Supply



- Domestic feedstock(miscanthus) is initial R&D step
- The price of cassava from Southeast Asia is cheaper than domestic feedstocks but BE from Brazil or US is cheaper than cassava BE
- Inevitable to import BE from Brazil or US

- Current Brazil BE price ≒ Domestic gasoline price
- But considering calorie(70%), lack of price competitiveness(12won/L increase for E3)

- Tendency of global expansion except some oil producing countries and Africa
- Mature for producing BE for beverage but lack of production and distribution technologies for fuel

Content

Alternative fuels in Korea

1 Bio-fuels in Korea

2 Biodiesel(commercialized)

3 Bioethanol(feasibility test)

4 Biogas & Bio Power Fuel

5 Summary

Status of Biogas Industry

- **During the research for the utilization of biogas as road transport, various recent governmental initiative and plan were found.**

  ⇒ Biogas has high potential biofuels in Korea

  ⇒ Upgrading and highly concentrated fuel technology(CBG, LBG)

  ⇒ Biomethane from biogas can be used as for natural gas vehicle(NGV) in Korea

<Biogas Plant>

<Biomethane gas station>

Status of Biogas Industry

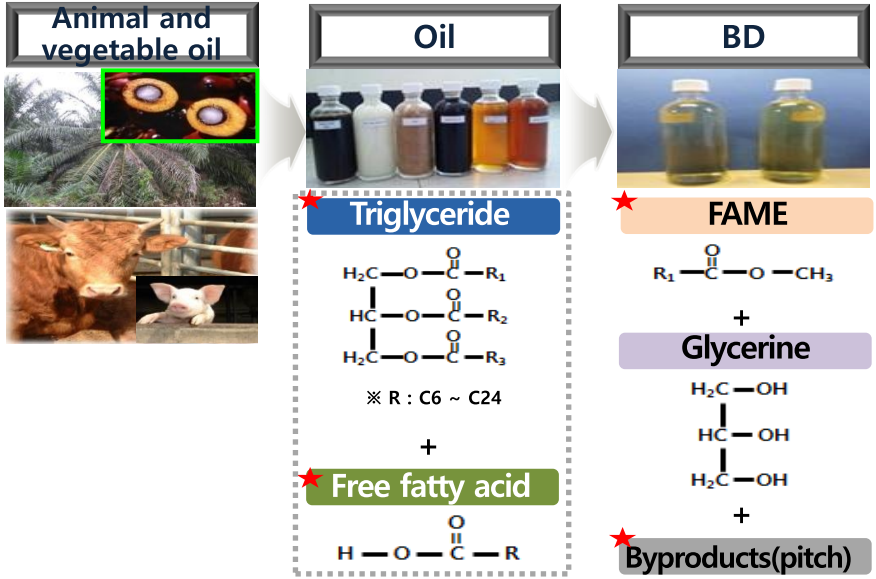
- Biomethane(BM) production plants(8 sites) for transport fuel in Korea

Company	Fuel type	Capacity (Nm^3/d)	Upgrading Process	Plant area
KOGAS / HYUNDAI ENGINEERING & CONSTRUCTION	Transport fuel	4,000 Nm^3/d	VPSA	Wonju sewage plant
Potlatch	Transport fuel	26,000 Nm^3/d	RPSA	Daegu sewage plant
Hansol 한솔이엠이	Transport fuel	4,800 Nm^3/d	RPSA +Cryogenic	SL Corp.
HALLA Halla Energy & Environment	Transport fuel	14,400 Nm^3/d	RPSA	SL Corp.
ECO ENERGY HOLDINGS	Transport fuel (city gas 80%)	5,040 Nm^3/d	PWS	Seonam sewage plant
ECO ENERGY HOLDINGS / 경남에너지주식회사 KYUNGNAM ENERGY CO., LTD.	Transport fuel (city gas 80%)	10,000 Nm^3/d	PWS	Changwon Duckdong sewage plant
HALLA Halla Energy & Environment	Transport fuel	14,400 Nm^3/d	RPSA	Busan suyoung sewage plant
KRICT	Transport fuel	1,440 Nm^3/d	Membrane/PSA	SL Corp.

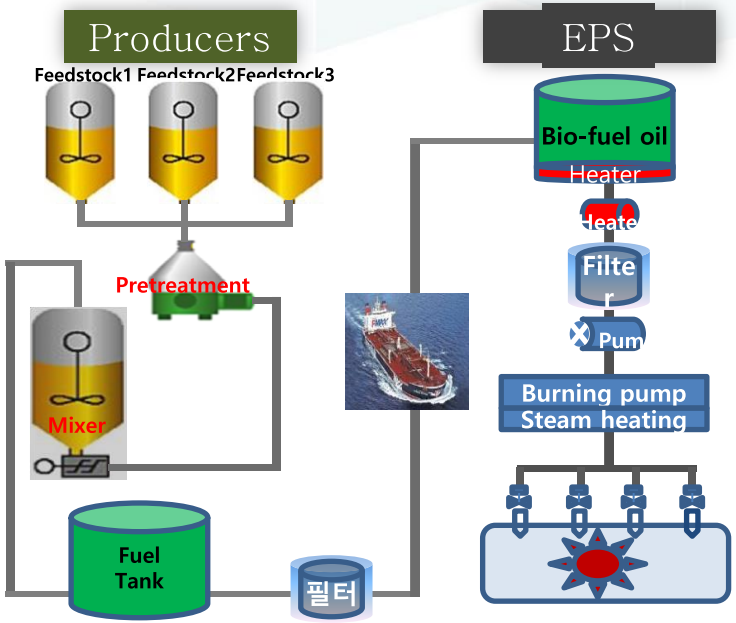
Status of Bio Power Fuel for Electricity

Composition of Bio-fuel oil

- Main feedstocks are Palm oil(RBD, PS), palm byproducts(PFAD, PAO), byproducts of biodiesel production process(BD Pitch), animal fat, cashew nut oil(CNSL), etc.
- Produced by refining and blending various feedstocks to meet its specifications.



(Main component of bio-fuel oil)



Production Process of Main feedstocks

Palm oil series

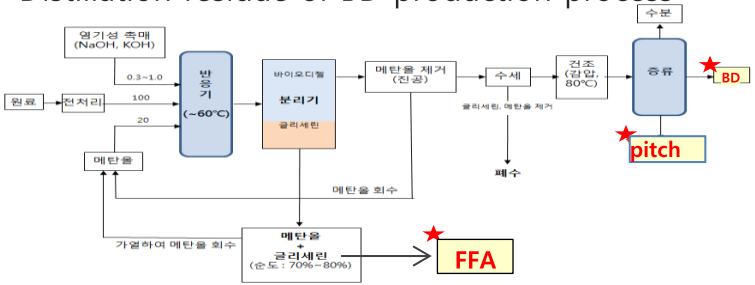
- ✓ CPO : Crud palm oil extracted from palm seed
- ✓ RBDPO : Refined palm oil(degumming, bleaching, odorization) of CPO
- ✓ RBD stearin : More saturated oil separated from RBD
- ✓ RBD olein : More unsaturated oil separated from RBD
- ✓ PAO : Oil on waste water(pond) from the process of palm oil extraction.

Animal Fat

- ✓ The Oil extracted by crushing, steam heating, refining residues from slaughterhouse and meat shop

Biodiesel series

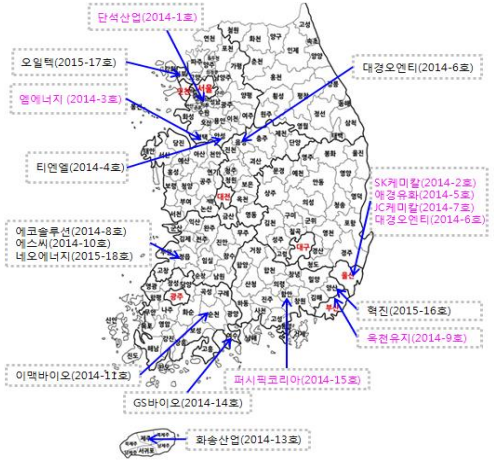
- ✓ FAME produced by reacting oils with methanol
- ✓ Distillation residue of BD production process



Status of Bio Power Fuel for Electricity

- Business Period : 1 Jan. 2014 – 31 Dec. 2018
- EPS : 4 Power suppliers(jungbu/seobu/nambu/dongseo) and KDHC
- Fuel suppliers : 19 companies are registered and about 350,000kL of bio-fuel oil was supplied in 2015 (supplied by 8 companies)
- Quality Inspection : After initial inspection, monthly and random inspection will be carried out

		Jungbu	Seobu	Nambu	Dongseo	KDHC
Power generators		Jeju Steam power No. 3 (75MW)	Pyeongtaek Steam Power No. 1 (350MW)	South Jeju Steam Power No. 1 (100MW)	Ulsan Steam Power No. 6 (400MW)	Daegu CHP (43.5MW)
Designated date		'14.2.20	'14.2.20	'14.2.20	'14.2.20	'14.6.23
Blending ratio		100%	10~20%	100%	10~20%	10~20 %
Supply (kL)	2014 (179,353)	73,582	1,627	94,061	10,083	-
	2015 (354,495)	110,856	4,958	176,574	61,412	695
	2016 estimate (332,000)	120,000	4,500	170,000	30,800	6,700



Quality specifications of Bio Power Fuel

Properties		Specs	EPS specs for bidding			
			Jungbu	Seobu	Nambu	Dongseo
Flash point(℃)		70 min	70 min	70 min	70 min	70 min
Kinematic viscosity(40℃, ㎟/s)		20 ~100	20 ~ 60	20 ~100	20 ~100	20 ~100
Residue(wt%)		10 max	5 max	10 max	5 max	10 max
Sulfur content(wt%)		0.1 max	0.1 max	0.1 max	0.1 max	0.1 max
Ash content(wt%)		0.10 max	0.10 max	0.10 max	0.10 max	0.10 max
Copper strip corrosion(50℃, 3h)		1b max	1b max	1b max	1b max	1b max
Poor point(℃)		27.5 max	27.5 max	27.5 max	20.0 max	27.5 max
Density(15℃, kg/㎥)		991 max	991 max	991 max	991 max	991 max
Water content(wt%)		0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
TAN(㎎ KOH/g)		25 max	25 max	25 max	25 max	25 max
Alkaline metals (mg/kg)	Na	70 max	50 max	50 max	50 max	50 max
	Ca	30 max	30 max	30 max	30 max	30 max
	K	70 max	50 max	50 max	50 max	50 max
Iodine value(g/100g)		120 max	120 max	120 max	80 max	120 max
Nitrogen(wt%)		0.3 max	0.3 max	0.3 max	0.3 max	0.3 max
Vanadium(mg/kg)		50 max	50 max	50 max	50 max	50 max
Total calorific value(kcal/kg)		9,000 min	9,000 min	9,000 min	9,000 min	9,000 min
Net calorific value(kcal/kg)		-	8,400 min	8,400 min	8,400 min	8,800 min
Moisture and sediment(vol%)		0.5 max	0.5 max	0.5 max	0.5 max	0.5 max
Si+Al+Fe(mg/kg)		200 max	200 max	200 max	200 max	200 max
Phosphorous(mg/kg)		100 max	20 max	40 max	20 max	10 max

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Summary

❖ Biofuels may be a viable option to reduce CO_2 in the transport sector.

❖ It is effective to refiners and importers based on new laws from July 31th, 2015 and it was applied biodiesel to blend with 2.5% in automotive diesel obligatorily.

❖ Especially, bioethanol implementation in Korea has several issues like the cost competitiveness, infra compatibility and security for supply to commercialize in Korea and also, Korean government will decide on the introduction of bioethanol in phase 2 of RFS since 2020.