Biofuel Promotion Policy and Economics in Korea

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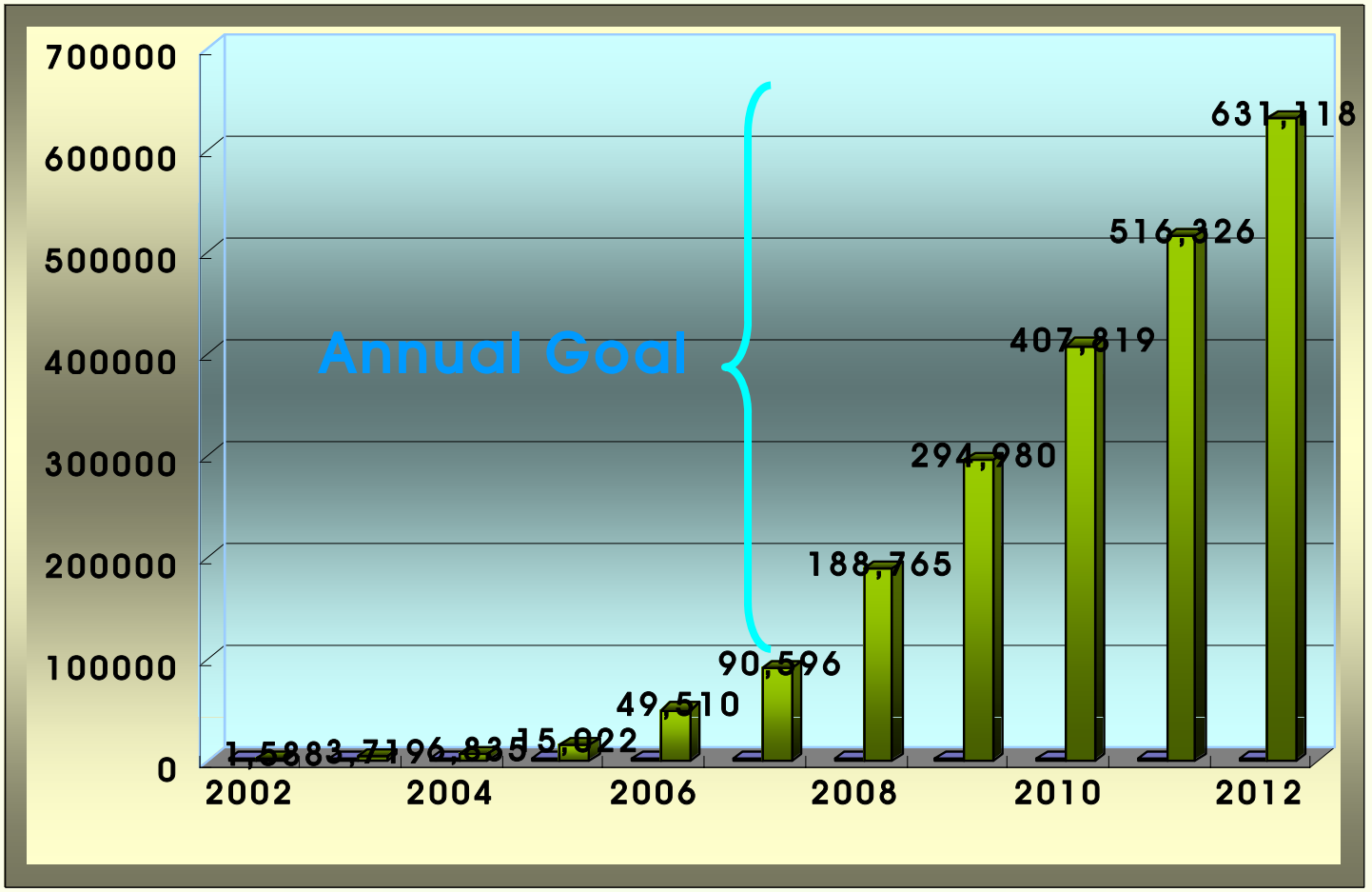
Contents

History of Biodiesel Production in Korea

- **Began in 2002 as demonstration project**
  - 58,000kL of BD was produced in June. 2007.
- **Over 90,000kL(0.5%of total diesel consumption) of BD will be provided until Dec. 2007.**
- **Provision of BD will grow by 1.0% in 2008, and 3.0% in 2012 of total diesel consumption**
  - 0.5% increases in each year
- **BD5 is commercialized in Korea in 2006, marked as the first country in Asia**
- **BD20 is limited on the vehicles enabling to repair in their own facilities due to the tech. problems**
  - 47kL of BD20 was produced in 23 fuel stations

Annual BD Production and Goals

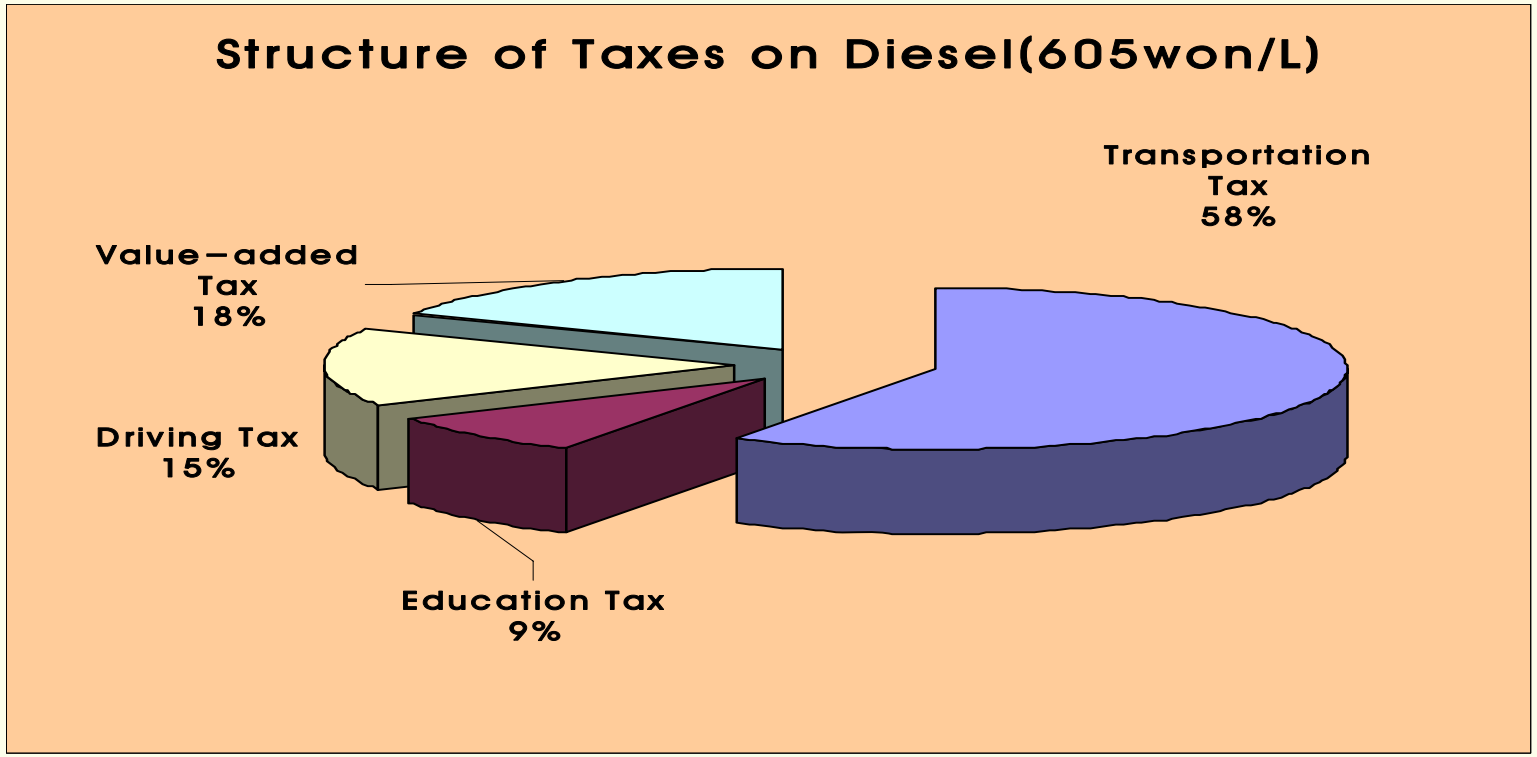


Source: Korea Biodiesel Association('02~'06)

BD Promotion Policy

- **Tax exemption on BD: 497won/liter(June.2007)→ 528won**

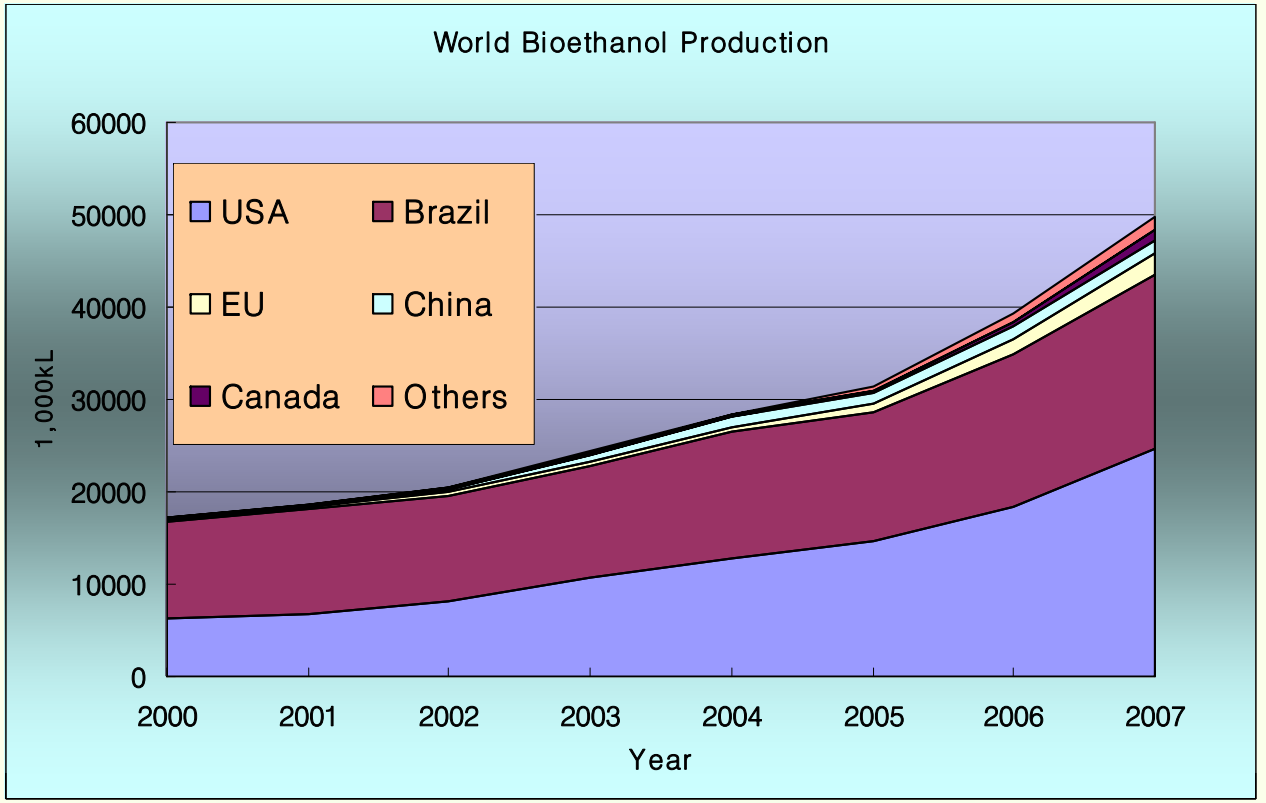
  = Exemption on Transportation Tax + Driving Tax + Education Tax



(Source: Petroleum Industry Division, MOCIE)

World Bioethanol Production

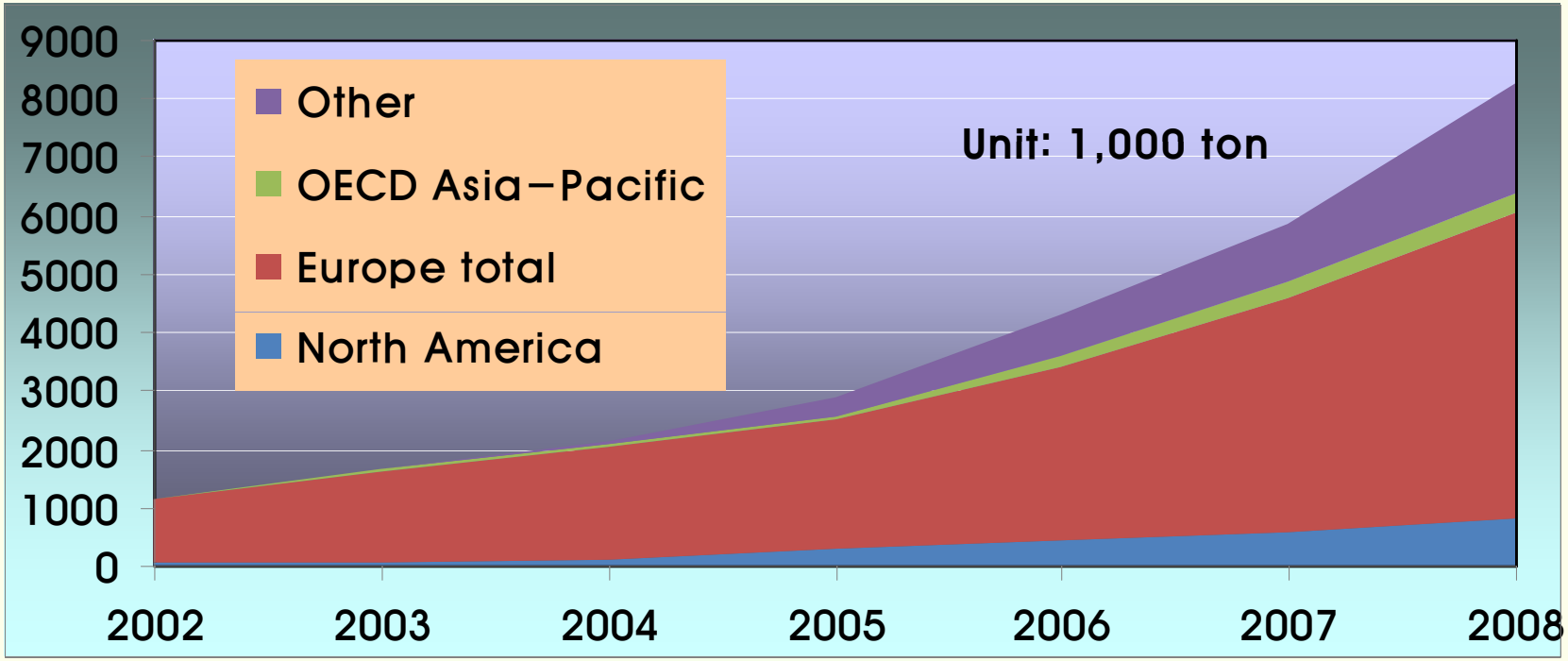
- World production increases by 3 times bet. 2000 and 2007 (about 2% of world gasoline consumption)
- U.S.A. production increases by 4 times for the same period



(Source: F.O.Licht, 2007, 'World Ethanol & Biofuels Report)

World Biodiesel Production

- 5.8MT of BD would be produced in 2007 (0.2% of world diesel consumption)
- Bet. 2002 and 2007, world BD production increases by 5 times, EU prod. increases by 3.7 times, OECD Asia prod. increases by 9.5 times, and North America prod. increases by 11 times!



(Source: OECD Trade Policy Studies, 2006), *2005: Estimated, **2006~2008: Projected)

Biofuel Promotion Policy in EU

- **Subsidy on biofuel promotion as a part of agricultural policy**
  - Unilaterally €45/ha supported by Common Agricultural Policy from 2003
  - Fuel Tax exemption as well as Environmental tax exemption also applied
- **3.18MT of BD produced in EU (2005)**
  - Share of Germany production: 52.4%
  - Share of entire EU diesel market: 1.6%
- **Promotion goal of BD in EU**
  - 2% of total diesel consumption in 2005
  - 5.75% in 2010, minimum 10% in 2020
- **Achievement of BD promotion goal was not promising**
  - Germany(3.8%) and Sweden(2.2%) only accomplished the 2005 goal

Germany and France Policy

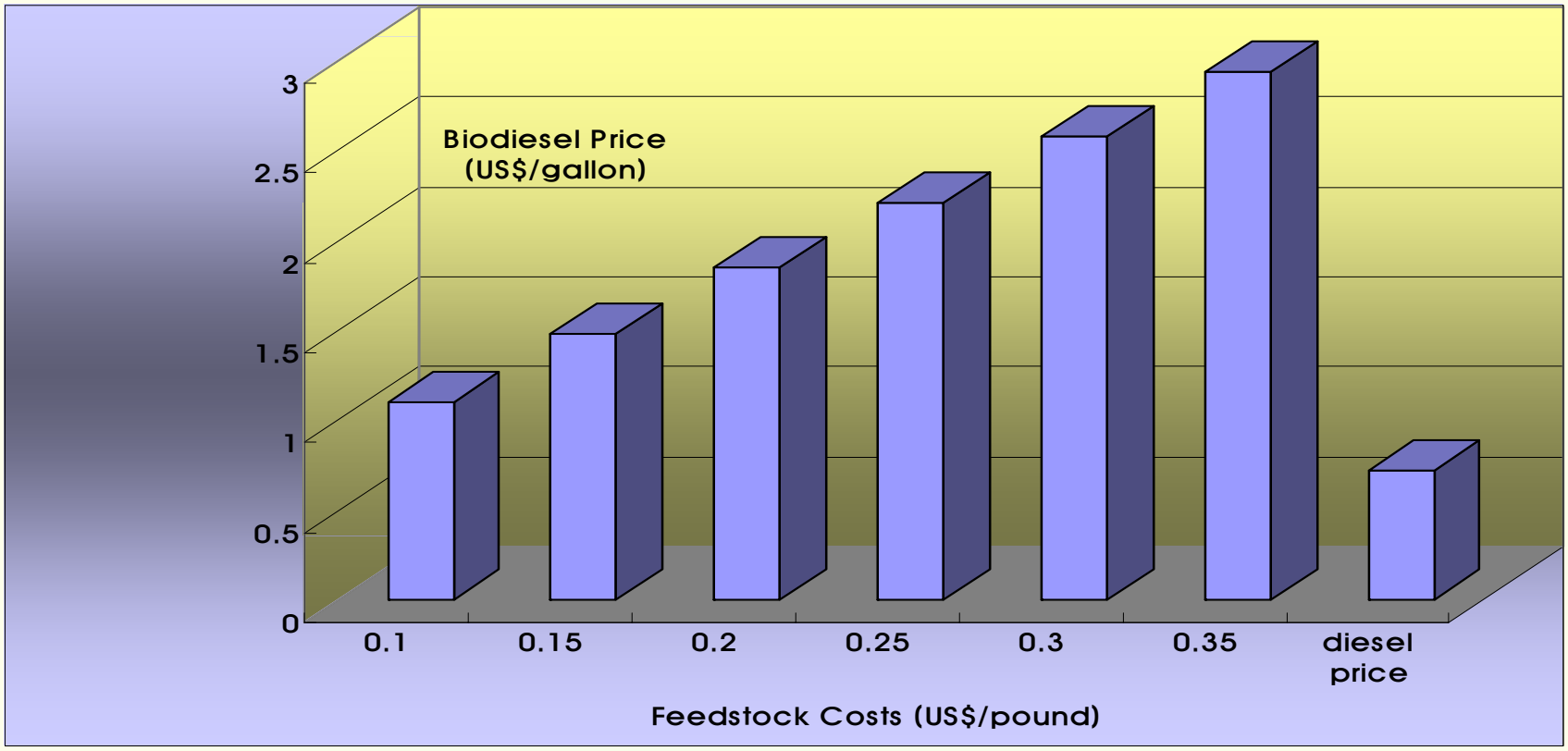
- **100% fuel tax exemption applied in Germany until 2005**
  - €0.63/liter exempted, but began to convert into partial exemption policy
  - From 2006, €0.15/liter is levied on BD consumption
- **Partial tax exemption policy in France**
  - Excise tax on diesel consumption: €0.39/liter
  - Excise tax exemption on BD: €0.25/liter (62% of exemption rate)
  - However, value-added tax is applied both of diesel and BD consumption
- **Stronger subsidy policy obtains successful outcome in the promotion of BD**
  - Share of BD in Germany: 0.3% in 1993 → 3.8% in 2005
  - Share of BD in France: 1.0% in the beginning of 1990's → less than 2.0% in 2005

Spain, the most similar case!

- **Starting BD pilot plant using waste cooking oil in 2003**
  - 6,000ton of BD was produced
  - In 2004, BD production increased into 13,000ton (capacity: 80,000t)
  - Production of BD in 2005 was 150,000ton (capacity: 250,000t)
- **However, the largest bioethanol country in EU**
  - They began BE in 1995 producing 260,000ton in 2005
  - Substitute MTBE for ETBE
  - Biofuel is responsible for 1.1% of total petrol and diesel use!
- **A successful story in biofuel promotion!**
  - By 2010, 500,000ton (1.7% of total trans. fuel use) of biofuels are their goal!
  - 10 year guarantee of fiscal support for commercial biofuel plants

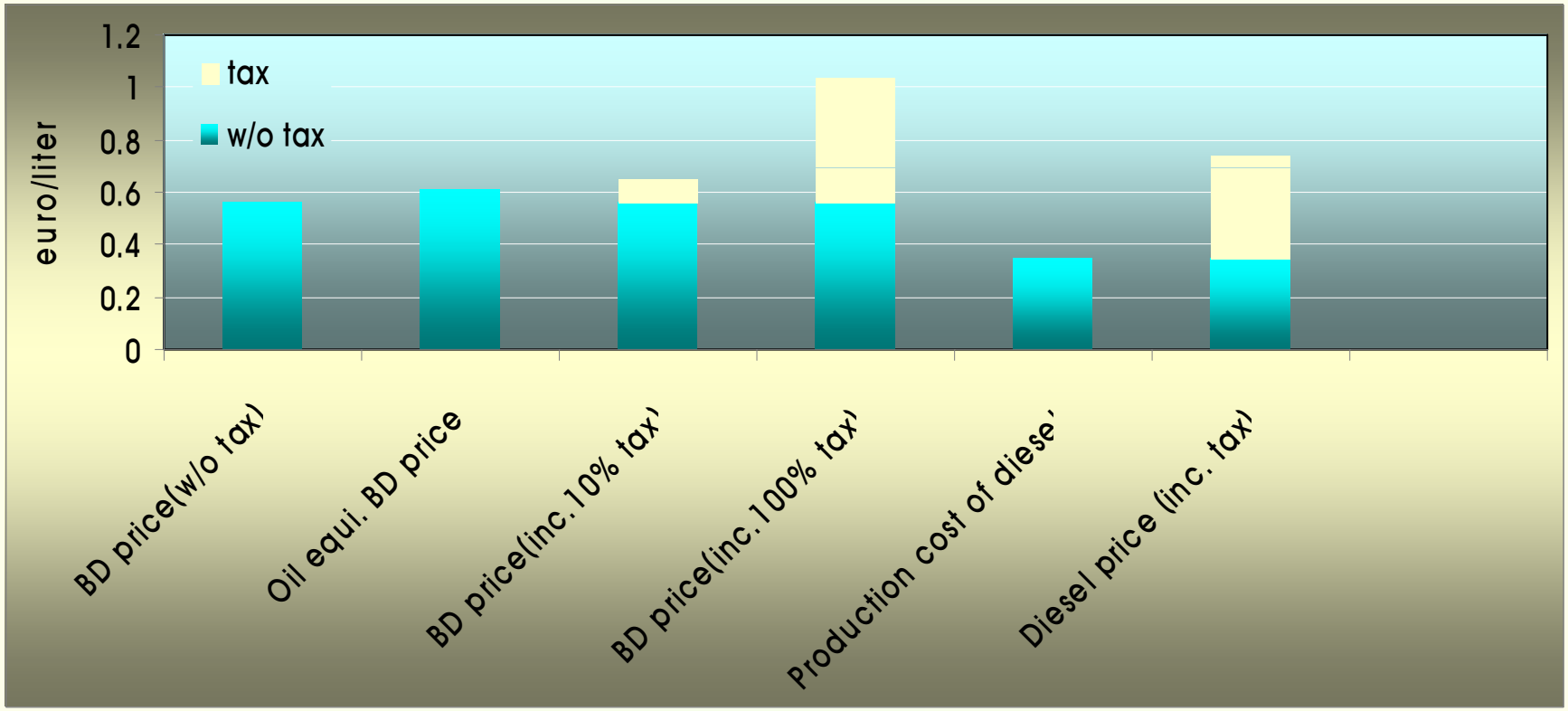
Review of Economics of Biodiesel

- **Shumaker et al.(2002)**
  - Estimation of production costs for different feedstock costs in Georgia, U.S.
  - Additional costs of diesel: $0.01~0.03 for BD2, $0.1~0.3 for BD20



Review of Economics of Biodiesel

- **Euguidanos(2002)**
  - Diesel price inc. tax(€0.393) was €0.739/liter in 2001
  - Oil equiv. BD price w/o tax was €0.606/liter and BD price with 10% tax was €0.65



Review of Economics of Biodiesel

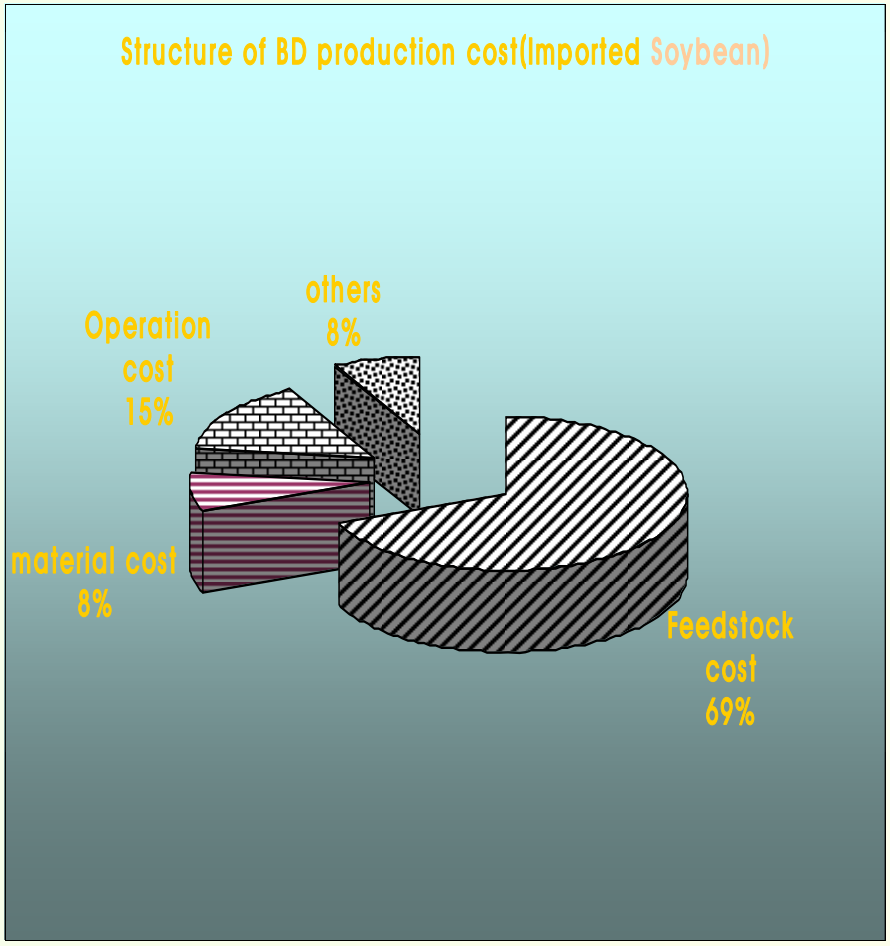
- **Radich (2004)**
  - Soybean and waste oil price estimation based on U.S. EIA were applied to calculate BD price
  - Prediction of Petroleum price was too optimistic from current point view!

Unit: $/gallon

Marketing Year	Soybean Oil	Yellow Grease	Petroleum
2004/05	2.54	1.41	0.67
2005/06	2.49	1.39	0.78
2006/07	2.47	1.38	0.77
2007/08	2.44	1.37	0.78
2008/09	2.52	1.40	0.78
2009/10	2.57	1.42	0.75
2010/11	2.67	1.47	0.76
2011/12	2.73	1.51	0.76
2012/13	2.80	1.55	0.75

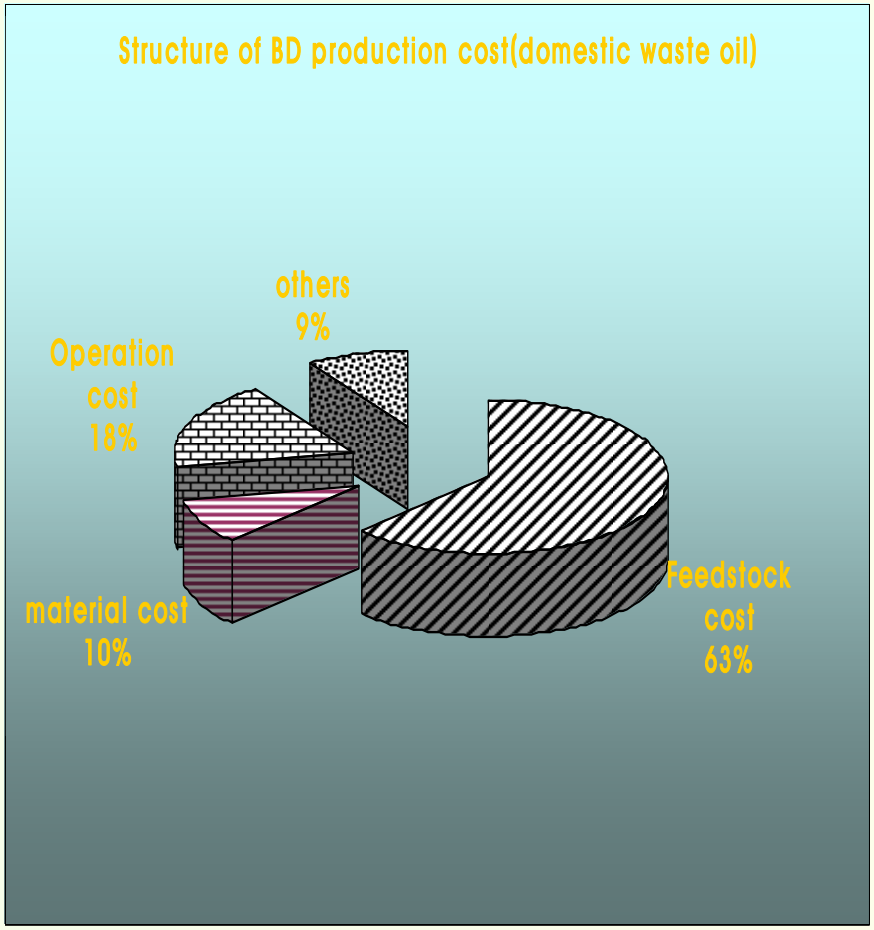
Economics of BD in Korea

- Average producer price of BD (Soybean): 987won/liter (2007.4)
- Average producer price of BD (Waste oil): 838won/liter
- Supply share of soybean–used BD: 77.3% (waste oil: 22.7%)
- Weighted average prod. cost of BD: 953won/liter
- Diesel producer price (w/o tax): 582won/liter



Structure of Production Costs of BD

- **Feedstock cost of BD**
  - Soybean: 679won/liter
  - Waste oil: 512won/liter
- **Average capital cost: 307won/liter**
  - Material cost + operation cost + others
  - Data from present BD firms (2007.4)
- **Minimum capital cost: 109won/liter**



Overview of Forecasting BD costs

- KEEI performed a study on the forecast of BD production cost for the next decade (June. 2007)
- Major Goal: determine the period of full tax exemption
- Assumption: tax exemption policy will phase out gradually as productivity and efficiency are improved in the future
  - For this purpose, promotion plan for new&renewable energy for transportation will be studied for next two years
- Necessary condition: R&D investment and support for the development of conversion tech. and productivity of feedstock

Data for forecasting the BD cost

- **Feedstock: Soybean and Palm Oil**
  - Data on Producer price, quantity of production per hectare, and farming area per capita: FAO(2007) and World Bank(2007) Database
  - Data extracted from 9 major exporting countries (117 obs. bet. 1991~2003)
- **Price of Waste Oil**
  - Assuming that it falls on about 90% of price of B/C oil
  - B/C oil price (w/o tax) data from Petroleum Information System of Korea National Oil Corporation (118 obs. bet. 1997.4~2007.4)

Statistics of Feedstock

- **Production of per hectare (Productivity)**
  - growing at 1.55% for soybean, and 0.64% for palm for 13 years
- **Farming area per capita (Scale of Economy)**
  - declining at 0.47% for soybean, and 2.1% for palm
- **Price range of soybean: $100~450/ton**
- **Price range of palm oil: $100~1,000/ton**
- **Waste oil price**
  - 162won/liter in Apr. 1997 → 427won/liter in Apr. 2007 (growing by 2.6 times)

Major Assumptions for forecasting BD costs

- **Feedstock Mix**

Soybean oil	77%
Waste oil	23%
Palm oil	0%

(2007)

Soybean oil	20%
Waste oil	20%
Palm oil	60%

(2017)

- **Biodiesel Conversion Cost**
  - No tech. progress: average capital cost (307won/L)
  - Tech. progress: minimum capital cost(109won/L)

Scenario and Sensitivity Analysis

•Scenario Design (no revenue from byproduct)

Type	Average capital cost	Minimum capital cost
Decreasing farming area per capita	scenario I	scenario II
Constant farming area per capita	scenario III	scenario IV

•Sensitivity Analysis (revenue from byproduct)

byproduct revenue	unit: won/liter
sales income of Glycerin	21.45
Revenue of feedstock residuals	30.80
Total	52.25

Regression Model for Soybean&Palm

- General production cost function for agri. feedstock: translog cost function
- Indep. Variable: year, log of yield per hectare (LYPH), log of hectare per person (LHPP)
- Data: 9 major export countries from FAO and WB bet. 1991~2003
- Regression formula

$$\ln PRI_{it}^{j} = \beta_0 + \beta_1 Year_t^{j} + \beta_2 LYPH_{it}^{j} + \beta_3 LHPP_{it}^{j} + u_{it}^{j}$$

Regression Results for Soybean and Palm Oil

Soybean

Variable	Coefficients	t–value
Constant	9.6629	0.754
YEAR	−0.0006	−0.092
LYPH	−0.4400	−4.412
LHPP	−0.0953	−2.344

Palm oil

Variable	Coefficients	t–value
Constant	−19.3259	−0.49
YEAR	0.0166	0.843
LYPH	−0.9538	−6.463
LHPP	−0.4008	−2.386

Regression Model for Waste Oil

- Price of waste oil and price of B/C oil moves together
- Data: 90% of B/C oil price bet. July. 1997 ~ April. 2007
- Cochrane–Orcutt method with AR(1) applied
- Dependent Var.: price of waste oil ($PRI_{wo,t}$)
- Indep. Var.: Month and ρ (autocorrelation coefficient)
- Regression Formula

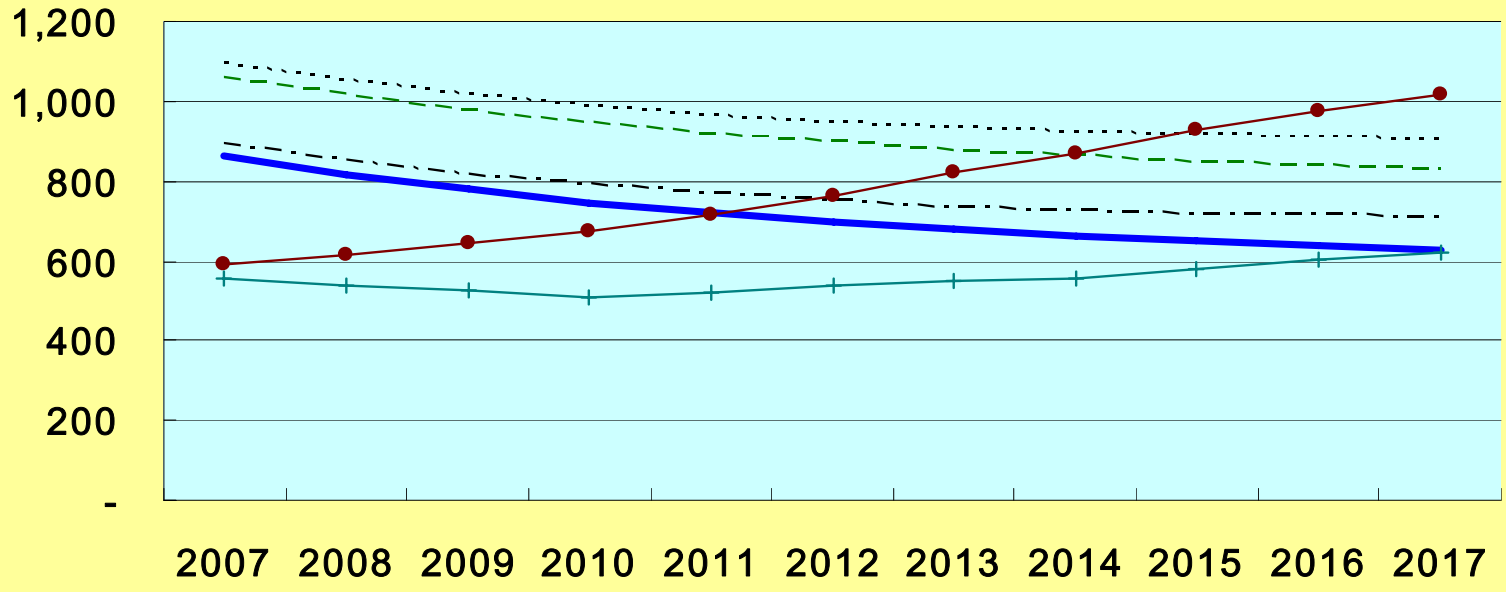
$$(PRI_{wo,t} - \rho PRI_{wo,t-1}) = \beta_0(1-\rho) + \beta_1(Month_{wo,t} - \rho Month_{wo,t-1}) + (u_t - \rho u_{t-1})$$

Regression Result for waste oil

Variable	Coefficient	Standard Error	b/St.Er.	|P[|Z|>z]
Constant	198.188	30.613	6.474	0.000
MONTH	1.931	0.410	4.705	0.000
RHO	0.867	0.046	18.831	0.000

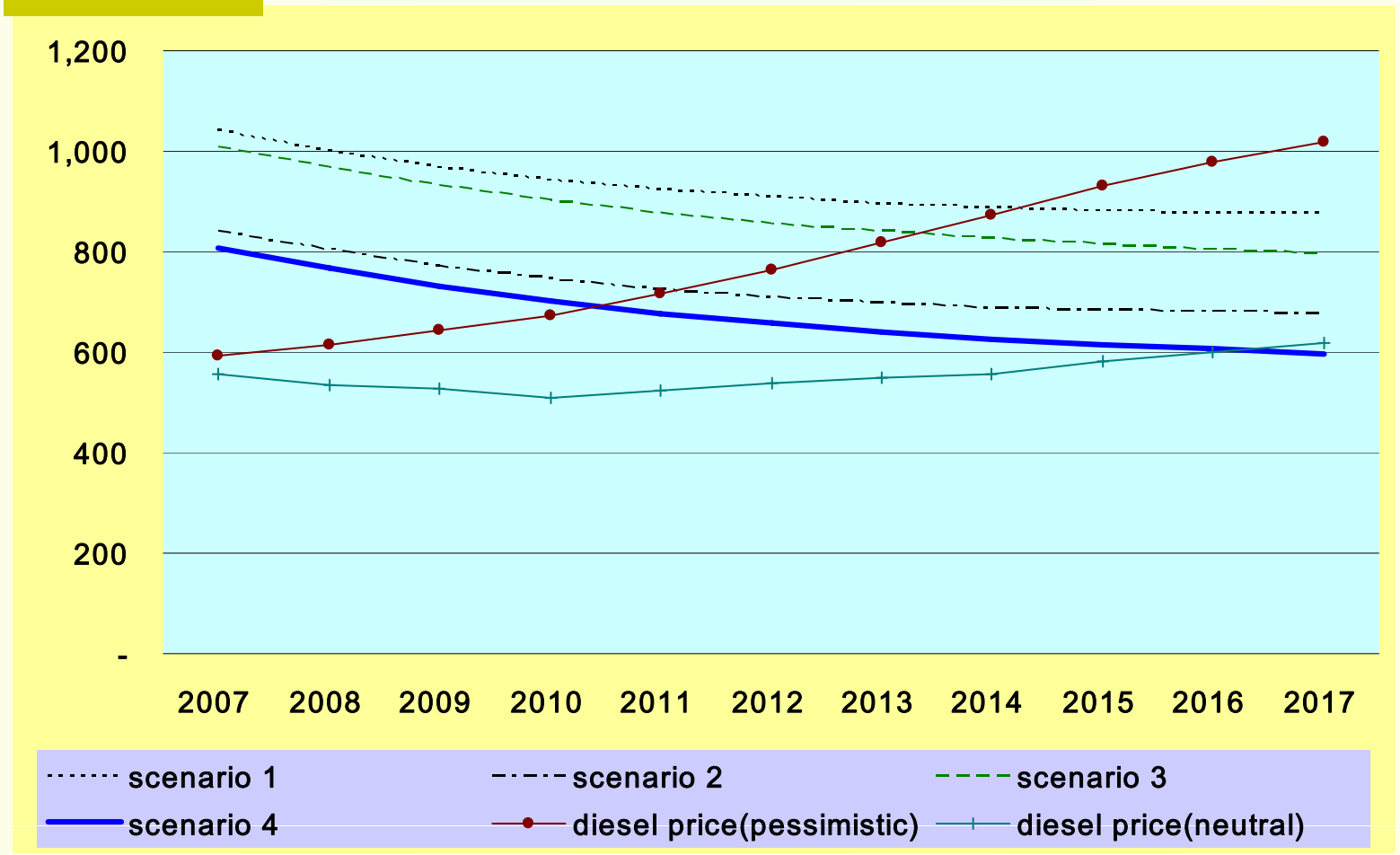
Price Comparison of Biodiesel & Diesel before tax

won/liter



Sensitivity Analysis

won/liter



Implication of BD Price Forecasting on the Government Promotion Policy on BD

- **The analysis shows that BD will be comparable with conventional diesel bet. 2011 and 2015 w/o gov. support policy**
  - However, it depends on strong assumptions such as improvement of productivity and pessimistic prediction on petroleum price for the next decade
  - Besides, production side was only considered until 2003, so sharp increases in demand side will affect considerably!
- **Full tax exemption bet. 2007~2010**
  - Confirmed in Sep.7.2007 through a coordinating meeting for economic policy among five ministries
- **70% tax exemption bet. 2011~2015**
- **Value-added tax exemption after 2016**
  - Total gov. subsidy for the next decade will be about 1.8 trillion won($

Annual BD Production and Tax Exemption Plan

Year	Share of BD in total diesel cons.(%)	Production of BD (kL)	Size of Tax Exemption (100 million won)
2008	1.0	188,765	938
2009	1.5	294,980	1,465
2010	2.0	407,819	2,026
2011	2.5	516,326	1,812
2012	3.0	631,118	2,215
2013	3.5	750,003	2,633
2014	4.0	873,093	3,065
2015	4.5	998,549	1,078
2016	5.0	1,135,041	1,225
2017	5.5	1,273,516	1,374
Total	–	3,662,103	17,830

Final Remarks I

- **Feedstock Supply Mix Stratergy**

Import	77%
Domestic Supply (Waste Oil)	23%
Direct Investment on Plantation	0%

(2007)

Import	50%
Domestic Supply	Waste Oil (25%)
	Rapeseed(5%)
Direct Investment on Plantation	20%

(2012)

- **We need to set this goal and gov. as well as private sector should cooperate to achieve it!**

Final Remarks II

- Development of tech. and sources for the utilization of various feedstock (e.g. Jatropha, Palm, Castor, Rapeseed, Biomass)
- Conversion from tax exemption policy to market–oriented policy
- Policy research on the intro. of RFS(Renewable Fuel Standard)
- More R&D investment on the dev. of second generation biofuels
- Suggestion of free trading among APEC including Latin America countries with regard to feedstock for biofuels