



# TRB Session 512: Global Trends and Environmental Effects of Biofuels Part 1

15 January 2008

## Biofuels – 2007 trends and developments

Lew Fulton

International Energy Agency, Paris

[LEW.FULTON@IEA.ORG](mailto:LEW.FULTON@IEA.ORG) [WWW.IEA.ORG](http://WWW.IEA.ORG)



# Biofuels: what happened during 2007...

- World ethanol and biodiesel production hit new highs
  - ◆ US beginning to outpace Brazil on ethanol production
- Feedstock prices soared
  - ◆ Corn, wheat, soy, rapeseed and palm oil approached record highs in key markets
  - ◆ Food v. fuel debate intensified
- Ethanol, biodiesel prices fell in many markets
- Policy developments tended to continue push for more, with some notable exceptions
- A few tepid steps toward sustainability



# Highlights: North America

- US now has 134 fuel ethanol plants with 66 under construction, production to reach 9 bln gallons (34 bln litres) in 2008
- Congress passed EISA
  - ◆ Requires 36 billion gallons (136 billion litres) of biofuels by 2022, expected to be largely ethanol
  - ◆ More than 4 times current US levels
  - ◆ Starting in 2016 some must be “advanced biofuels” reaching 21 billion gallons by 2022
- California: low carbon fuel standard to cut average fuel CO<sub>2</sub> by 10% by 2020 may trigger substantial increases in biofuels use
- Canada beginning to move, likely to reach 1 billion litres by 2008, 2 bil by 2010
  - ◆ Also looking at national blending requirements up to 5%



# Highlights: Europe

- **European Commission looking to require oil industry to cut GHG emissions**
- **Updated renewables directive end of January**
  - ◆ Discussion of 6.5% target by 2012 on way to 10% by 2020
  - ◆ Sustainability criteria likely
- **Biodiesel profitability squeezed due to glut**
  - ◆ Biodiesel overcapacity problems
  - ◆ Loophole resulted in import of 1 mln tonnes of US biodiesel
  - ◆ Palm oil imports cut by 20% during the year
- **Germany – cutting subsidies (increasing biofuels taxes)**
  - ◆ 9 Eurocents from Aug 2006, up to 45 cents by 2012



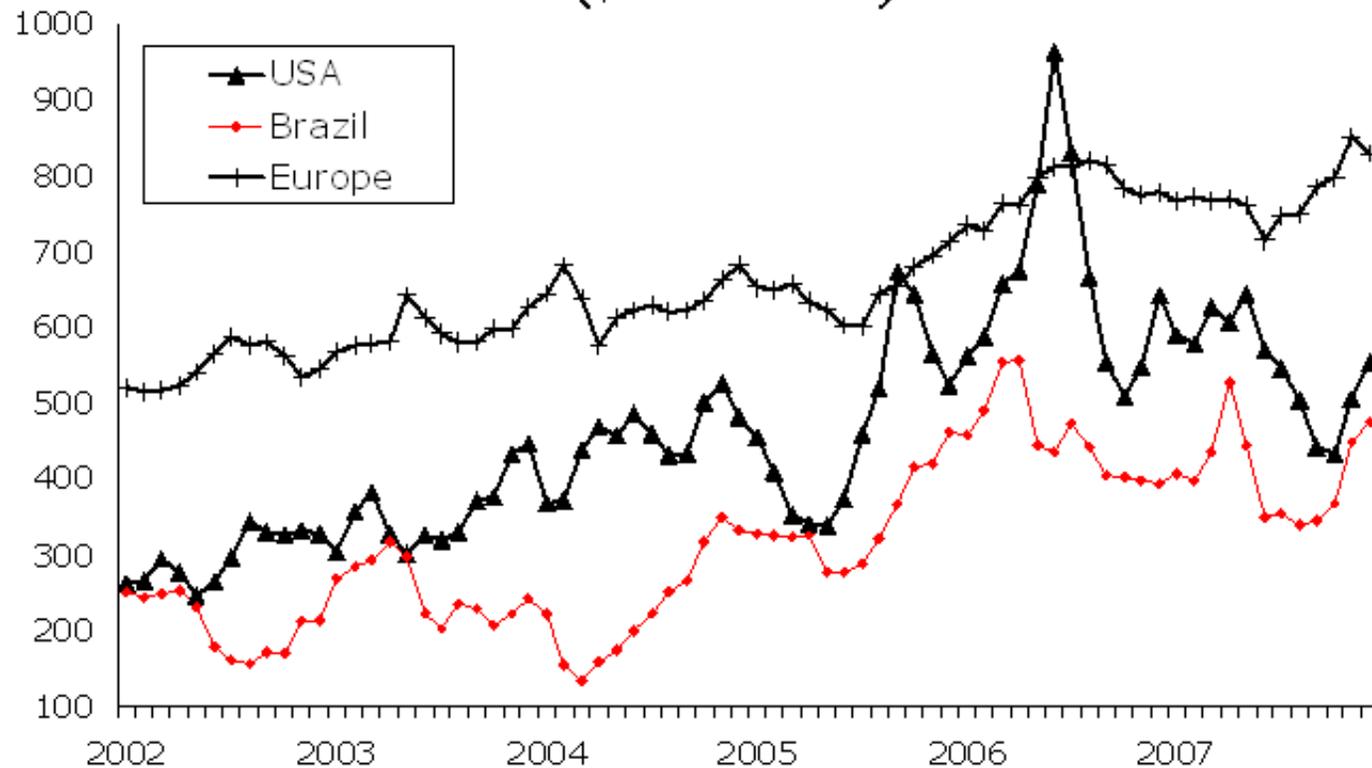
## Elsewhere in the World

- Brazil, India, bumper sugar crop – sugar prices have dropped by 13%
  - ◆ Brazilian domestic ethanol demand keeps rising
  - ◆ India quickly implemented a 5% blending requirement during 2007, moving to 10% in 2008
- Thailand moving to E-20 in early 2008
- S.Africa going to 2% by 2013, no maize
- Bali COP: biofuels not included in WTO “green goods” list



# World - Fuel Ethanol Prices

(\$/cubic metre)



Source: F.O. Lichts



## Reference international commodity prices for sugar, maize and wheat, 2005-2007

Commodity	Average price for 2005 (USD/tonne)	Peak price since May 2005 (USD/tonne and week ending)	Average price, for 2007 (USD/tonne)	Percentage change, nominal terms, avg. 2005 to mid-May 2007
Sugar <sup>1</sup>	\$218	\$406 (03.02.06)	\$222	2%
Maize <sup>2</sup>	\$109	\$203 (23.02.07)	\$164	50%
Wheat <sup>3</sup>	\$150	\$353 (21.12.07)	\$235	57%

1. Based on weekly averages of International Sugar Organization (ISO) daily price, expressed in US cents per pound.

2. US No.2, Yellow, price at U.S. Gulf ports (Friday quotations), expressed in USD per short ton.

3. US No.2, Soft Red Winter Wheat, price at U.S. Gulf ports (Tuesday quotations).

Source: Data from Food and Agricultural Organization of the United Nations, "International Commodity Prices" website ([www.fao.org/es/esc/prices](http://www.fao.org/es/esc/prices)), accessed on 9 September 2007.

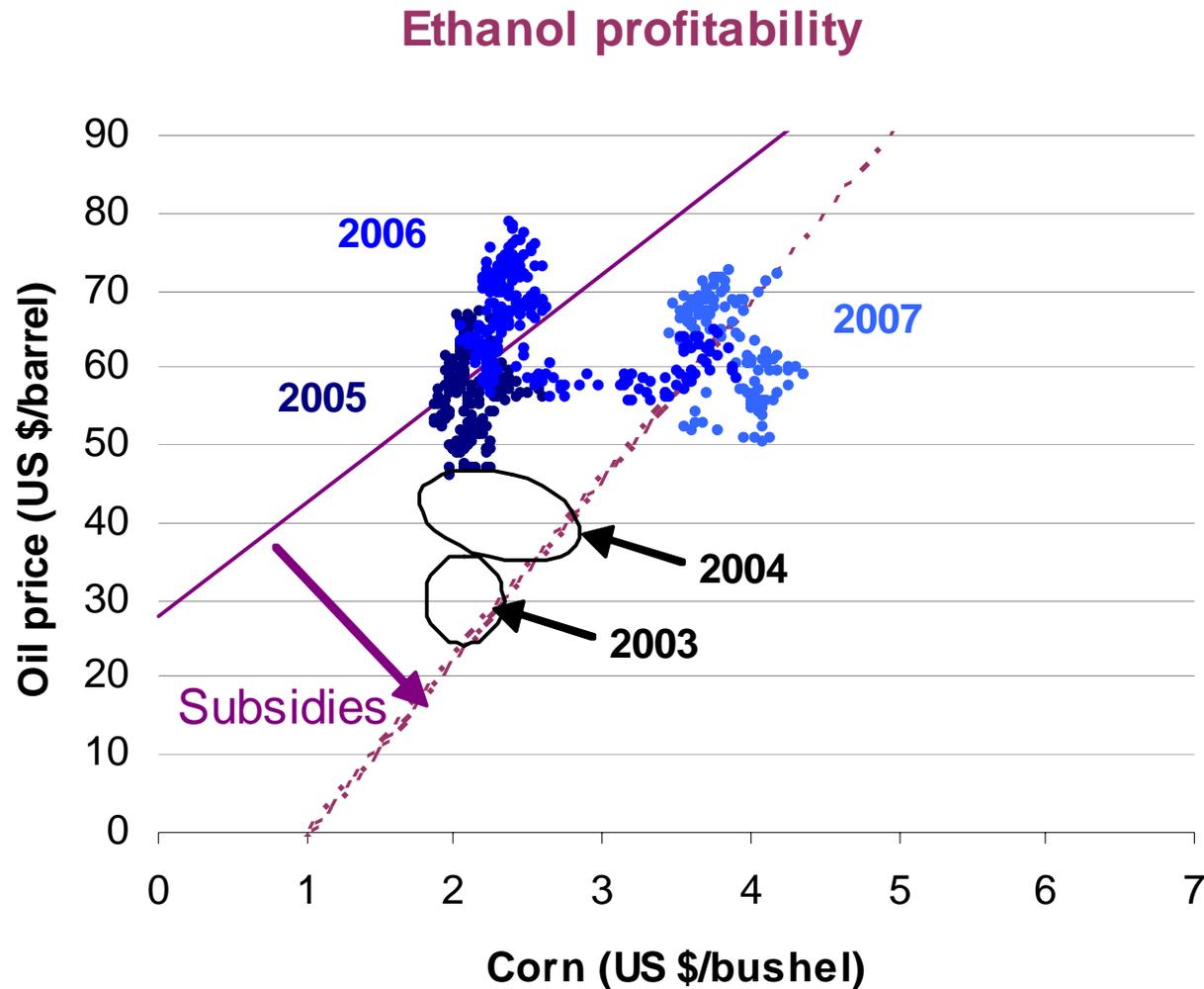
Source: GSI Global Subsidies Initiative

INTERNATIONAL ENERGY AGENCY

AGENCE INTERNATIONALE DE L'ENERGIE

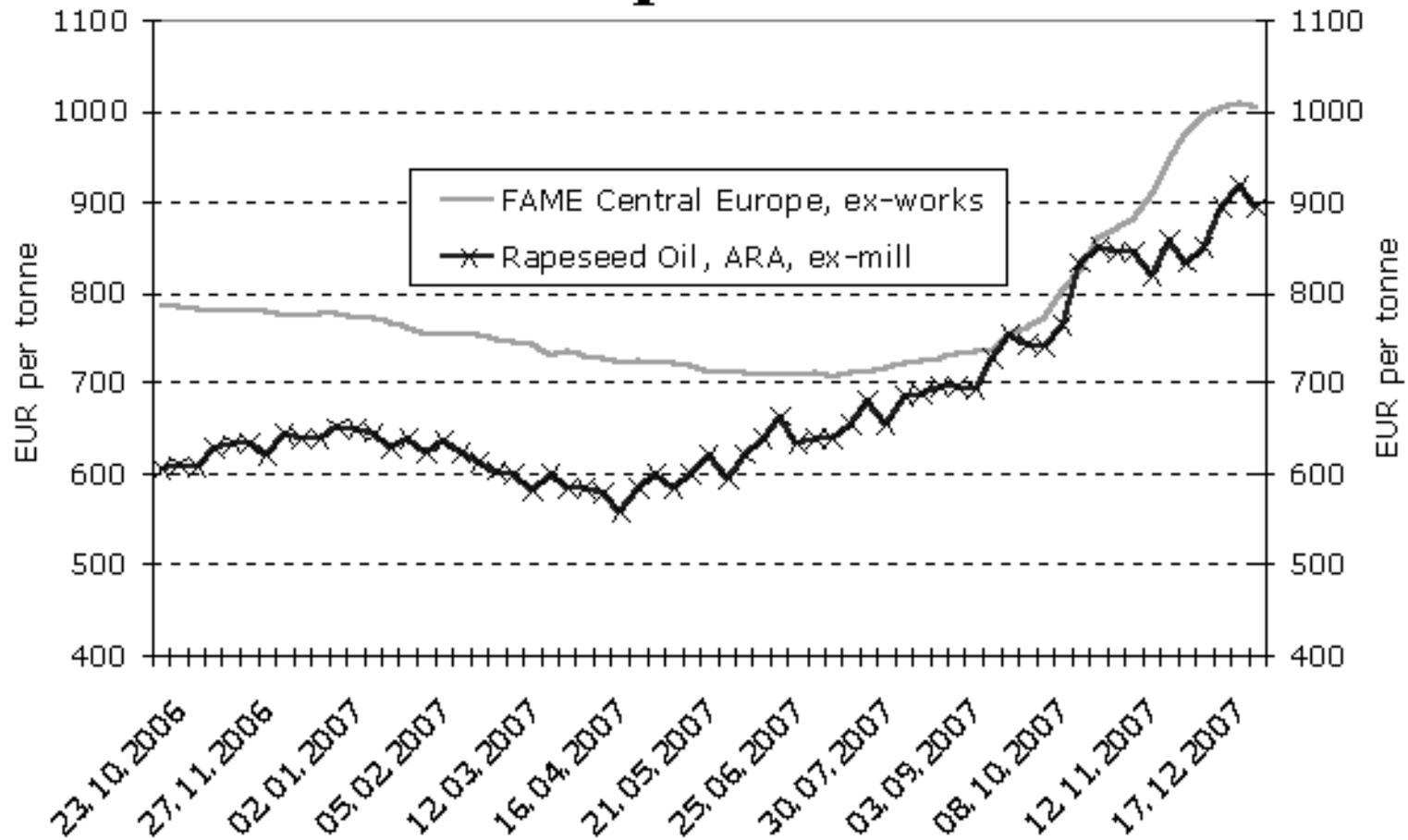


# US corn ethanol developments





## Central Europe - Prices for FAME and Rapeseed Oil



Source: F.O. Lights



## Reference international commodity prices for rapeseed oil, soybean oil and crude palm oil, 2005-2007

Commodity	Average price for 2005 (USD/tonne)	Peak price since May 2005 (USD/tonne and month)	Average price for 2007 (USD/tonne)	Percentage change, nominal terms, 2005 avg. to 2007 avg.
Rapeseed oil <sup>1</sup>	\$669	\$1273 ( <i>Nov 07</i> )	\$931	<b>39%</b>
Soybean oil <sup>2</sup>	\$545	\$1138 ( <i>Nov 07</i> )	\$856	<b>57%</b>
Crude palm oil <sup>3</sup>	\$422	\$952 ( <i>Nov 07</i> )	\$765	<b>81%</b>

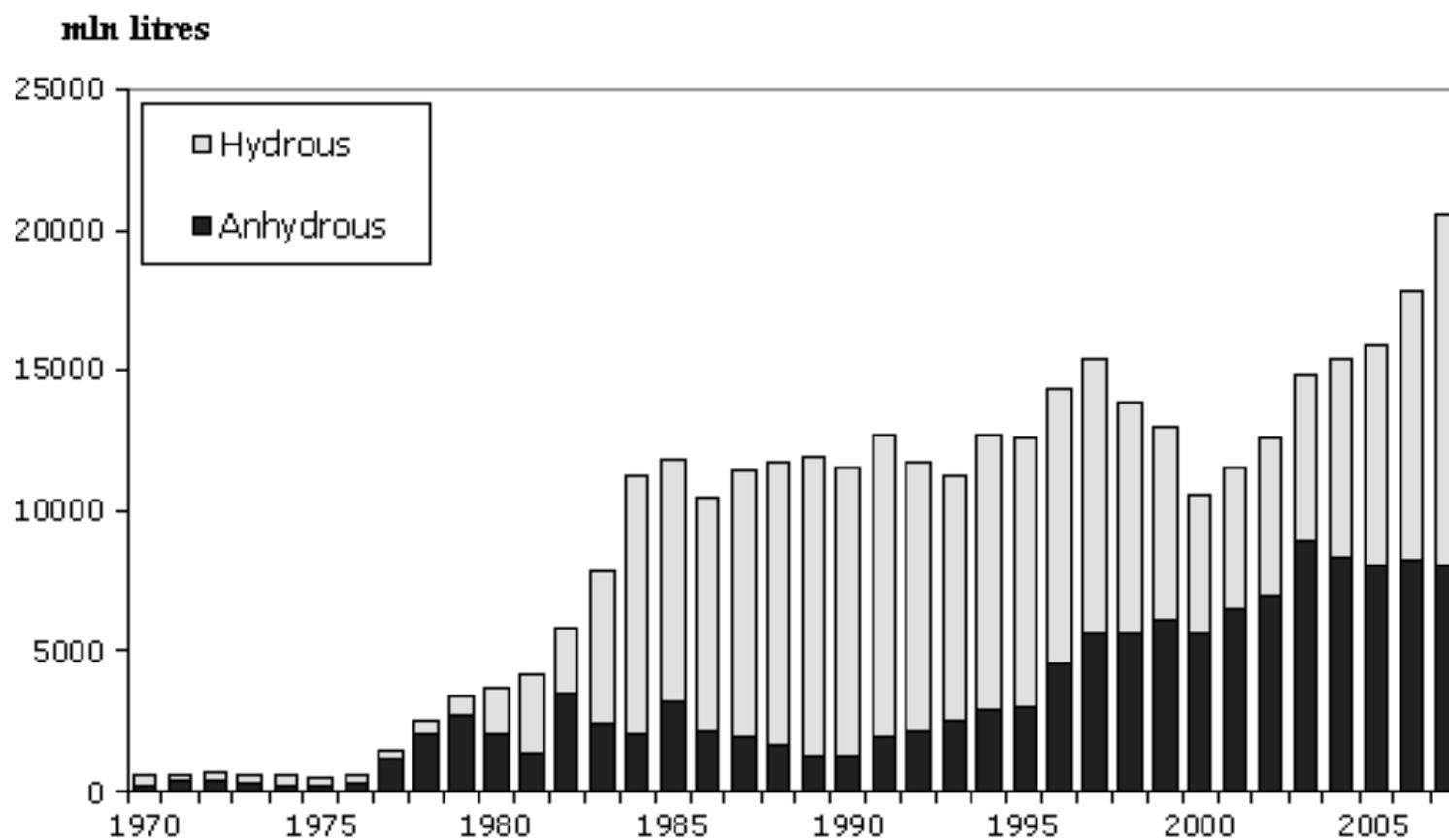
1. Monthly averages of ex-mill price (f.o.b.), Netherlands.
2. Monthly averages of ex-mill price (f.o.b.), Netherlands.
3. Monthly averages of import price (c.i.f.), north-west Europe.

*Source:* Data from Food and Agricultural Organization of the United Nations, "International Commodity Prices" website ([www.fao.org/es/esc/prices](http://www.fao.org/es/esc/prices)), accessed on 13 January 2008.

**Source: GSI Global Subsidies Initiative**

# Brazil - Ethanol Production

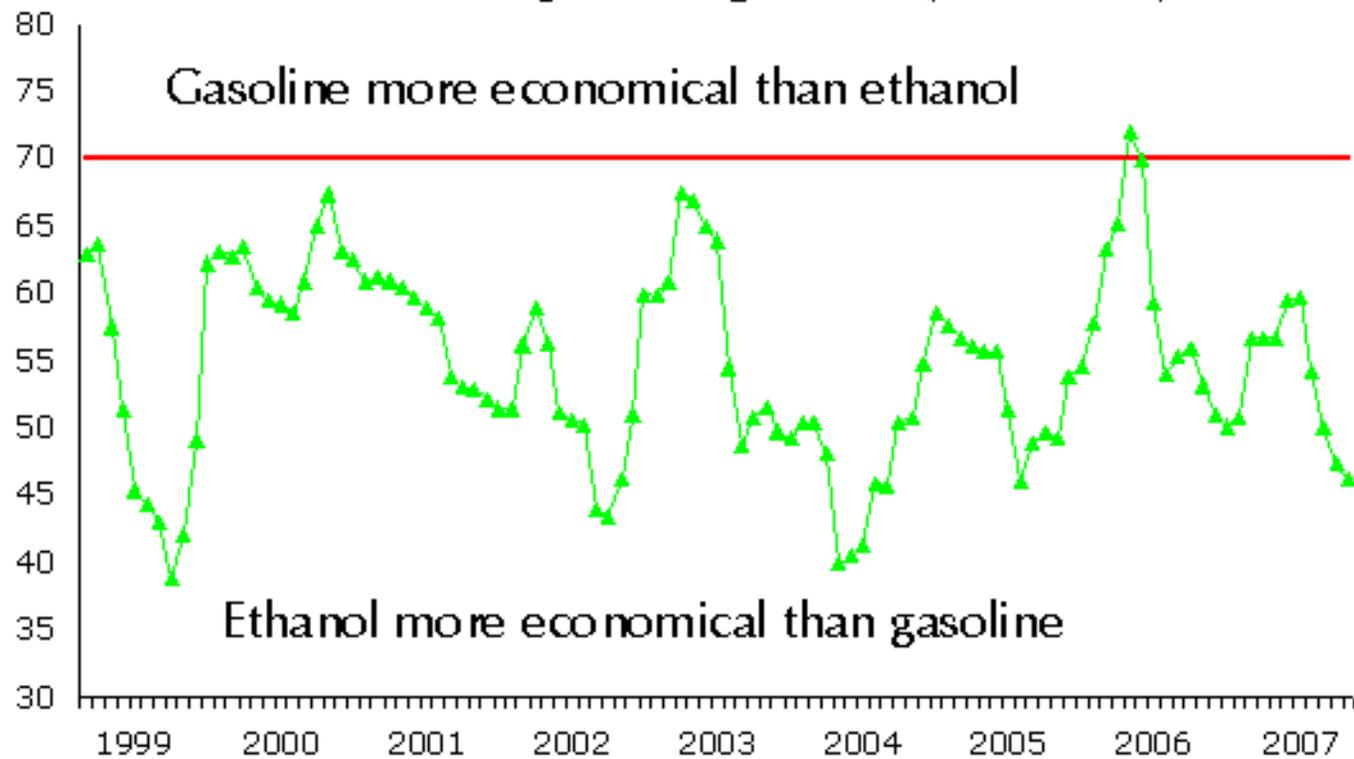
## by type



Source: F.O. Lichts



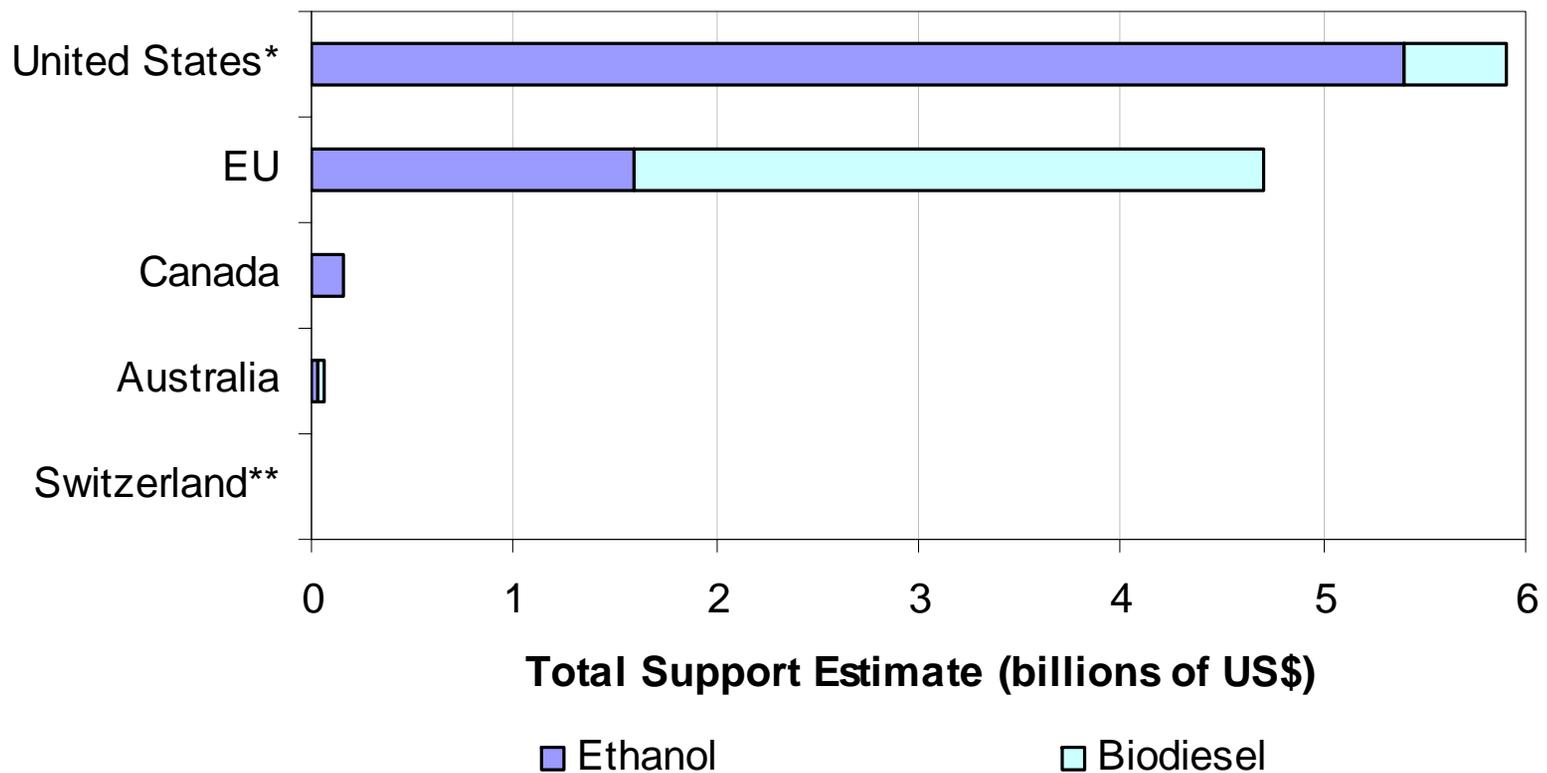
## Brazil - Fuel Ethanol Price in % of the price of gasoline (Sao Paulo)



Source: F.O. Lichts



# Total Support Estimates for Biofuels, Selected OECD Countries



Source: GSI Global Subsidies Initiative



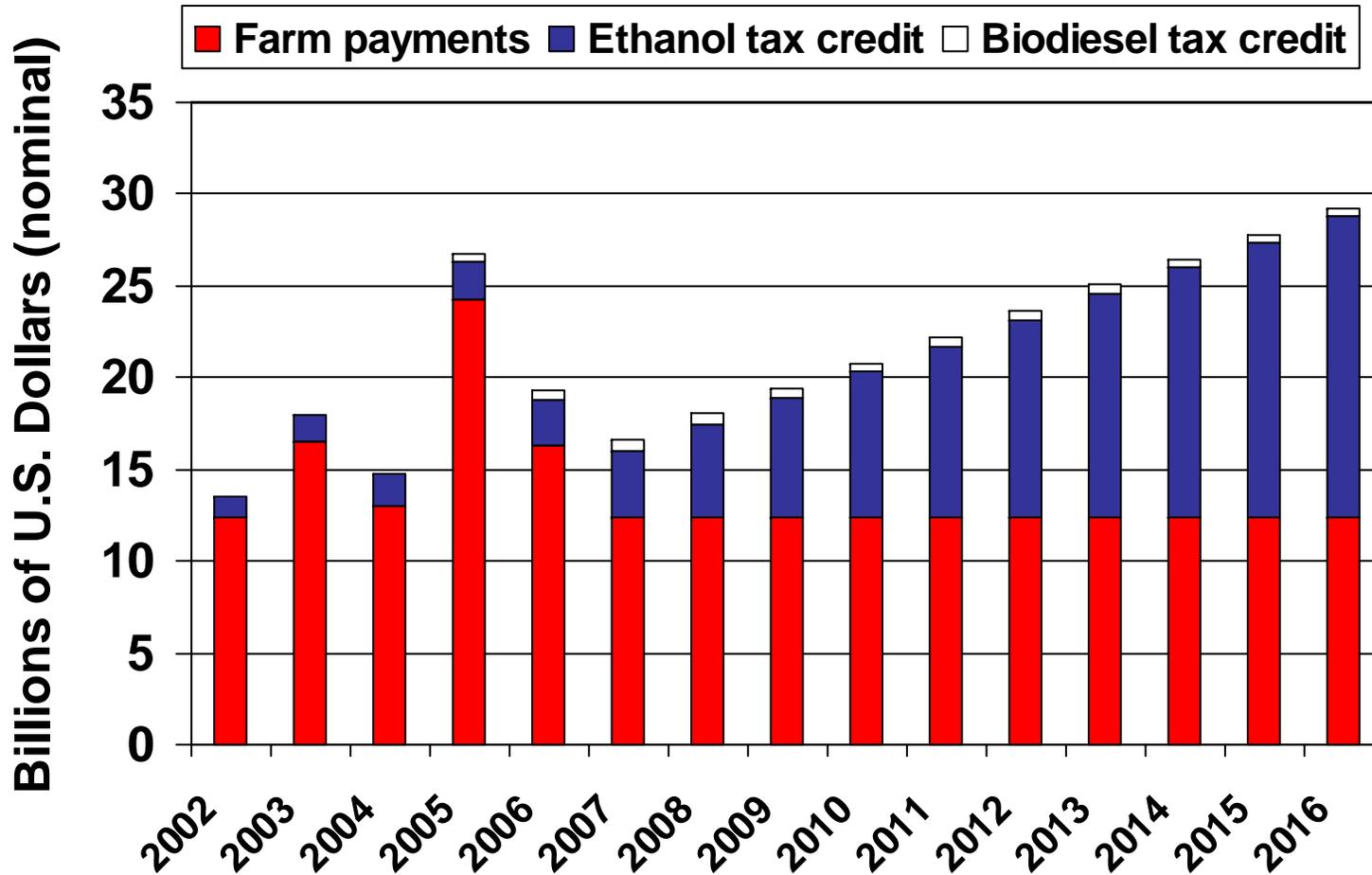
# Support rates in 2006

OECD economy	Ethanol		Biodiesel		Comment
	Average	Variable	Average	Variable	
United States	0.29 – 0.36	Federal: 0.15 States: 0 – 0.11	0.54 – 0.67	Federal: 0.26 States: 0 – 0.26	No limit on VEETC or VBETC; some state payments are budget-limited.
EU <sup>2</sup>	1.00	1.00	0.70	0.70	Situation varies widely by member state
Canada	0.40	Federal: up to 0.10 Provinces: 0 – 0.10	0.20	Federal: up to 0.20 Provinces: 0 – 0.20	Total federal payments and most provincial payments are budget-limited. Several are scheduled to decline.
Australia	0.40	0.30	0.40	0.30	Not budget-limited.
Switzerland <sup>3</sup>	0.60	0.60	1.00	0.60 – 2.00	Through end-2007, excise tax concessions limited to national total of 20 million litres per annum.

Source: GSI Global Subsidies Initiative



# Total of farm payments and biofuel subsidies in the United States: 2002-2016



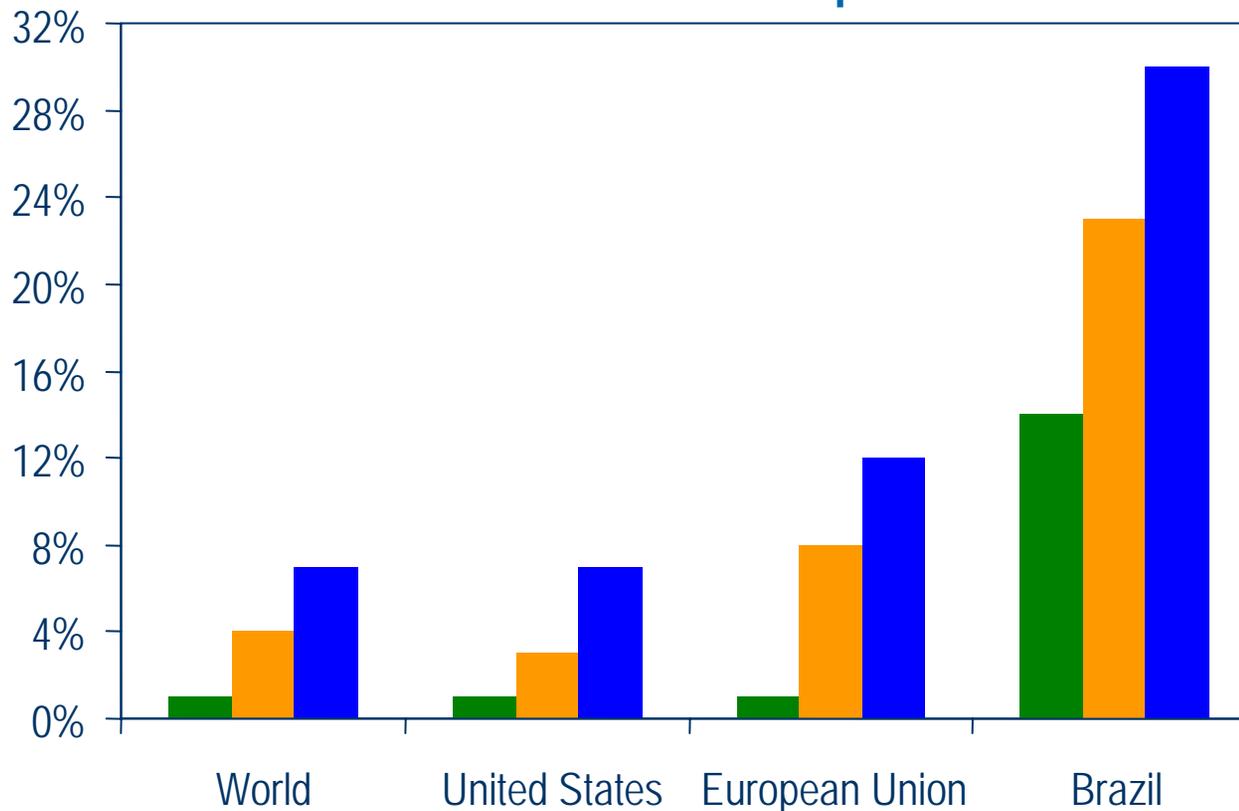
Source: GSI Global Subsidies Initiative



# IEA WEO 2006: Outlook for Biofuels

*1<sup>st</sup> generation biofuels are expected to play a larger role in meeting world road-transport fuel demand*

Share of Biofuels in Road-Transport Fuel Demand

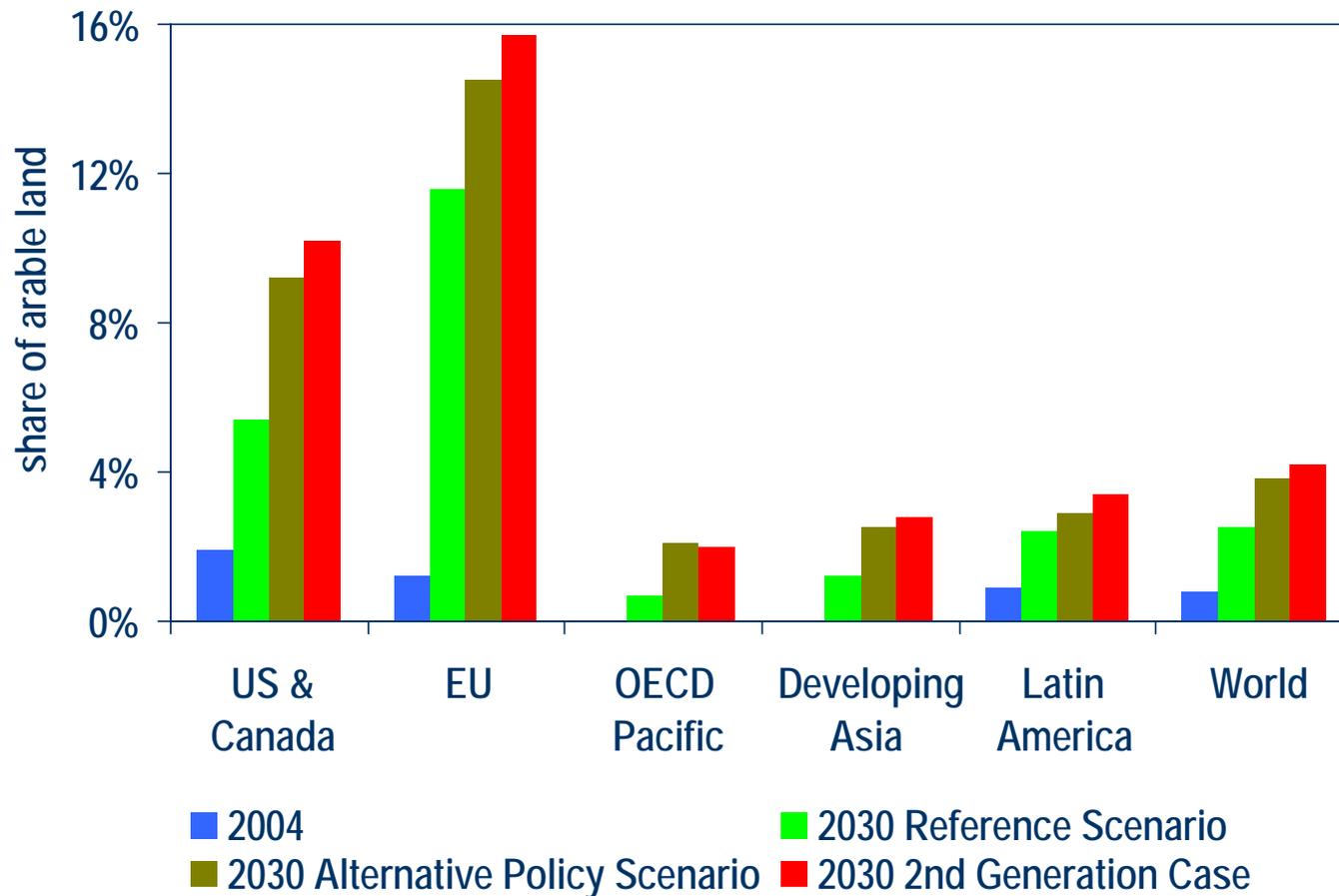


Source: IEA  
World Energy  
Outlook 2006

■ 2004 ■ 2030 Reference Scenario ■ 2030 Alternative Policy Scenario



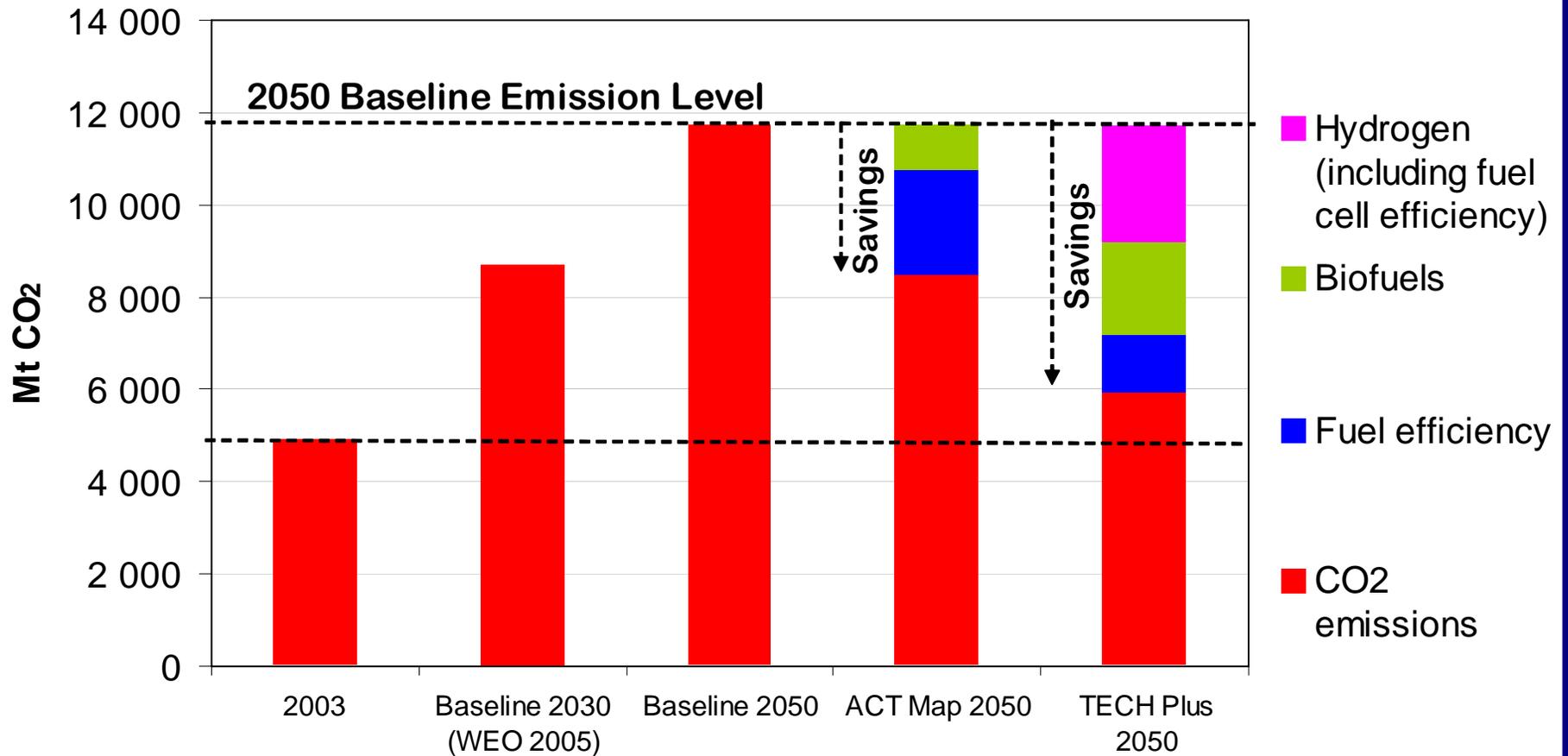
# Land Requirements for Biofuels in WEO Scenarios



*A significant proportion of the world's arable land is turned over to biofuels production – even in the Reference Scenario*



# World Transport CO<sub>2</sub> Emissions, BAU Case to 2050, IEA/ETP2006



Source: IEA Energy Technology Perspectives, 2006 Ed.



# A typology of liquid biofuels

Fuel	Feedstock	Regions where currently produced	GHG reduction impacts v. petroleum fuel	Costs	Biofuels yield per hectare of land	Land types
Ethanol	Grains (wheat, maize)	US, Europe, China	low-moderate	moderate	moderate	croplands
Ethanol	Sugar cane	Brazil, India, Thailand	high	low	high	croplands
2 <sup>nd</sup> Gen Ethanol	biomass (cellulose)	none	high	high	high	croplands, marginal lands
Biodiesel (FAME)	oil seeds (rape, soy)	US, Europe	moderate	moderate	low	croplands
Biodiesel (FAME)	Palm oil	Southeast Asia	moderate	low-moderate	Moderate-high	coastal lands
2 <sup>nd</sup> Gen Biodiesel (BTL)	Any biomass (via F-T)	none	high	high	high	croplands, marginal lands



## 2<sup>nd</sup> Generation Biofuels: Ligno-cellulosic ethanol

- Progress, but still challenges ahead
  - ◆ Effectiveness of pretreatment
  - ◆ Enzyme cost and effectiveness
  - ◆ Process overall efficiency
  - ◆ Production of (valuable) co-products
- Costs still are well above starch-ethanol costs
- There are at least 12 pilot cellulosic ethanol (and biorefinery) plants around the world
  - ◆ DOE has invested in 6 new plants in the US, combined capacity on order of 100 mil gallons
  - ◆ Canada has budgeted \$500m for investment in large-scale facilities



## 2<sup>nd</sup> Generation - BTL

- Biomass-to-liquids can be almost any type of biomass, gasified, and F-T process to achieve hydrocarbon fuel
- Intensive RD&D especially in Germany
- Progress, but still issues
  - ◆ Feedstock handling, combustion
  - ◆ Synthesis gas clean-up
  - ◆ Scale related issues
  - ◆ Costs still well above grain ethanol
  - ◆ Possibility to co-fire with fossil (e.g. coal) as a transition strategy



# Conclusions

- **Global biofuels use growing very rapidly...**
  - ◆ Policy drivers and oil prices
  - ◆ Already appear to be having impacts on feedstock prices
- **But unclear if policy trends will continue**
  - ◆ Caution the new watchword
- **Production still dominated by grains and oil seeds**
  - ◆ Low yields, sustainability concerns
  - ◆ Much more work needed to understand food, land use change impacts
- **2<sup>nd</sup> generation biofuels to the rescue?**
  - ◆ Hard to say when they will really emerge
  - ◆ Even these approaches will require land, though much less per unit energy, perhaps less competition with food production