Kiel Institute
for the World Economy

Food vs. Fuel
The Role of Biofuels in Climate Policy

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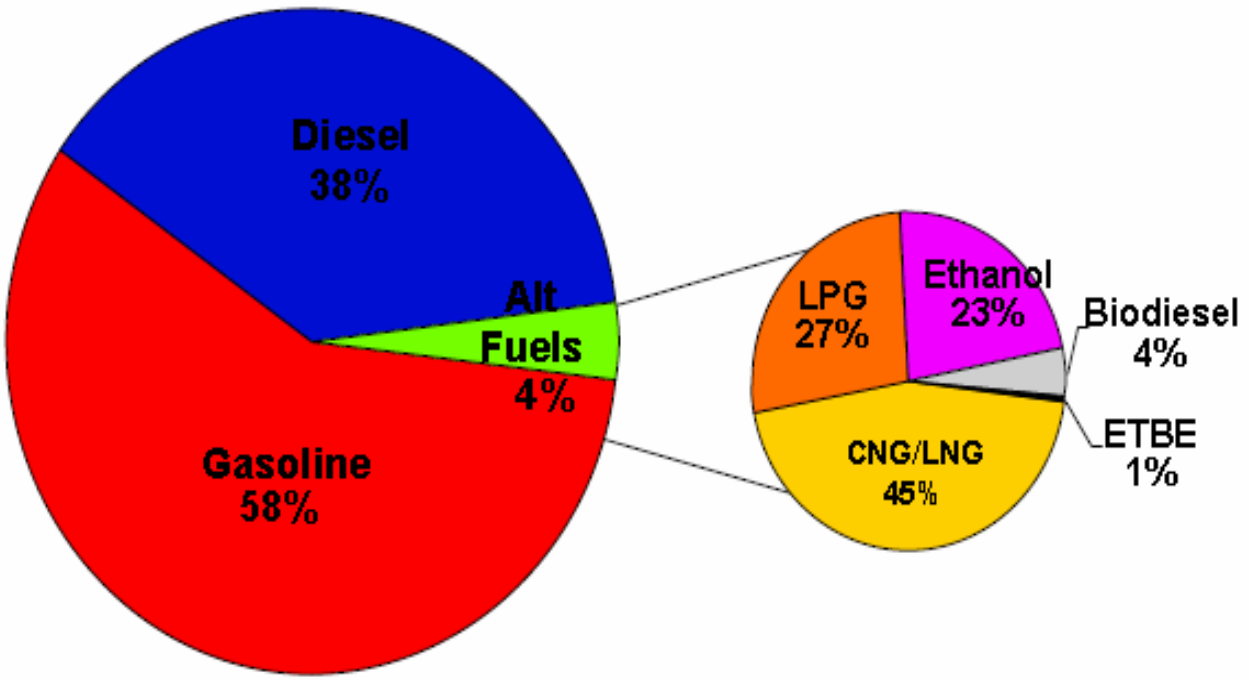
Outline

- The World Biofuel Market
- Policy Objectives and Economic Perspectives
- GHG-Balances and MACs for Biofuels
- Food vs. Fuel
- Open Questions:
  - How much Biomass is available at what cost?
  - Modelling land use conflicts
  - Biomass Certification

World Transport Fuel Demand (2005)

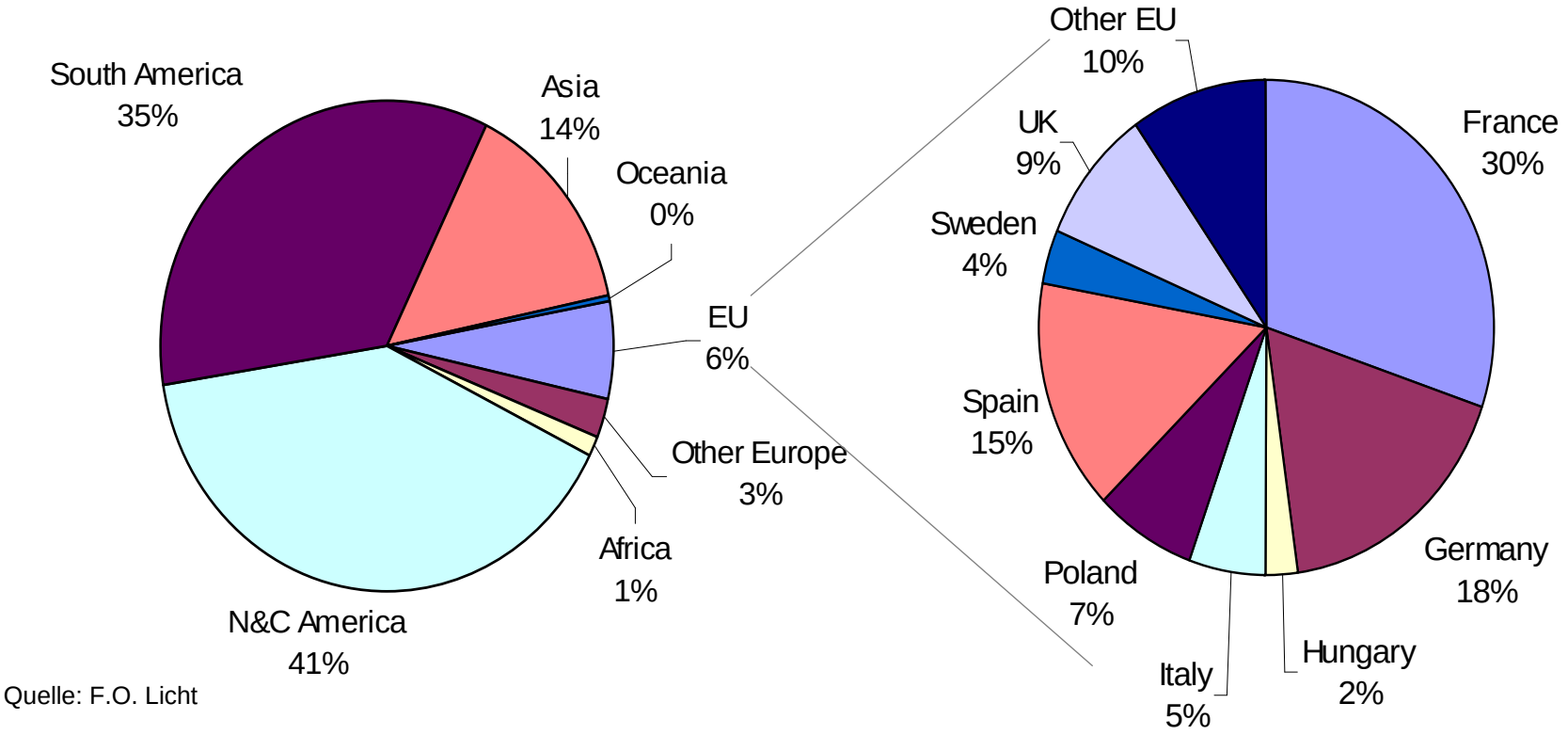


Source: Hart's World Refining and Fuels Service, 2006

Alternative fuels amount to 4% of global fuel consumption,

The share of Biofuels is 1%

Bioethanol Production (World 2005)

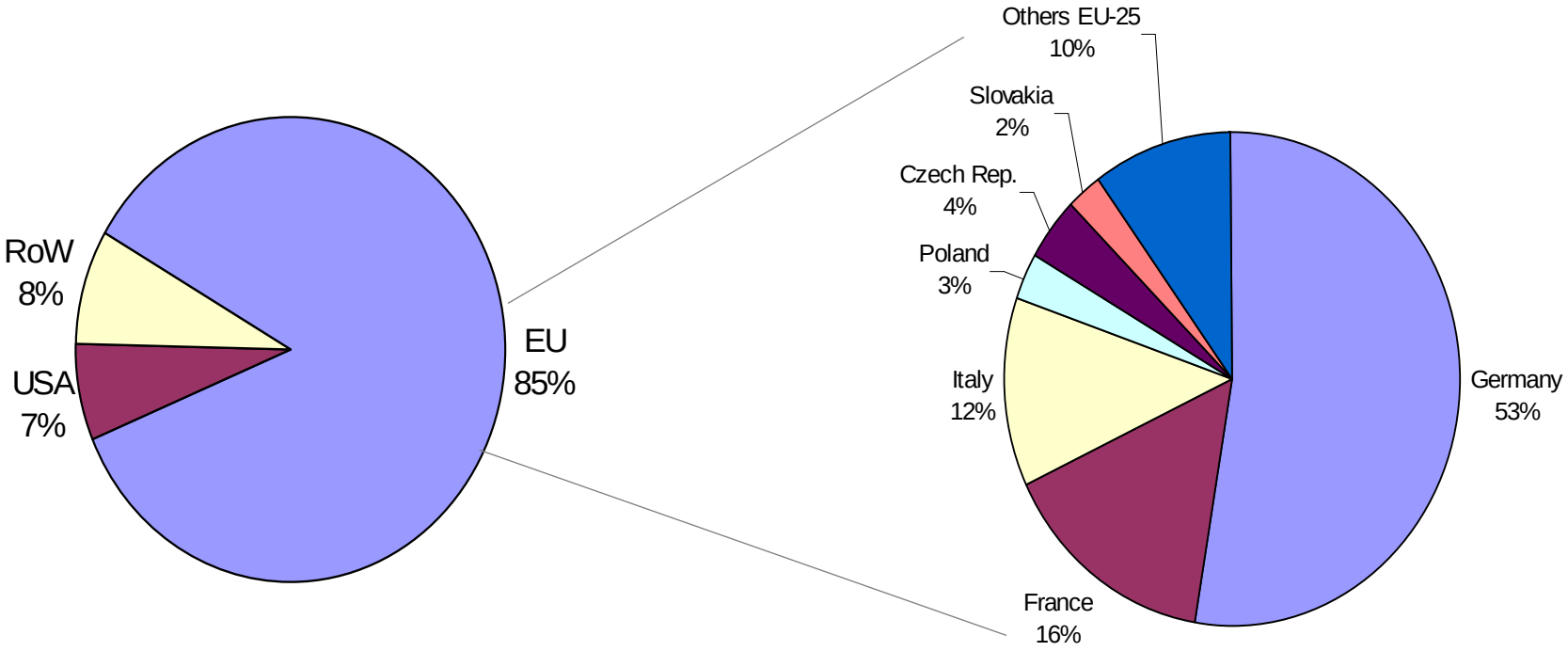


Quelle: F.O. Licht

45 Mio. m³ Ethanol were produced in 2005 , in 2006 50 Mio. m³ are expected

Only about 2,7 Mio. m³ were produced 2005 in the EU, for 2006 3,1 Mio. m³ are expected

Production of Biodiesel (World 2005)



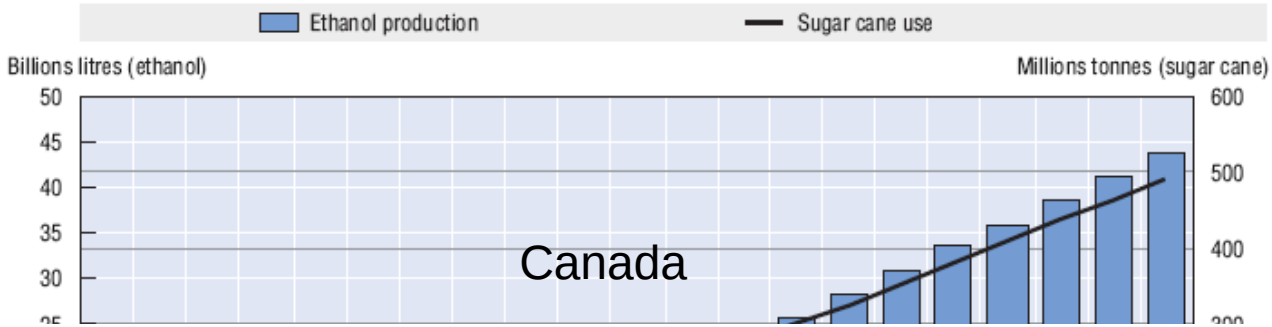
Quelle: Diester Industrie International/ EBB

Worldwide Biodiesel production is 3,8 Mio. t in 2005

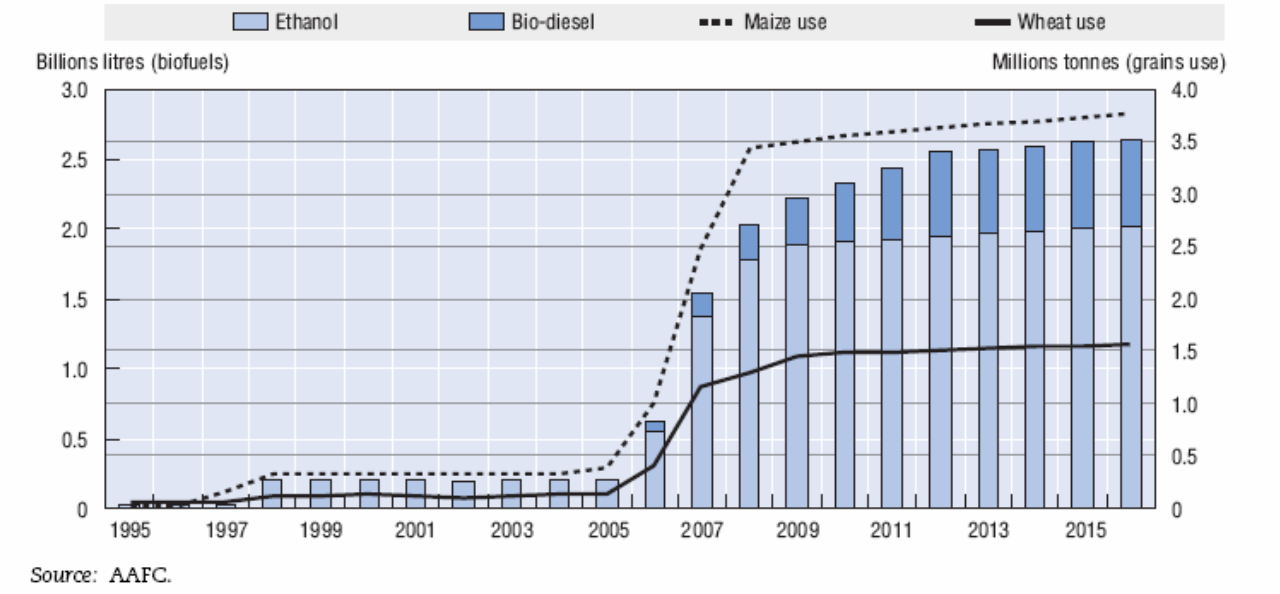
Of which 3,2 Mio. t are produced in the EU, more than half of it in Germany

OECD-FAO Forecast for Ethanol Production

Brazil

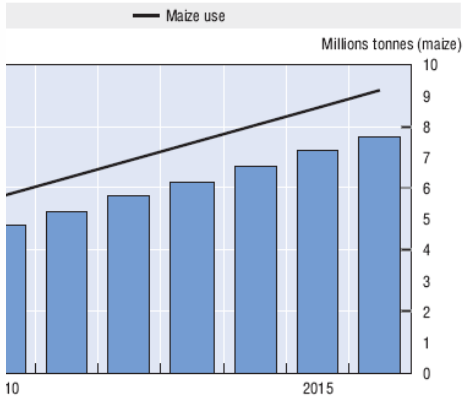


Canada



Source: AAFC.

China

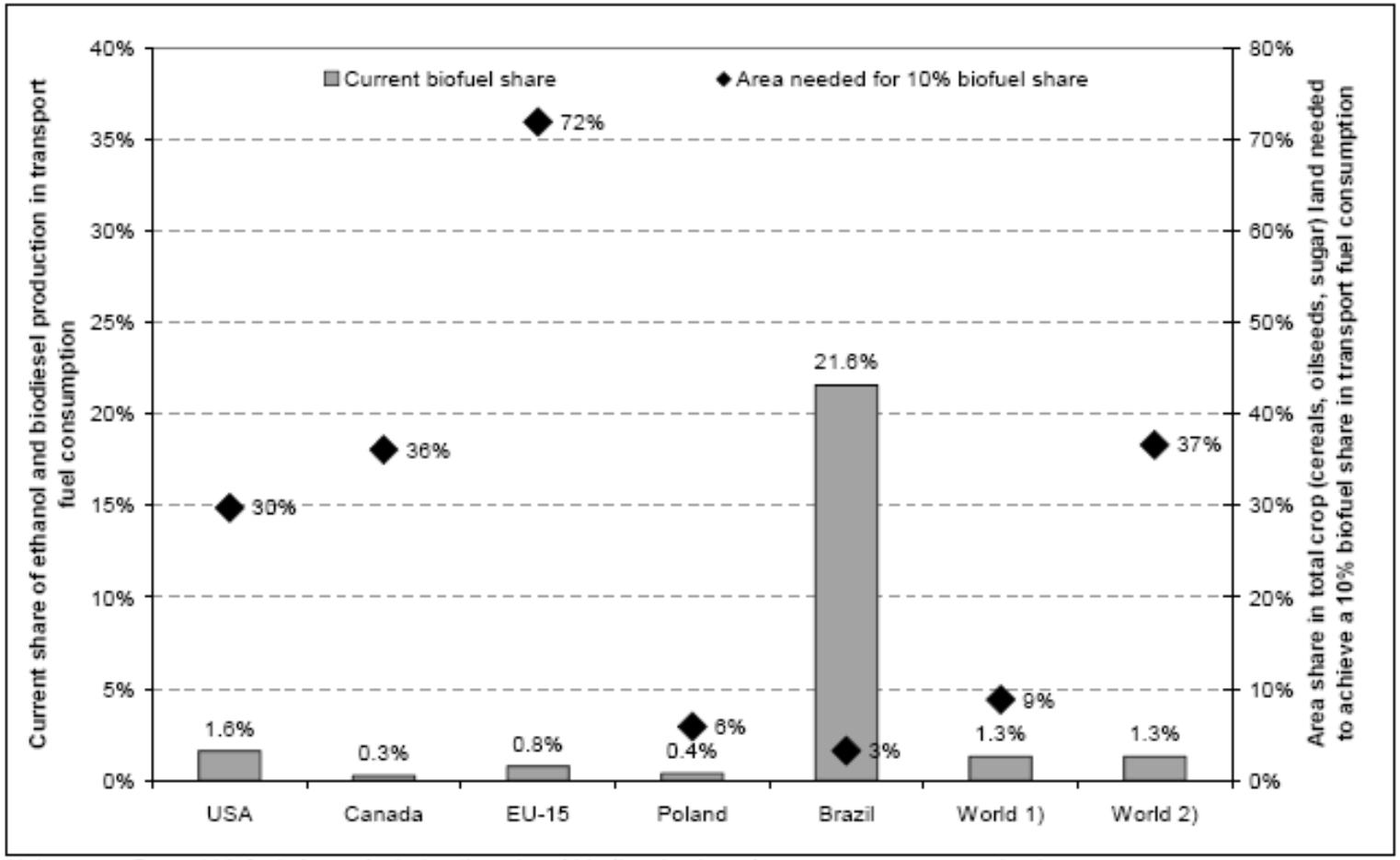


EU-Goals for Biomass in the Energy Mix

- 69 MtOE (4%) Primary Energy from Biomass today
- 150 MtOE Primary Energy from Biomass until 2010 („Biomass Action Plan“)
- 20 % Renewables until 2020 („Renewable Energy Road Map“)
- 10 % of Fuel Consumption until 2020 with Biofuels („Renewable Energy Road Map“)
- 43 MtOE Biofuel Potential in the EU (EEA)

Support for Biofuels

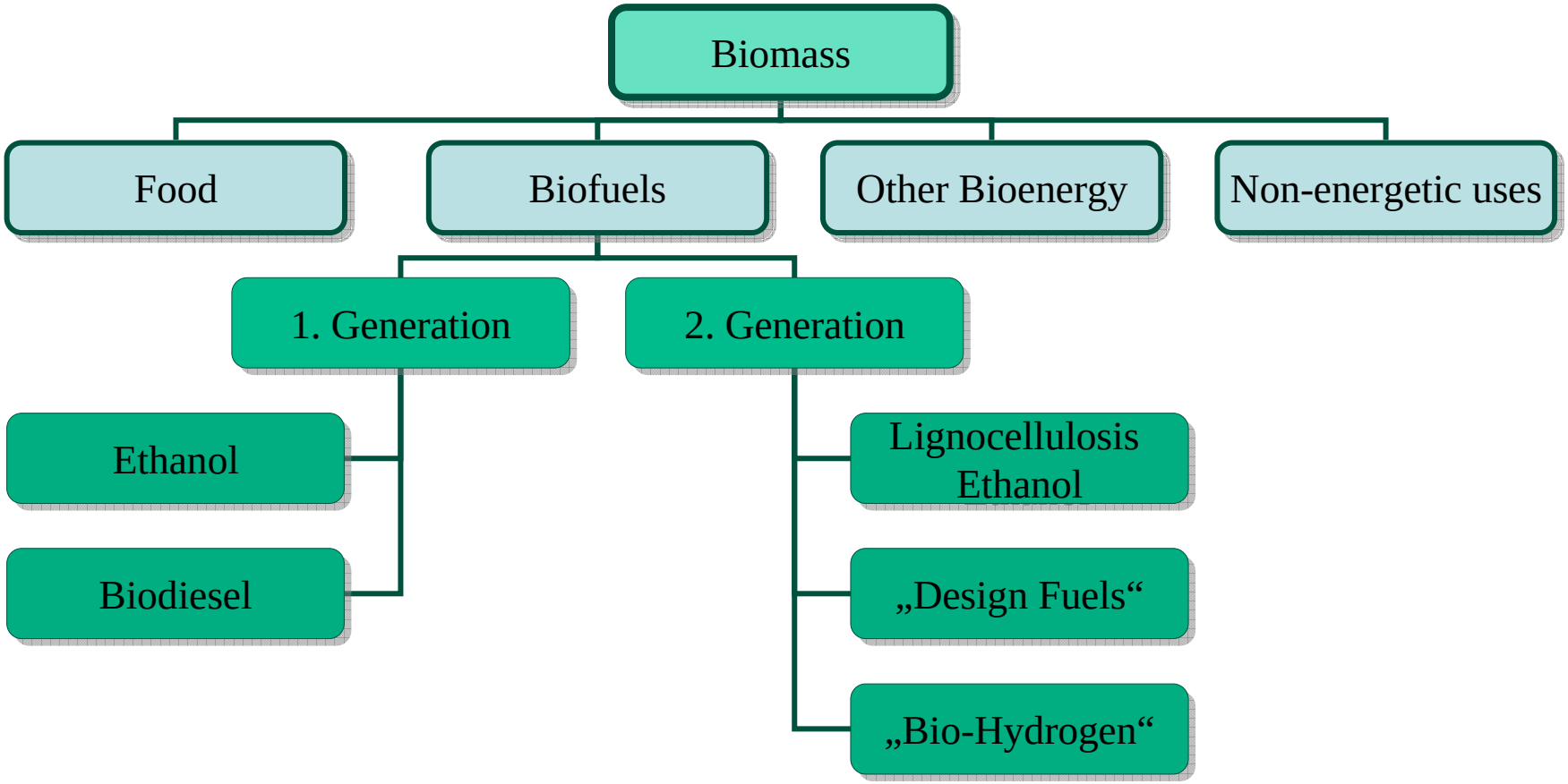
- Tax exemptions
- Tariffs & Quotas
- Product Specifications
- Mixing Requirements
- Agricultural Subsidies
- Investment Subsidies



Notes: Current biofuel shares include ethanol and biodiesel only – shares are on an energy basis.
World area shares are calculated relative to land used for cereals, oilseeds and sugar globally (World [1)]) and within the five major biofuel producing regions only (World [2)]).
All areas requirements are calculated on the basis of average crop area and yield data for 2000-2004 and transport fuel consumption in 2004. For these calculations, the 2004 shares in the feedstock mix are assumed to remain unchanged. Details on the calculations can be found in Annex 2.
Note that calculations for the EU exclude ethanol transformed from wine which represented about 18% of EU ethanol production in 2004.

Source: OECD Secretariat.

Biomass Uses



How Much Climate Mitigation?

	Biodiesel	Reines Pflanzenöl	Bioethanol aus Zucker bzw. Stärke	Bioethanol aus Lignozellulose	BtL	Biogas (Biomethan aus Silomais)	Bio-Wasserstoff
Bruttokraftstoff-ertrag (GJ/ha bzw. l Kraftstoff-äquivalente/ha)	51 / 1408	51 / 1420	Zucker: 132 / 4054 Stärke: 54 / 1660	21 / 640	135 / 3907	178 / 4977	160 / 4742
Netto-energieertrag (GJ/ha)	38	35	Zucker: 88 Stärke: 30	18*	118	113	120
Erzeugung (in% des substituierten fossilen Kraftstoffs)	5,5	ca. 0,7	Zucker: 0 Stärke: 1,0	0	0	0	0
Produktions-kosten (€/GJ)	19	14	Zucker: 24 Stärke: 22	30	30	21	26 - 37
Internationale Wettbewerbs-fähigkeit	Faktor 1,2 bis 1,3	Faktor 1,3	im Vergleich zu BRA: Faktor 2,5	k.A.	k.A.	z.Z. kein internationaler Wettbewerb	k.A.
CO_2^e-Einsparung t/ha	3,4	3,3	Zucker: 7,2 Stärke: 2,9	1,6	10	ca. 8	k.A.
CO_2^e-Vermeidungs-kosten (€/t CO_2^e)	154	83	Zucker: 290 Stärke: 252	295	272	273	k.A.
Aufwand Markteinführung	In 2005 ca. 1 Mrd. € Steuerausfall	In 2005 ca. 130 Mio. € Steuer-ausfall	In 2005 ca. 214 Mio. € Steuer-ausfall	Förderung nötig, eher F&E erforderlich	Noch nicht im Markt, F&E erforderlich	Noch nicht im Markt, evtl. Pilotprojekte	Noch nicht im Markt, F&E erforderlich

Source: Schmitz et al. 2006

How Much Cl Second Generation Biofuels

	Biodiesel	Reines Pflanzenöl	Bioethanol aus Zucker bzw. Stärke	Bioethanol aus Lignozellulose	BtL	Biogas (Biomethan aus Silomais)	Bio-Wasserstoff
Bruttokraftstoff-ertrag (GJ/ha bzw. l Kraftstoff-äquivalente/ha)	51 / 1408	51 / 1420	Zucker: 132 / 4054 Stärke: 54 / 1660	21 / 640	135 / 3907	178 / 4977	160 / 4742
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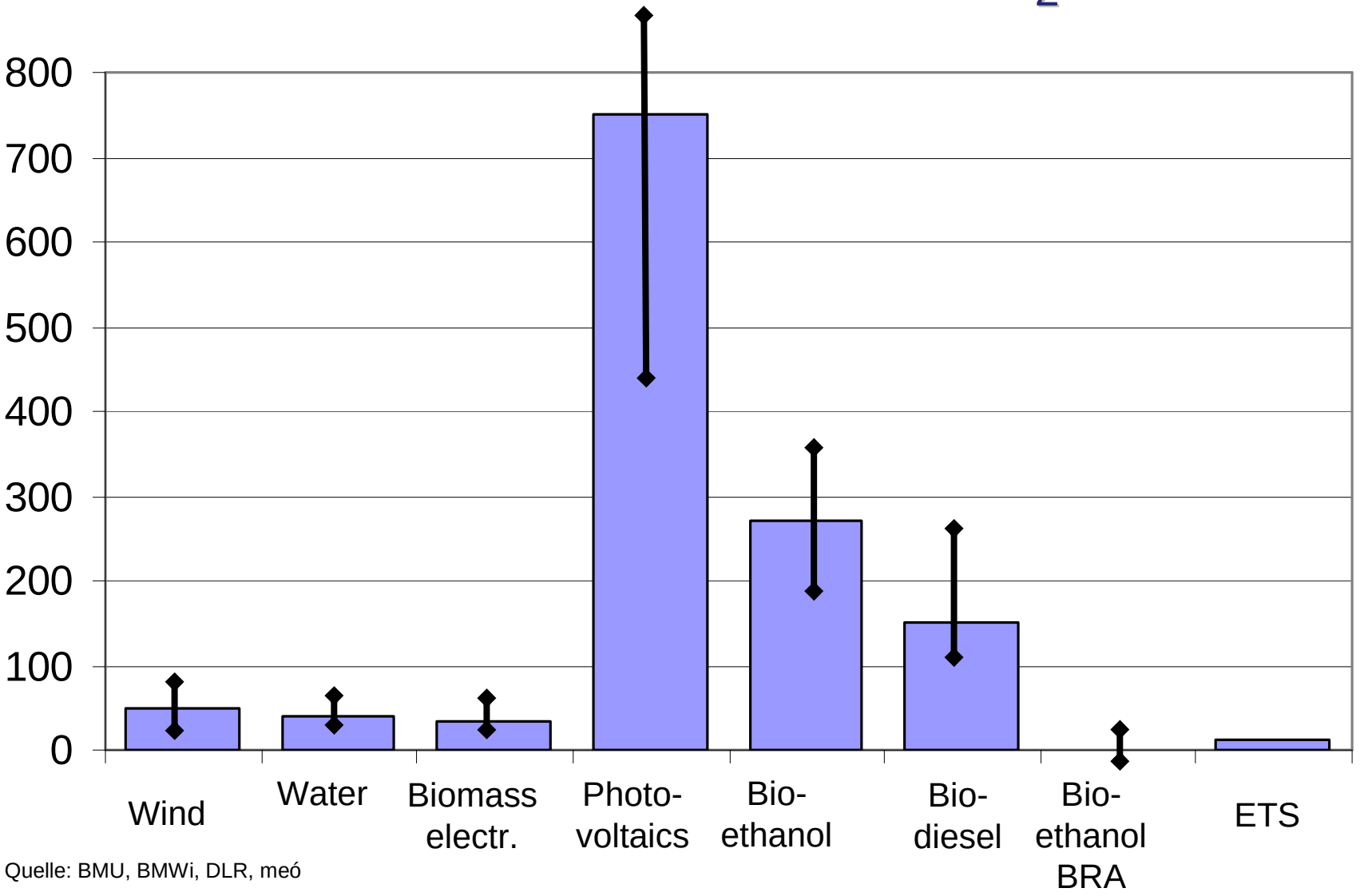
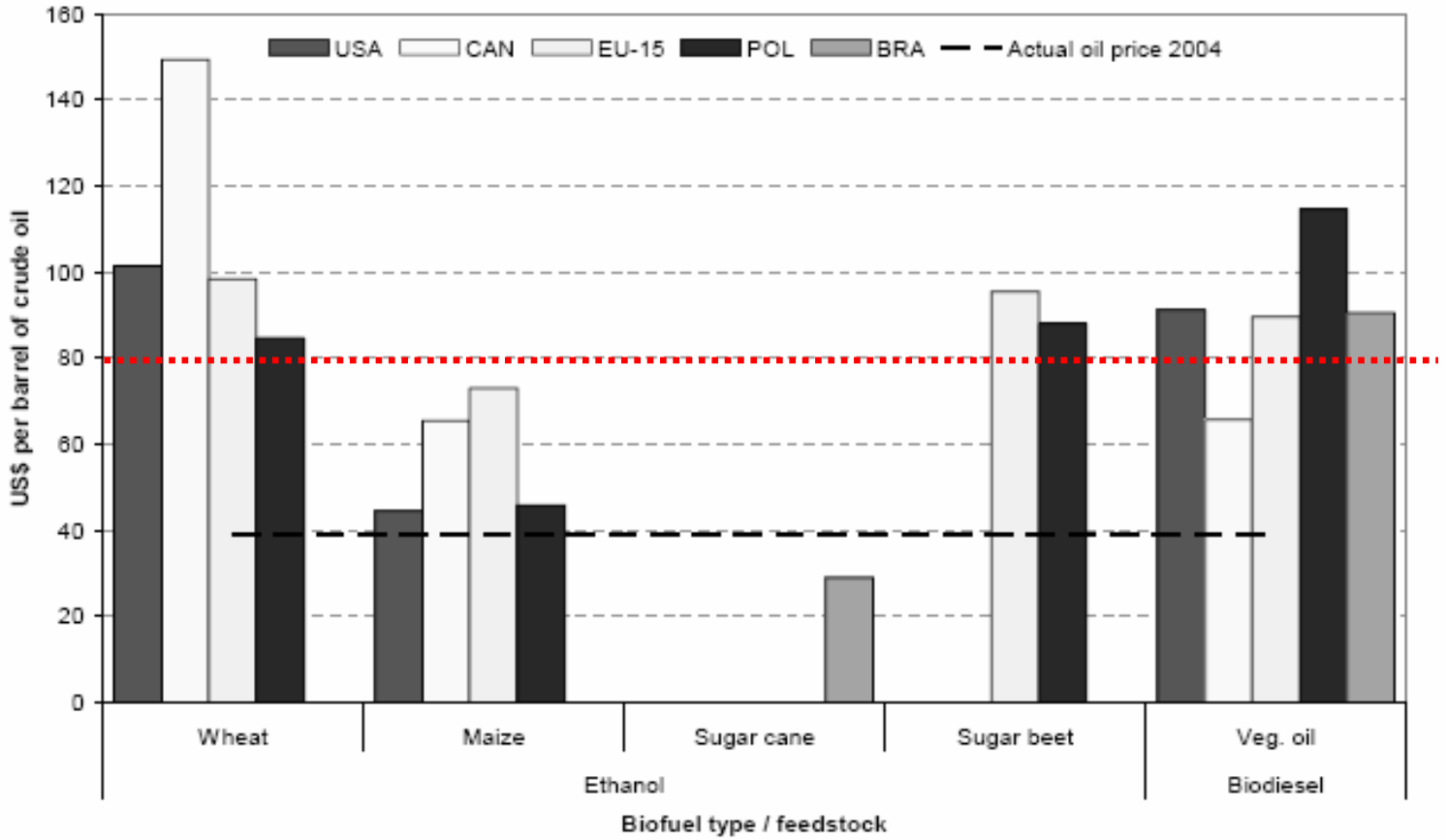
Abatement Costs of CO_2



Quelle: BMU, BMWi, DLR, meó

Threshold Prices for Crude Oil (2004)



Note: Threshold prices represent estimated crude oil prices at which domestic tax-free gasoline and diesel prices are equal to the production costs of ethanol and biodiesel, respectively, taking into account the differences in their energy content. These calculations assume unchanged production costs at their calculated 2004 level and therefore do not consider changes in feedstock prices and costs for process energy due to changed crude oil prices.

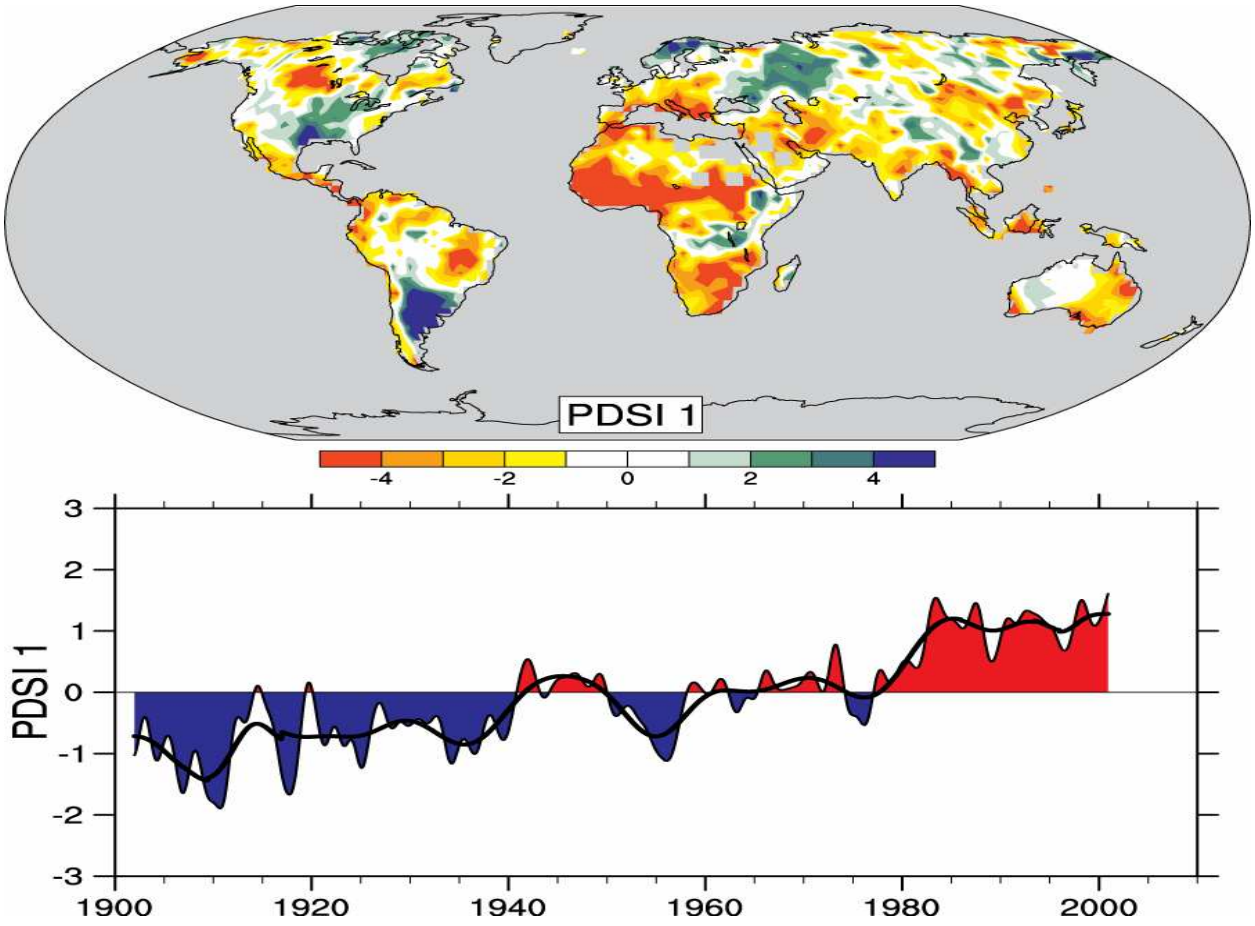
Source: OECD 2006

FAO Food Outlook

Cereals	Million tonnes				% per annum			
	1979-81	1997-99	2015	2030	1979 to 1999	1989 to 1999	1997-99 to 2015	2015 to 2030
World								
Production	1 442	1 889	2 387	2 838	1.4	1.0	1.4	1.2
Food	706	1 003	1 227	1 406	1.9	1.4	1.2	0.9
Feed	575	657	911	1 148	0.6	0.6	1.9	1.5
Developing countries								
Production	649	1 026	1 354	1 652	2.5	2.1	1.6	1.3
Food	524	790	1 007	1 185	2.2	1.7	1.4	1.1
Feed	113	222	397	573	3.8	4.4	3.5	2.5
Net trade	- 66	- 103	- 190	- 265				

Meat	Million tonnes				% per annum			
	1979-81	1997-99	2015	2030	1979 to 1999	1989 to 1999	1997-99 to 2015	2015 to 2030
World								
Production	132	218	300	376	2.8	2.7	1.9	1.5
Food	130	214	297	373	2.8	2.7	1.9	1.5
Developing countries								
Production	45	116	181	247	5.5	5.9	2.7	2.1
Food	44	116	184	252	5.6	6.1	2.7	2.1
Net trade	- 0.2	- 1.2	- 3.9	- 5.9				

Climate Change and Water Availability



The most important spatial pattern (top) of the monthly Palmer Drought Severity Index (PDSI) for 1900 to 2002.

The time series (below) accounts for most of the trend in PDSI.

Cereal Projections based on Climate Models

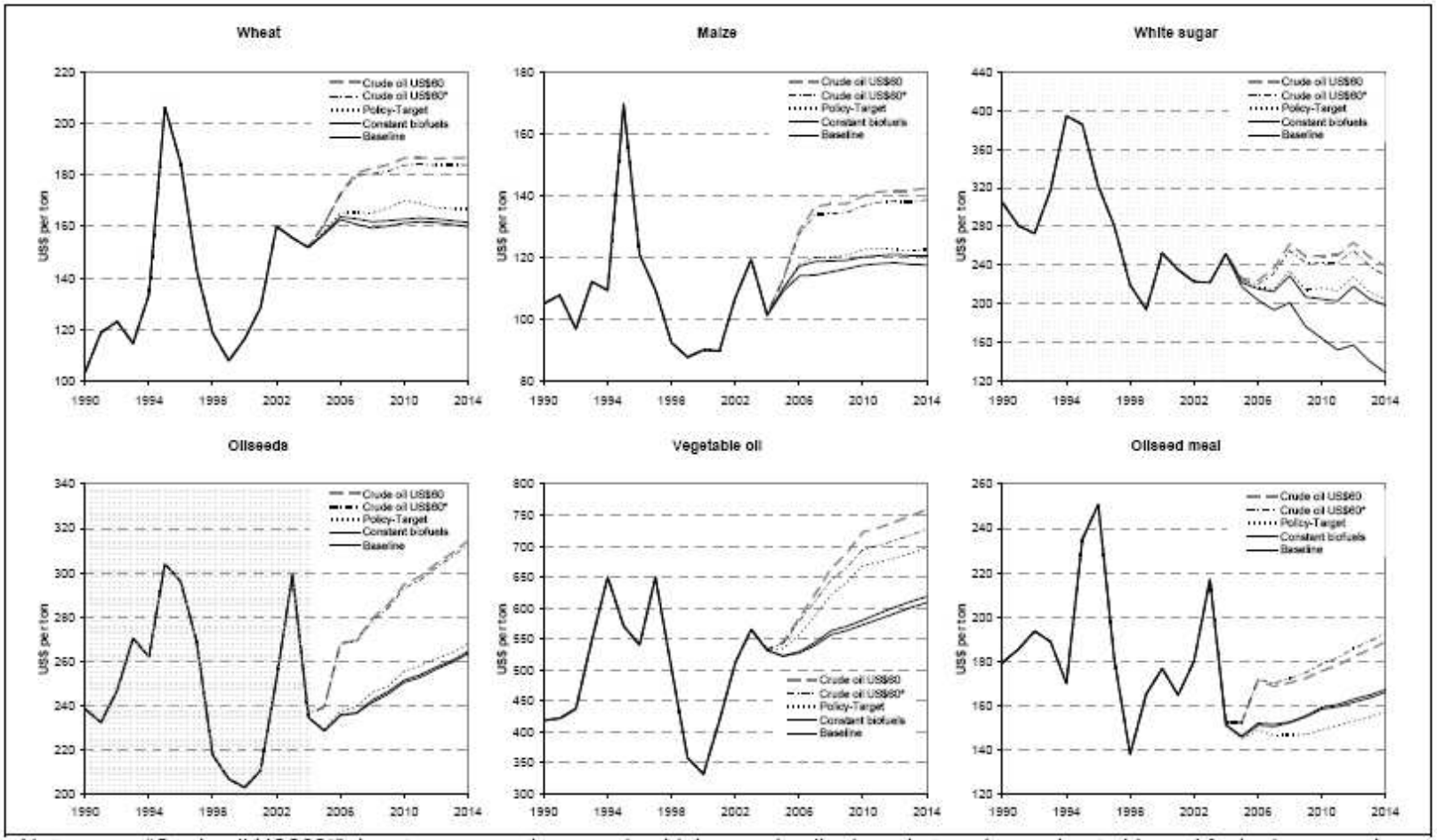
Table 5.28. Number of countries, projected year 2080 population, and change in cereal production potential on currently cultivated land of developing countries, rain-fed multiple cropping, 2080s.

Climate model	Number of countries			Projected population, 2080 (10^9)			Change in cereal production potential (10^6 tons)			
	G[a]	N	L	G	N	L	G	N	L	Total
ECHAM4	40	34	43	3.1	0.9	3.7	142	–2	–117	23
HADCM2	52	27	38	3.2	1.2	3.3	207	3	–273	–63
CGCM1	25	26	66	1.1	1.1	5.5	39	3	–268	–226

[a] G = countries gaining +5% or more; N = small change of –5 to +5%; L = countries losing –5% or more.

Source: Global Agro-ecological Assessment for Agriculture in the 21st Century: Methodology and Results. IIASA 2002.

OECD Crop Market Study

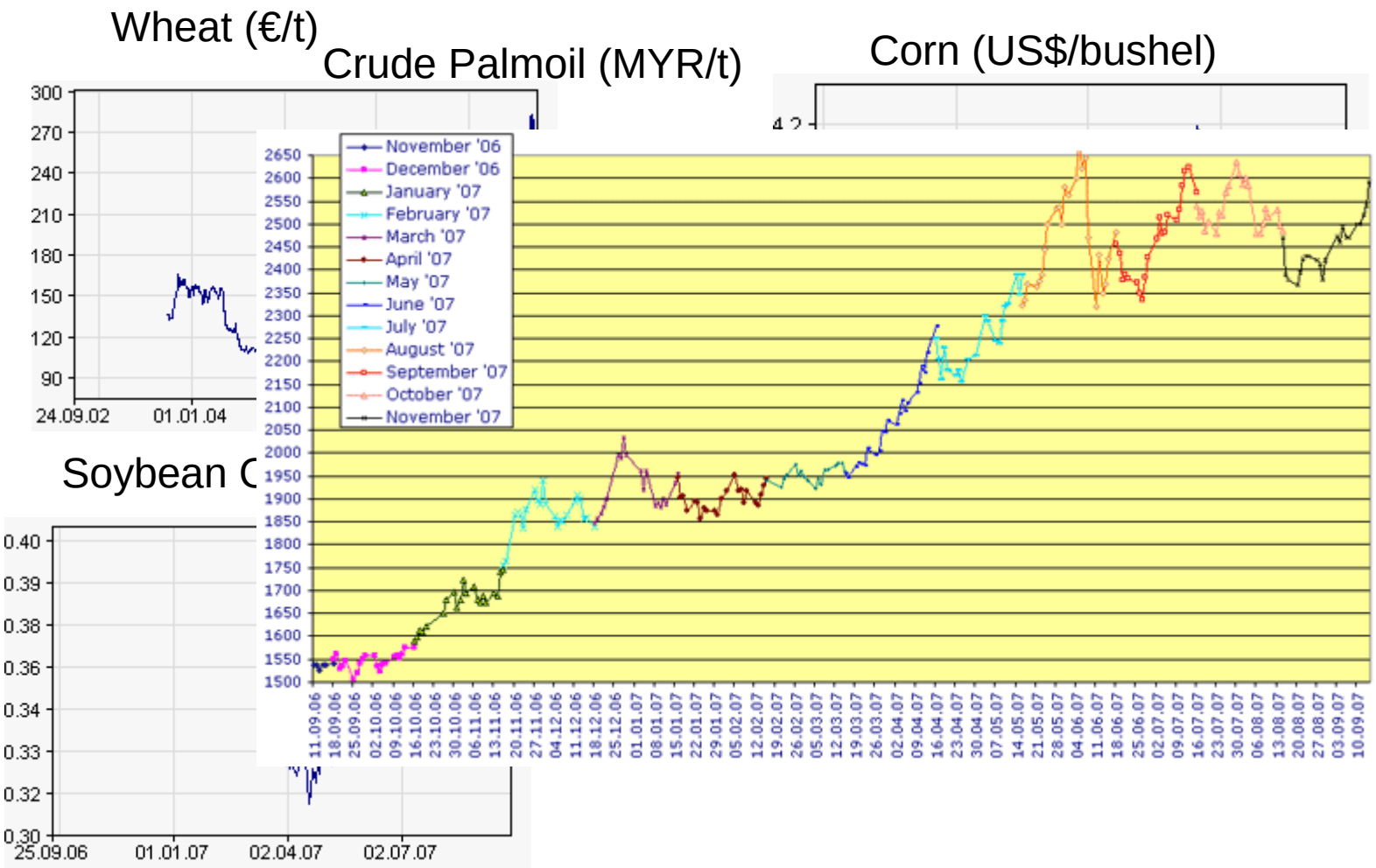


Note: "Crude oil US$60*" denotes a scenario assuming higher crude oil prices, but unchanged petrol-based fuel prices – and hence unchanged biofuel prices – relative to the policy-target scenario.

Source: OECD Secretariat.

Source: M. v. Lampe: Agricultural Market Impacts of Future Growth in the Production of Biofuels, www.oecd.org/dataoecd/58/62/36074135.pdf; schriftliche Auskunft des Autors

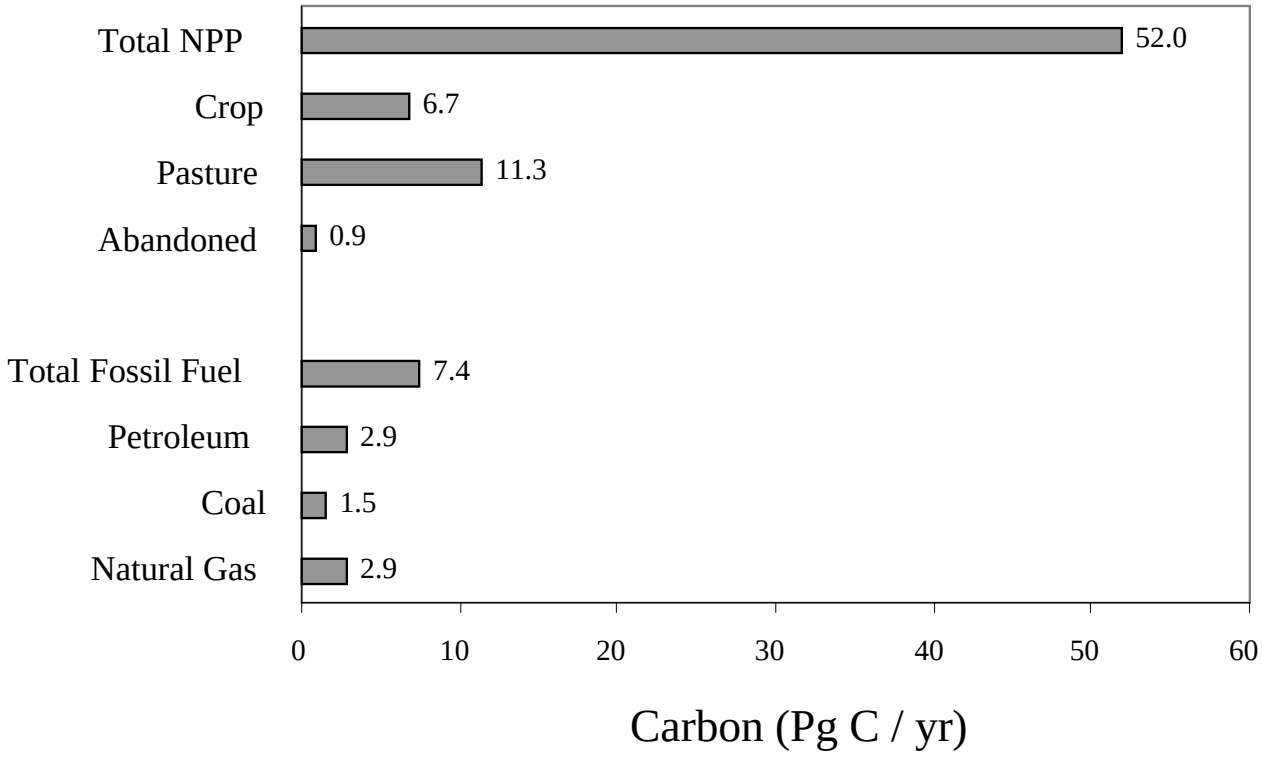
Prices for Agricultural Products



World Market for Biofuels

- Important suppliers of Biodiesel:
  - Indonesia
  - Malaysia
- … of Ethanol:
  - Brazil
  - USA (Netimporter)
- Exporters supply large amounts of food products and possess significant Biodiversity.
- Certification of Biofuels
  - CO_2 Certificate
  - Sustainability Certificate

Total Energy Availability



Source: Chris Field, „Biomass Energy“. Presentation at the GCP-Meeting, South Africa, 8/2007.

Unresolved Questions

- Land use decisions and food prices
- GHG-Balances for Biofuels in Developing Countries
- Other ecologic effects of the expansion of areas for Biofuel production
- Indirect effects of land use changes – „Leakage“
- Second generation Biofuels
  - Technical feasibility
  - Biomass potential as feedstock
  - Conflict with other biomass uses
  - Economics of 2. generation biofuels

Policy Issues

- Integrating Biofuels into Climate Policy
- Managing Competition for Bioenergy
- Allocating Bioenergy Efficiently
- Certification of Biofuels
- Introducing Biofuels into the ETS
- Distribution Effects of Biofuel Promotion
  - Within Regions
  - Between Regions