Overview

Bioenergy: local and global potentials, competitiveness and impacts on food security

Third Biomass-Asia Workshop

Tokyo, 15.11.2006

Josef Schmidhuber

Senior Economist
Global Perspective Studies Unit
ESDG
Food and Agriculture Organization of the United Nations

Overview

1. How big is the potential for bioenergy, globally and regionally?
2. How competitive are the various forms of bioenergy?
3. How does an increased use of bioenergy affect food prices and markets?
4. How do higher food and fuel prices affect international food security?
5. Summary and conclusions

How big is the market for biofuels?

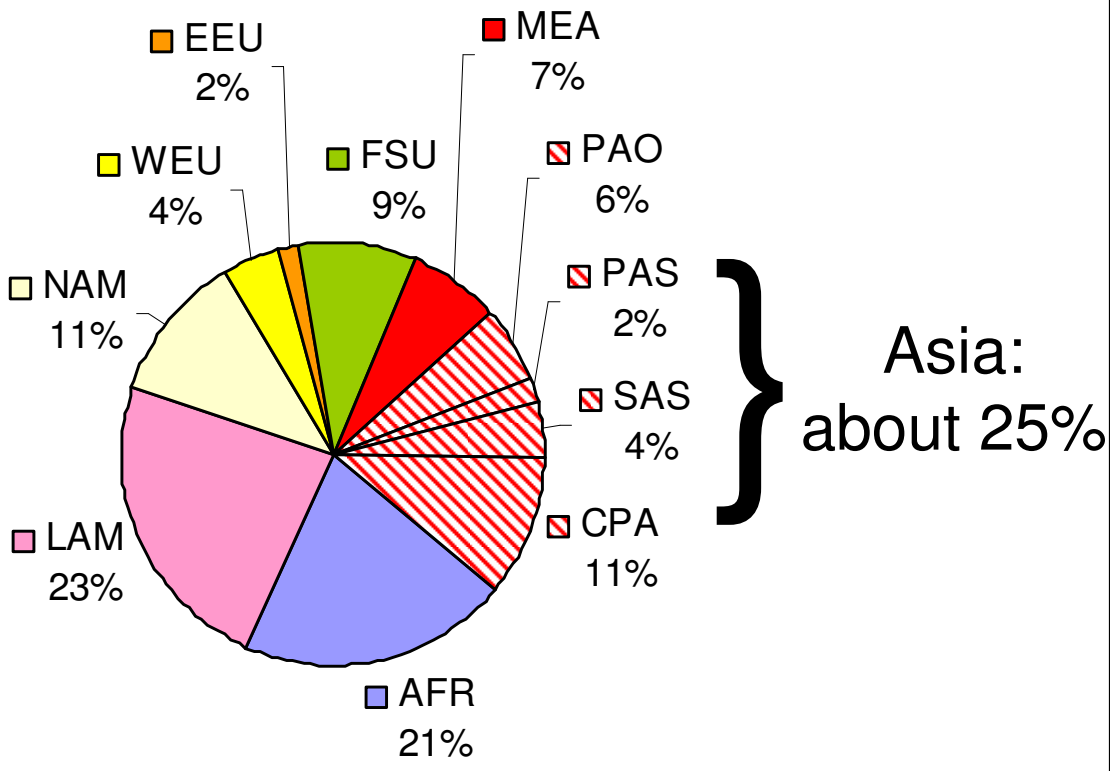
Energy production and potential, biofuels and land use

			Exajoule (10^{18}), EJ[9]			million ha
Energy source		Year	World	OECD	non-OECD	World
All sources (TPES)		2002[2]	428	224	205	
		2030[2]	670			
		2050[2]	850			
Biomass	Actual use	2002[2]	47[11]	14	33	
	Theoretical potential		>>2000	Global photosynthesis: ~ 4000 EJ		
	Technical potential	1990[1]	225			
		2050[1]	400			
	Economic potential	1990[1]	89			
		2050[1]	158			
Biofuels	Ethanol[7]	2004[3]	0.84	0.34	0.51	9.52[4]
	Biodiesel[7]	2003[3]	0.06	0.04	0.02	0.47[4]
	Potential[1]	2050[1]	53[10]			
			million ha			
Agricultural land[8]	Used	1997-99	1506	658	848	850[4/5]
	Total suitable		4188	1406[6]	2782[6]	(4730)

1.) Potential based on Schrattenholzer and Fischer, IIASA, 2000
2.) Based on IEA: Key energy statistics, 2004
3.) Derived from http://www.earth-policy.org/Updates/2005/Update49.htm, Earth Policy Institute
4.) Assuming an average yield per hectare for ethanol of 4200 l (3000 l US maize, 5500 l Brazil cane, 6900 l France sugar beet) and of 3800 l/ha for biodiesel (average). Most recent yields are about 10% higher for cane and 20% higher for maize.
5.) 850 million ha would be required to meet today's transport fuels needs (77 EJ) at current yields (l biofuel/ha), technology, and crop composition.
6.) Area for developing and developed countries, not OECD and non OECD
7.) Assuming an energy content of 34 MJ/l for biodiesel and 21.1 MJ/l for ethanol
8.) Bruinsma (ed), World agriculture: towards 2015/2030, An FAO Perspective, 2003, total suitable land for rainfed agriculture
9.) 41.868 Mtoe = 1 EJ
10.) IEA (2003), "Biofuels for Transport", table 6.8.
11.) 15-60 EJ: most biomass fuels are not traded on world markets, estimates of consumption are highly uncertain.

How big is Asia's share in the global bioenergy potential?

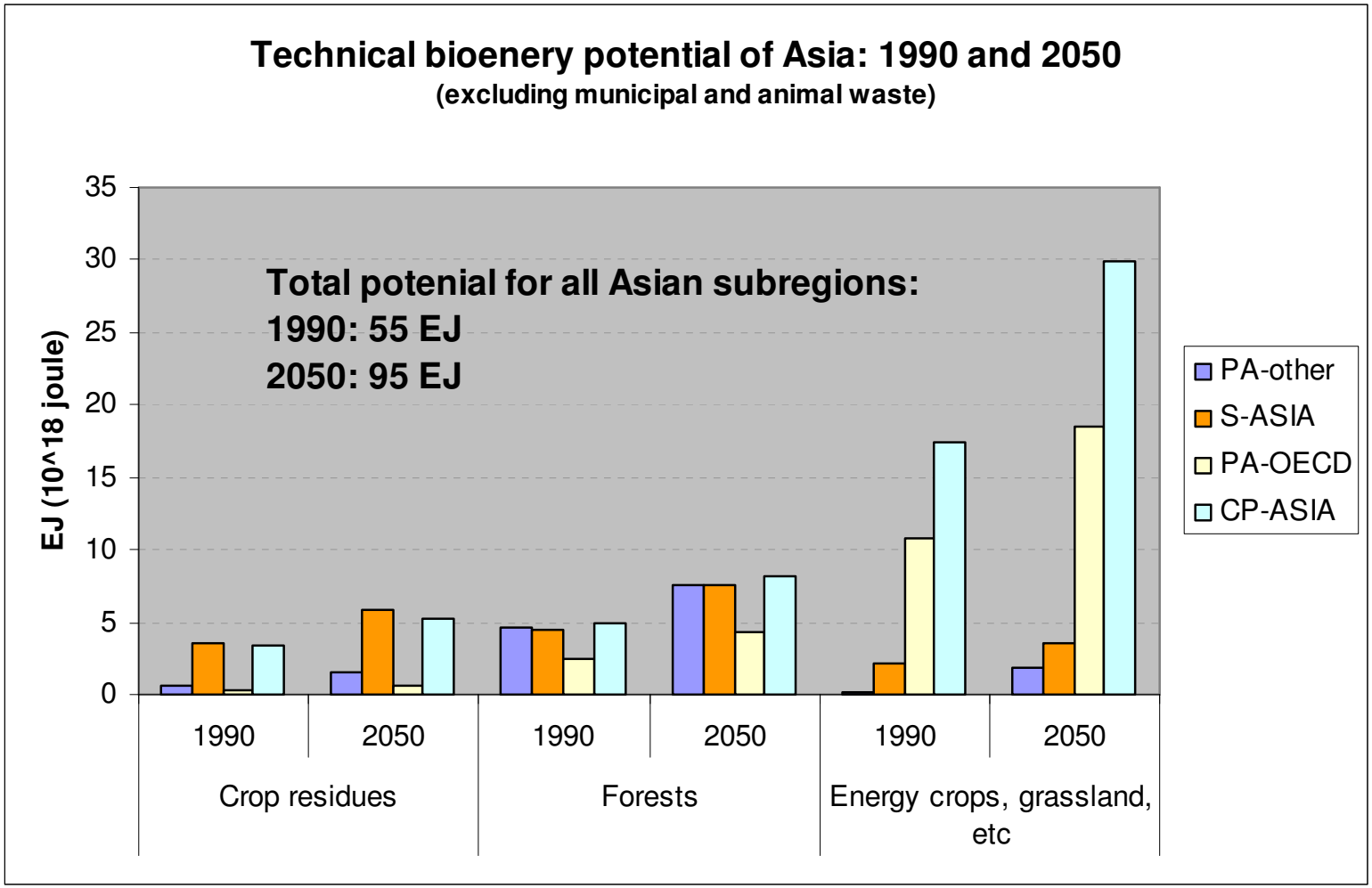
Technical bioenergy potentials by region: Shares in 1990 of a total of 225 EJ



How big is the market for biofuels?

Energy production and potential, biofuels and land use

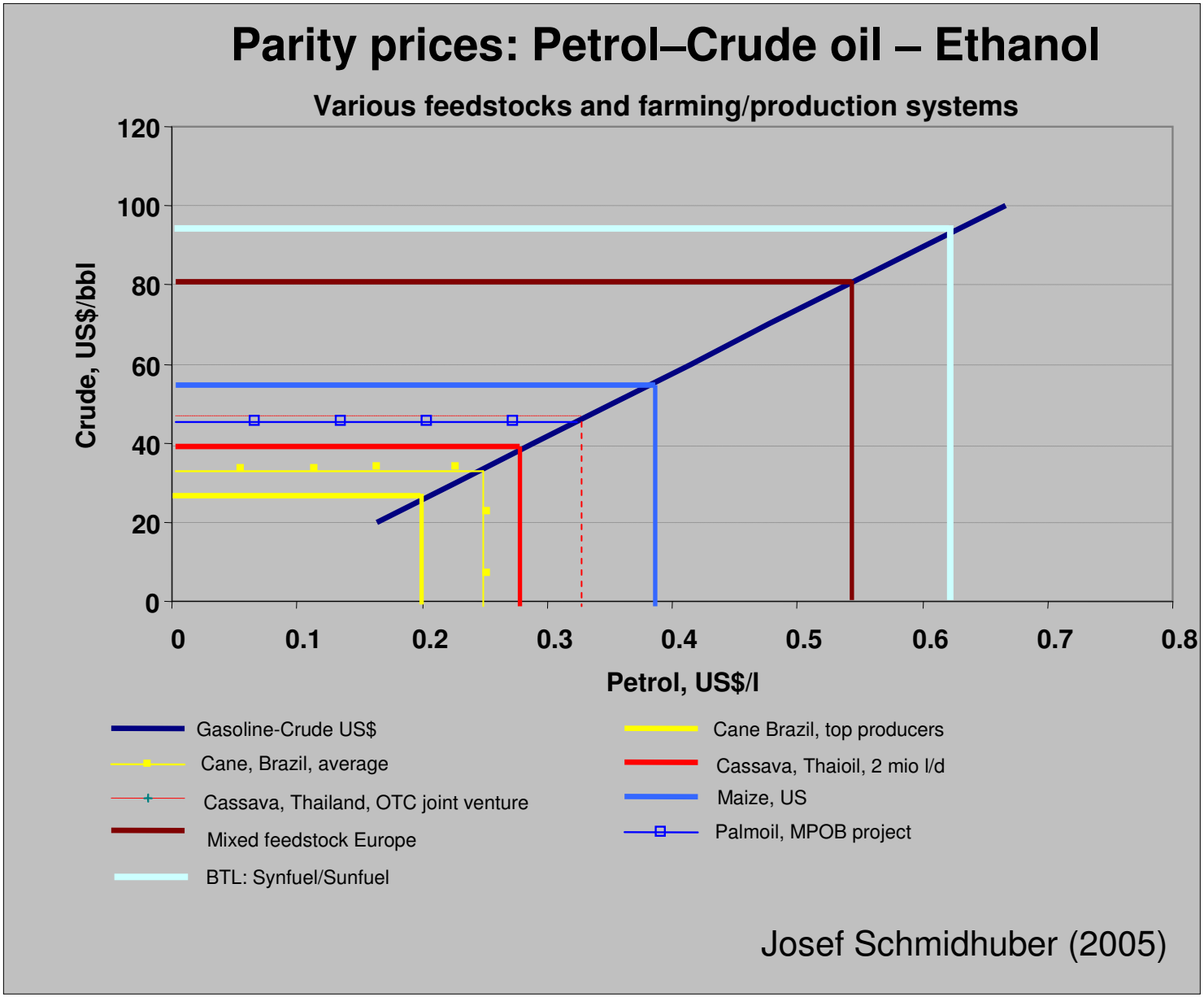
The potentials



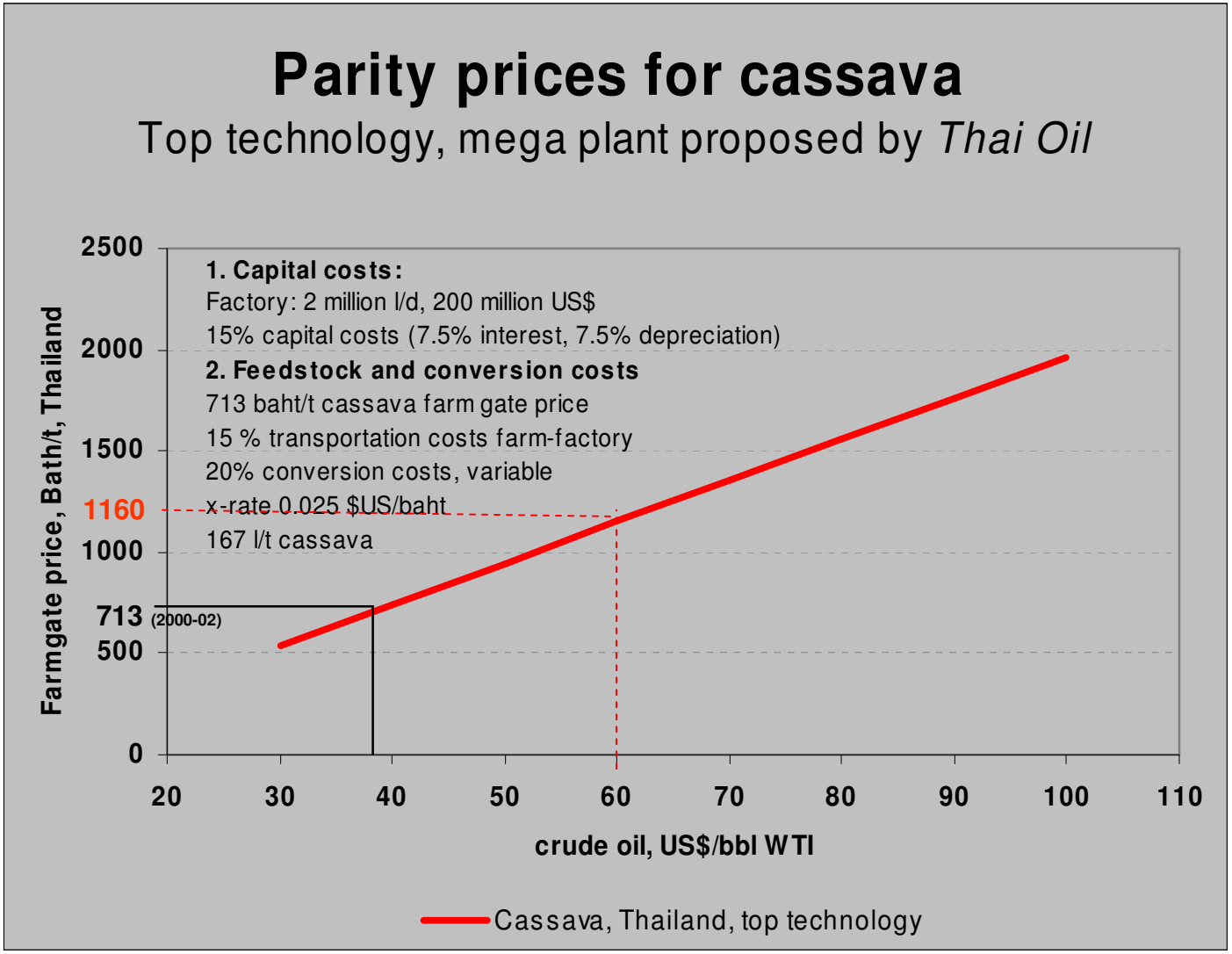
Overview

1. How big is the potential for bioenergy, globally and regionally?
2. How competitive are the various forms of bioenergy?

Competitiveness by feedstock



Cassava, mega plant, top technology



Source: own calculations based on EIA, IEA, FAO data. J. Schmidhuber (2005)

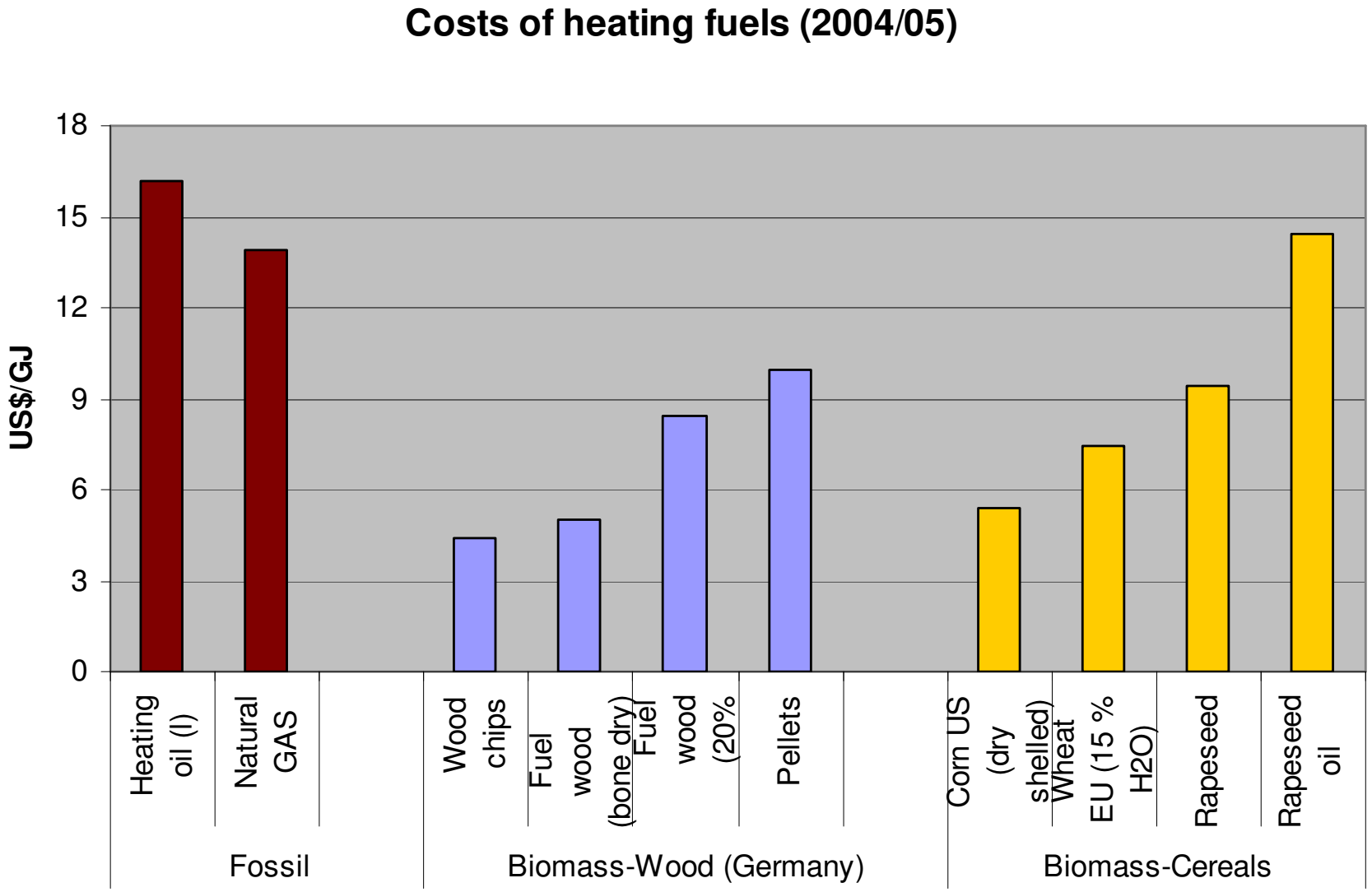
Capital costs v feedstock costs: large scale

Feedstock price for cassava In baht/t farm gate	Ethanol plant capacity	
	200,000[1] l/d (1,300t cassava/d)	2,000,000[2] l/d (12,800 t cassava/d)
	share of capital costs %	
713	29	21
1000	23	17
1500	17	12

1.) This plant will be located in the Chok Chai district of Nakhon Ratchasima, Thailand's main cassava-producing province. It is a joint venture of the Agricultural Co-operative Federation of Thailand and O.C.T. Land & Energy L.C., USA. The former is 4000 member farm co-operative and will hold 60% of the registered capital, the latter is an affiliate of O.C.T. Fiberglass Products, based in Wichita, Kansas and will hold 40% of the capital.

2.) A feasibility study endorsed by Thai Oil and "strategic partners" found an ethanol plant of this size appropriate and necessary to match the company's fossil fuel refinery capacity and its blending needs for gasohol production. The investment needs have been pegged at US$150-250 million, daily output would be about 1.5-2 million l. It should be noted that the plant would consume, at an extraction rate of 167 l ethanol/ cassava a total amount of about 4.3 million tonnes of cassava per annum. This is about 25% of total cassava production (2000-04 average) and equivalent to the entire output of the Nakhon Ratchasima district, Thailand's main cassava producing area.

Saving the conversion costs ...

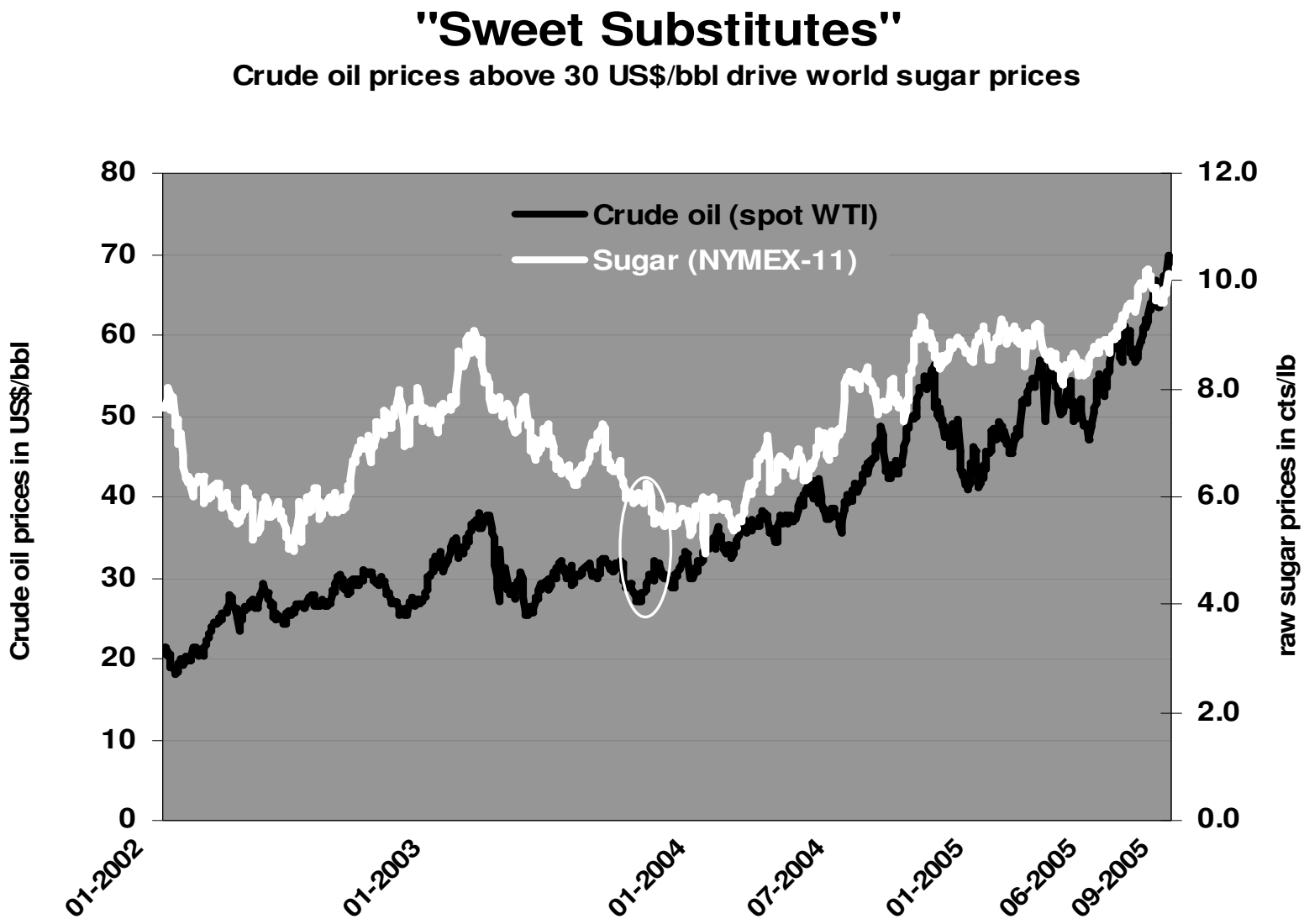


Source: own calculations based on EIA, IEA, FAO data. J. Schmidhuber (2005)

Overview

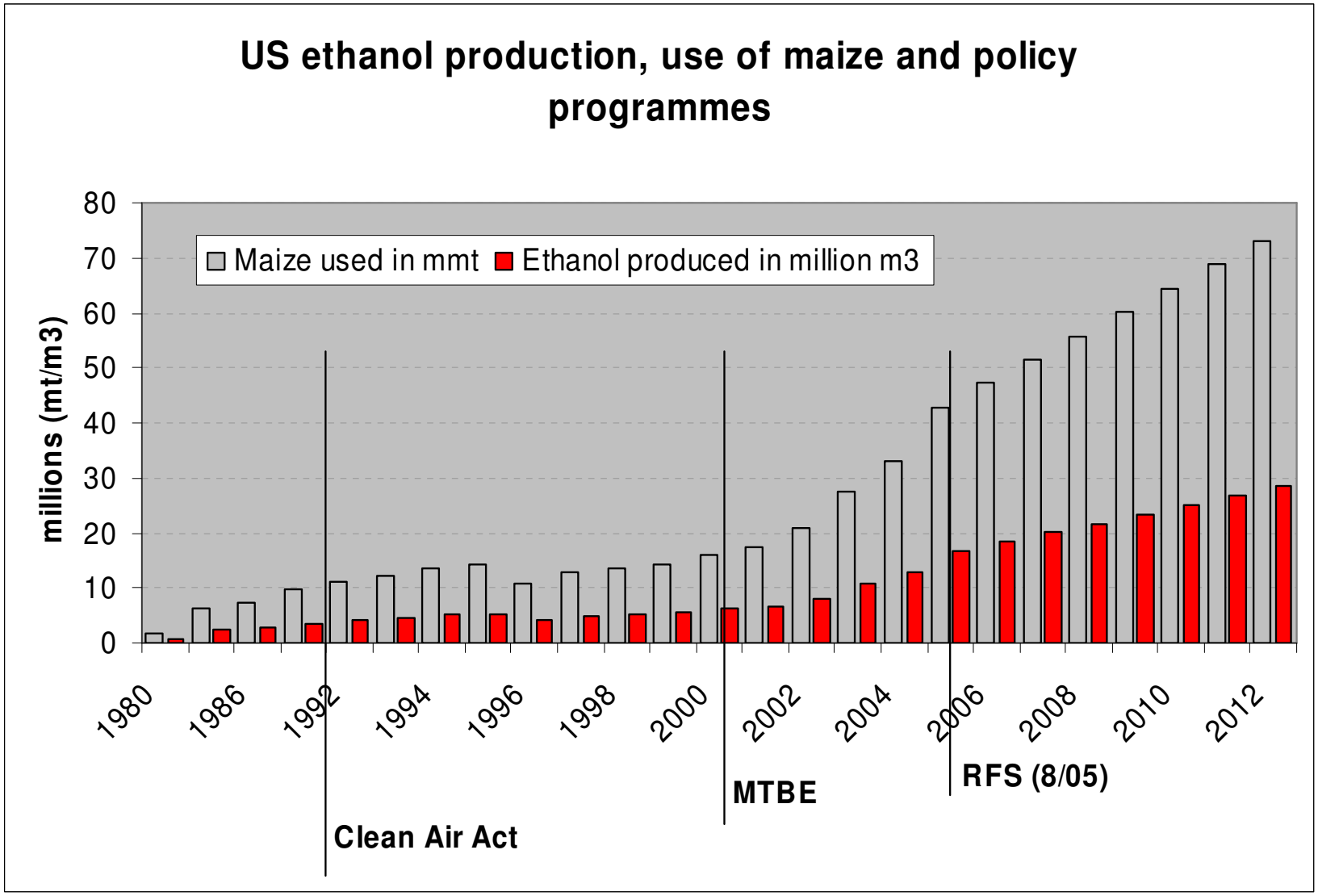
1. How big is the potential for bioenergy, globally and regionally?
2. How competitive are the various forms of bioenergy?
3. How does an increased use of bioenergy affect food prices and markets?

The price links



Data: Nymex and EIA, J. Schmidhuber (2005)

US ethanol-some market impacts



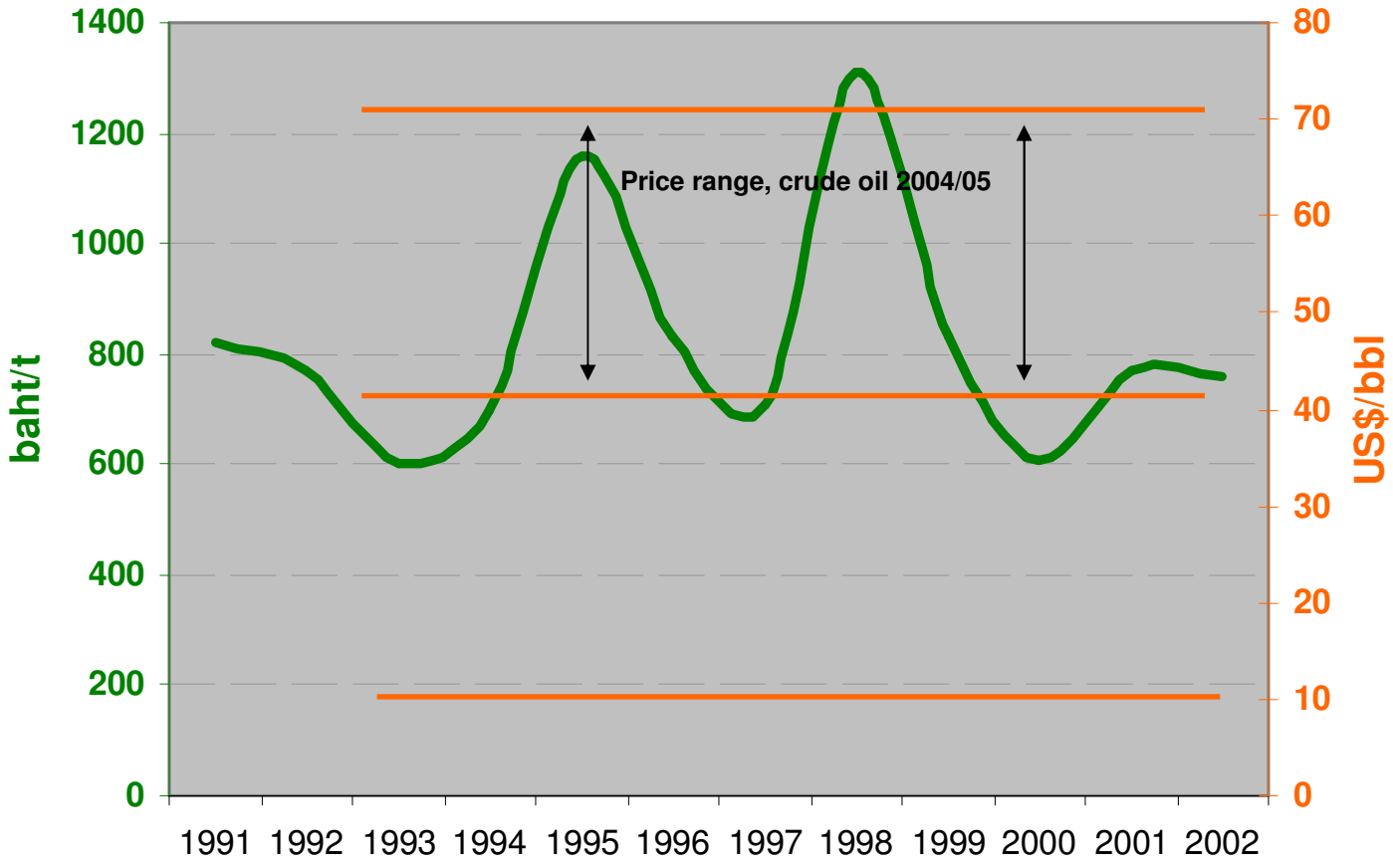
Cross links: Impacts on international commodity prices

	An additional 10 million tonnes of …				
	Sugar	Maize	Sugar and Maize	Soybeans and Maize	Sugar, Maize and Soybeans
Corresponding energy [biofuels]	0.195 EJ	0.087 EJ	0.282 EJ	0.167 EJ	0.349 EJ
Commodity	… used for biofuels would change international prices (percent) in the long-run by :				
Sugar	+9.8	+1.1	+11.3	+2.3	+13.8
Maize	+0.4	+2.8	+3.4	+4.0	+4.2
Vegetable oils	+0.3	+0.2	+0.2	+7.6	+7.8
Protein	+0.4	-1.2	-1.2	-8.1	-7.6
Wheat	+0.4	+0.6	+0.9	+1.8	+2.0
Rice	+0.5	+1.0	+1.2	+1.1	+1.4
Beef	+0.0	+0.2	+0.2	+0.4	+0.4
Poultry	+0.0	-0.4	-0.4	-2.1	-2.0

Source: @2030 simulation results

Price corridor for cassava: prices should not fall below the energy equivalents and not rise faster than energy prices

Thai farm gate prices for cassava and parity prices for crude oil

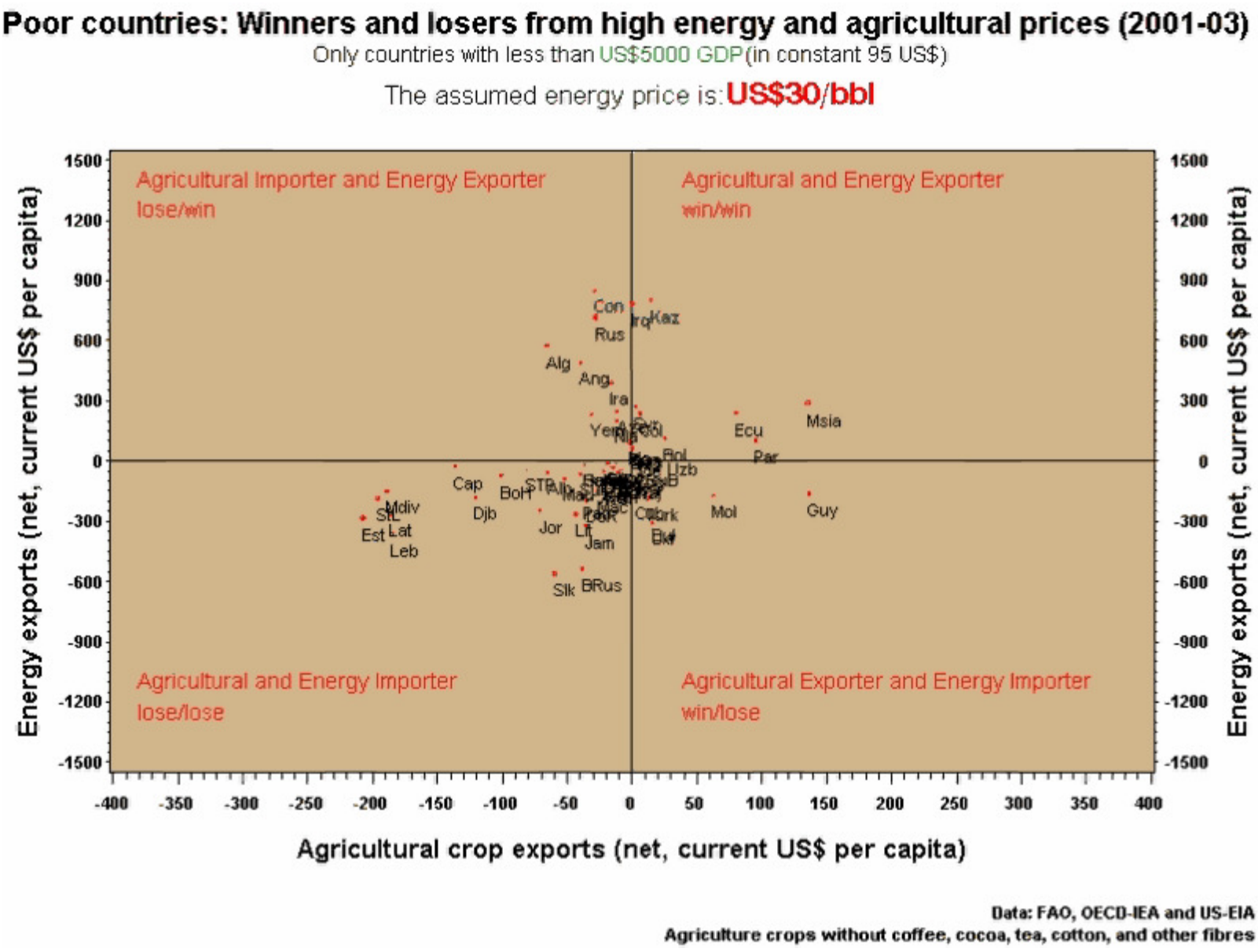


Source: Farm gate prices from FAOSTAT
Parity prices for oil from own calculations

Overview

1. How big is the potential for bioenergy, globally and regionally?
2. How competitive are the various forms of bioenergy?
3. How does an increased use of bioenergy affect food prices and markets?
4. How do higher food and fuel prices affect international food security?

International food security: Boom or bust for trade balances through an increased link between energy and food prices



Data: FAO, OECD-IEA and US-EIA
Agriculture crops without coffee, cocoa, tea, cotton, and other fibres

Summary, Conclusions, Outlook

Summary and Conclusions

1. Potential: differentiate between theoretical, technical and economic potential
   - The technical bioenergy potential was about 225 EJ in 1990 and about 400 EJ in 2050. It could cover about 50% of energy needs.
   - The economically viable potential is less than half of the technical potential (less than 25% of global energy needs).
2. Competitiveness: availability is inversely related to competitiveness
   - Crop residues, waste oils, animal and municipal wastes, etc. are the most competitive feedstocks but there potential is limited.
   - Integrated biofuel systems based on multi-feedstock input systems and multi-product output systems (e.g. biofuels and chemical byproducts) to provide improved competitiveness compared to current “one-feedstock one-product” systems;
   - Many energy crops are less competitive than wastes and residues at the moment but their potential is larger; significant differences in the competitiveness across countries and feedstocks.
   - Future: Butanol, Ligno-cellulosic feedstocks and synfuels
3. Energy prices above US$30-35/bbl directly affect agricultural prices:
   - they create a floor price for agricultural produce;
   - but agricultural prices will not rise faster than energy prices;
   - Paradigm shift possible with an end to falling real prices, but neo-Malthusian scenarios are unwarranted.
4. Impacts on food security
   - Winners and losers depending on the trade balance and net effects on energy and food prices;
   - food availability to decline, access to food to improve;
   - Improvements depend on land ownership, institutional support, creation of rural employment, land and labour intensity of bioenergy use and technologies;
   - Policy challenge: harness an agricultural renaissance without harming food security
5. Research needs and open questions
   - What impacts on land prices, rents, the environment, biodiversity, etc.?
   - How WTO compatible are current support for and protection of ag-bioenergy fuels and feedstocks?
   - Is there need for new companion policies, institutional settings, etc?
   - How to make production and processing of bioenergy feedstocks pro-poor?