Biomass to Chemicals and Fuels:
Science, Technology and Public Policy

National Initiatives and Energy Security

Biofuels: The Mindset Shift

Thinking and Acting Outside the Energy Box

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In conjunction with
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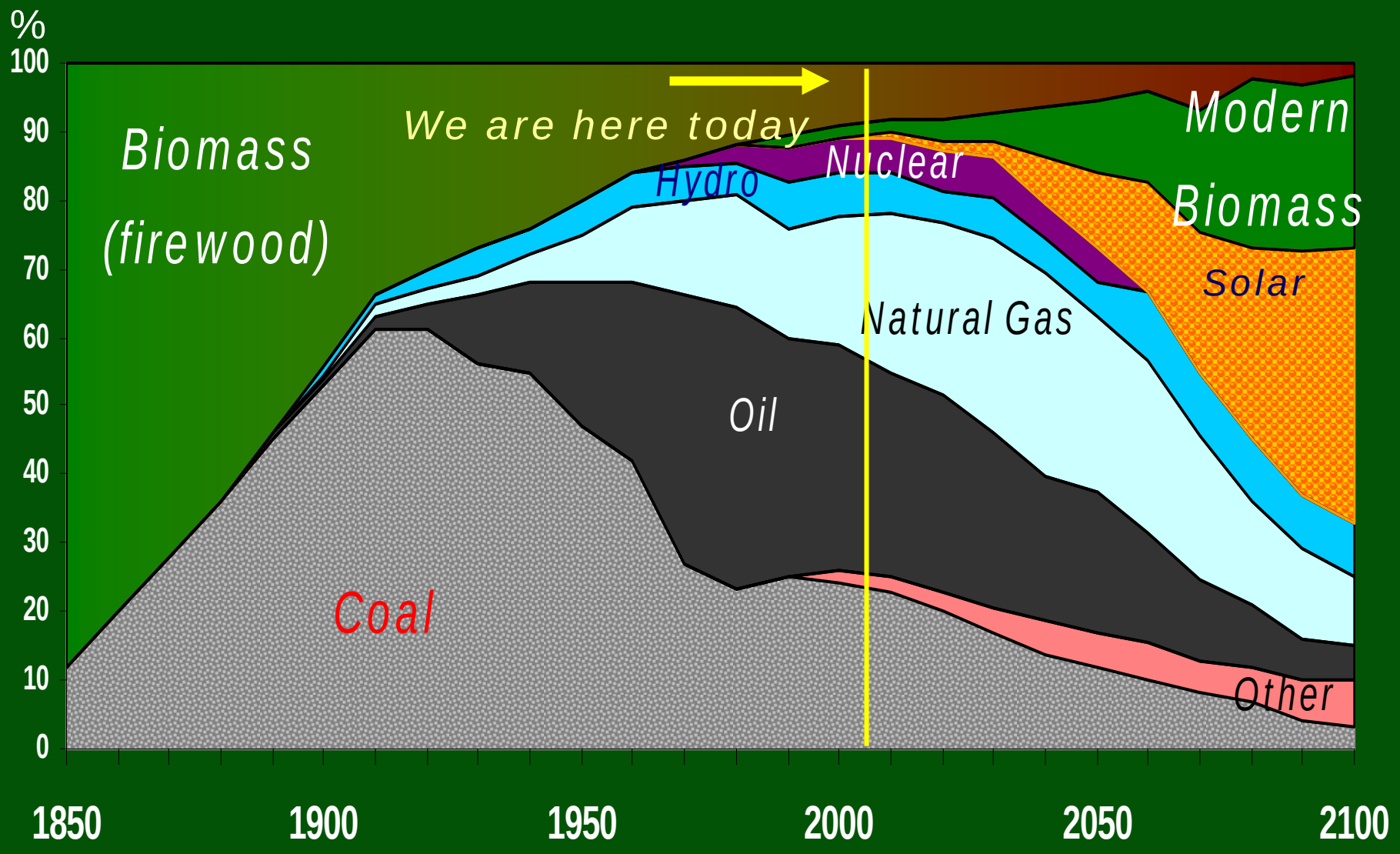
The Mindset

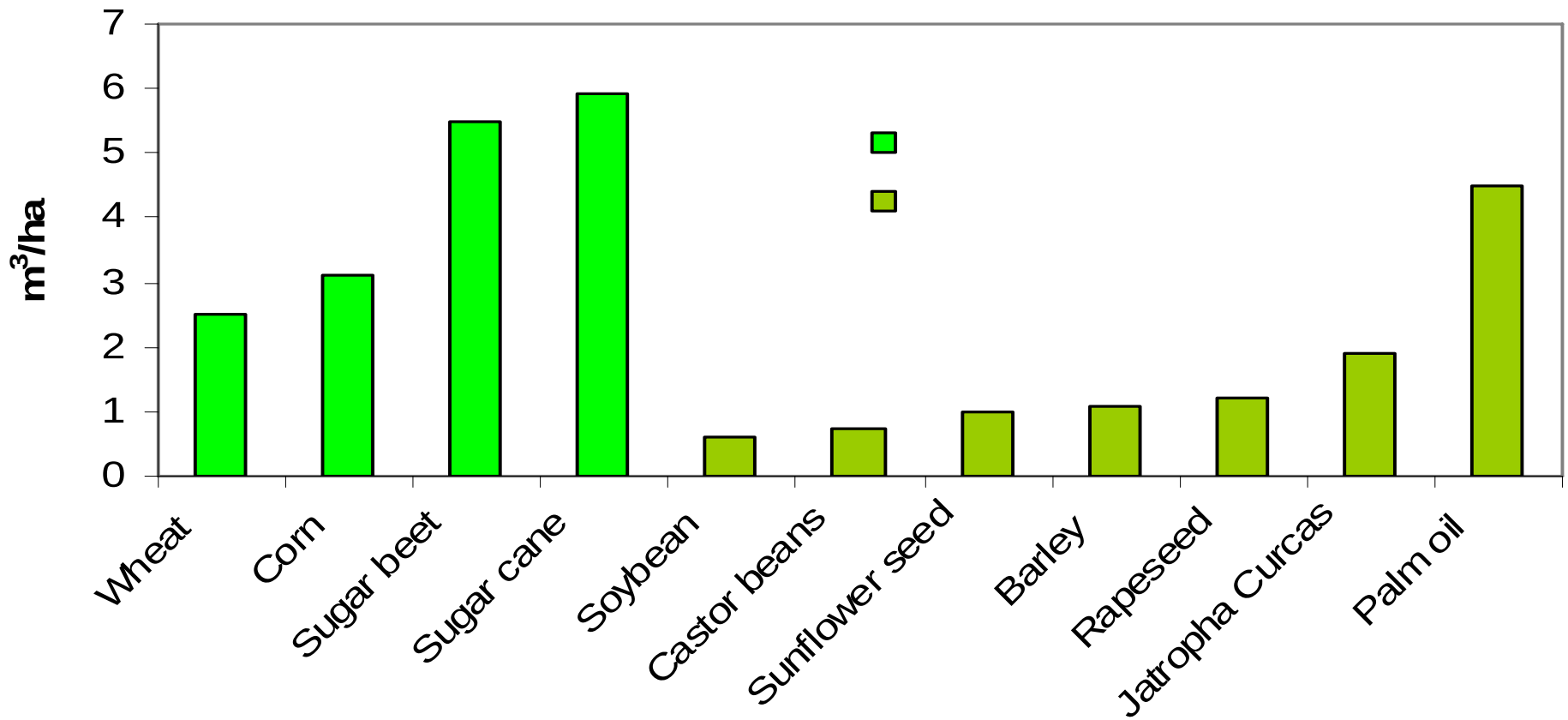
- *Oil dependence, Security concerns*
- *(Sub) urban sprawl*
- *Work place logistics*
- *Road vs rail*
- *Private vs public transportation*
- *Energy waste vs demand management*
- *Energy waste vs efficiency, innovation*

The Beginning of a New Era



Source: Nakícenovic, Grübler and MaConald, 1998

Biofuel Yields: Ethanol and Biodiesel Feedstocks



Sources: Horta Nogueira, L.A. Biodiesel in Brazil Workshop on Sustainable Biomass Production for the World Market. IEA Bioenergy Task 40: Sustainable Bioenergy Trade Campinas, December 2005. http://www.fairbiotrade.org/downloads/nogueiranovdec05.pdf; The Indian Biofuels Programme – National Mission on Bio-diesel - Dr. R Mandal International conference and expo on Biofuels - 2012: Vision to reality. TERI. Ministry of Rural Development, Ministry of Petroleum and Natural Gas, Oil Industry Development Board, Ministry of Environment and Forests, World Bank, Tata Motors, GTZ, Hindustan Petroleum Corporation Ltd., and Wartsila. Silver Oak, India Habitat Centre, Lodhi Road, New Delhi, 17-18 October 2005 http://www.teiin.org/events/docs/5biofuel.htm

The New York Times

May 1, 2006

EDITORIAL

Ethanol's Promise

The political scramble to find quick answers to rising oil prices has produced one useful result, which is to get people talking about substitute fuels that could make us less vulnerable to market forces, less dependent on volatile Persian Gulf oil producers and less culpable on global warming.

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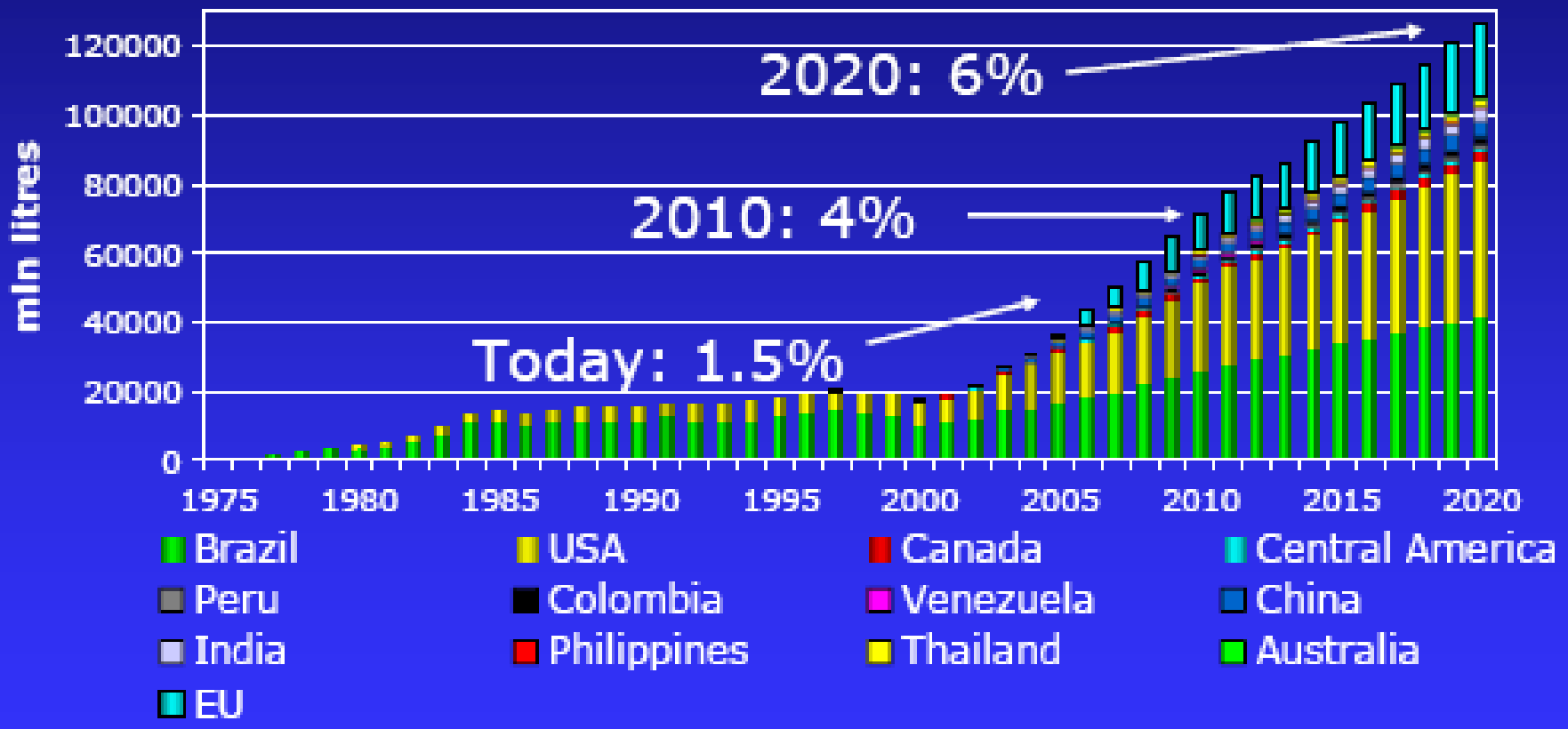
World Ethanol 2005

production by country



Source: Berg, Christoph (2005). "2005 The Year When Everything Went Right." F.O. Licht's World Ethanol 2005, Amsterdam, 2-4 November.

Brazil Biofuels Policy History

- *Sugar cane based ethanol: displaces 40% gasoline + oil self-sufficiency (2006)*
- *State of São Paulo initially driving supply and demand*
- *Up to 1975: Ethanol blending when convenient*
- *1975: Proalcool*
- *1980s: Neat ethanol introduced*
- *1990s: Moderate oil prices, Ethanol set backs, Ethanol imports, Removal of all incentives, except blend mandate*
- *2000s: Ethanol competitive, Expansion, Exports, Biodiesel, Brazilian FFVs, World trade promotion, NYBoT futures contract*

Brazilian Sugar Cane Industry: Key Stakeholders

Agriculture

- 50 thousand sugar cane growers

Sugar and Ethanol Making

- 346 mills/distilleries

Ethanol transportation, storage, distribution and end-use

Gasoline Retail Stations

- 32,030 Gas Stations sell neat ethanol (92% of the total)
- Free market prices

Brazilian FFVs

Exports

- 2.38 Billion liters exported in 2004

Fuel Distributors

- 160 Operating Distributors
- Only distributors may blend ethanol with gasoline

Source = MAPA – MME – MDIC - 2005

National Policy Lessons

- *Consensus among the key stakeholders: oil industry, auto industry and ethanol/sugar makers*
- *Cooperation between cane growers and mill/distillery owners*
- *National innovation system in place*
- *Agricultural research, extension, and application by farmers: Critical for lowering production costs*
- *Comprehensive utilization: surplus bagasse, cogeneration*
- *Waste reduction in harvest (field burning of tops and leaves) and ethanol production (stillage disposal)*
- *Supportive government policies*

⇒ *Replication of Brazil's ethanol experience requires assessing risks and the factors necessary for success over the long term*

Adapted from Kojima, Masami and Todd Johnson (2006). Potential for Biofuels for Transport in Developing Countries; Presentation at World Bank Energy Week, Washington, DC, 7 March

Biofuels for domestic consumption in key developing countries, besides Brazil

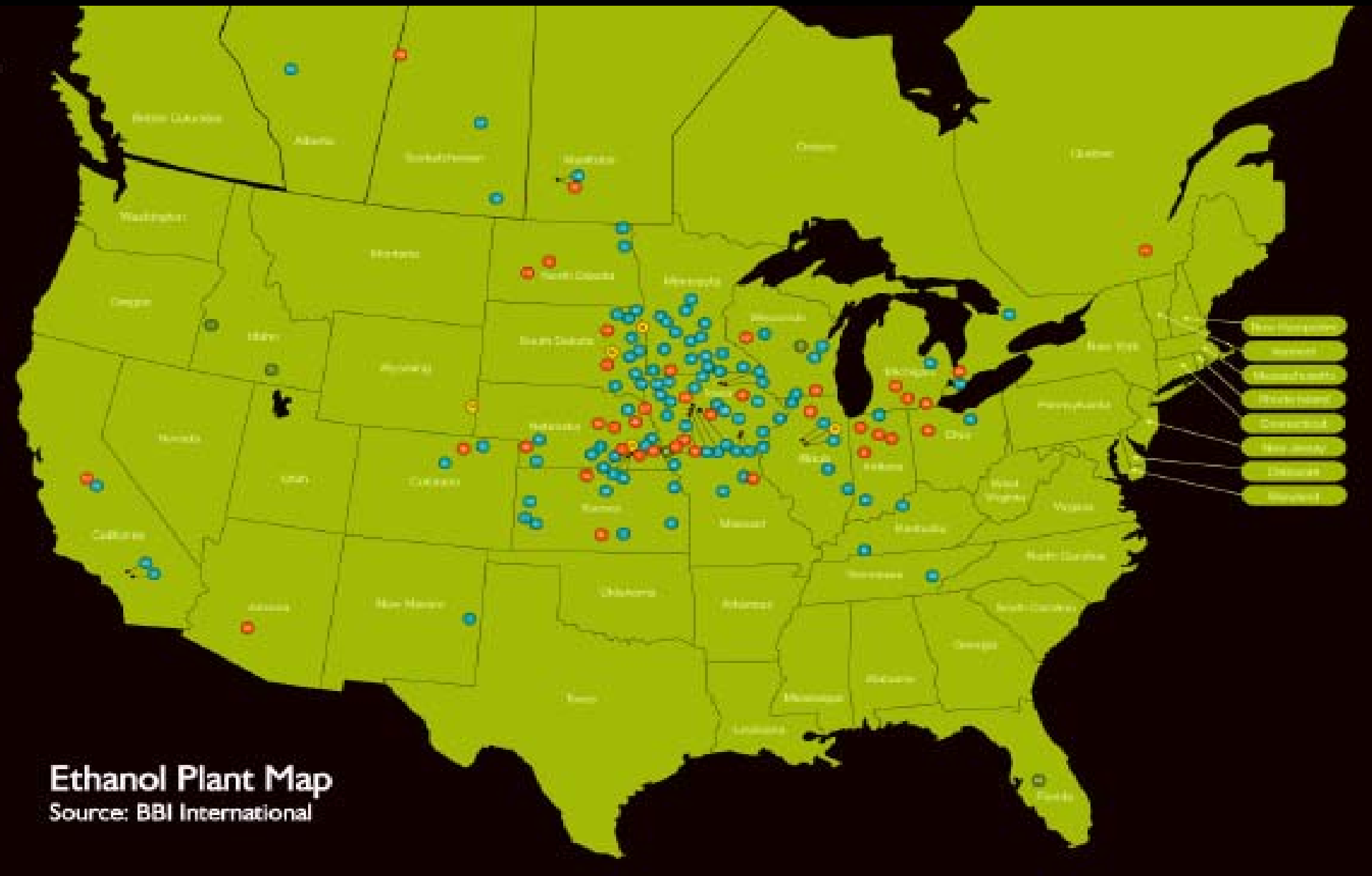
- *China: 20% of gasoline consumed contained ethanol in 2005*
- *Colombia: 10% ethanol in gasoline targeted*
- *India: 5% ethanol in certain states if ethanol is not more expensive, biodiesel purchase policy*
- *Indonesia: 3% of energy from plant-based fuels by 2025*
- *Malaysia: biodiesel from palm oil, trial underway*
- *Philippines: coco-biodiesel, ethanol planned*
- *Thailand: explosive growth of E10*

Source: Kojima, Masami and Todd Johnson (2006). Potential for Biofuels for Transport in Developing Countries; Presentation at World Bank Energy Week, Washington, DC, 7 March

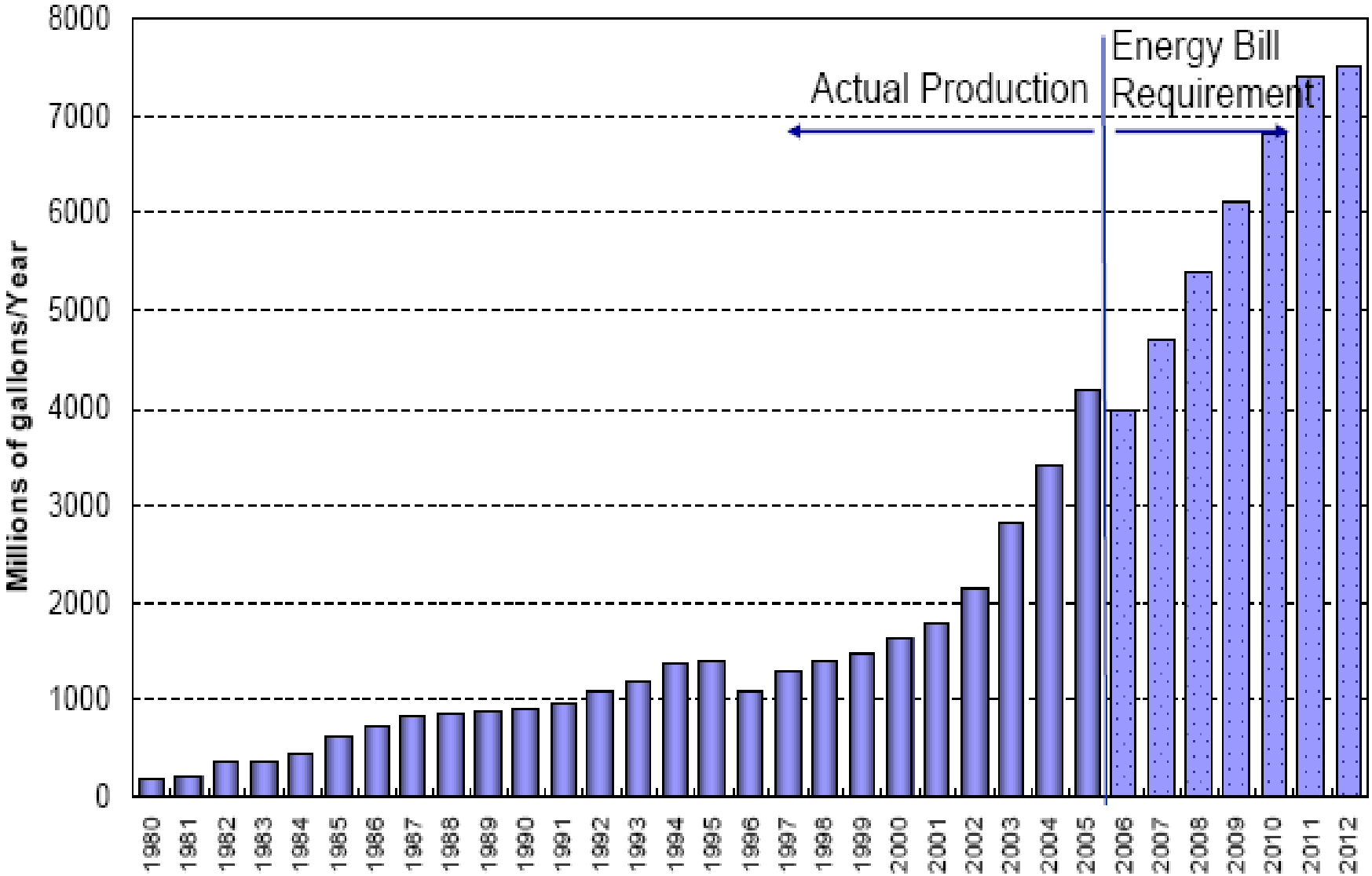
US Biofuels Policy History

- *Corn based ethanol: displaces 3% gas (2006)*
  30% of 2004 demand DOE target for 2030
- *California, East driving demand, Midwest supply, States' programs and mandates*
- *1980s: Gasohol stretching gasoline, octane, fiscal incentives, imports, import barriers*
- *1990s: Moderate oil prices, Reformulated gasoline oxygen, Winter gasoline, MTBE and Ethanol, Stretching gasoline, Octane*
- *2000s: MTBE ban, Ethanol expansion, 2005 Energy bill, Biofuels mandates, Biodiesel, US FFVs E-85 program, Chicago exchanges corn ethanol contracts*

North American Ethanol Distilleries



U.S. Fuel Ethanol Production has Experienced Large Increases, and the Trend Will Continue

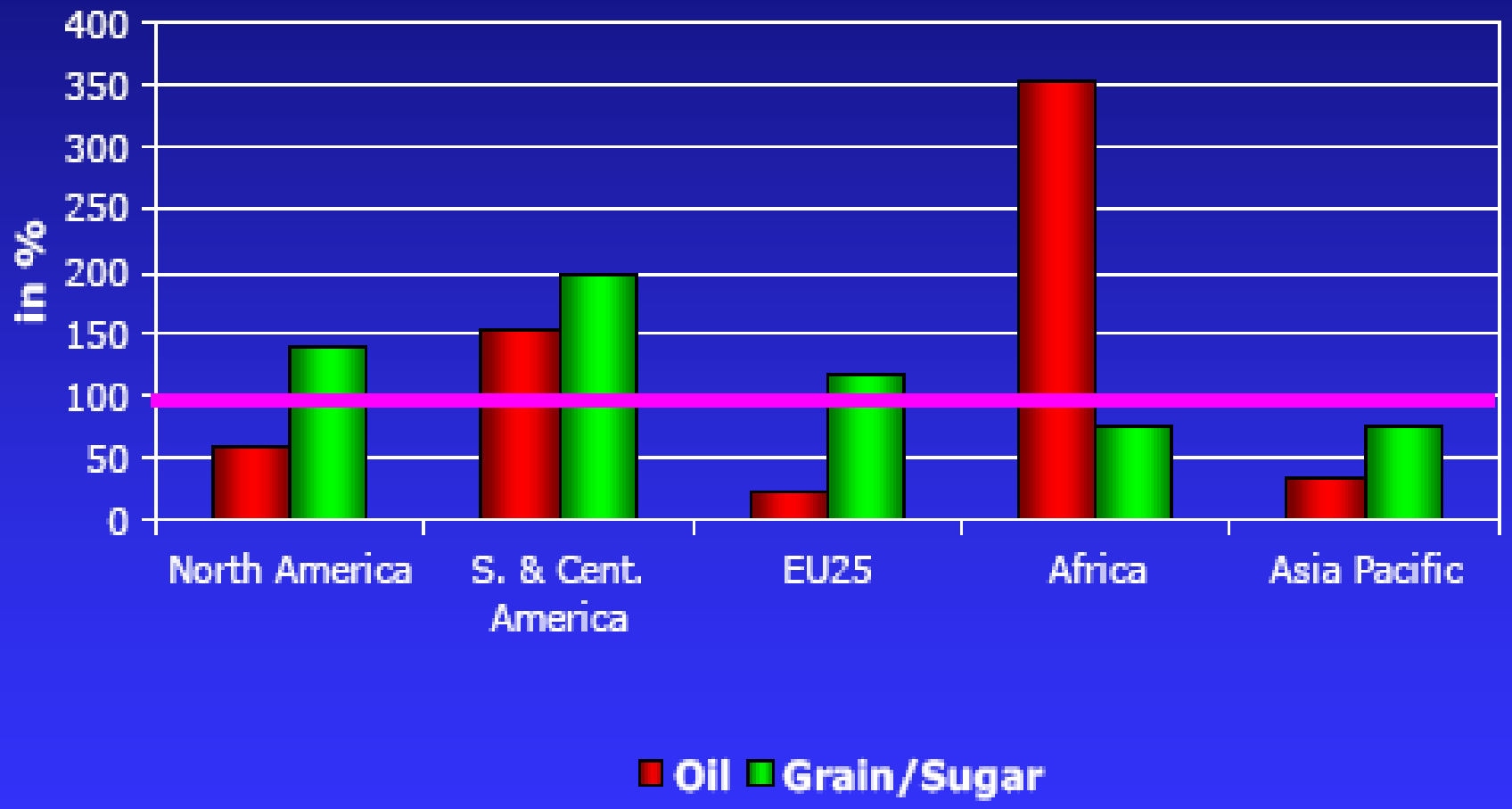


Source: Renewable Fuels Association

Cellulosics-based Biofuels in the USA

- *Limits to starch, sugar based biofuelss*
- *DOE sponsored research on enzymatic, thermochemical, acid hydrolysis, hybrid hydrolysis/enzymatic, etc.*
- *The Biomass Research and Development Act of 2000 helps, but*
- *Federal support via Energy Policy Act of 2005 (P.L. 109-58) needs funding*
- *National security, climate change and rural economic pressures addressed by cellulosic technologies.*
- *Will cut oil imports, reduce GHG emissions and create rural jobs*

Fuel vs. food – self-sufficiency ratios



Source: Berg, Christoph (2005). "2005 The Year When Everything Went Right." F.O. Licht's World Ethanol 2005, Amsterdam, 2-4 November.

Barriers and Drivers to Biofuels Policy Formulation

- *Risk perception*
- *Venture capital availability*
- *Marketing approaches*
- *Lacking infrastructure*
- *Public policies, innovation system, the environment*
- *Sustainable supply, well functioning market*
- *Definite limits to biofuels to meet transport fuels demand*

And

- *Investors and consumers demanding change, including de-linking biofuels from the food/feed markets*
- *Biofuels for transportation directives in the EU*
- *Renewable Energy Portfolio Standards in US*
- *Growth in China, India, Indonesia, Malaysia and Thailand*
- *Japan biofuels demand expected to grow considerably*
- *LT future looking investors, e.g. Goldman Sachs $ 30 million investment in logen cellulosics-base ethanol*

Biofuel Sustainability

- *Mindset shift required: Let us not switch from wasting fossil fuel to wasting biofuels!*
- *Any able country should:*
  - *promote its domestic biofuels*
  - *play international market: trade, invest, transfer technology*
- *Biofuels must be traded internationally, sourced from world's stabler areas*
- *Carbon recycling will add value to biofuel*
- *From curiosity to commodity, biofuels becoming sustainable fuels*

Biofuels innovation is a must

- *10% Ethanol replaces ~10% gasoline*
- *FFVs may be wasteful if off-optimum*
- *Hybrids performance is variable*
- *5% Biodiesel replaces ~5% diesel*
- *0.17% DiesoLIFT replaces 5% diesel !*
  - *30 times more efficient than biodiesel*
  - *Saves fossil (diesel) and renewable resources (biodiesel)*
  - *Biofuel-based energy security enhancing technology ready to use*

The Mindset Shift

- *Biofuels in diverse fuel mix, + Security*
- *Reorganize (sub) urban living*
- *Use IT to the fullest*
- *Renewed role for rail*
- *Promote public transport convenience*
- *Turn the ignition key off (sometimes)*
- *Increase CAFE, inclusion, innovation*