

The Competition for Biofuels and Alternative Energy.

Brent Sohngen

State Specialists, Environmental Economics
AED Economics, Ohio State University

Main Points

- Review two studies examining energy outlook to 2030
 - Dept. of Energy, Energy Information Administration. 2007. “Annual Energy Outlook 2007, With Projections to 2030.” DOE/EIA-0383(2007).
<http://www.eia.doe.gov/oiaf/aeo/>
 - Dept. of Energy, Energy Information Administration. 2006. “International Energy Outlook, 2006.” DOE/EIA-0484(2006).
<http://www.eia.doe.gov/oiaf/ieo/>
 - Conclusions: **Despite massive economic growth globally, there is little evidence of non-renewable scarcity by 2030. Biofuels and renewables will have to become substantially cheaper through technology change (or more subsidies) to have a large impact on energy economy by 2030.**
- Climate Change policy could alter the equation, however, long-term forecasts suggest that the most important impacts on biofuels and other renewables will be seen after 2030.
- Policy that favors biofuels and renewables could speed up their adoption
 - Carbon taxes, cap and trade systems, Renewable Portfolio Standards.
- Some policies would not favor biofuels and renewables:
 - CAFÉ Standards, Investments in mass transit (depending on type), etc.

What Affects the Viability of Bio- and Alternative- Energy?

- Energy Supply and Demand:
 - Markets are Global
 - Prices set by international competition
 - Demand Factors: Economic Growth, Tastes and Preferences
 - Supply: Discoveries, Technology Change
 - Short and Long Run issues.
- Policy Issues:
 - Energy & Farm Policy.
 - Land-Use Policy.
 - Local Policy
 - Carbon/Climate Policy.

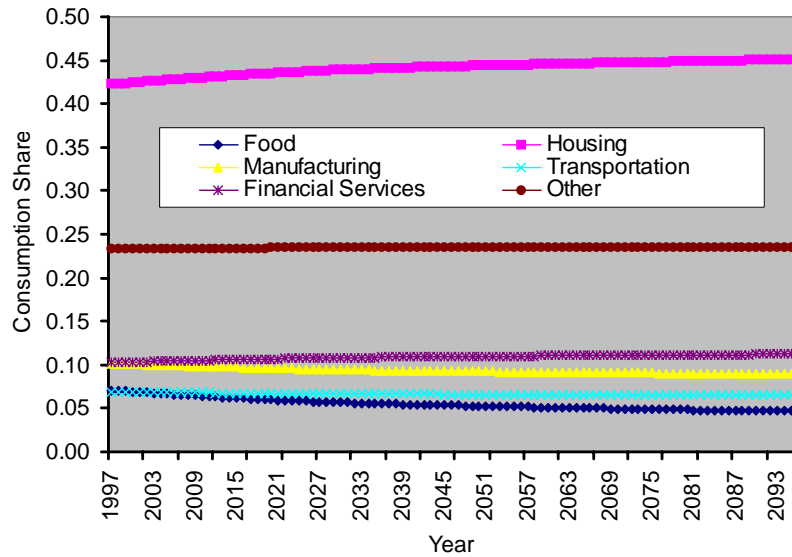
GDP & Population Growth

(EIA International Energy
Outlook, 2006)

	2003	2030	% Chg/yr
GDP (Bn/yr)			
US	10,321	23,112	3.0%
Europe	10,799	19,394	2.2%
China	5,994	28,833	5.8%
India	3,429	14,102	5.2%
World	50,786	140,331	3.8%
Population (Millions)			
US	291	365	0.8%
Europe	530	562	0.2%
China	1,299	1,446	0.4%
India	1,070	1,449	1.1%
World	6,312	8,203	1.0%
GDP/Capita			
US	35,467	63,321	2.1%
Europe	20,375	34,509	2.0%
China	4,614	19,940	5.4%
India	3,205	9,732	4.1%
World	8,046	17,107	2.8%

Tastes and Preferences

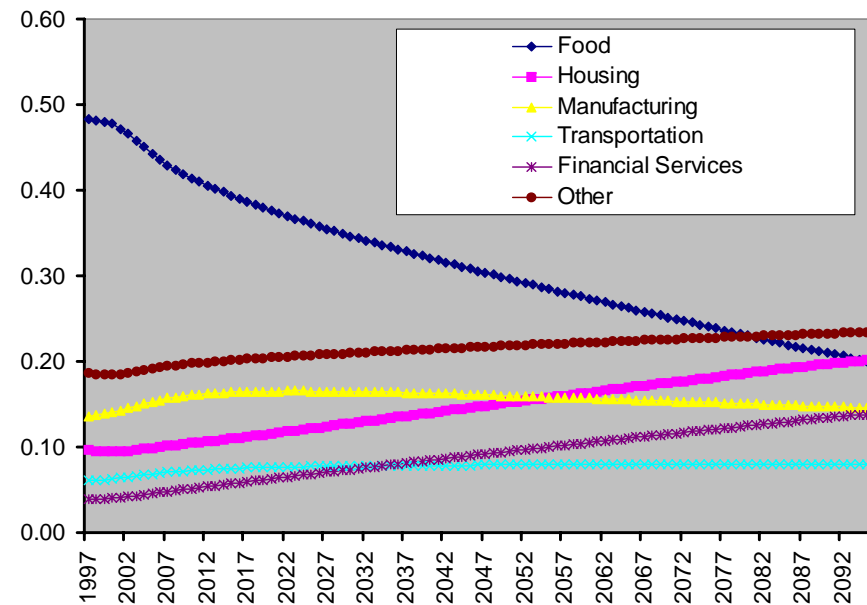
Results based on Reimer and Hertel (2002)



US Consumption Shares 1997 - 2095

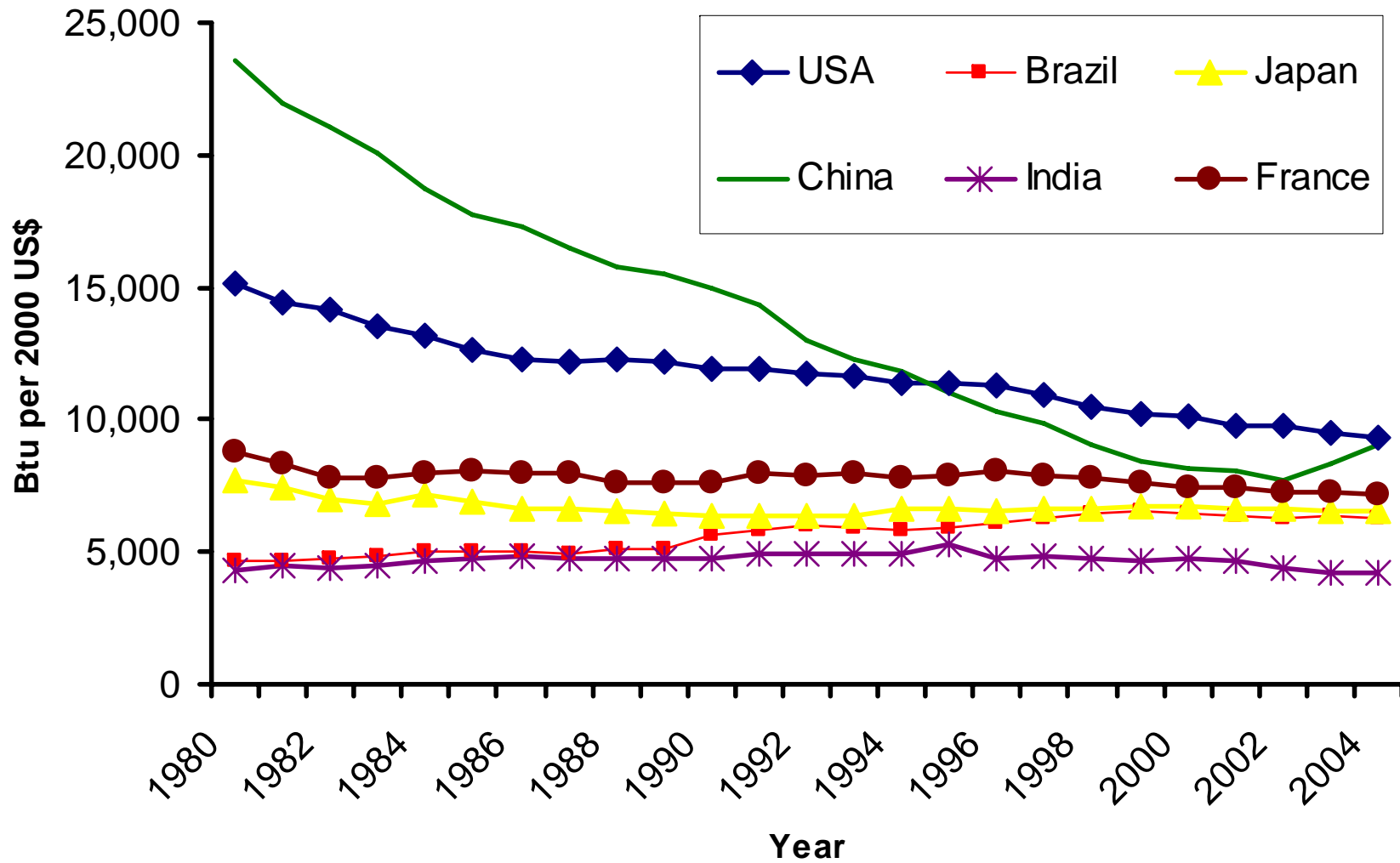


China Consumption Shares



Tech. Trends: Energy Intensity

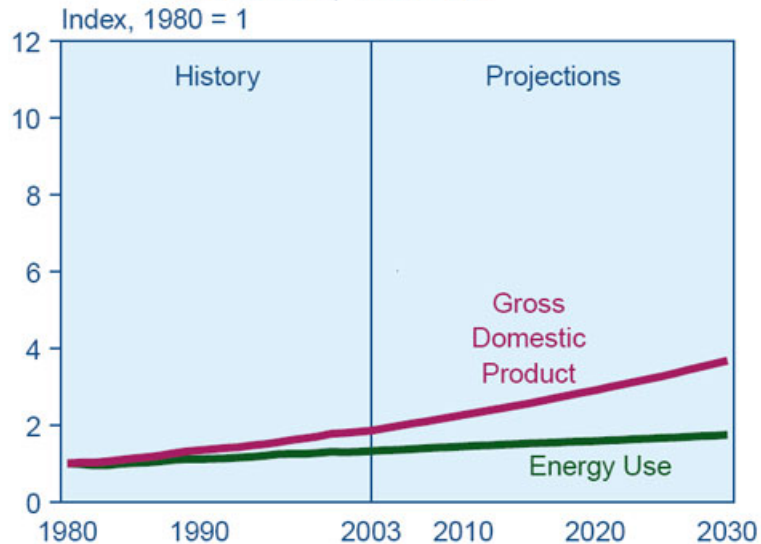
(International Energy Outlook, 2006)



Will Income Continue to be De-linked from Energy?

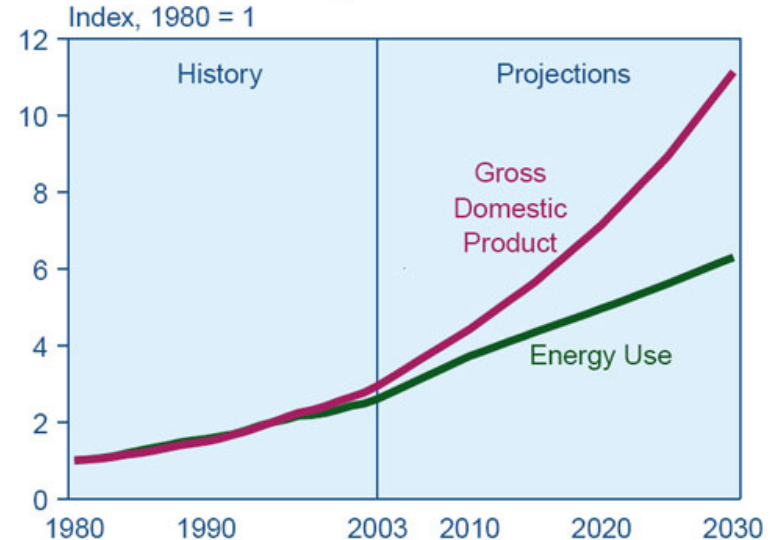
Energy Intensity (Int'l Energy Outlook, 2006)

Figure 15. Growth in Energy Use and Gross Domestic Product for the OECD Economies, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).

Figure 16. Growth in Energy Use and Gross Domestic Product for the Non-OECD Economies, 1980-2030

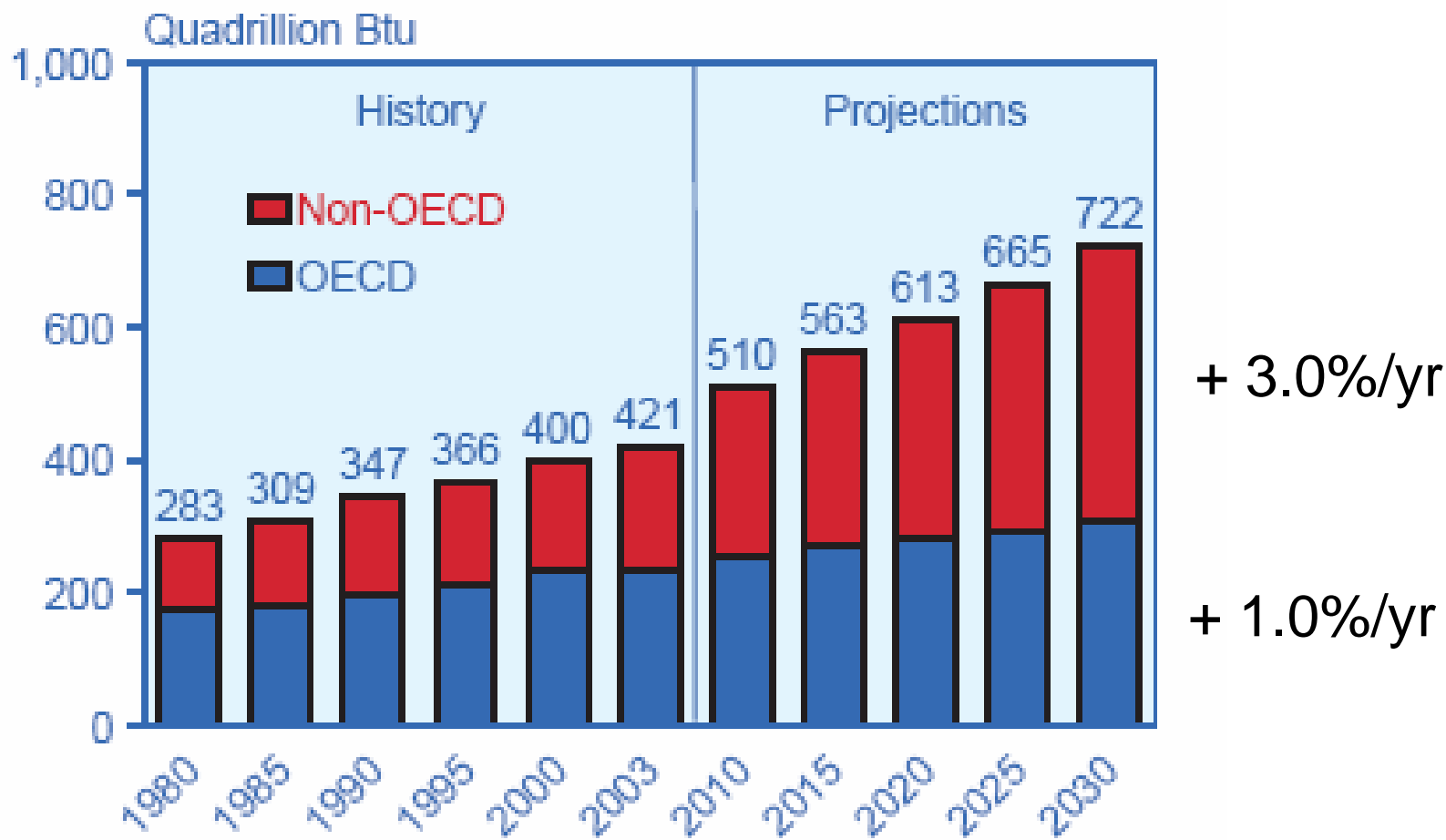


Note: Non-OECD economies in this figure exclude non-OECD Europe and Eurasia.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).

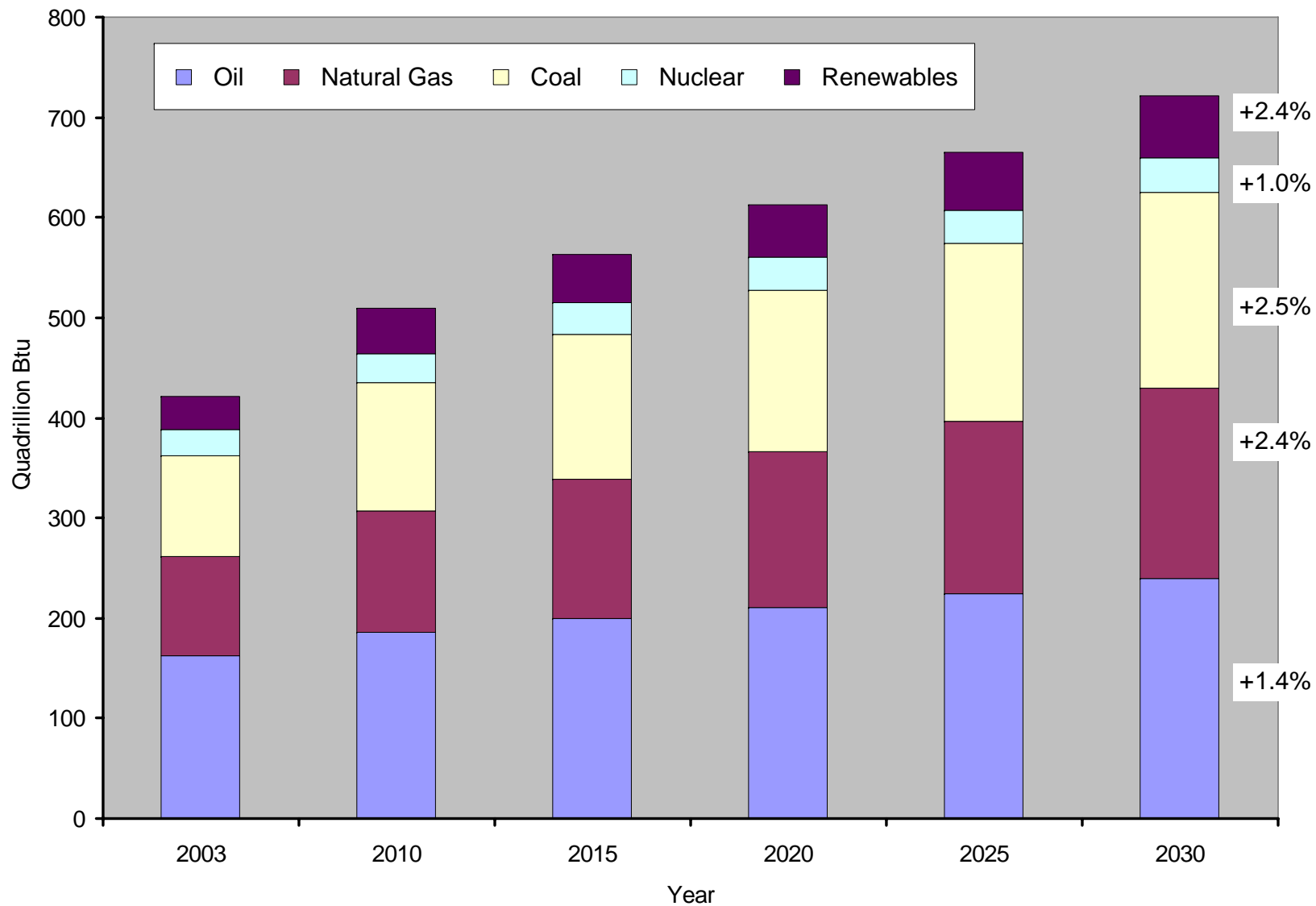
Most Growth in Energy Consumption is in Non-OECD

Figure 1. World Marketed Energy Consumption by Region, 1980-2030



World Energy Consumption

(2003 – 2030) + 2.0%/yr (IEO, 2006)



Where Does the Growth in Energy Consumption Occur?

*International Energy
Outlook (2006)*

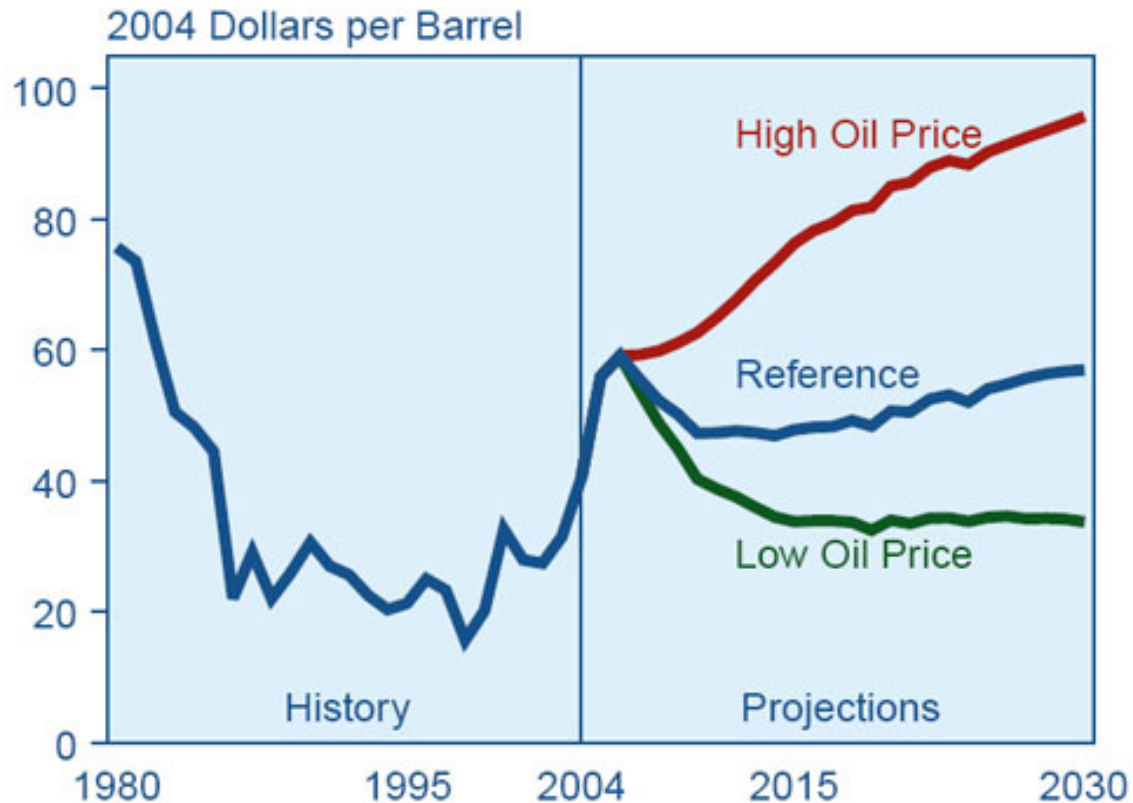
	Avg. Ann. % Chg (2003- 2030)
China	4.2
India	3.2
Other Non-OECD Asia	3.0
Central and South America	2.8
Africa	2.6
Mexico	2.5
Brazil	2.5
Middle East	2.4
South Korea	2.2
Non-OECD Europe and Eurasia	1.8
Russia	1.6
Canada	1.3
United States	1.2
Australia/New Zealand	1.2
OECD Europe	0.7
Japan	0.3
World	2.0

Summary: World Outlook to 2030

- Large growth in energy consumption:
Globally = + 2.0%/yr
US = + 1.2%/yr
- Biomass and renewable energy will increase more strongly than other sectors:
Globally = + 2.4%/yr
US = + 1.9%/yr
- Technological Progress continues to de-intensify energy consumption in the economy:
Globally = -1.8 %/yr
US = -1.8 %/yr

World Oil Prices

Figure 32. World Oil Prices in Three Cases, 1980-2030



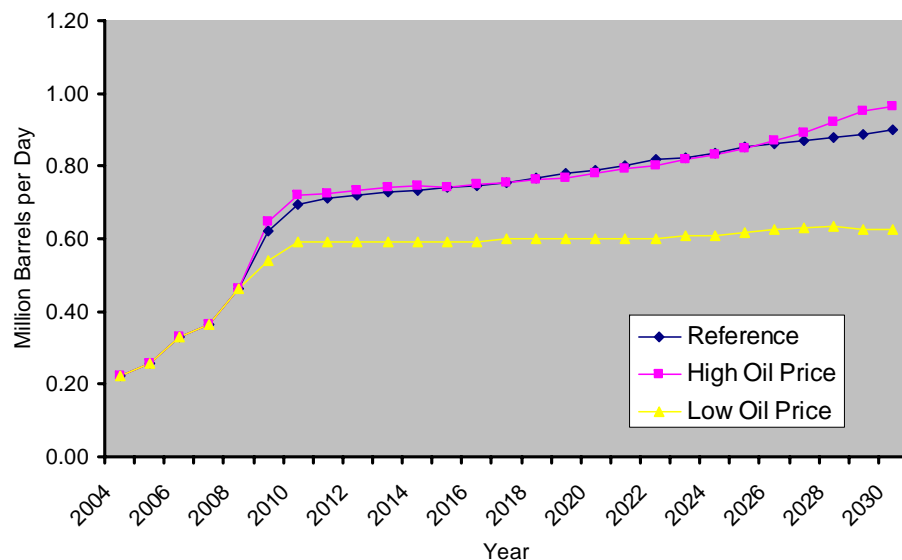
Sources: **History:** Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0384(2004) (Washington, DC, August 2005), web site www.eia.doe.gov/emeu/aer/.
Projections: EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006).

- Range due to uncertain political stability, not due to scarcity or “Peak Oil”.
- Reference Case=> < \$60/barrel
- High: Reserves 15% lower and costs 15% higher
- Low: Reserves 15% higher and costs 15% lower.

Implications for Domestic Ethanol

EIA (AEO, 2007)

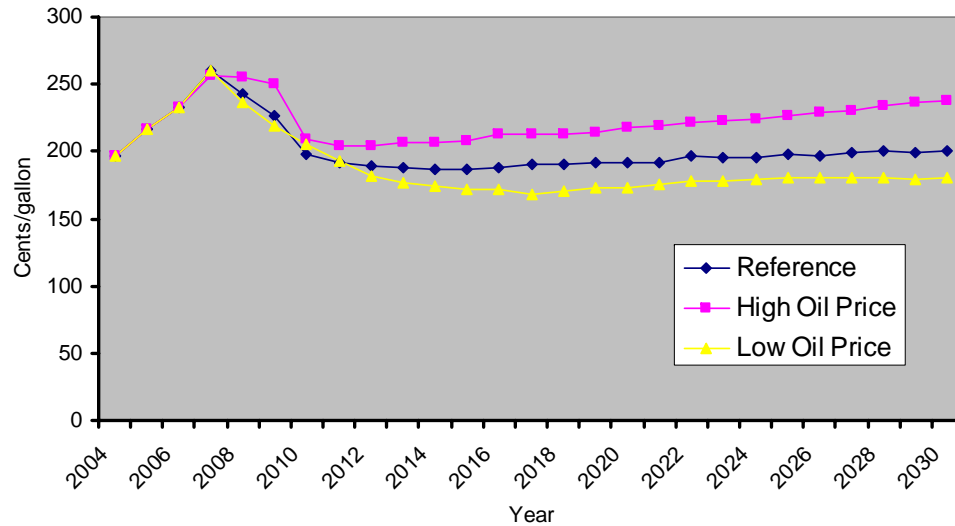
Domestic Ethanol Prod.



- US reference “Oil” Consumption (2030): 27 MB/day
 - Why such a small increase in ethanol with high world oil price?
 - Crude imports fall 2.5 MB/dy
 - Total Petroleum falls 2.4 MB/dy
 - Tech change in petroleum processing.
 - Consume 8% less petroleum
 - Gas prices rise 7%
- => Ethanol accounts for only **3%** of the reduction in total petroleum supply.

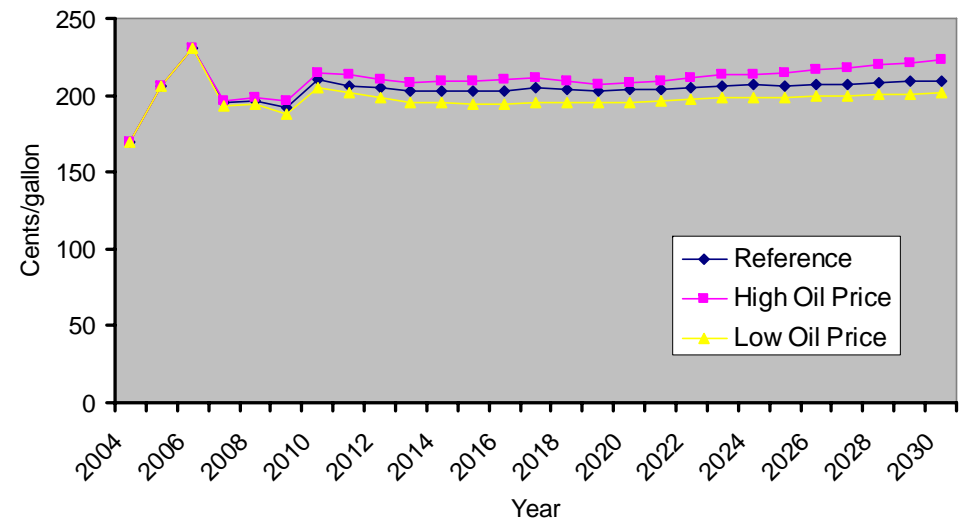
Ethanol and Gasoline Prices

EIA (AEO, 2007)



←

Gasoline Prices

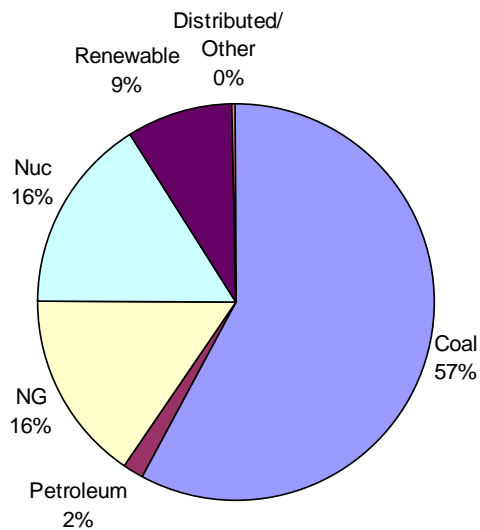


Electricity Sector and Renewables?

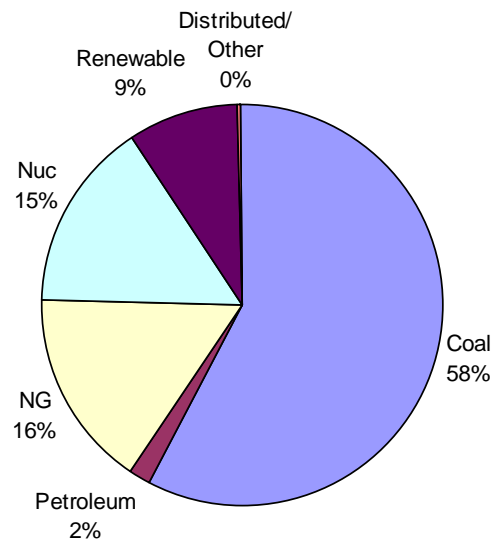
Market Penetration in 2030

EIA (AEO, 2007)

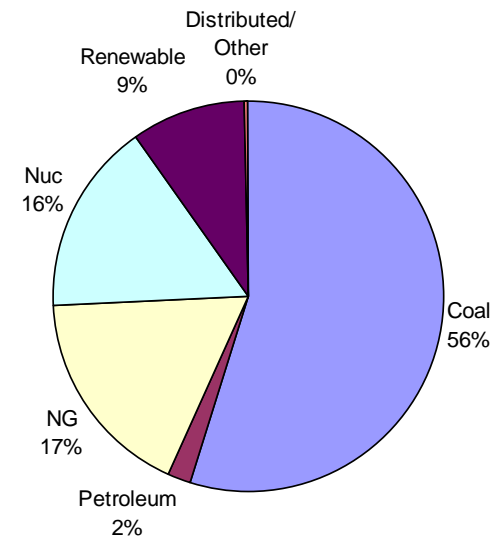
High GDP Growth



Reference



Low GDP Growth



Total Generation Expansion

1.81%/yr

1.45%/yr

1.07%/yr

Renewable Generation Expansion

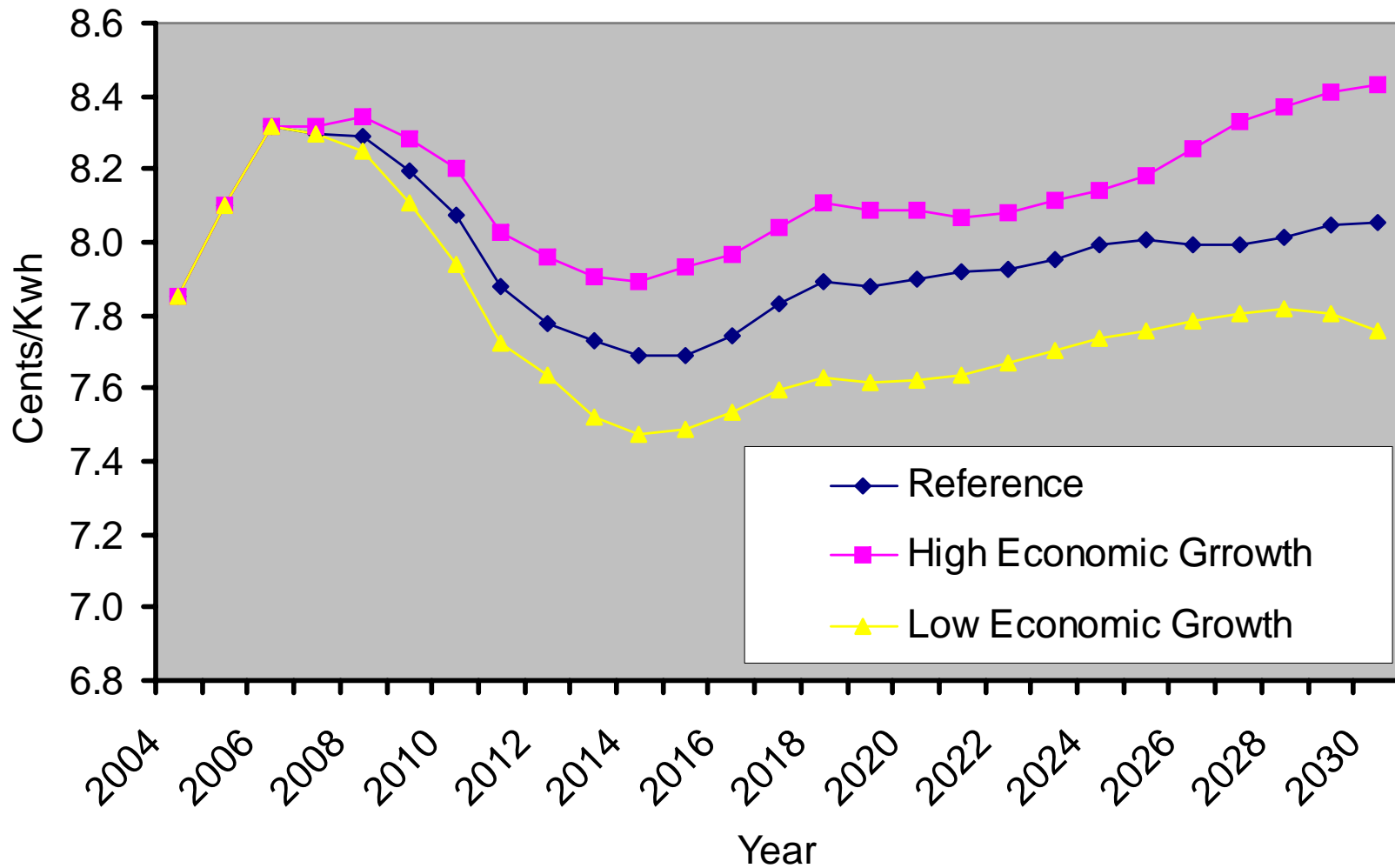
1.64%/yr

1.40%/yr

1.22%/yr

Why So Little Renewable Expansion?

Average Electricity Prices (EIA, 2007)



Summary for 2030

EIA (AEO, 2007)

Petroleum Markets

	Reference	Low Oil	High Oil
Oil (\$/B)	\$59	\$36	\$100
Gasoline (\$/gal)	\$2.09	\$2.01	\$2.23
E85 (\$/gal)	\$2.00	\$1.81	\$2.38

Electricity Markets

	Reference	Low GDP	High GDP
Electricity (c/Kwh)	8.1	7.8	8.4
Renewable Growth (%/yr)	1.4%	1.2%	1.6%
Coal Growth (%/yr)	2.0%	1.4%	2.4%

Limitations of EIA Analysis

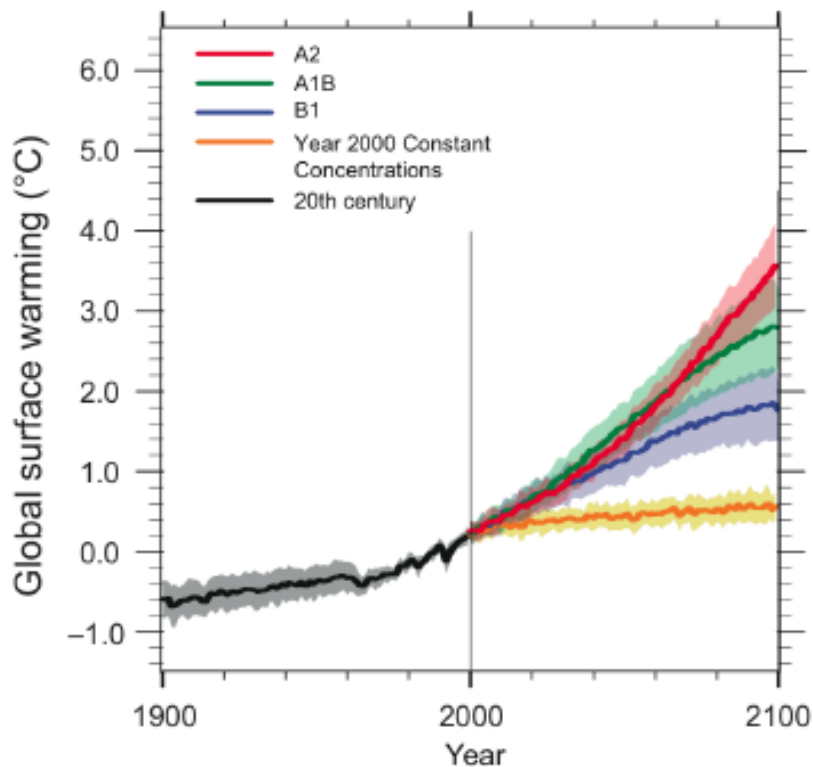
- Do not model land use and supply
 - Competition for land could have large implications for potential expansion of ethanol.
- Conservative about technology improvements in cellulosic ethanol
 - Improved processes would increase role for land use component.
- BUT, the implications of both of these for prices is unclear.
 - Improved technology could raise prices in land market further.
 - Limits to technology solutions...

Environmental Constraints

- Analysis to 2030 ignores environmental constraints on the economy
 - Climate Change policy could change this picture dramatically.
- What is the nature of the “Climate Problem”
- What effects will this have on Bio-Energy?

Range of Potential T Change

IPCC WGI (2007)



IPCC Figure SPM-5

- IPCC range of temperature change over century is roughly 1° - 4° C, or 0.2° C/decade
 - CO₂ concentrations rise to 500 – 900 ppmv
- Stabilizing CO₂ concentrations at 2000 levels (370 ppmv) would still lead to + 0.1 ° C/decade

Economic Synopsis of the *Climate Problem*

- A large number of economic studies have now been conducted
 - Damage estimates: \$6 - \$30/ t C (\$1.63 - \$8.17/ t CO₂).
 - Recommend a slow start, with more stringent carbon constraints over time.
 - Estimates in Stern Report problematic to many economists.
- Stabilization Policy is a more costly alternative
 - The more dramatic the cuts, the larger the costs.
 - Clarke et al. (2006) suggest that the most stringent cuts could reduce GWP by more than 6% globally by 2100.

Analysis by the U.S. Climate Change Science Program

(Clarke et al., 2006)

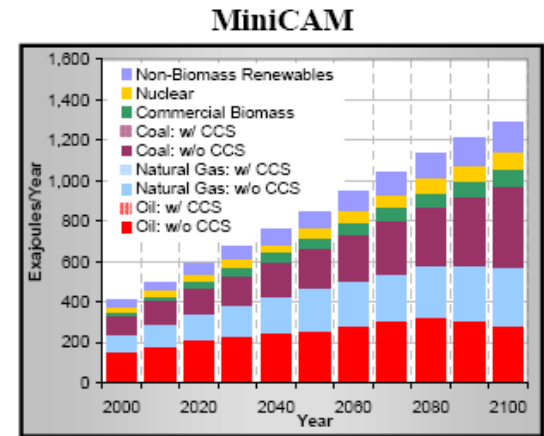
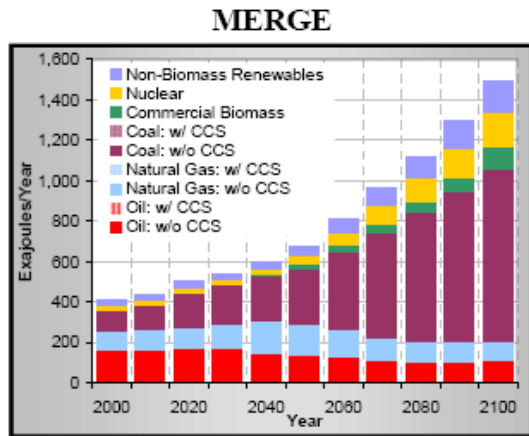
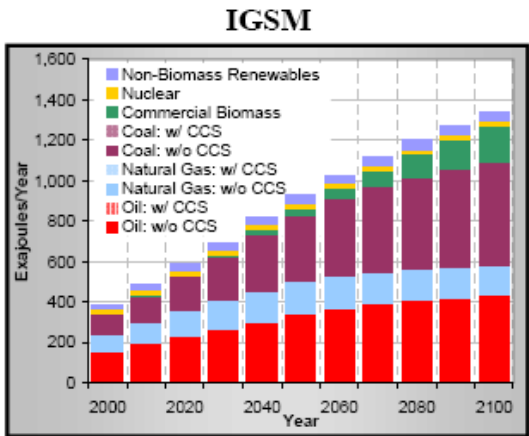
- Utilized 3 well known energy-economy models
 - MiniCam (Battelle/PNL)
 - IGSM (MIT)
 - Merge (EPRI)
- Consider stabilizing CO₂ concentrations:
 - Reference (800 – 900 ppmv)
 - 750, 650, 550, 450 ppmv
- Models analyze energy options for meeting these very stringent constraints.

Global Energy Choices

Clarke et al. (2006)

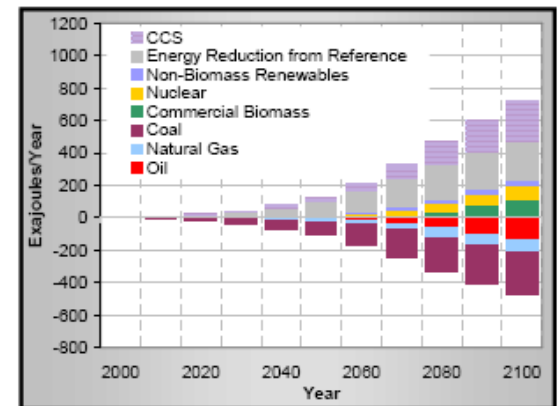
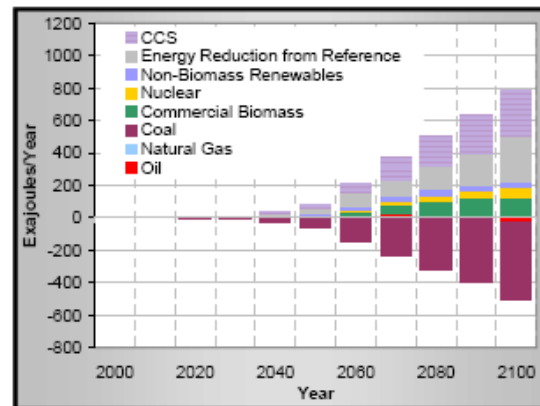
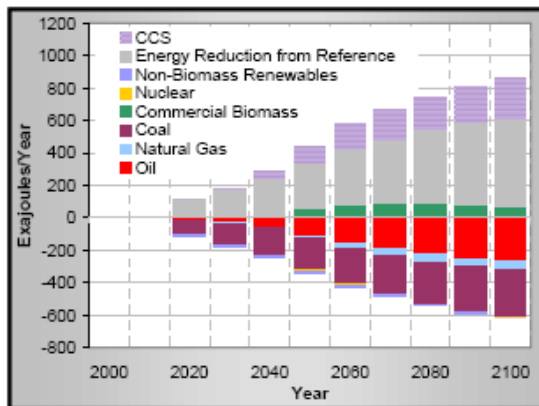
Reference Case

Reference Scenario Global Primary Energy



Changes in 550 ppmv

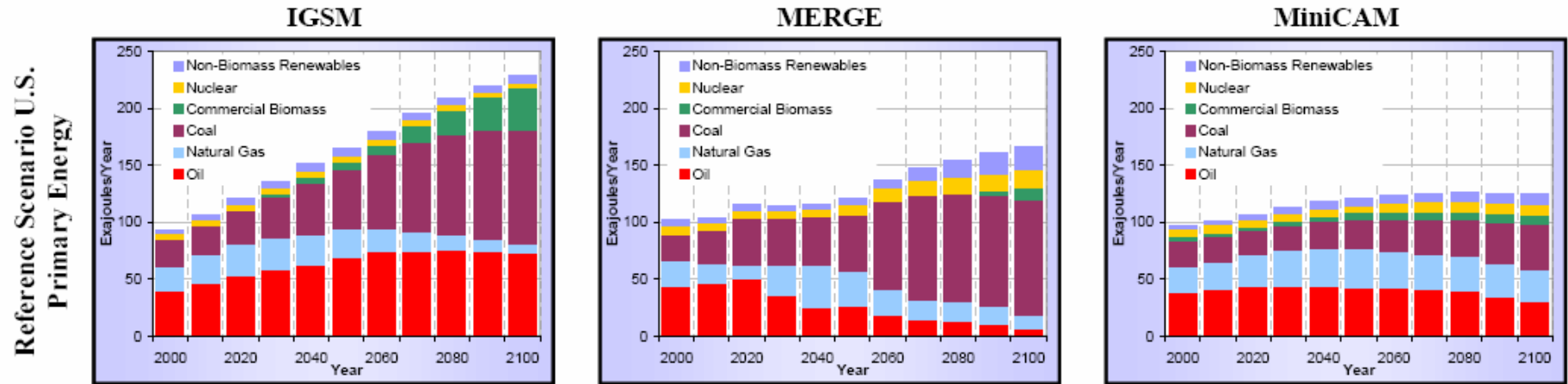
Level 2 Scenarios: Change in Global Primary Energy



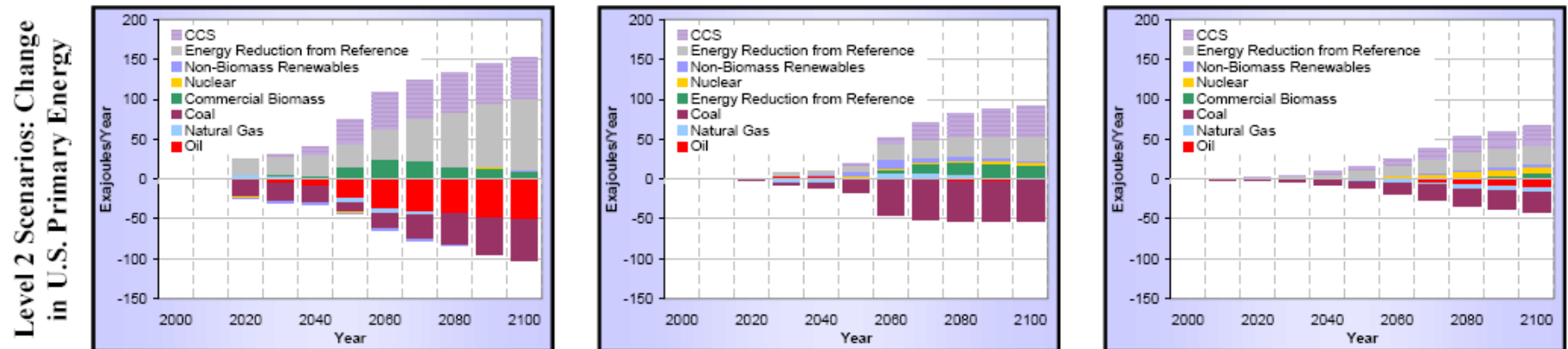
U.S. Energy Choices

Clarke et al. (2006)

Reference Case

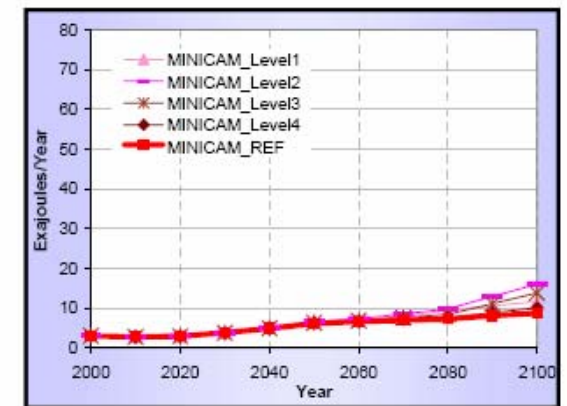
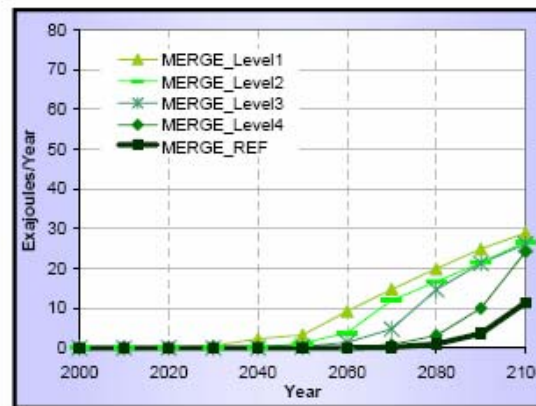
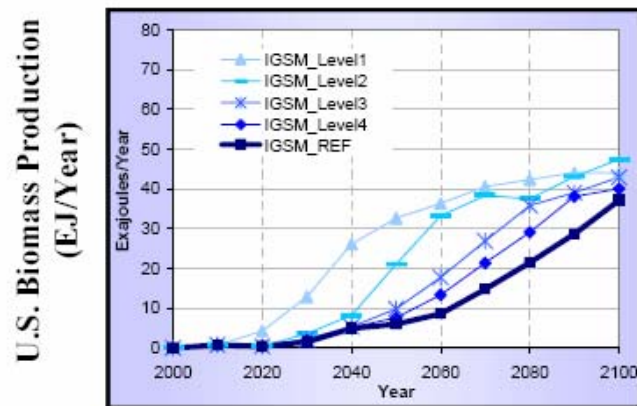
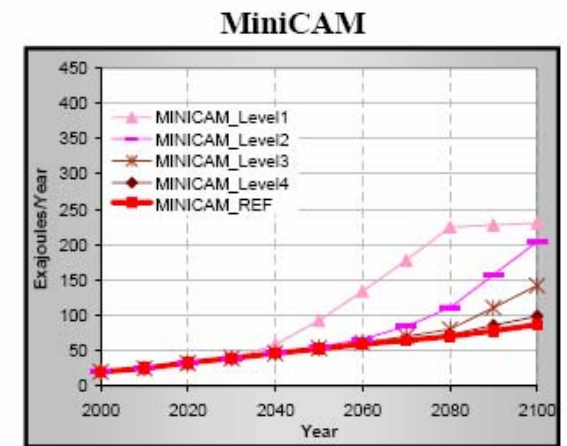
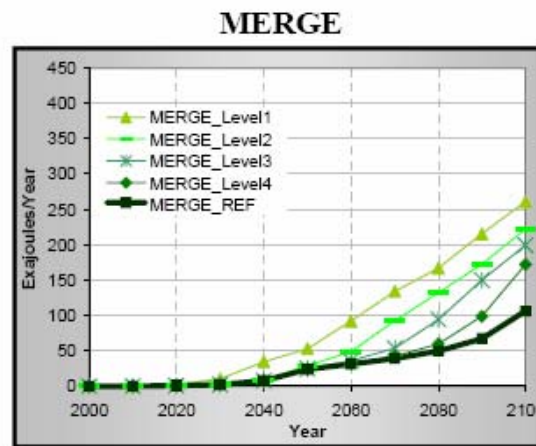
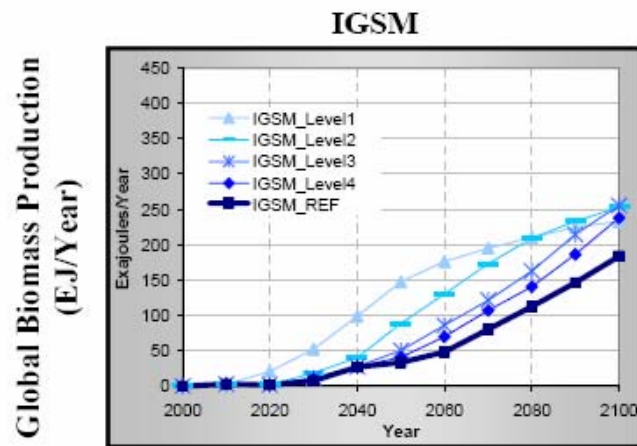


Changes in 550 ppmv



Commercial Biomass Production

Clarke et al. (2006)



Biofuels and Alternatives in the Long-Run?

- Reference Scenario
 - Little evidence of resource scarcity over century.
 - Little scope for biomass and non-renewables in the first 30-50 years.
 - Models differ on long-run prospect
- Climate Stabilization Policy
 - All models agree that biomass and non-renewables are important component.
 - Differ on which of these is emphasized.

Conclusions

- EIA projects a limited role for biomass and other renewables to 2030
 - Do not model land or improved technologies well, although implications for markets of including these is unclear
- Models to 2100 suggest limited role for biomass and other renewables until after 2030.
 - However, they are crucial for meeting climate stabilization targets