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Biomass: Energy, Fuel and Chemicals

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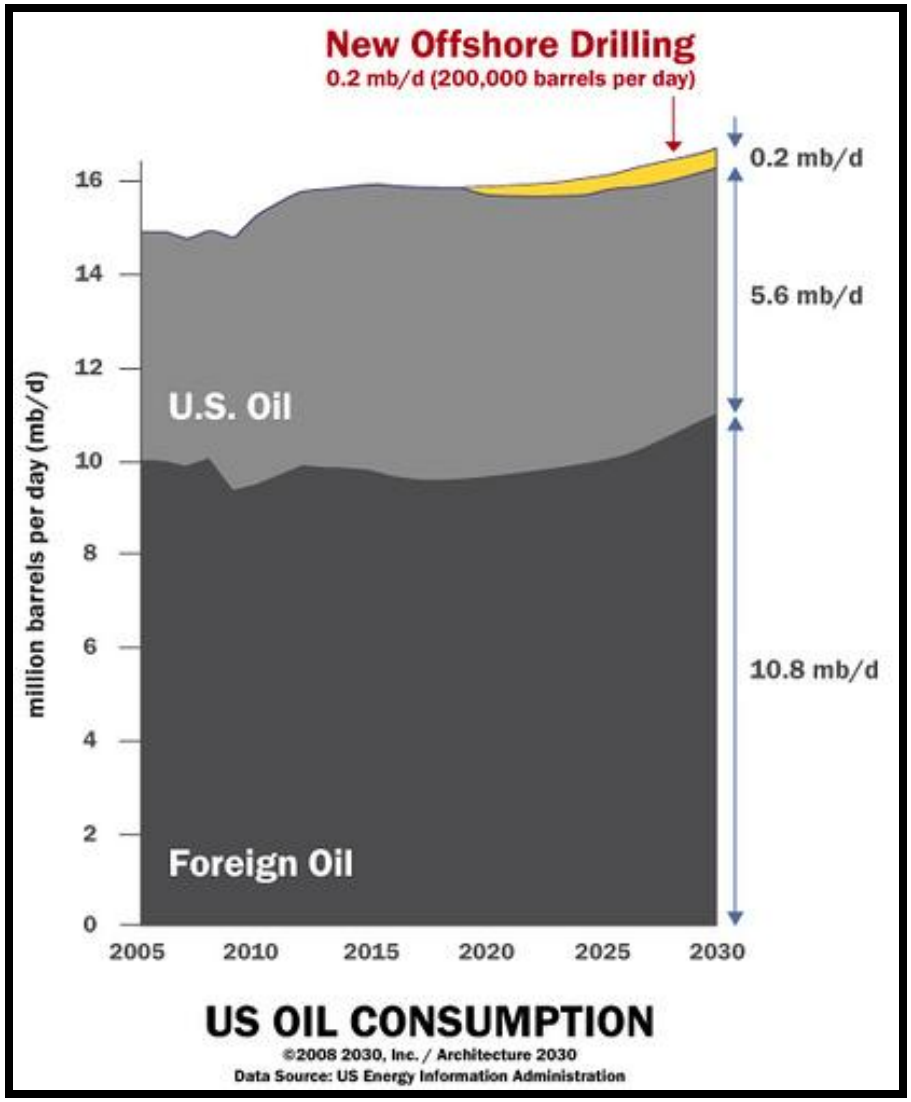
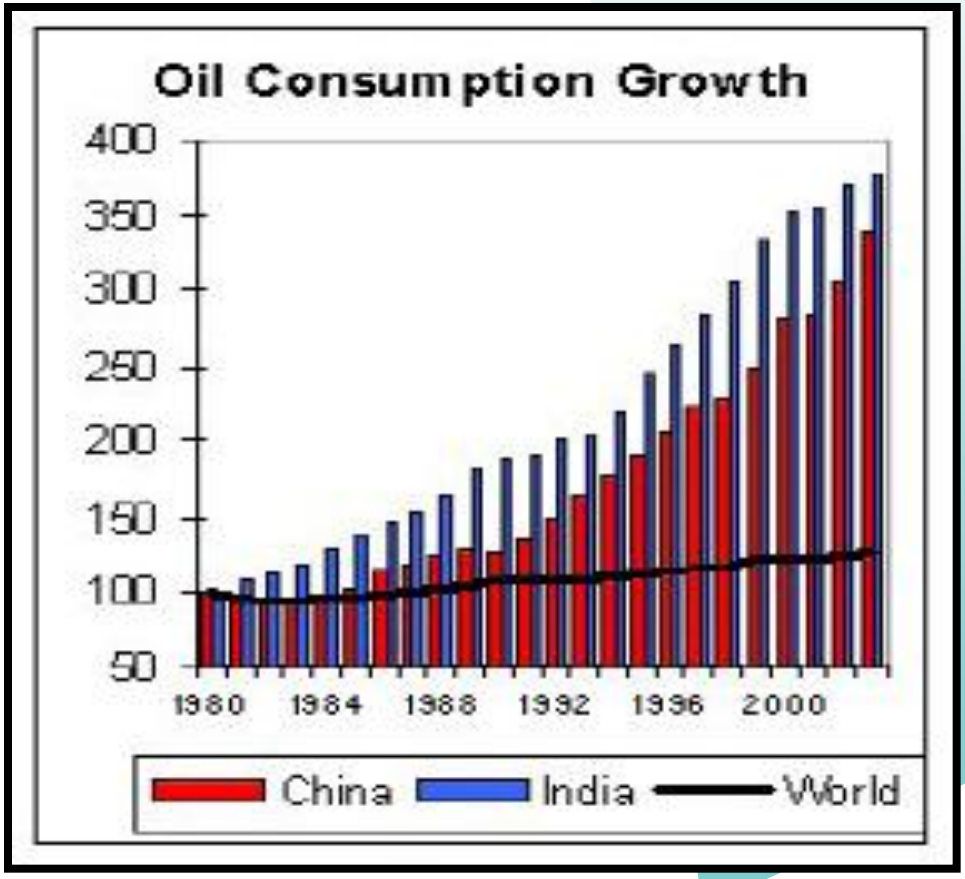
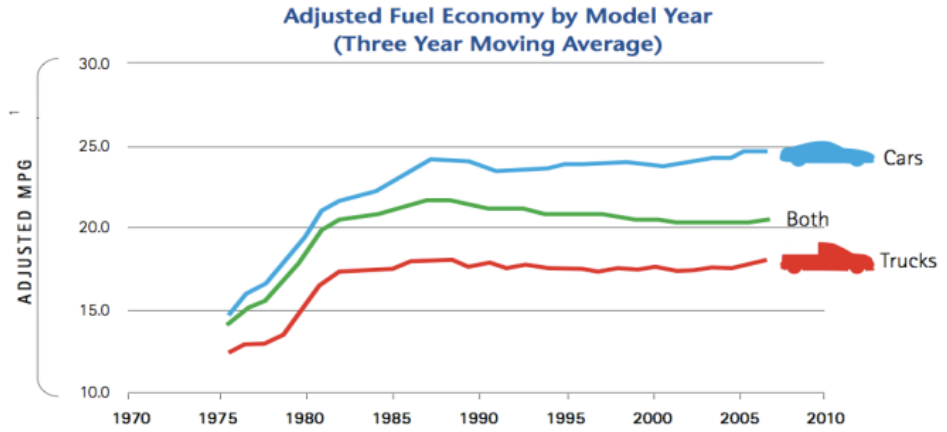
Transportation Fuel Addiction



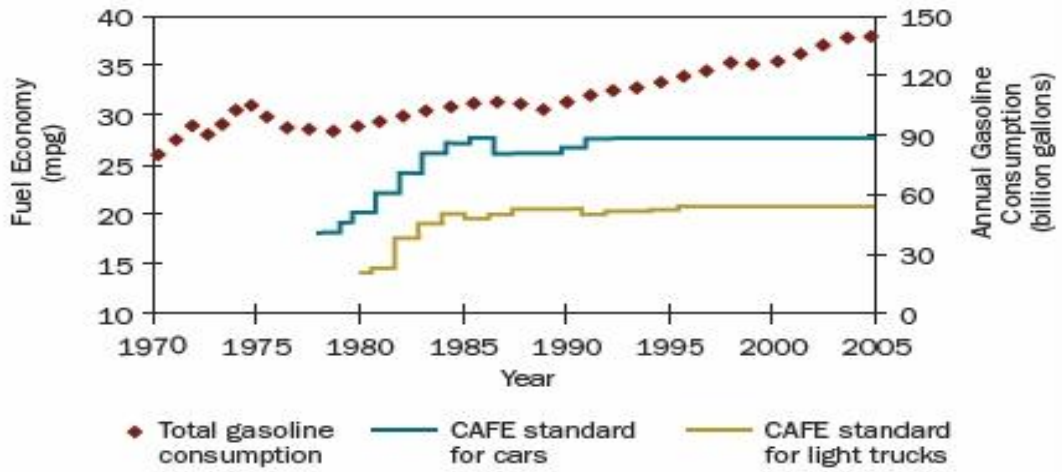


Energy Efficiency?

History of Fuel Economy: One Decade of Innovation, Two Decades of Inaction

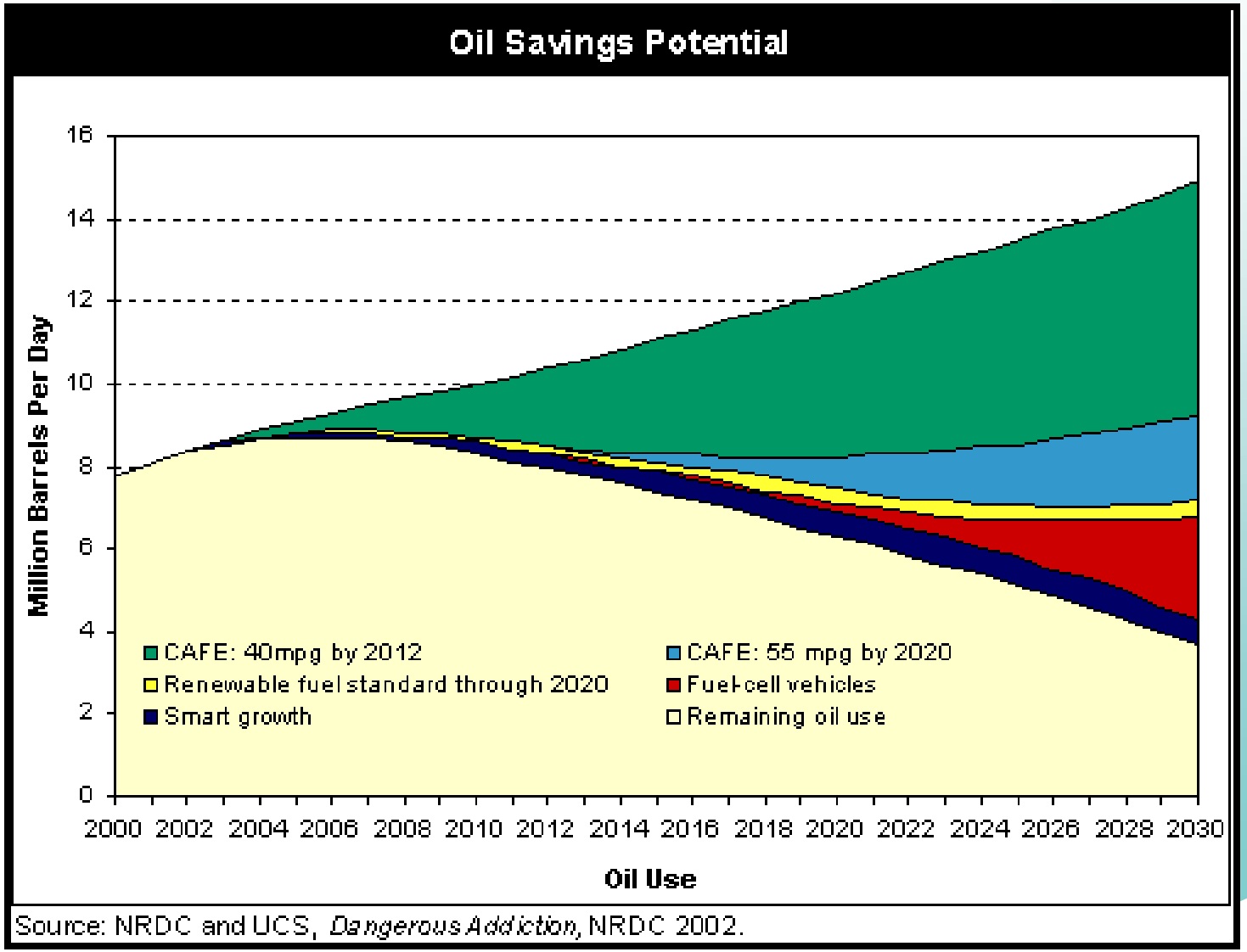


The Impact of CAFE Standards on Gasoline Consumption

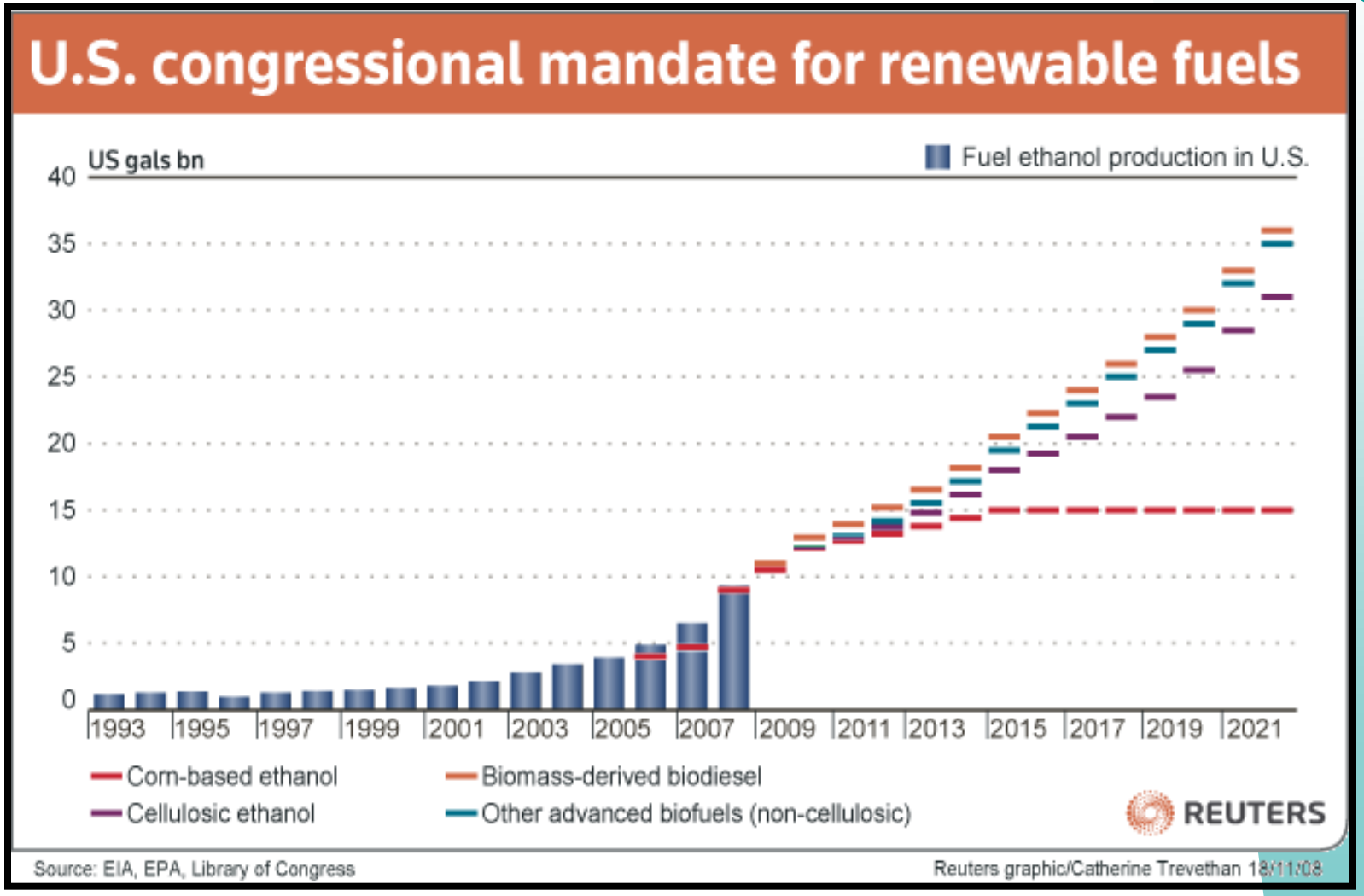


Fuel economy standards have not improved since the 1990s, leading to increased gasoline consumption. Data source: NHTSA 2004; Davis and Diegel 2007.

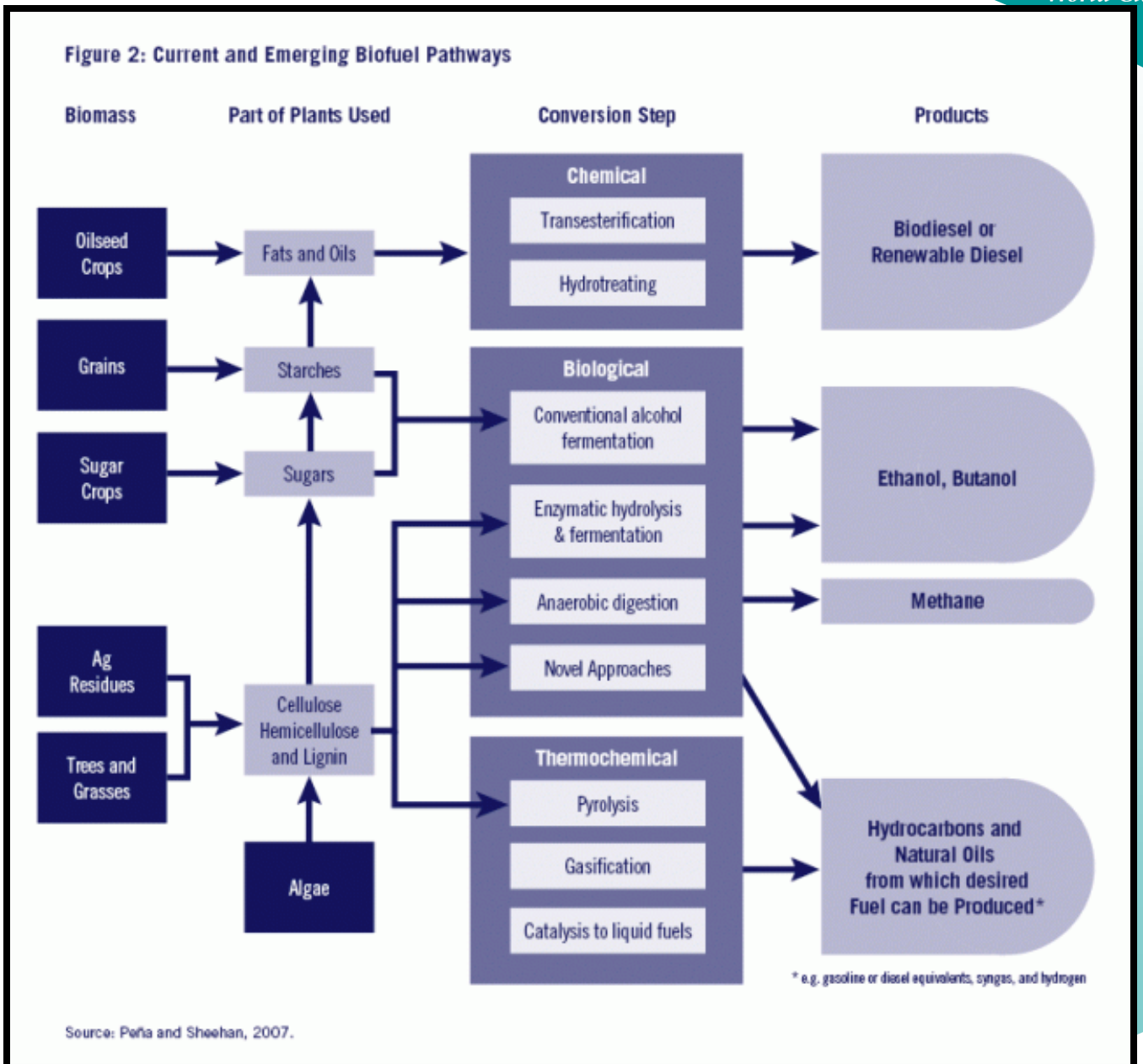
Energy Efficiency?



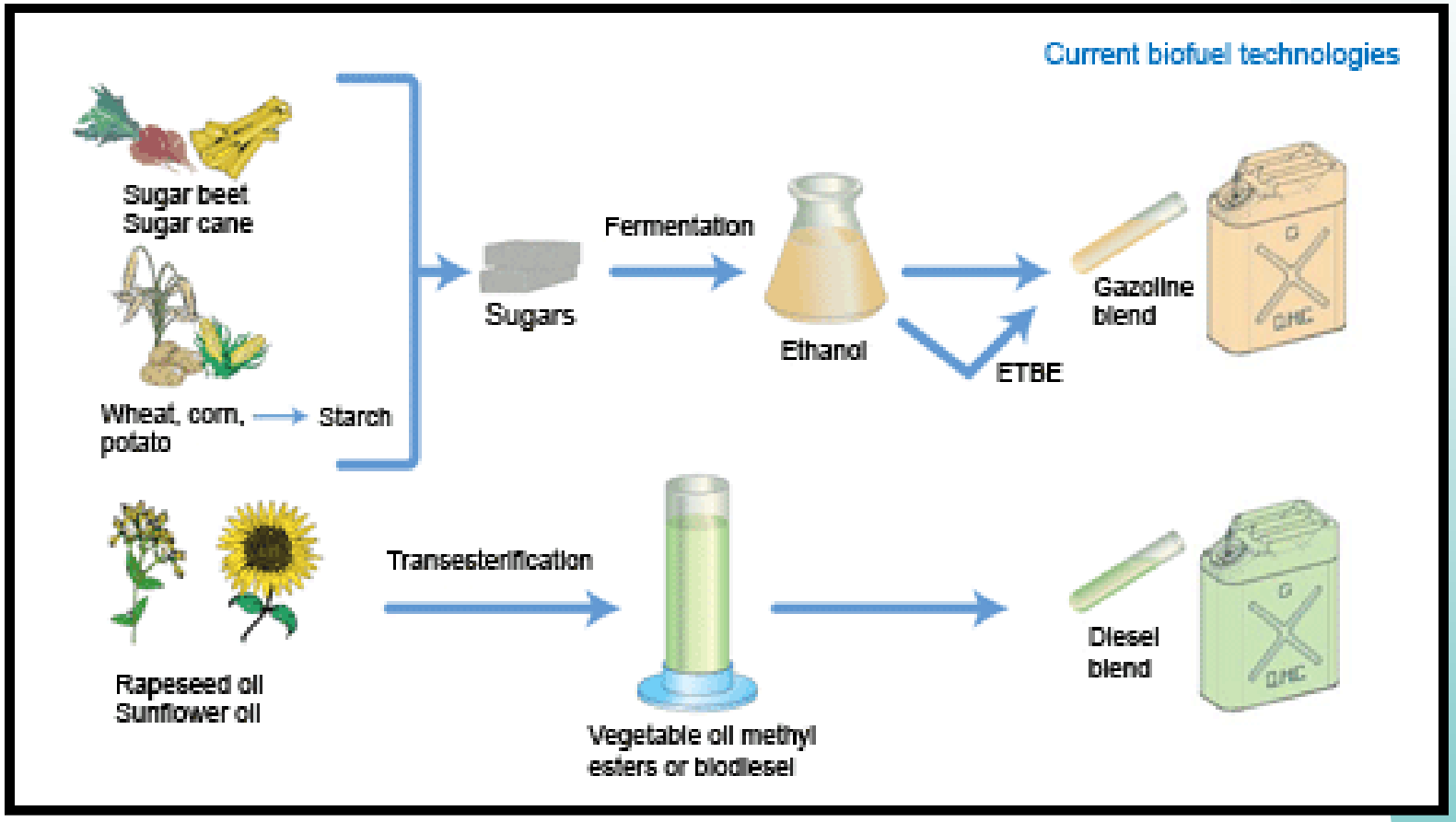
Biomass to Biofuels



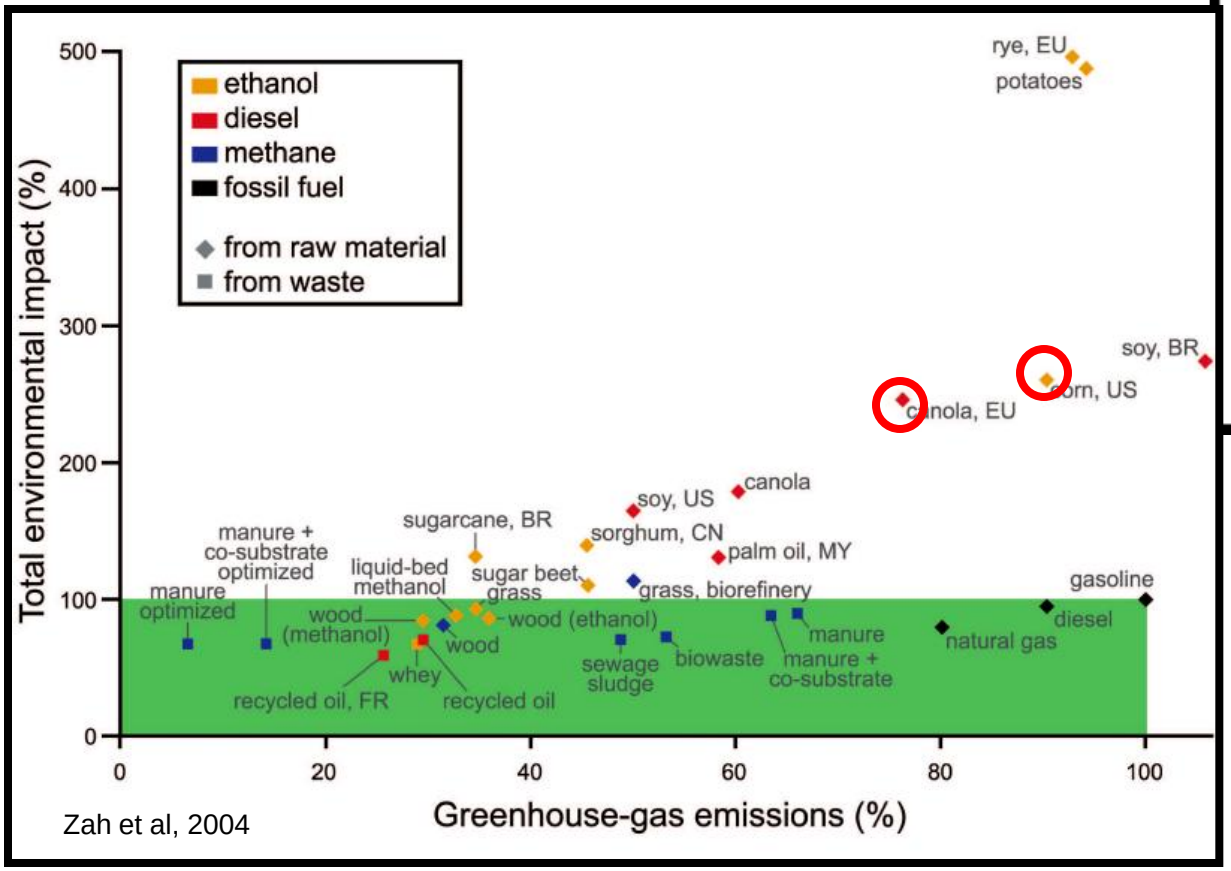
Biomass to Biofuels



First Generation Biofuels

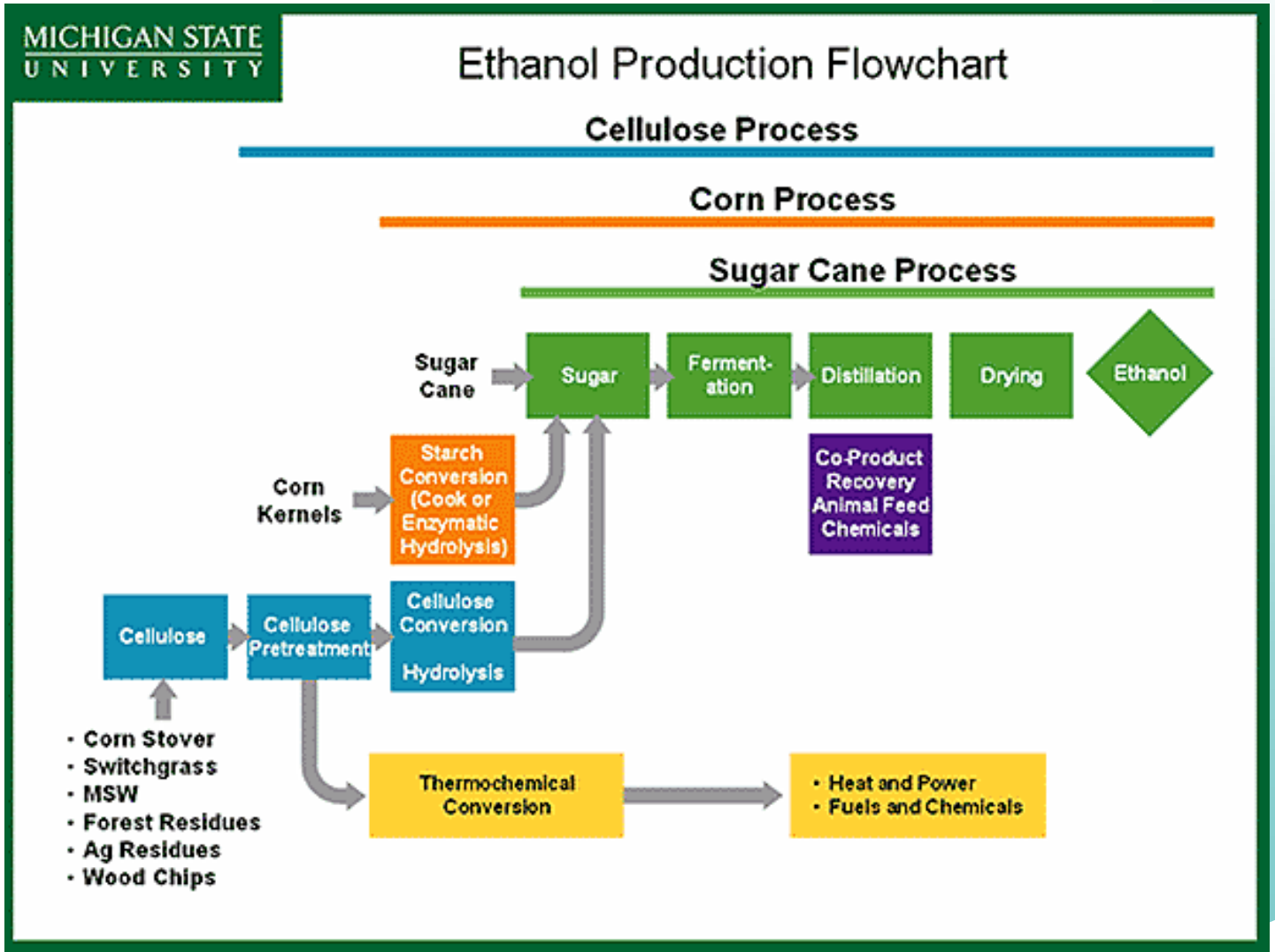


First Gen. Biofuel Concerns

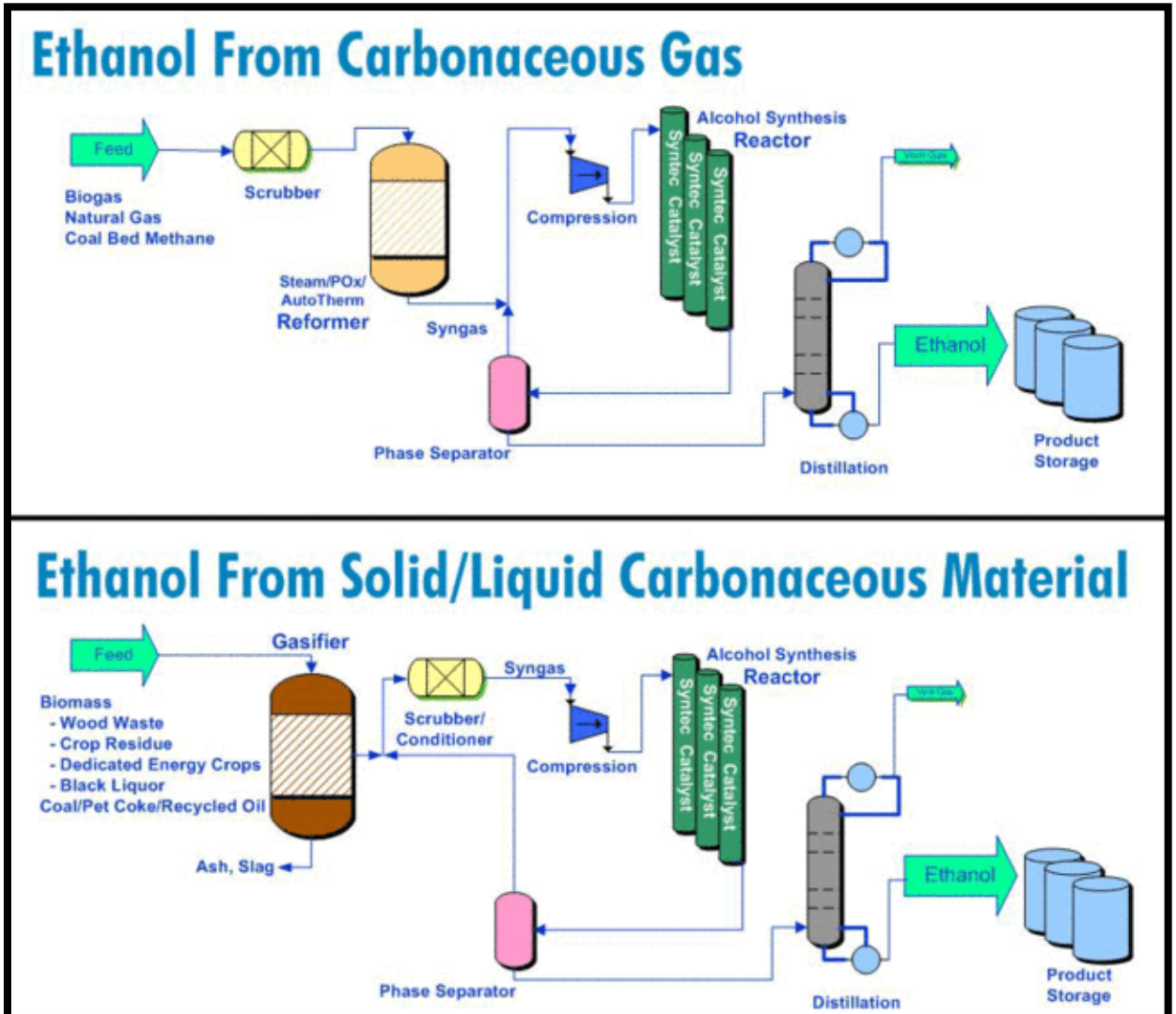


Zah et al, 2004

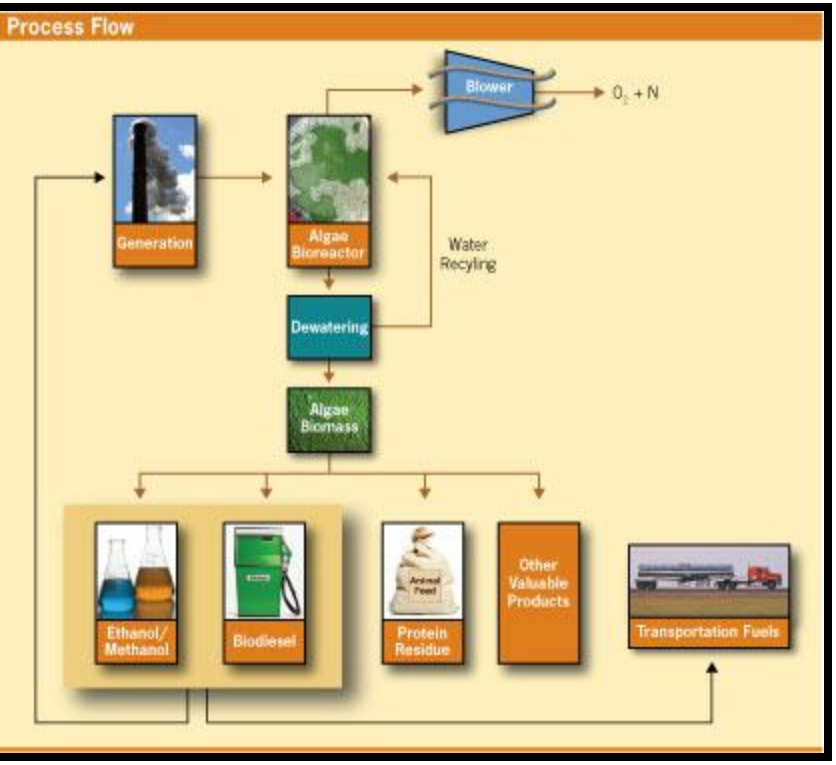
Second Generation Biofuels: Fermentation

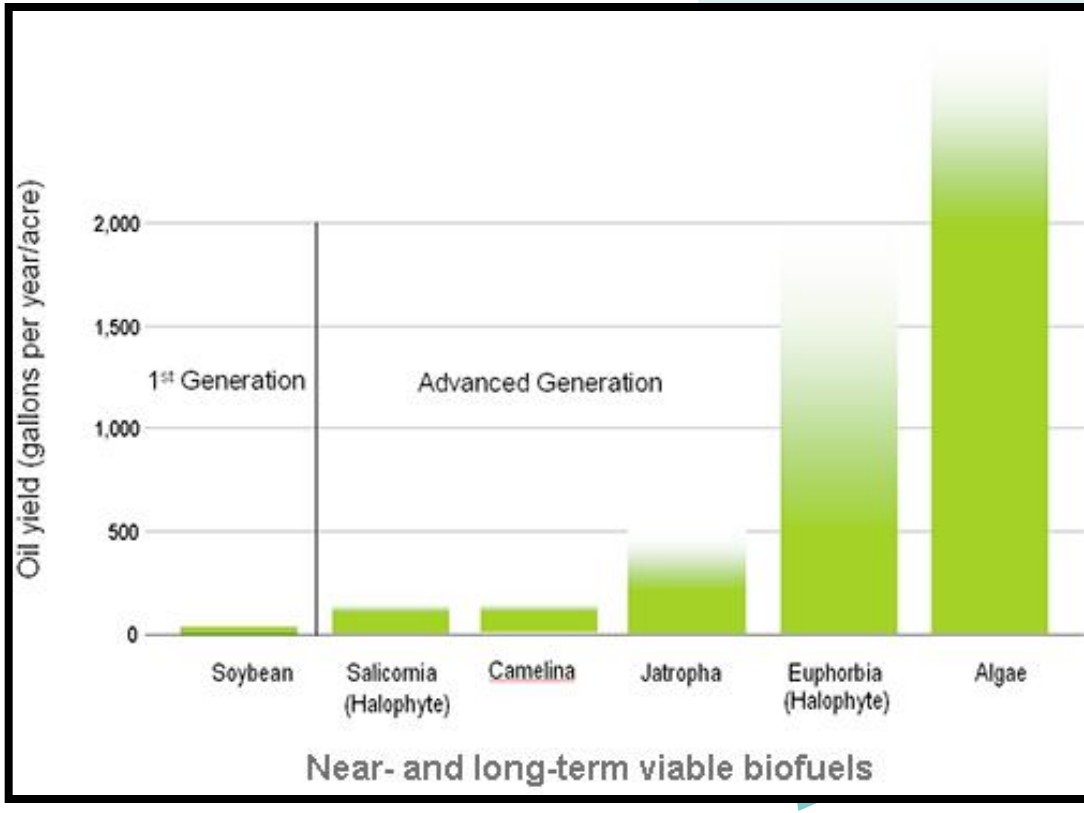


Second Generation Biofuels: Thermal

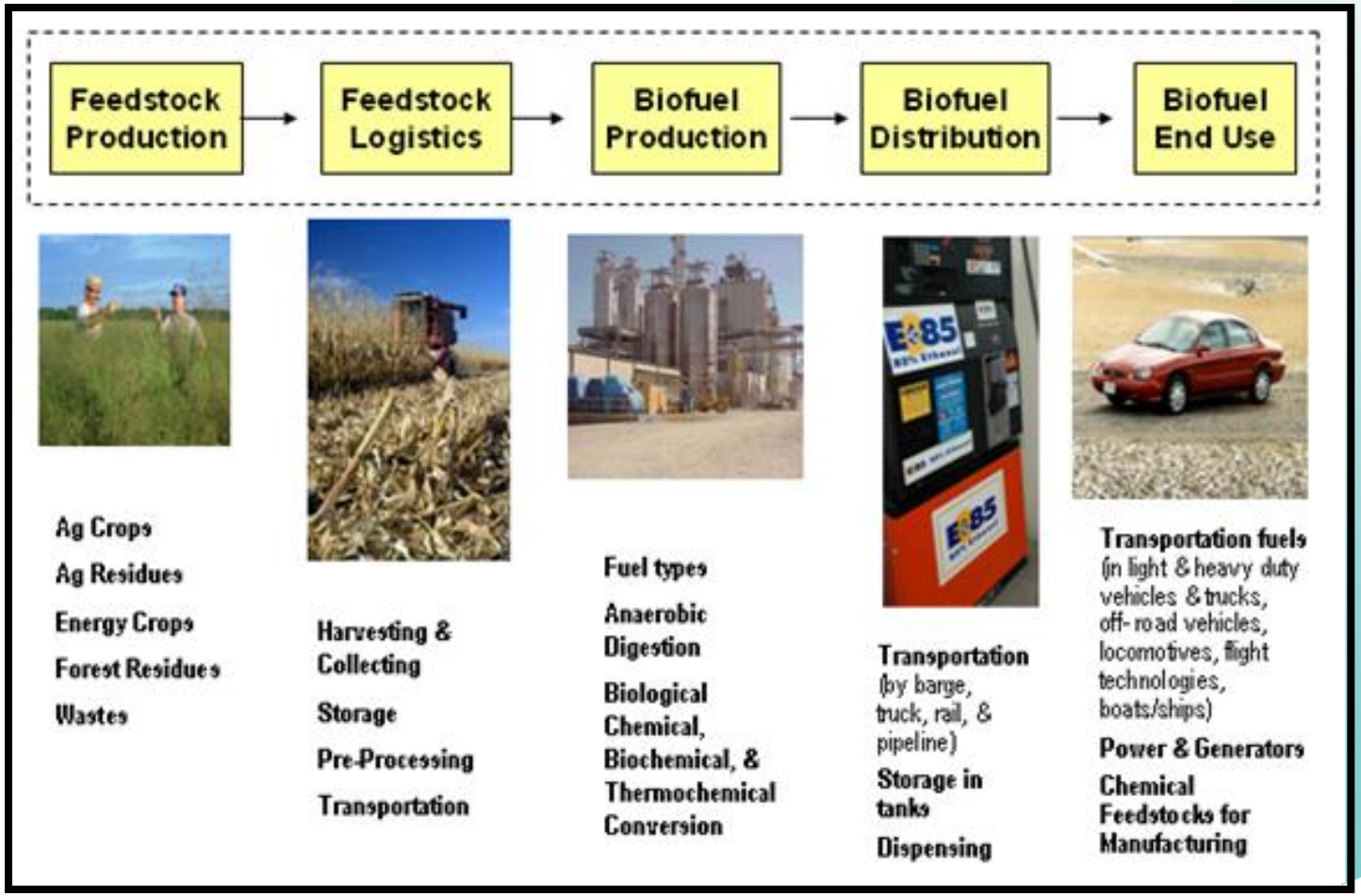


Third Generation Biofuels





Processing Technology / Products as part of a system



Summary

HOW GREEN ARE BIOFUELS?

Biofuels are getting a bad rap as stories of rising food prices and shortages fill the news. But the environmental, energy and land use impacts of the crops used to make the fuels vary dramatically. Current fuel sources – corn, soybeans and canola – are more harmful than alternatives that are under development.

FUEL SOURCES

CROP	USED TO PRODUCE	GREENHOUSE GAS EMISSIONS* Kilograms of carbon dioxide created per mega joule of energy produced	USE OF RESOURCES DURING GROWING, HARVESTING AND REFINING OF FUEL: WATER	FERTILIZER	PESTICIDE	ENERGY	PERCENT OF EXISTING U.S. CROP LAND NEEDED TO PRODUCE ENOUGH FUEL TO MEET HALF OF U.S. DEMAND	PROS AND CONS
Corn	Ethanol	81-85	high	high	high	high	157%-262%	Technology ready and relatively cheap, reduces food supply
Sugar cane	Ethanol	4-12	high	high	med	med	46-57	Technology ready, limited as to where will grow
Switch grass	Ethanol	-24	med-low	low	low	low	60-108	Won't compete with food crops, technology not ready
Wood residue	Ethanol, biodiesel	N/A	med	low	low	low	150-250	Uses timber waste and other debris, technology not fully ready
Soybeans	Biodiesel	49	high	low-med	med	med-low	180-240	Technology ready, reduces food supply
Rapeseed, canola	Biodiesel	37	high	med	med	med-low	30	Technology ready, reduces food supply
Algae	Biodiesel	-183	med	low	low	high	1-2	Potential for huge production levels, technology not ready

* Emissions produced during the growing, harvesting, refining and burning of fuel. Gasoline is 94, diesel is 83.

Source: Martha Groom, University of Washington; Elizabeth Gray, The Nature Conservancy; Patricia Townsend, University of Washington; as published in Conservation Biology

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Conclusion

- Washington's low-hanging fruit = organic wastes
- Energy efficiency is essential to making biofuels / biopower work
- Sustainability concerns must be addressed
- We still have technical and economic hurdles to solve
- Biomass provides our only renewable source for advanced fuels / chemicals