

Introduction to Biofuel

April 30, 2009

EEP 142

Presented By:

Nan Shi

Doris Chen Yu

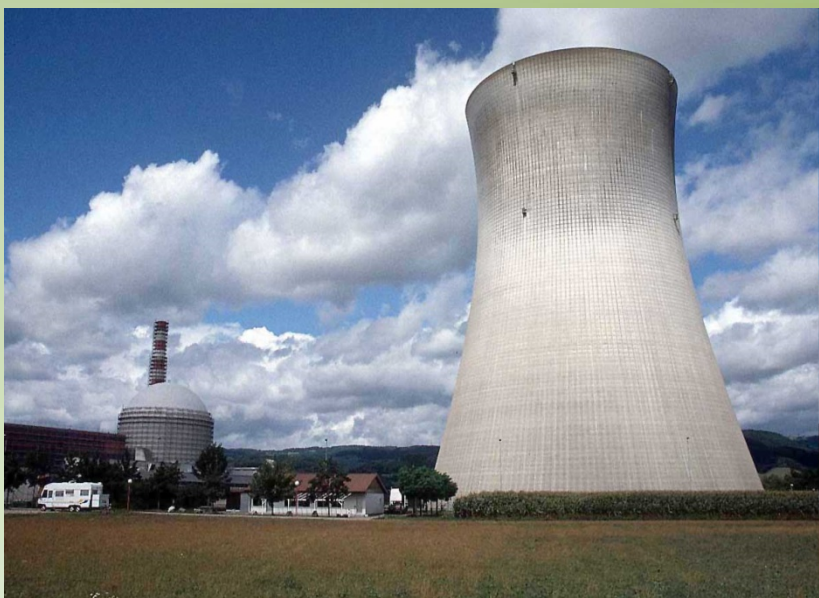
Hui (Becky) Li

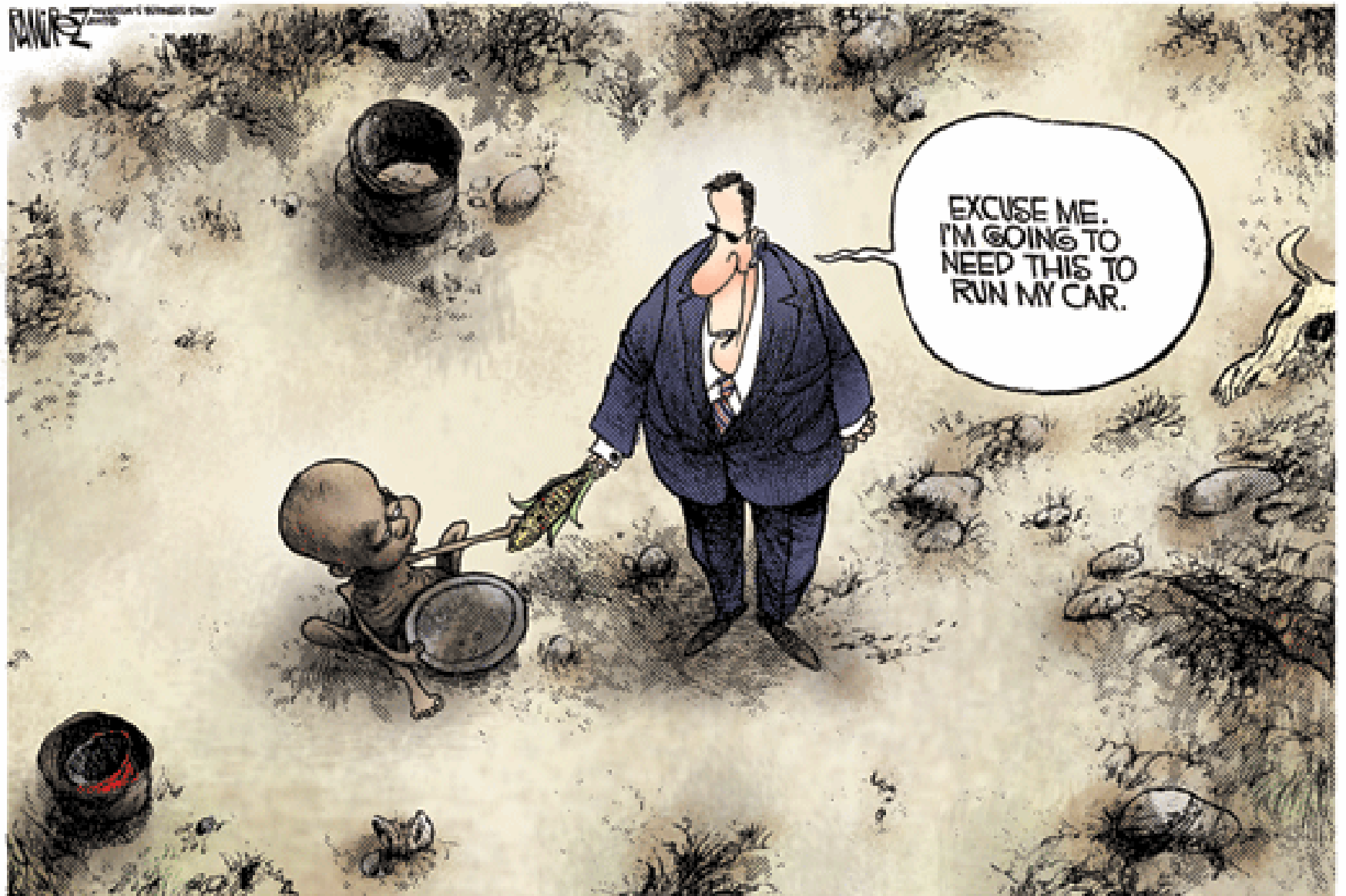
Songxu (Daniel) Wu

The Green Energy Economy Is the Future

- To describe what's needed to wean the country off fossil fuels, people often use the word *transition*. As in “the transition to a clean-energy economy” – *US News and World Report*
- What will the future look like?
 - *Disappearance of electrical grid?*
 - *Fruits, grains and vegetables grown in our backyard?*
 - *Cars running on hydrogen-powered fuel cells?*

Green Energy





EXCUSE ME.
I'M GOING TO
NEED THIS TO
RUN MY CAR.

Overview of the Introduction

- **What is Biofuel?**
- **How is Biofuel made?**
- **Why Biofuel?**
- **First and Second Generation of Biofuels**

What Is Biofuel?

- ✓ Biofuel: solid, liquid, or gaseous fuel consisting of, or derived from biomass — recently living organisms or their metabolic byproducts, such as manure from cows.
- ✓ Fossil fuels: derived from long dead biological materials.



How Is Biofuel Made?

- Originally came from the sun- captured through photosynthesis by the plants used as feedstock for biofuel production, and stored in the plants' cells.
- Various plants and plant-derived materials are used for biofuel manufacturing.
 - *Sugar crops*
 - *Natural oils from plants like oil palm, soybean, or algae,*
 - *Wood and its byproducts*
 - *Flaxseed, rapeseed (primarily in Europe)*
 - *Waste from industry, agriculture, forestry, and households*

Why Biofuels?

- **Replacement For Hydrocarbon-based Fuels**

- **Environment Aspect**

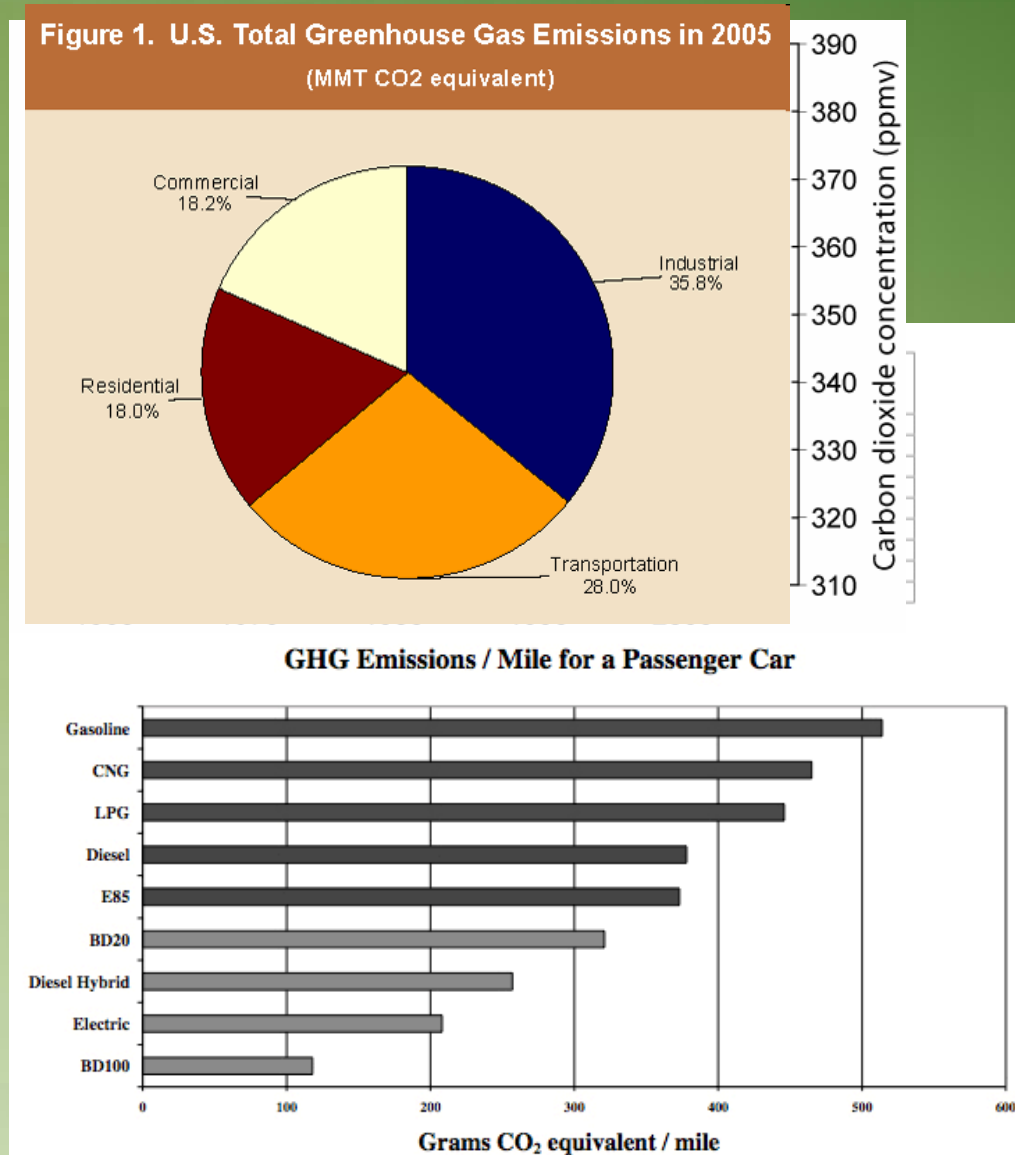
- ✓ *Renewable, Sustainable*
- ✓ *Reducing Greenhouse Gas Emissions*
- ✓ *Cleanly Burning*

- **Economic Aspect**

- ✓ *Increasing Energy Security*
- ✓ *Boosting Profitability of Agricultural and Conversion*
- ✓ *Controlling Wastes*

Green House Gas (GHG) Emission

- Global Warming
 - Rise in sea level
 - Hurricanes
 - Lowering of ocean pH
- GHG emission
 - Continue to grow with rapid economic development
 - Kyoto Protocol
 - Transportation accounts for approximately 25% of total GHG emission
- Biofuel for transportation can reduce GHG emission
 - have a higher energy content compared to gasoline, diesel and natural gas



Employment in the agricultural sector

Secure future development of rural areas of developed countries: EU and US

- Countries like China and Brazil are more efficient with farming
- EU and US who used to rely on cash crops are no as globally competitive as before
- Develop soybean (biodiesel) and corn (bioethanol) in rural areas of the US are seen as ways for families to maintain their traditional lifestyle and to protect the country's agricultural economy
- The US has a large surplus of biomass



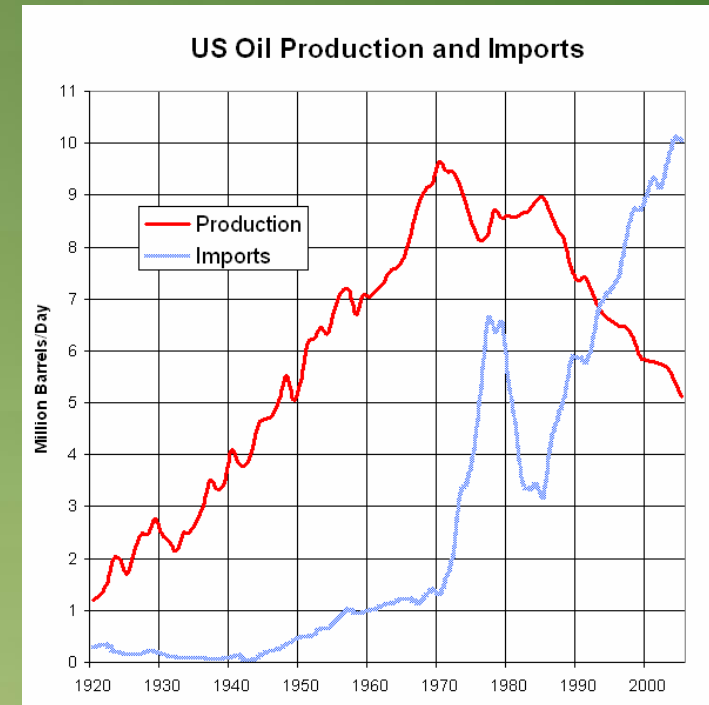
Peak oil theory and energy independence

- Peak oil

- M. King Hubbert successfully predicted that U.S. production of oil will peak between 1965 and 1970
- Demand for oil will continue to increase while global supply for oil may or may not have peaked (different theories)
- Positive aspect of peak oil: drive for alternative energy sources such as Solar, wind, and BIOFUEL

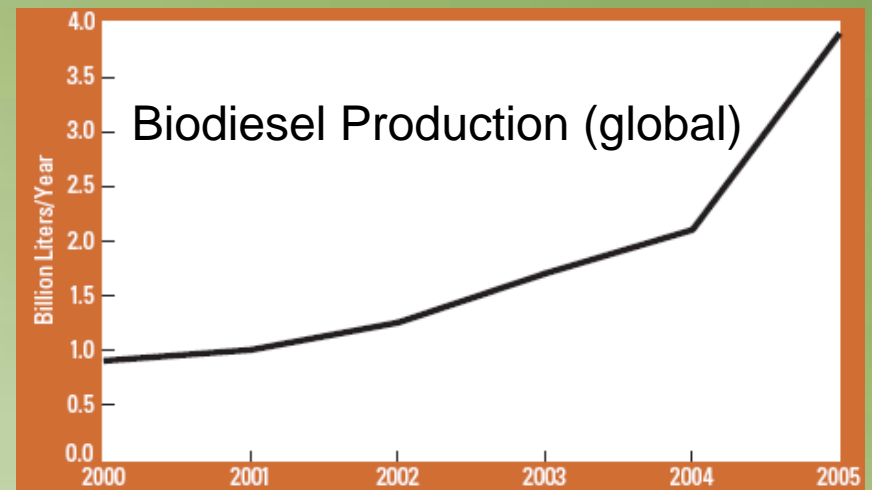
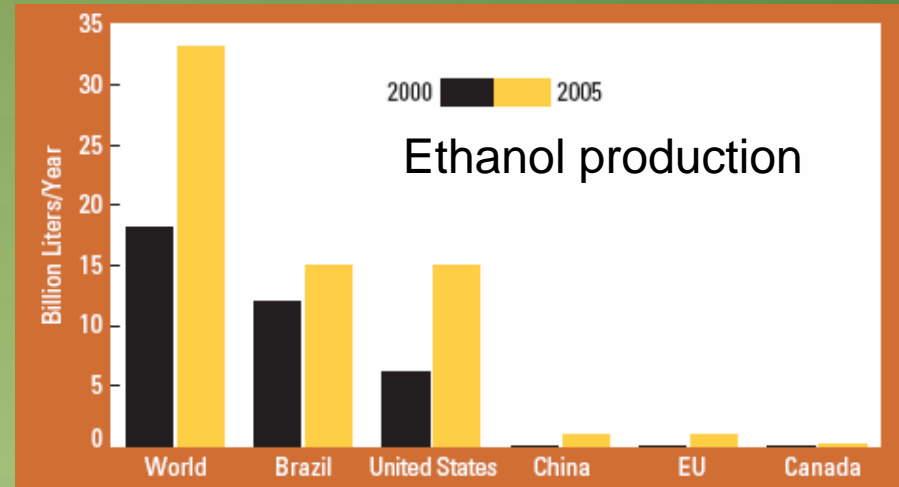
- Energy Independence

- Crude oil price continue to increase
 - Ability to extract unconventional source of oil (oil sand, shale) is problematic
- EU meeting: increased use of biofuel will reduce the reliance of member states on external sources (OPEC)
- U.S. “small step an average american can take in winning the war on terrorism”



Resource potential and policy

- Biofuel is often considered a transition renewable energy source to hydrogen fuel cell, nuclear, solar or wind
 - Current ethanol capability: 6.5 billion gallons a year
 - 77 new ethanol plants and 8 expansion projects underway
 - 2.2 billion bushels were used to produce ethanol in 2006/2007
 - 3.2 billion bushels were expected to be used in 2007/2008
 - Issues with land
- Require extensive government intervention (policy)



First and Second Generation

➤ First Generation:

- Current chief candidate (along with biodiesel) as a petroleum replacement for internal combustion engines, is a fuel generally derived from food crops such as sugarcane, sugar beet, maize (corn), sorghum and wheat, although other forms of biomass can also be used, and may even be preferable.
- The problems associated with biomass energy derived from first-generation sources are highly unlikely to provide a long-term substitute for fossil fuels.

➤ Second Generation:

- Derived from feedstock not traditionally used for human consumption.
- Likely to only remain a niche player in a broader energy mix.

First and Second Generation

➤ First Generation:

- ✓ Concerns about biomass previously destined for human consumption being diverted to fuel production.
- ✓ Concerns about inefficiency of first-generation biofuels.
- ✓ Concerns about lower energy content of first-generation biofuels than conventional petroleum products.

➤ Second Generation:

- ✓ Less concerns about the use of these fuels leading to famine in developing countries, or adversely affecting consumer prices in developed nations.
- ✓ The benefits of using these second-generation biofuels are manifold.
 - *Environmental side: More environmentally friendly and produce less greenhouse gases*
 - *Economic Side: Produced at a more competitive price*
- ✓ Second-generation processes make use of the vast majority of the feedstock to avoid the kind of waste inherent in the production of first-generation biofuels.

Biofuel Resources

“It’s yellow. It comes out of the ground. It’s very valuable.”

- John Smith

“Oh! Here, we lots of it.”

- Pocahontas

John Smith was defining what gold is from Disney’s Pocahontas movie, but Pocahontas thought Smith was talking about corn.

We see that corn is just as valuable as gold. Today, fuel can come from environmentally friendly natural products such as sugarcane, maize (corn) and sorghum.



Environmental Benefits

- Biofuels benefit environmental by reducing GHGs and reducing local pollution.
- Bioethanol is water soluble, non toxic and biodegradable.
- Ethanol can replace 10% of the world's gasoline without clearing more rainforests and by doing less harm to the environment than current agriculture.
- Biofuels offer low levels of carbon dioxide emission.
- Hydrocarbon-based fuels produce greater noxious by productions like carbon monoxide compared to biofuel which produces compounds like nitrogen oxides; but the biofuel by product is less dangerous to human health and the environment.

Environmental Problems

- However, recent research has suggested that biofuels, particularly those derived from palm biodiesel blends, may be more carcinogenic than conventional fuels.
- Fuels derived from biomass energy cannot be considered truly carbon-neutral because of the stages of production, transportation and processing require nonrenewable energy.
- It is not clear whether the energy used in the day to day farming practices, production and application of fertilizer, pesticides and herbicides, and the production of bioethanol itself actually cancel out a good deal of the deal derived from burning bioethanol.
- Studies have shown that fermentation and distilling of first generation biofuels create negative net energy.

Social-Economics Benefit

- **Reduce the price of oil** – cheaper ethanol reduces the demand of oil and the price of oil.
- **Reduce fossil fuel imports** – The use of ethanol can reduce the use of gasoline. A reduction in the use of gasoline reduces some of the dependence on unstable foreign sources of oil.
- **Reduce the poverty rate** – Most ethanol plants are in rural communities, and ethanol production increases jobs due to plant construction, operations, and maintenance.

Social-Economics Benefit (Cont.)

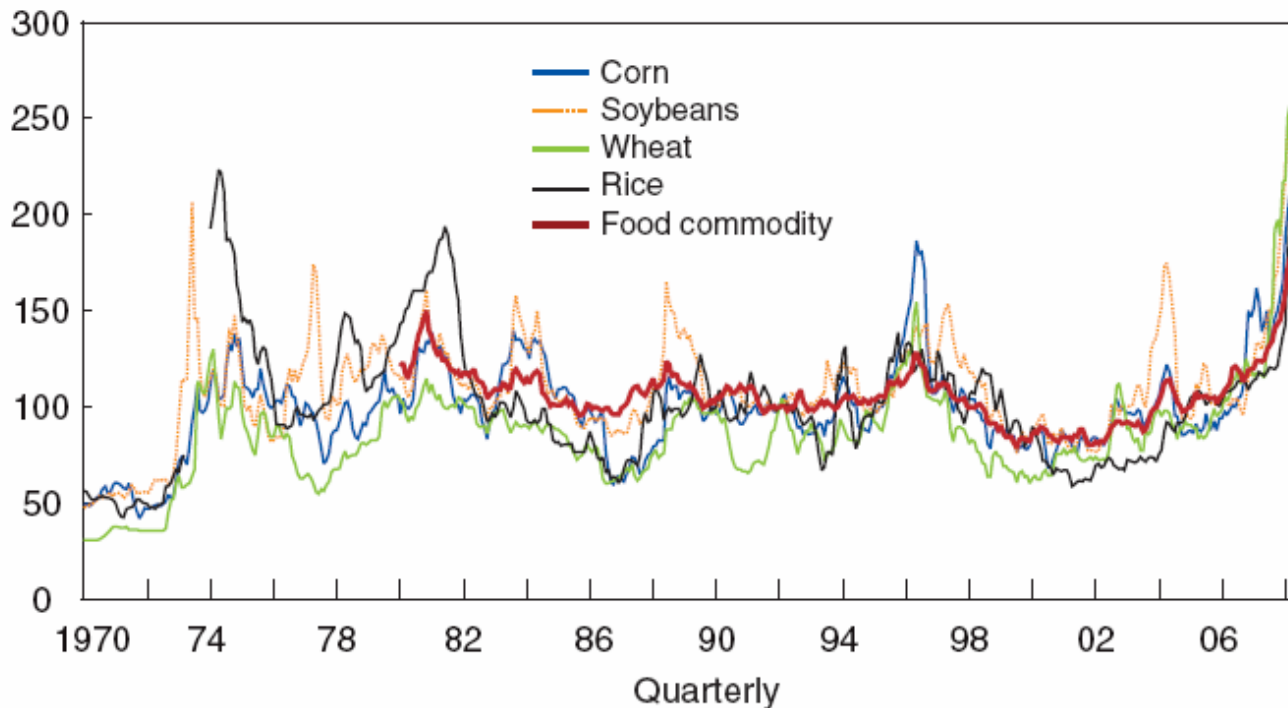
- **Rise in farm land value** – High demand of corn leads to a rise in farm land values.
- **Health benefits from reduced global warming**
- **More efficient use than gasoline and protect vehicles**
– Ethanol can help prevent engine knocking, and it increases gasoline's lubricity.
- **Low adoption cost** – Ethanol can be used by all gasoline vehicles in the United States in concentrations up to about 10%. Ethanol provides lower vehicle emissions without the need to purchase a hybrid vehicle.

Social-Economics Cost

Upward pressure on food prices

Food commodity price spikes since 1970

Index: January 1992 = 100



Source: International Monetary Fund: International Financial Statistics.

Social-Economics Cost (Cont.)

- **Increasing in water price** – more water are used for crop and less for people, create water shortage.
- **Create new health problem** – If formaldehyde is allowed to be produced while ethanol is employed, biofuel reduces the air quality.



Social-Economic Cost (Cont.)

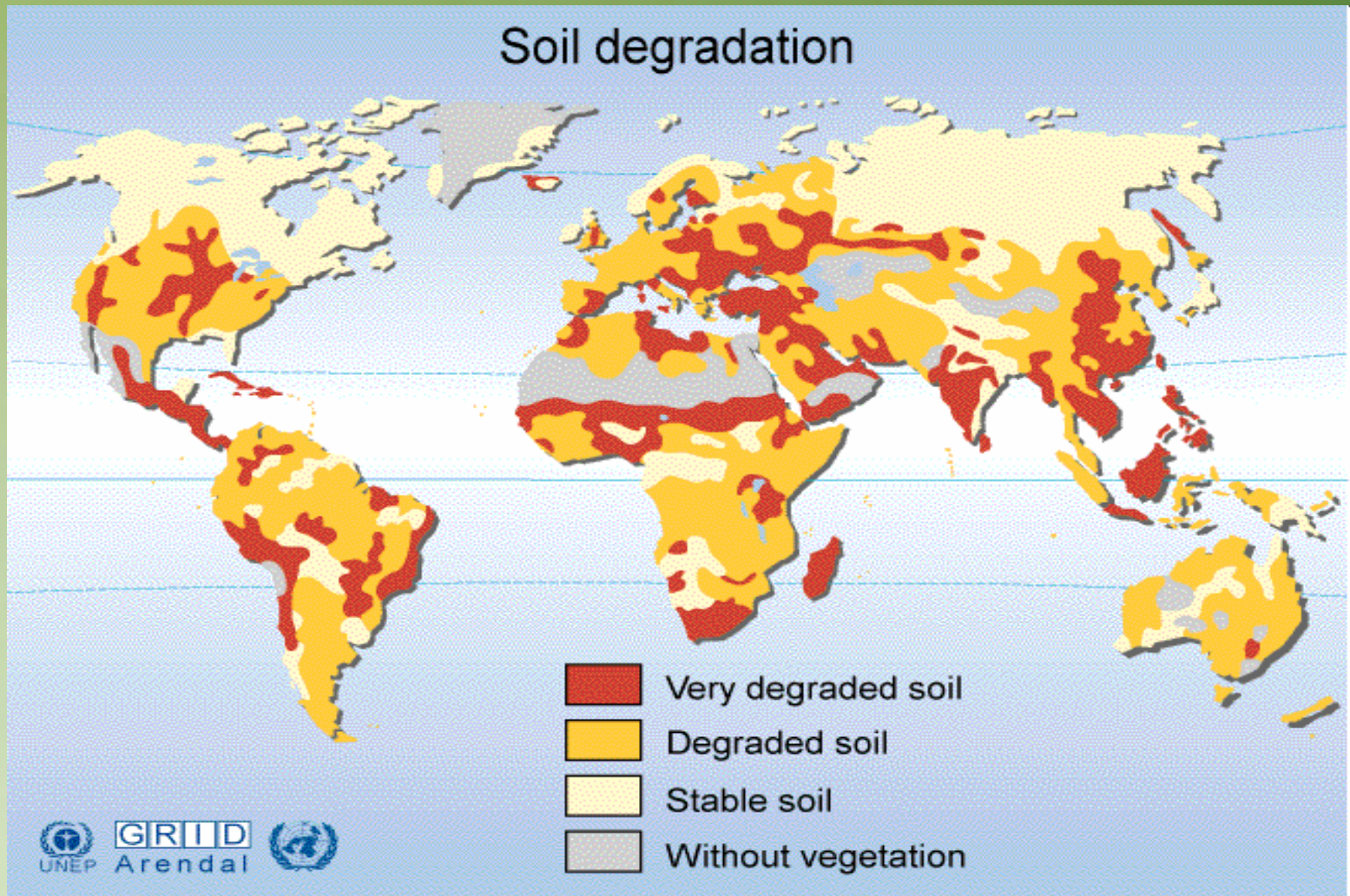
- **More energy is required for producing biofuel than they can be generated** – Cornell University researcher David Pimental concludes that producing ethanol from corn requires 29% more energy than the end product itself is capable of generating.
- **High transition cost from gasoline to biofuels** – Shifting from gasoline to biofuels, given the number of gas-only cars already on the road and the lack of ethanol or biodiesel pumps at existing filling stations, would take some time.

Socio-Economical Problem

Soil Degradation

- With the increase in demand for alternative energy sources, demand for agricultural land could increase.
- Increase demand for biofuel derived from cash crops such as sugarcane, sugar beet, maize and sorghum would result in major changes to current land uses.
- There has to be some kind of regulation to make sure there is no more greater deforestation, land degradation of low-fertility tropical soils, and concomitant rise in CO² output.

Soil Degradation



Socio-Economical Problem

Deforestation

- Ethanol is more effective, as far as CO² emissions are concerned, than the preservation of native forests.
- Deforestation will result in the extinction of species, the alteration of weather patterns, soil degradation, and erosion.
- Deforestation causes a change in local climates and affects future land usage and affects level of precipitation all because of extensive agricultural efforts.



Policies for Biofuel

- Energy and Carbon Policies
 - Tax credit for biofuel
 - Mandatory blending
 - Energy tax or carbon tax
 - Policies for flex vehicles
- Farm Policy
- Trade
- Government funding for R&D



Energy and Carbon Policy

Tax credit for biofuel: Tax reduction to lower the cost of biofuel in order to compete with gasoline and diesel

- Volumetric Ethanol Excise Tax Credit (VEETC)
 - Fixed tax credit of \$0.51 per gallon for ethanol
 - \$1 per gallon for biodiesel
- Direct controls/mandatory blending
 - The U.S. energy act of 2005: mandates the production of 12 billion gallon by 2010
 - Renewable Transport Fuel Obligation in the UK: requires oil companies to blend 5% biofuel in motor fuel by 2010-2011
 - India/China/Thailand: mandatory blending 5-10%
 - Brazil: mandatory blending 20-25%
- Energy or carbon tax
 - Traditional fossil fuel are taxed up to the same price as biofuel
 - Finland and Sweden (where biomass is now cheaper than coal)
- Flex vehicles
 - These are vehicles that are designed to run a blend up to 85% ethanol
 - Tax credits

Title	Code or Law ^a	Fuel Type	Incentive	Qualifying Period	Limits ^c
Volumetric Ethanol Excise Tax Credit (VEETC)	Public Law 108-357 ^b	ethanol of 190 proof or greater from biomass (e.g. corn grain, cellulose)	\$0.51 per pure gal of ethanol used or blended.	January 2005 – December 2010	Available to blenders/retailers
Volumetric Excise Tax Credit for Biodiesel	EPACT 2005 ^c §1344, Title XIII, Subtitle D	Agri-biodiesel (e.g. from soybeans or other oil seeds)	\$1.00 per pure gal of agri-biodiesel used or blended	Expires December 31, 2008	Available to blenders/retailers
Volumetric Excise Tax Credit for Biodiesel	EPACT 2005 §1344, Title XIII, Subtitle D	Waste-grease biodiesel	\$0.50 per pure gal of waste-grease biodiesel used or blended	Expires December 31, 2008	Available to blenders/retailers
Volumetric Excise Tax Credit for Biodiesel	EPACT 2005 §1344, Title XIII, Subtitle D	Renewable diesel – made from biomass by thermal depolymerization process	\$1.00 per gal of diesel fuel used or blended	Expires December 31, 2008	Available to blenders/retailers
Small Ethanol Producer Credit	EPACT 2005 §1347, Title XIII, Subtitle D	Ethanol from biomass (e.g. corn grain, cellulose)	\$0.10 per gallon ethanol or biodiesel produced up to 30 million gallons	Expires December 31, 2008	< 60 million gallon production capacity Cap at \$1.5 million per yr per producer Can offset the alternative minimum tax
Small Biodiesel Producer Credit	EPACT 2005 §1345, Title XIII, Subtitle D	Agri-biodiesel	\$0.10 per gallon ethanol or biodiesel produced up to 15 million gallons	Expires December 31, 2008	Same as above
Income Tax Credit for E85 and B20 Infrastructure	EPACT 2005 §1342, Title XIII, Subtitle D	Ethanol or biodiesel	Permits taxpayers to claim a 30% credit for cost of installing clean-fuel vehicle refueling property at business or residence	January 2006 – December 2007	\$30,000 limit on tax credit

Farm Policy

- Feedstock account for more than half of biofuel production cost
- Agriculture policies focused on controlling supply (import and export regulation), land regulation.
 - Industrial countries: protect producers from imports from lower cost producers
 - Developing countries: tax exports to fund government budgets on biofuel
 - Helps increase output and lower market price of commodities
 - Common Agricultural Policy: EU
 - supports the biofuel sector by allowing growing biofuel crops on set-aside land, and through direct payment to energy crops grown

Trade

- Trade restrictions on both feedstock and biofuel
 - Import tariffs are everywhere in most biofuel-producing countries.
 - Protecting the interests of domestic producers and also restricting benefits to selected countries
 - Taxation of exports
 - Argentina, levies an export tax of 27.5% and 24% on soybean seeds and soybean oil
 - aims at promoting the export of value-added finished product and not just raw materials
 - Export subsidies for agricultural and industrial products
 - Enable high cost domestic producers to compete with low cost producers in the international market

Government Funding for R&D

- The Biomass Research and Development Program is operated jointly by DOE and USDOA: offers \$12 million in support for R&D of biomass-based products and related processes
- Private companies
 - British Petroleum, UC Berkeley and University of Illinois: Energy Bioscience Institute

Implications and impacts of the policies

- All policies will lead to reduction in the consumption of oil at a national level through increase in supply of biofuel or reduce oil demand.
- Net GHG offsets from the policies are uncertain due to variation in crop and production and processing of the feedstock
- All policies that encourage the production of biofuel will positively impact rural areas
- Food processing industry will suffer due to higher prices of the raw input, and livestock industry might also be affected
- Impact on consumer surplus

References

- 1. <http://www.veggiebus.com/emissions.html>
- 2. http://are.berkeley.edu/~dwrh/CERES_Web/Docs/wps4341.pdf
- 3. <http://www.globalchange.umich.edu/globalchange1/current/lectures/soils/soils.html>
- 4. Michael Charles, Rachel Ryan and etc, Public policy and biofuel: the way forward? Energy policy 35 (2007) 5737

QUESTIONS?