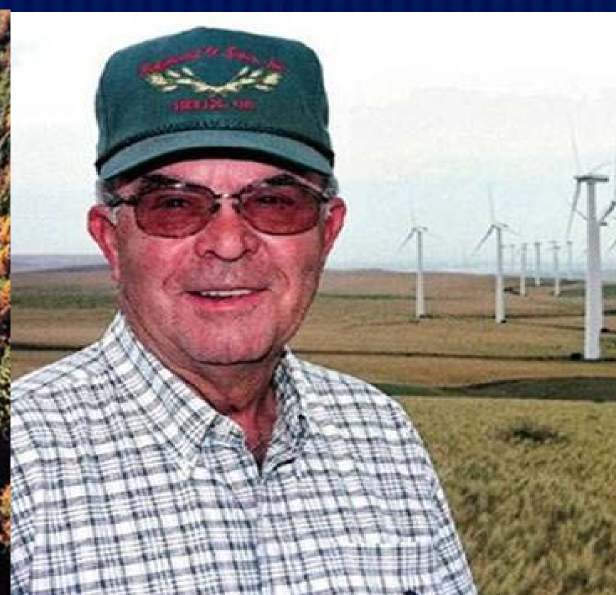



# Biofuels – Toward the Next Generation

BCSEA Energy Solutions,
June 10, 2008
Patrick Mazza,
Research Director,
Climate Solutions

Climate Solutions

# Climate Solutions

- Climate Solutions mission is to accelerate practical and profitable solutions to global warming by galvanizing leadership, growing investment and bridging divides.

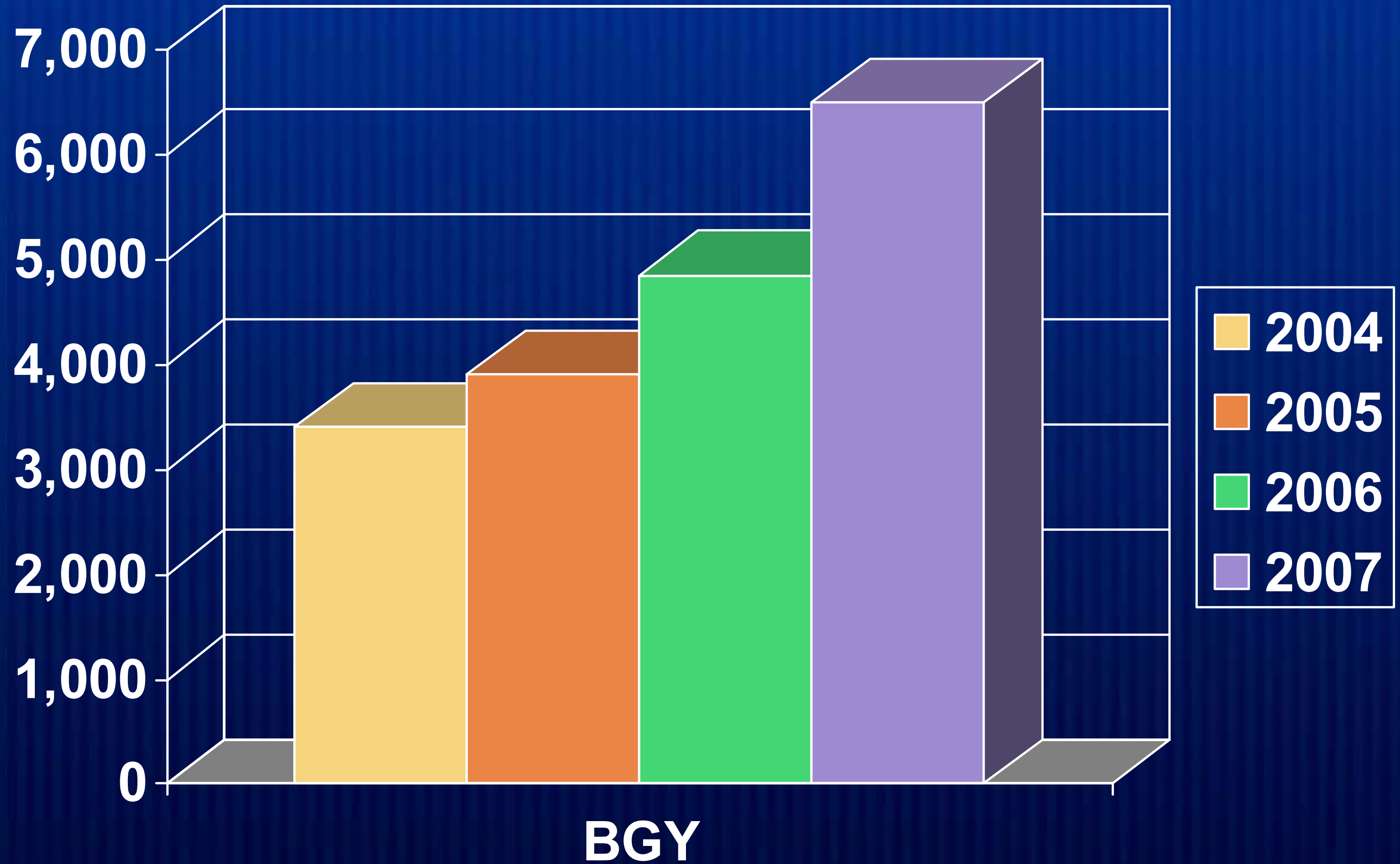
Climate Solutions

# This Presentation

- First generation biofuels growth
- Energy and food price impacts
- Carbon impacts
- Converging on next generation feedstocks.

Climate Solutions

# Corn Ethanol Boom




Climate Solutions

# Biofuels making significant fuel supply contribution

- International Energy Agency - biofuels “represented 49% of the growth in non-OPEC oil supply in 2007 and this share is expected to rise to 55% in 2008.”
- Merrill Lynch - Without the growth gasoline would cost consumers 50 cents per gallon more.

Climate Solutions

# Biofuels Food Price Impact

- Is it 3% as stated by USDA, 10% by UN FAO or 30% as stated by Oxfam?
- Other factors
  - Asian affluence revolution – increased animal feed for meat and dairy
  - Fossil fuel price increases – affect on-farm energy, fertilizer, processing, transport
  - Drought conditions – Australian wheat areas

Climate Solutions

# Carbon Debt from Land Clearing – Fargione et al

- Southeast Asian tropical rainforest to palm biodiesel – 86 years.
- Southeast Asian peatland rainforest to palm biodiesel – 423 years.
- Brazilian tropical rainforest to soy biodiesel – 319 years.
- Brazilian wooded Cerrado to sugarcane ethanol – 17 years.
- Brazilian grassland Cerrado to soy biodiesel – 37 years.
- US Midwest grassland to corn ethanol – 93 years.
- US Midwest conservation reserve lands to corn ethanol – 48 years.
- US Midwest conservation reserves to cellulosic ethanol – 1 year.
- US marginal croplands to cellulosic ethanol – no carbon payback time.

Climate Solutions

# Searchinger et al

- U.S. corn ethanol of 56 billion liters above projected 2016 production levels would divert 12.8 million hectares of U.S. corn production to ethanol, bringing 10.8 million hectares of new cropland into cultivation, primarily in Brazil, China, India and the U.S. Assumes average corn yields will stay the same.
- Land converted to farming will release 25 percent of its soil carbon, an average of 351 metric tones per hectare.
- GREET model lifecycle analysis 20 percent greenhouse gas reduction to corn ethanol compared to gasoline before indirect land use changes
- With change would take 167 years to pay back soil carbon losses. Based on this researchers calculate that corn-ethanol would emit double the greenhouse gases of gasoline over the first 30 years after 2016.
- Cellulosic ethanol has far lower net emissions of greenhouse gases.  But if switchgrass feedstock crops replace corn, the displacement effect would still require a 52-year carbon payback period.
- Scenario in which corn yields increase 20 percent, soil carbon emissions are only half of estimates, and corn ethanol before land use changes reduces emissions 40 percent compared to gasoline would reduce carbon payback time to 34 years.

Climate Solutions

# Michael Wang, Argonne

- Argonne and other organizations updating their models to reflect indirect land use conversions.
- Corn ethanol growth figures used by Searchinger correlate to 30 billion gallons a year of production by 2015. However, the new federal renewable fuel standard caps corn ethanol production at 15 billion annual gallons. The Searchinger study "examined a corn production case that is not relevant to U.S. corn ethanol production in the next seven years."
- Incorrect to assume no growth in corn yields. Yields have increased 800 percent over the past 100 years, and 1.6 percent annually since 1980. They could well gain two percent annually through 2020 and beyond.
- Lowballs the contribution of coproducts by at least 23 percent, which drives up their estimates of farmland needed to replace feed corn.
- "There has also been no indication that U.S. corn ethanol production has so far caused indirect land use changes in other countries because U.S. corn exports have been maintained at around two billion bushels a year and because U.S. DGS exports have steadily increased in the past 10 years. . . It remains to be seen whether and how much direct and indirect land use changes will occur as a result of U.S. corn ethanol production."

# New U.S. Federal Renewable Fuel Standard

- Contains greenhouse gas criteria.
- Corn ethanol must yield a 20 percent reduction.
- Cellulosic ethanol must reduce emissions 60 percent and other advanced biofuels 50 percent.
- The latter two represent 21 billion of the annual 36 billion gallon by 2022 standard.
- The lifecycle studies that measure emissions are mandated by law to include both direct and indirect land use impacts.
- The Environmental Protection Agency is now conducting those studies, which will be used in rulemaking to adopt the standard.
- EPA can reduce goals 10 percent, for instance, corn ethanol to a net 10 percent GHG reduction.

Climate Solutions

# Beyond the war of studies

- General agreement – Shift to next generation feedstocks that do not compete with food markets

Climate Solutions

# Searchinger et al

"This study highlights the value of biofuels from waste products because they can avoid land use change and its emissions. To avoid land use change altogether, biofuels must use carbon that would reenter the atmosphere without doing useful work that needs to be replaced, for example, municipal waste, crop wastes and fall grass harvests from reserve lands. Algae grown in the desert or feedstock produced on lands that generate little carbon today might also keep land use change emissions low. . . "

Climate Solutions

# Fargione et al

- ”Degraded and abandoned agricultural lands could be used to grow native perennials for biofuel production which could spare the destruction of native ecosystems and reduce GHG emissions. Diverse mixtures of native grasslands perennials growing on degraded soils, particularly mixtures containing both warm season grasses and legumes, have yield advantages over monocultures, provide GHG advantages from high rates of carbon storage in degraded soils, and offer wildlife benefits.”

Climate Solutions

# Tillman Study

- University of Minnesota study finds that high-diversity grasslands can produce biofuels in ways that actually remove carbon from the atmosphere, by sequestering carbon in soils and roots while yielding up to 238 percent more energy than monoculture crops.
- David Tilman; Hill, Jason and Lehman, Clarence, “Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass,” Science, Dec. 8, 2006

Climate Solutions

# Charcoal Vision

- Combined production of bioenergy and charcoal, with charcoal returned to the soil.
- Networks of small-scale pyrolyzers that employ heat to convert biomass into bio-oils, biogas and charcoal.
- Scale would reduce transportation costs and keep the charcoal product close to the biomass source.
- Bio-oils would be shipped to energy markets, while biogas would run the pyrolyzers.
- Charcoal buried in soils would retain at least half its carbon after 1,000 years. Other benefits include increased water retention and improved fertility.

# Seeking Synergies

- David Laird, “. . . The scientific debate should be focused on how to design integrated agricultural biomass-bioenergy systems that build soil quality and increase productivity so that both food and bioenergy crops can be sustainably harvested.”

# Questions

- patrick@climatesolutions.org
- www.climatesolutions.org

Climate Solutions