Federal Environmental Symposium
Sustainable Production of Biofuels

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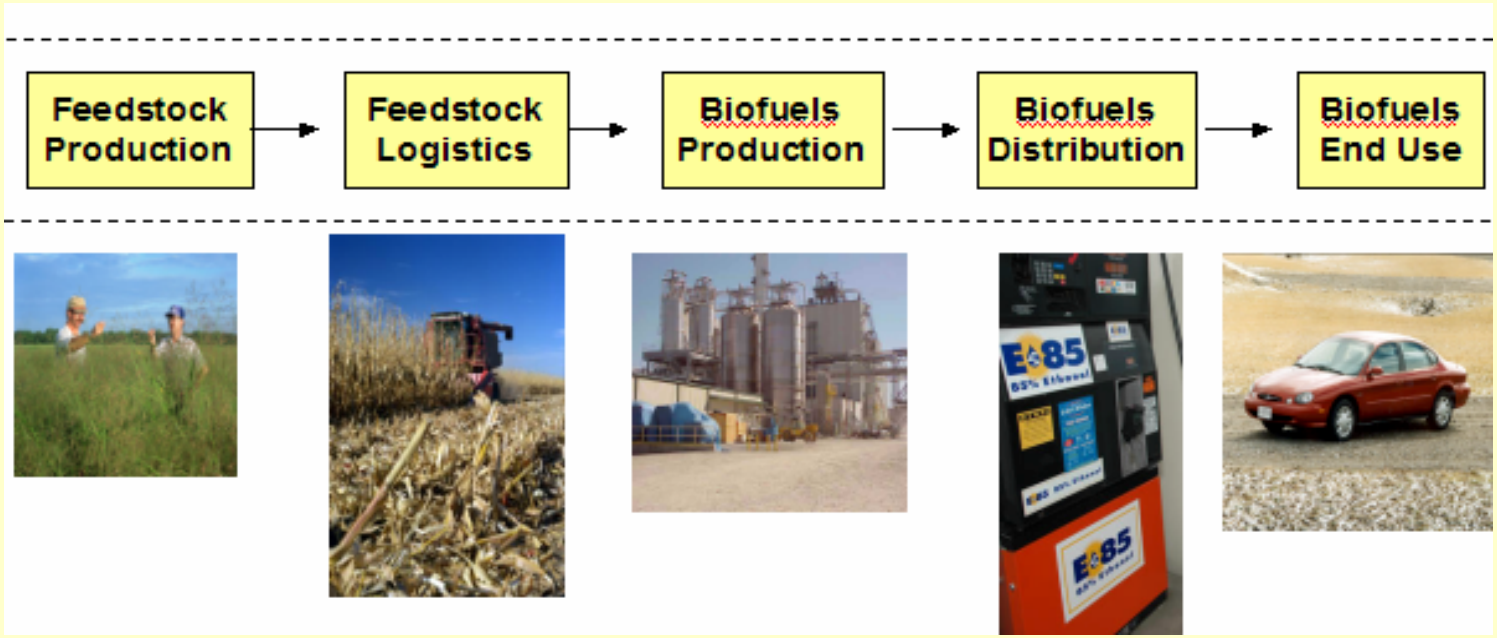
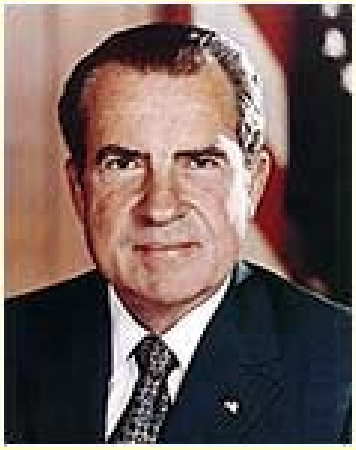
June 19, 2008



Federal/State Mandates

- Advance energy security
- Reduce Greenhouse Gas emissions
- Stimulate rural agricultural development
- Protect environment and natural resources

The Energy Crisis



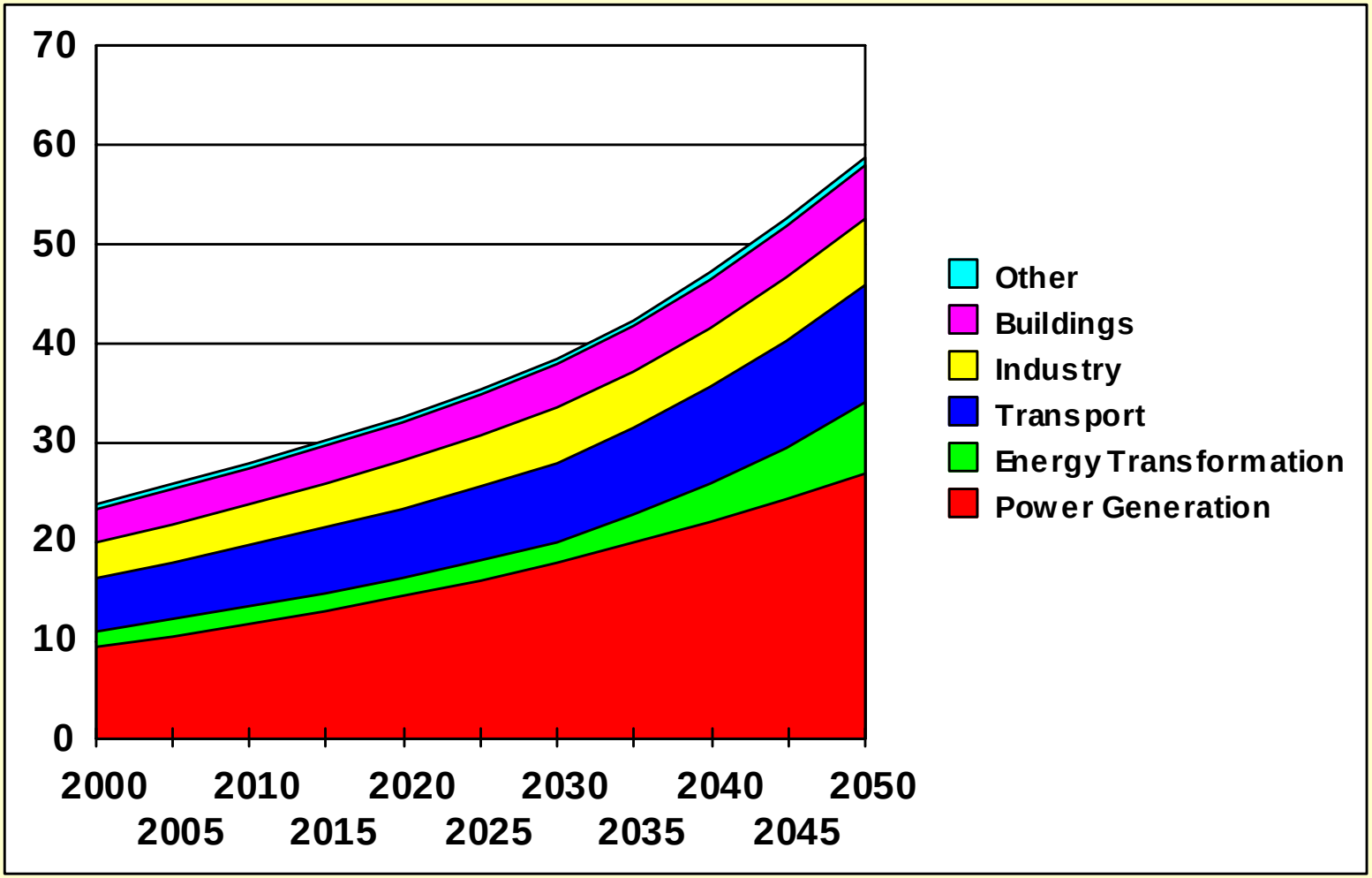
In all of the 186 State of the Union messages delivered from this place in our history, this is the first in which the one priority, the first priority, is energy.

Tonight I want to have an unpleasant talk with you about a problem unprecedented in our history. With the exception of preventing war, this is the greatest challenge our country will face during our lifetimes. The energy crisis has not yet overwhelmed us, but it will if we do not act quickly

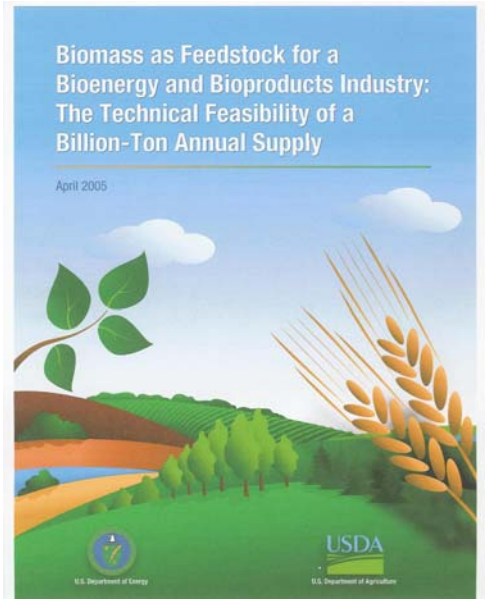
President Bush

“America must have an energy policy that plans for the future, but meets the needs of today. I believe we can develop our natural resources and protect our environment.”

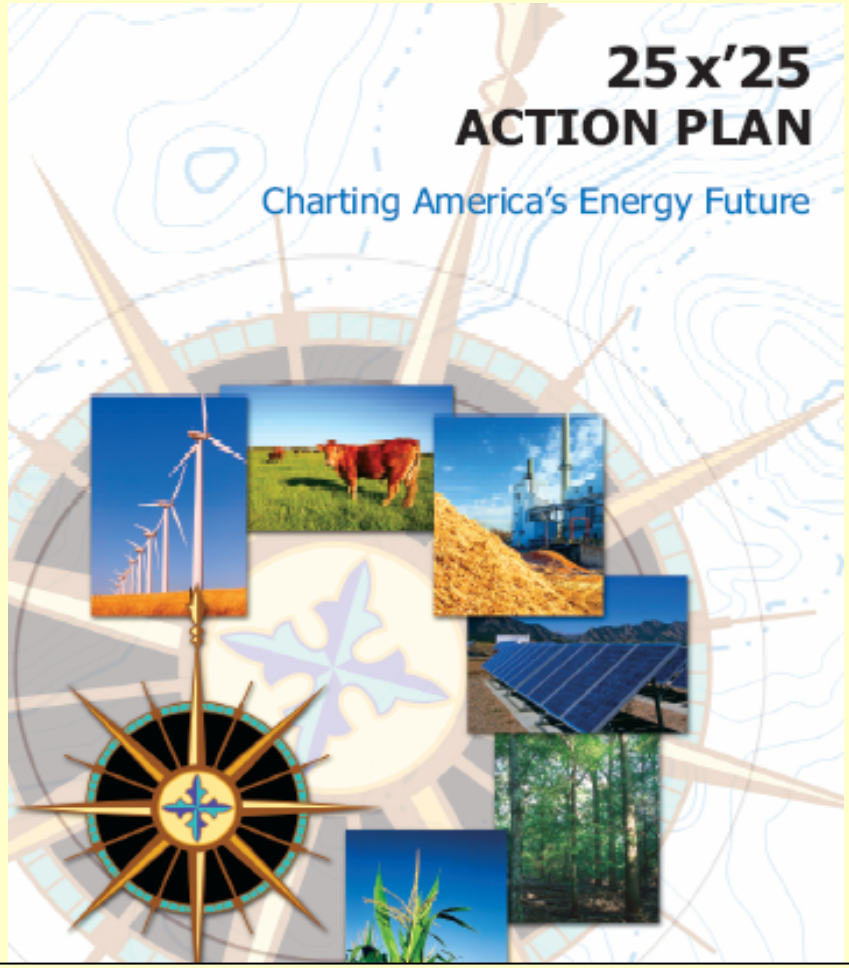
World Projection of CO_2 Emissions, by Sector **(IEA, 2006)**



Conversion of Available Feedstocks



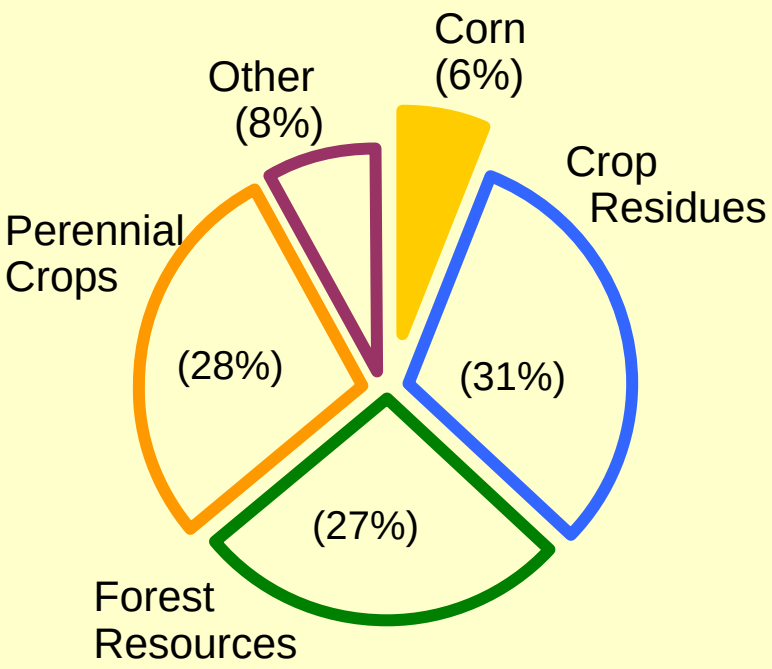
- "Billion Ton" study indicates that enough biomass is potentially available to displace > 30% of current U.S. petroleum consumption, with no impacts to food, feed, or export demand
- But it requires variety of biomass types
  - Agricultural lands
  - Corn stover, wheat straw, soybean residue, manure, switchgrass, poplar/willow energy crops, etc.
  - Forest lands
    - Forest thinnings, fuelwoods, logging residues, wood processing and paper mill residues, urban wood wastes, etc.



Renewable energy production must conserve, enhance and protect natural resources, and be economically viable, environmental sound and socially acceptable

Biomass Resources

Projected U.S. Biofuel Sources



Today: Nearly all ethanol is made from corn grain

The Future: Cellulosic biomass will be the primary source for fuel ethanol

Sources of Cellulosic Biomass:

- Agricultural residues
- Forestry residues
- Terrestrial & aquatic crops and trees grown for energy purposes
- Selected municipal, agricultural, and industrial wastes

In the future, far more ethanol will be made from cellulosic biomass than from corn.

* Source: *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: Technical Feasibility of a Billion Ton Annual Supply*. 2005. DOE and USDA.

April 26, 2006

CALIFORNIA: Gov. Directs State Agencies to Expand 'Bio-Fuels'

California does not grow much corn. What it does have is biomass in other forms - corn stover, other crops, agricultural waste like rice straw, forestry waste, and urban waste including municipal solid waste (MSW) and sewage. So the focus for ethanol production in California - which imports 95% of the ethanol it blends into its gasoline - has NOT been on corn fermentation but on biomass conversion. Conversion technologies (CTs) can turn biomass into clean electricity, heat, and ethanol with virtually zero toxic emissions. Developing these technologies could be the solution to the world's fossil fuel dependence and a boon to California's economy.

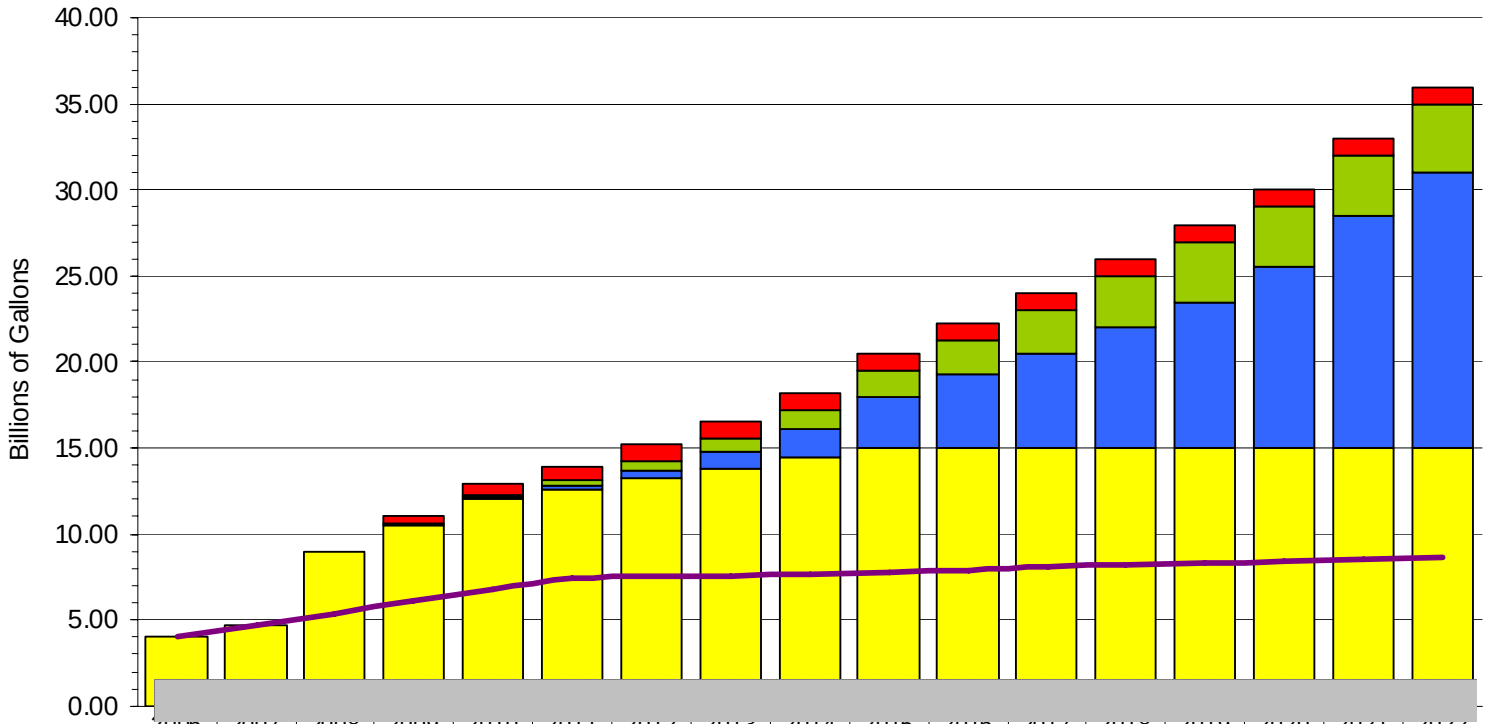
Governor Schwarzenegger gets it. Witness his executive order April 25th in response to the relentless price hikes on gasoline in the state and his environmental commitment to reduce pollution
and greenhouse gases.

Energy Independence & Security Act 2007

Type of Fuel	BGY
Total Renewable Fuels by 2022	**36 BGY**
Corn Ethanol (Capped at 15 BGY)	**15 BGY**
Advanced Biofuels – Includes imported biofuels and biodiesel. Includes 1 billion gpy biodiesel starting in 2009 All must achieve ≥ 50% reduction of GHG emissions from baseline*	**21**
Cellulosic Fuels – Includes cellulosic ethanol, biobutanol, green diesel, green gasoline All must achieve ≥60% reduction of GHG emissions from baseline*	**16**

***Baseline = average lifecycle GHG emissions as determined by EPA Administrator for gasoline or diesel (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005**

Renewable Fuel Standard (RFS), 2007-2022



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biomass-based Diesel				0.50	0.65	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Balance of Advanced				0.10	0.20	0.30	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	3.50	3.50	4.00
Celullosic Advanced					0.10	0.25	0.50	1.00	1.75	3.00	4.25	5.50	7.00	8.50	10.50	13.50	16.00
Conventional Biofuels	4.00	4.70	9.00	10.50	12.00	12.60	13.20	13.80	14.40	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Current RFS PL 109-58	4.00	4.70	5.40	6.10	6.80	7.40	7.50	7.60	7.70	7.80	7.90	8.10	8.20	8.30	8.40	8.50	8.60

EPA- Rule Making: Renewable Fuel Standards

- EPA Renewable Fuel Standard-1 (Before EISA) analysis assessed first order impacts
  - GHG impacts of corn and soybean acres in US
- RFS-2 (After EISA) more complete assessment of domestic and international impacts
  - Corn and soybeans plus other crops
  - Land use changes
  - International impact of decreased US exports
    - Increased crop production in other countries adds GHG
    - Land use impacts critical

Lifecycle Assessment

- Lifecycle assessment required to determine which fuels meet mandated GHG performance thresholds compared to petroleum fuel replaced
  - 20% reduction for new facility renewable fuel
  - 50% reduction for biomass-based diesel
  - 60% reduction for cellulosic biofuel
- Lifecycle assessment must include impacts on land use
- Corn based ethanol capped at 15 billion/gallons

Sustainable and Environmentally Responsible Biofuels (EISA)

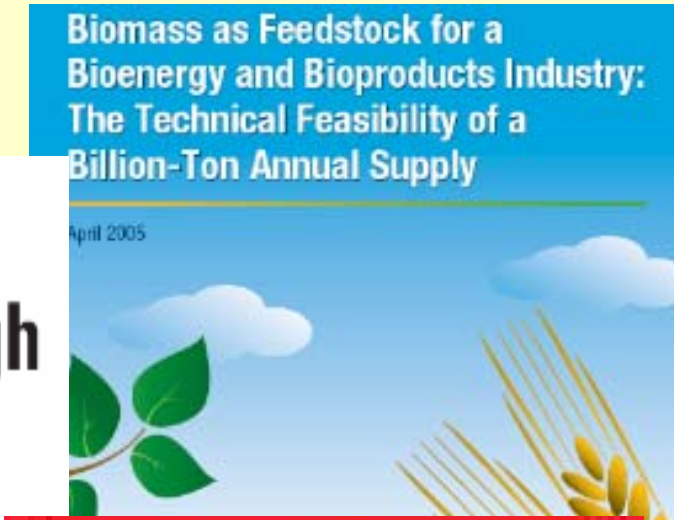
Two Clear Environmental Goals:

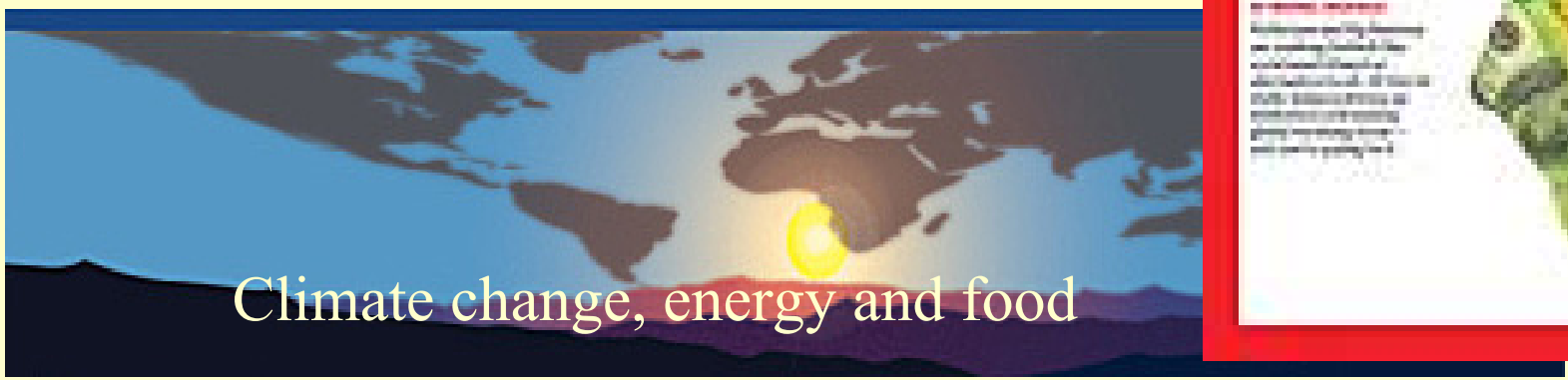
- Use of renewable fuels results in significant reductions of GHG emission
  - $\geq$ 50% reductions over lifecycle, determined by EPA, compared to baseline
  - Includes the full biofuel system
- Biofuel production does not adversely impact the environment or natural resources
  - EPA to assess and Report to Congress on environmental impacts of biofuel system
  - Particular recognition of impacts to water quality, EISA amends the Clean Air Act to integrate *water quality* into a fuel assessment analysis

Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change

Timothy Searchinger,[1*] Ralph Heimlich,[2] R. A. Houghton,[3] Fengxia Dong,[4] Amani Elobeid,[4] Jacinto Fabiosa,[4] Simla Tokgoz,[4] Dermot Hayes,[4] Tun-Hsiang Yu[4]

Most prior studies have found that substituting biofuels for gasoline will reduce greenhouse gases because biofuels sequester carbon through the growth of the feedstock. These analyses have failed to count the carbon emissions that occur as farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels. By using a worldwide agricultural model to estimate emissions from land-use change, we found that corn-based ethanol, instead of producing a 20% savings, nea





EPA Strategic Framework

Feedstock Production → **Feedstock Logistics** → **Biofuels Production** → **Biofuels Distribution** → **Biofuels End Use**

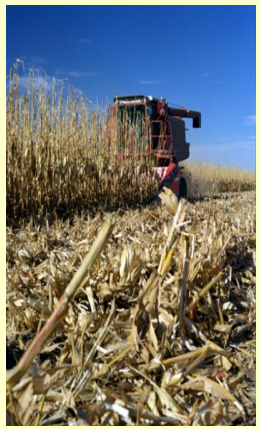
Ag Crops

Ag Residues

Energy Crops

Forest Residues

Wastes



Harvesting & Collecting

Storage

Pre-Processing

Transportation

Fuel types

Biochemical Conversion

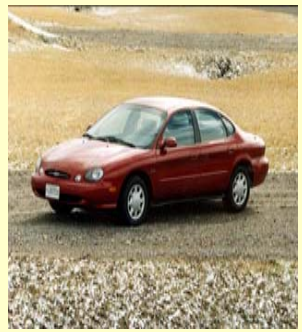
Thermochemical Conversion

Anaerobic Digestion

Transportation

Storage

Dispensing

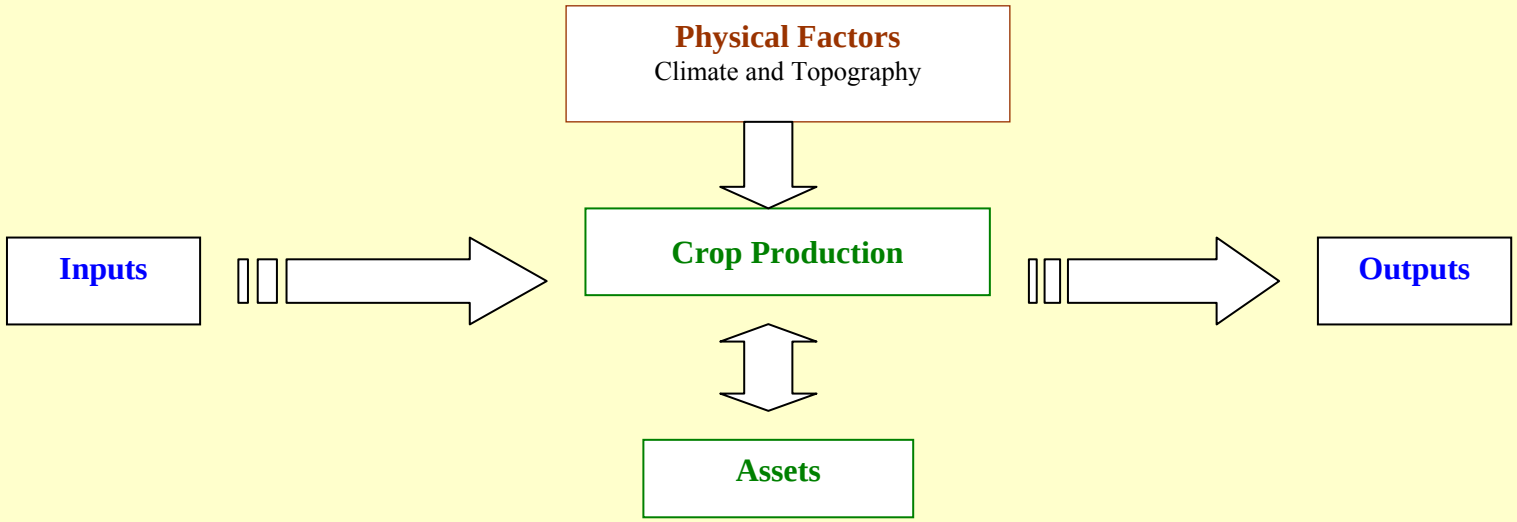


Transportation fuels (in light- & heavy-duty vehicles & trucks, off- road vehicles, locomotives, flight technologies, boats/ships)

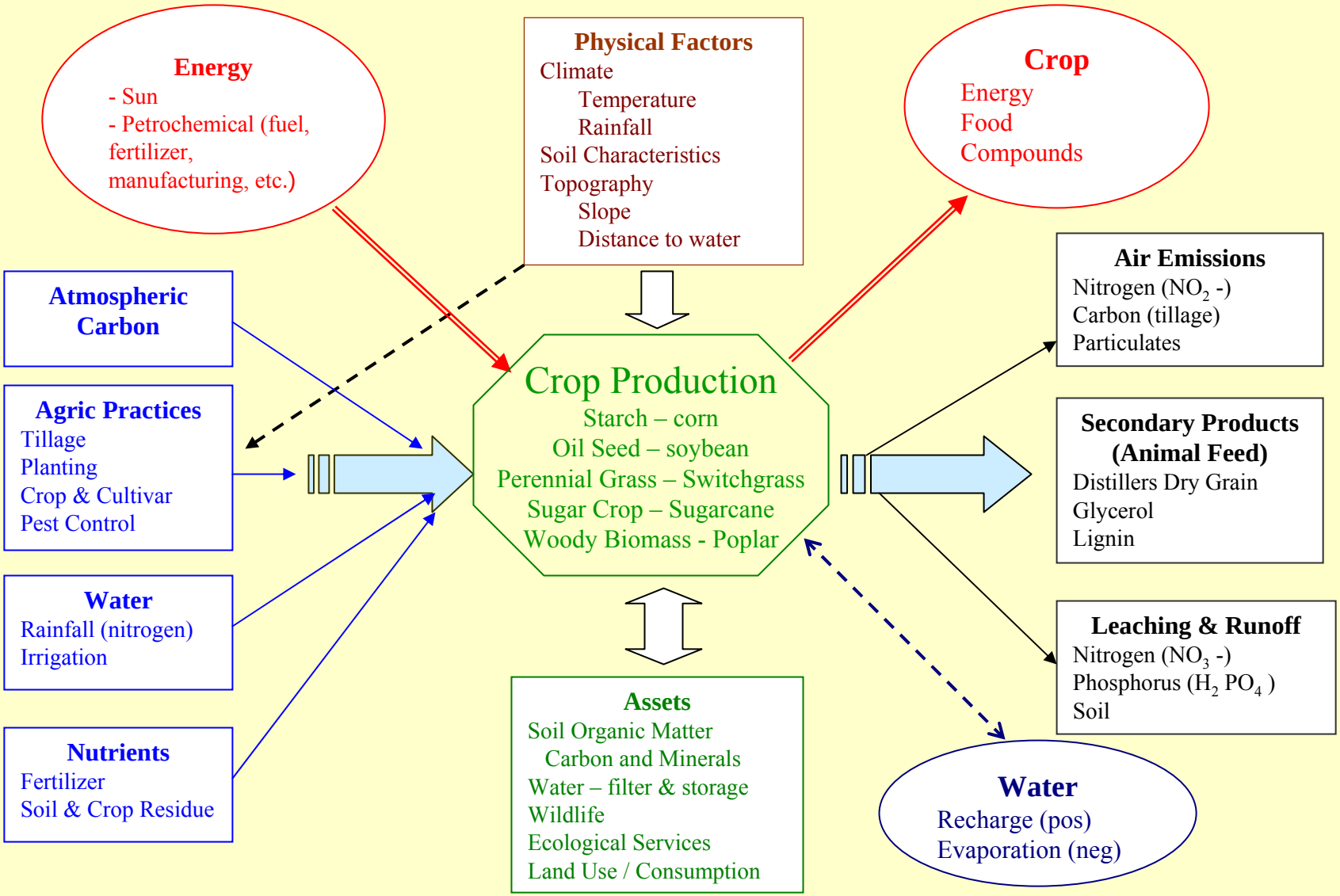
Power & Generators

Chemical Feedstocks for Manufacturing

Crop Production Generalized Diagram

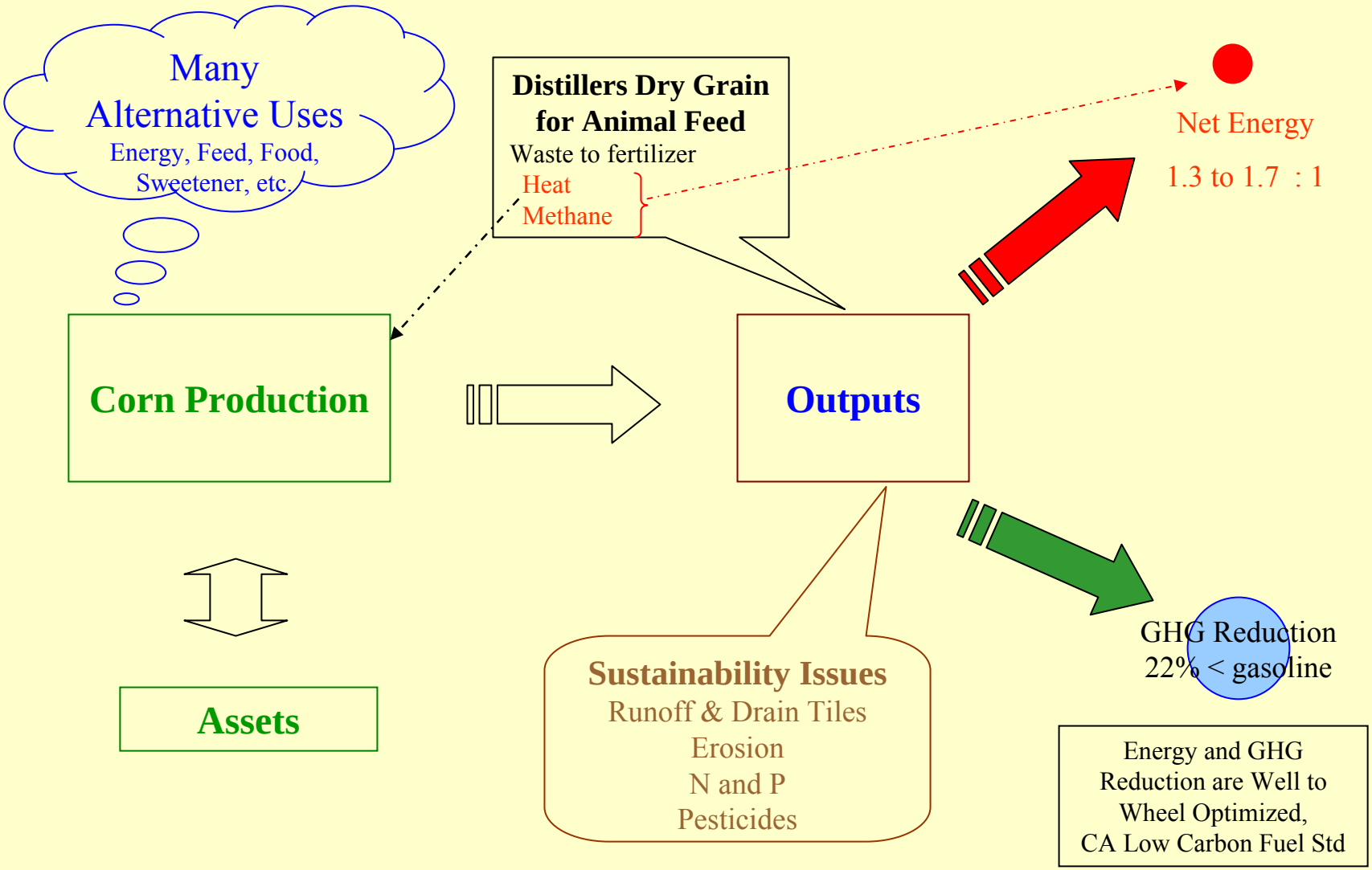


Inputs and Outputs of Biofuel Crop Production



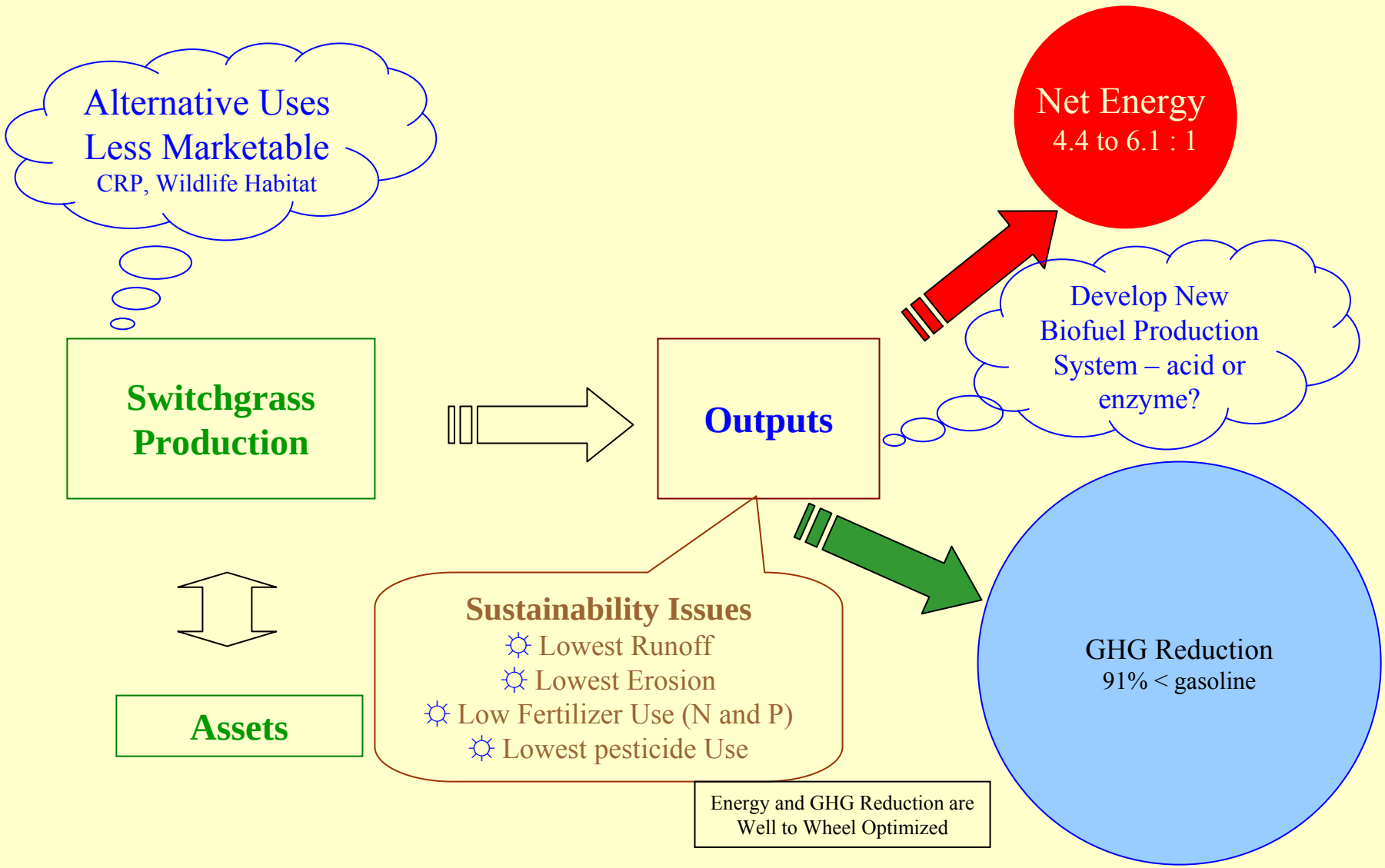
Starch (Corn) For Ethanol – Outputs

►*low net energy; serious sustainability issues*◄



Cellulosic Ethanol (Switchgrass) – Outputs

►higher net energy; sustainability advantages; technical/financial barriers◄



EPA Planning for Sustainable Production and Use of Biofuels

9				8		4		
		3			6			
	4		1				6	1
7								
		5		9		3		
4					7			9
2								
8	3	6					1	
				4	2			

The Sudoku of Biofuels

Ethanol from corn							
		Techno-logy					**Nitrates**
	Cellu-losic						
				Soil loss		**Water**	
	Bio-waste	**Ag prac-tices**					
Conser-vation	**Climate change**				**Phos-phate**		
		Pricing				**Eco-Services**	

Assessing Impacts of the Biofuel System

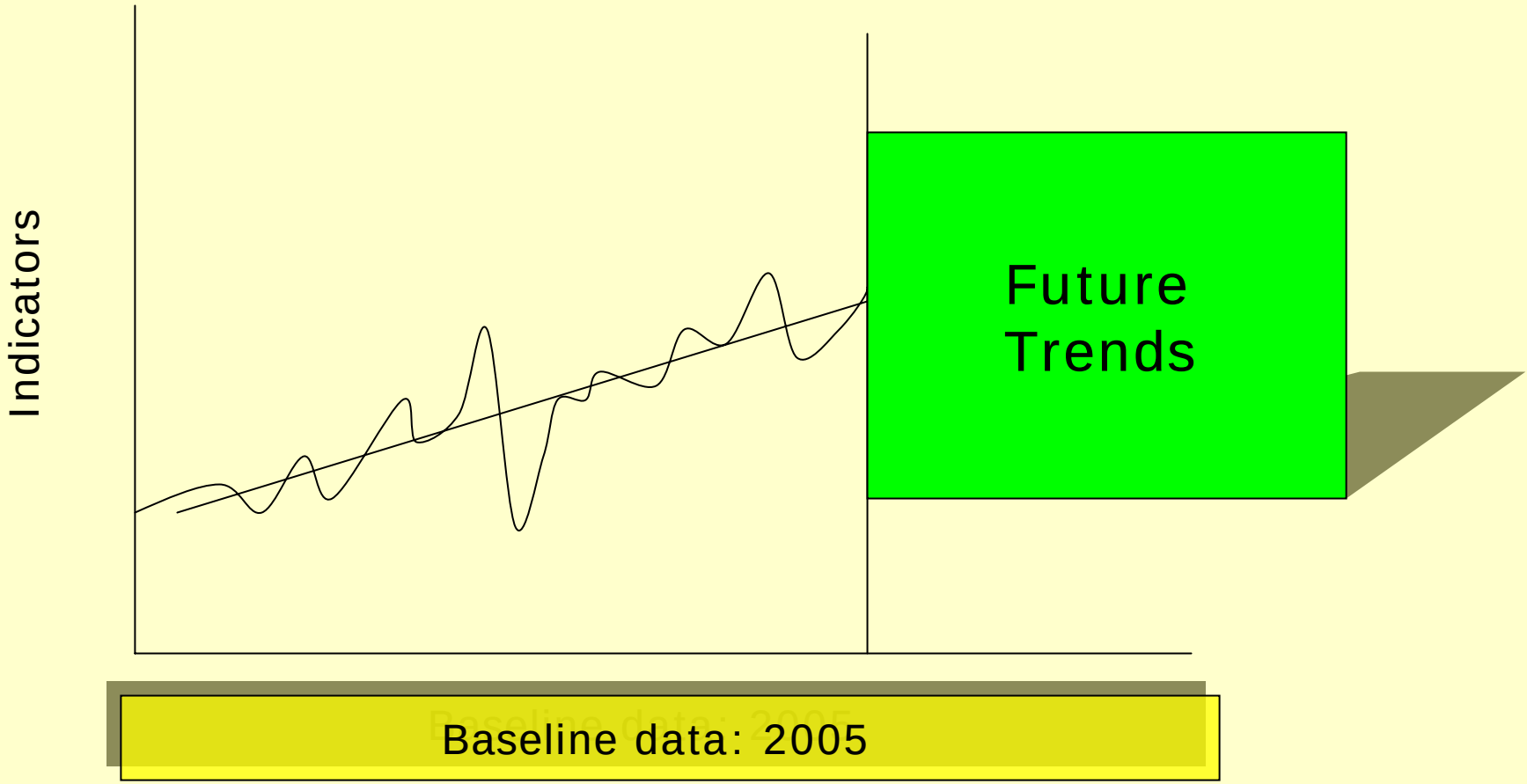
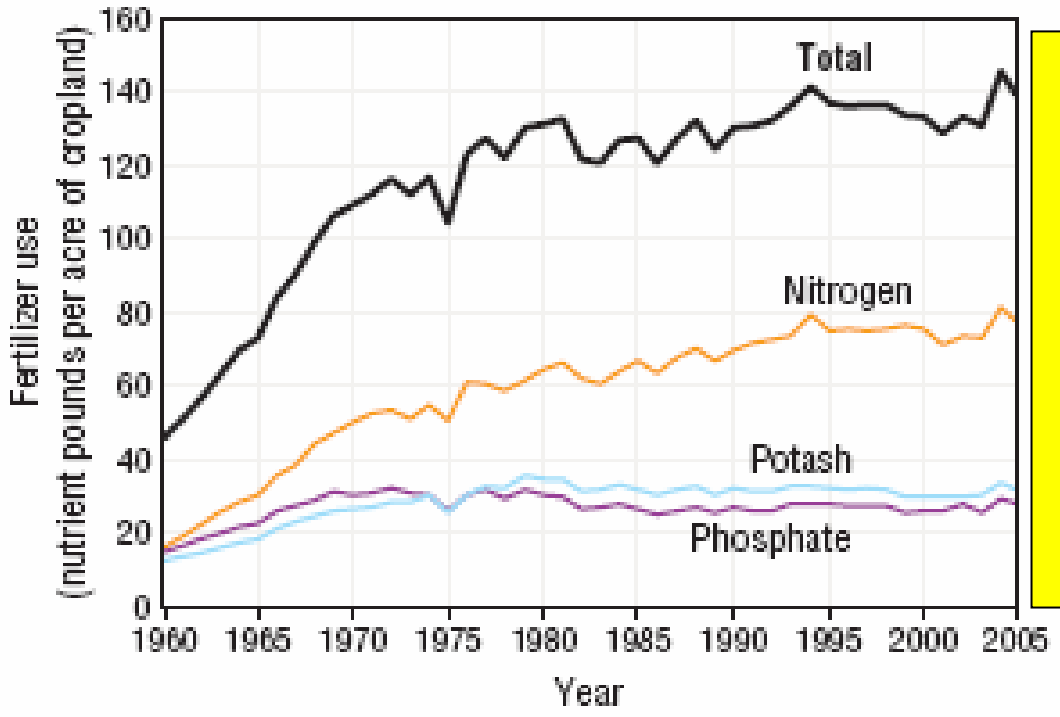


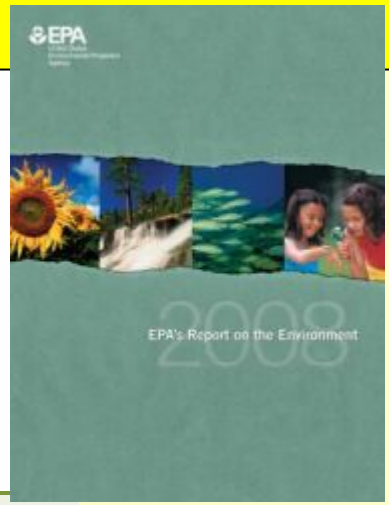
Exhibit 4-16. Commercial fertilizer use in the U.S., 1960-2005[a]



[a]Based on sales data. Per-acre use based on the acreage of harvested or failed cropland, as determined by USDA's National Agricultural Statistics Service.

Data source: *Lubowski, 2006; Wiebe and Gollehon, 2006*

Future Trends



EISA Section 204 EPA Report to Congress

SEC. 204. Not later than 3 years after the enactment of this section and **every 3 years thereafter,** the Administrator of the Environmental Protection Agency, in consultation with the Secretary of Agriculture and the Secretary of Energy, shall assess and report to Congress on the impacts to date and likely future impacts of the requirements of section 211(o) of the Clean Air Act on the following:

(1) Environmental issues, including air quality, effects on hypoxia, pesticides, sediment, nutrient and pathogen levels in waters, acreage and function of waters, and soil environmental quality.

(2) Resource conservation issues, including soil conservation, water availability, and ecosystem health and biodiversity, including impacts on forests, grasslands, and wetlands.

(3) The growth and use of cultivated invasive or noxious plants and their impacts on the environment and agriculture.

In advance of preparing the report required by this subsection, the Administrator may seek the views of the National Academy of Sciences or another appropriate independent research institute.