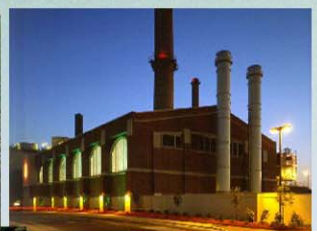
The BioEconomy – Today and Tomorrow

Presented to:

TRANSITION TO A BIO ECONOMY

Integration of Agricultural and Energy Systems



Westin Atlanta Airport • Atlanta, Georgia

Presented by:

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Senior Scientific Advisor
Under Secretary of Agriculture for Research,
Education and Economics

February 12–13, 2008

Bioeconomy Yesterday, Today and Tomorrow

- **Agriculture has a long history on utilization research for agricultural products –**
  - **Develop new food and industrial products**
  - **Enhance farm income and rural economy**

- **The dynamics of our present day energy situation has significantly increased interest in utilization of agricultural products and residues**

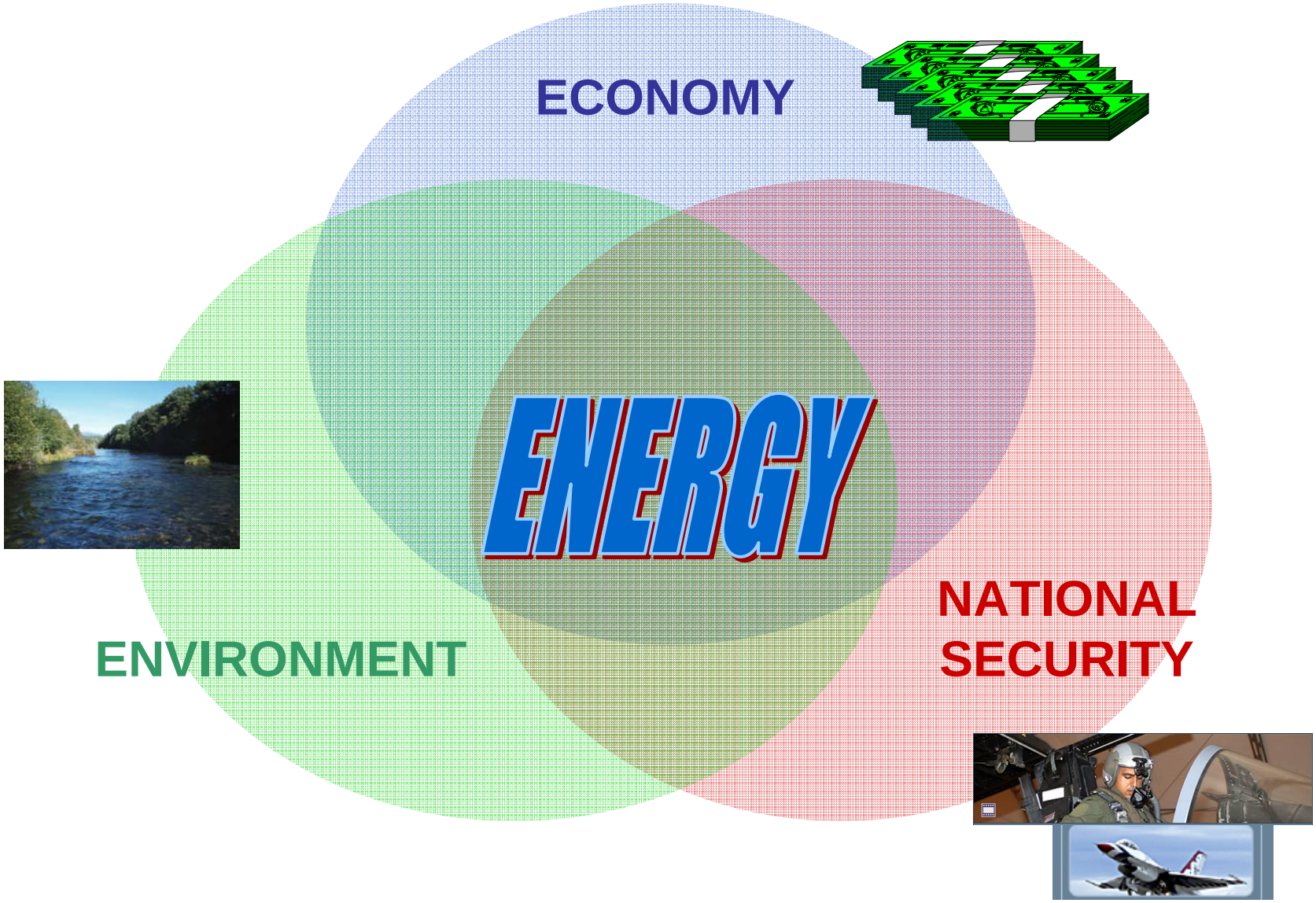
Bioeconomy & Energy

Agriculture today is linked to energy and –

Energy is linked to the Bioeconomy

Food, Fiber AND Energy AND Bioproducts

The Centrality of Energy



The Road We Are Traveling Today

- ***Economy***
  - ***We send over $200 billion a year across our borders for oil.***
  - ***Gasoline prices are going higher and higher***
  - ***Importing over 70% of nitrogen fertilizer***
  - ***The U.S. thinks of itself as a bastion of productivity, yet in energy we use twice as much energy per unit of output as our European competitors***
- ***National Security***
  - ***U.S. imports about 60% of its oil & large share from the Middle East.***
  - ***Oil supplies vulnerable to regional geopolitical instabilities***
  - ***World consumes about 2 barrels for every barrel discovered***
  - ***Took 125 years to use a trillion barrels; second trillion will take 30 years;***
  - ***Demand growing rapidly in Asia and other developing regions***

The Road We Are Traveling Today

- ***Climate***
  - **Greenhouse Gases are increasing – In the past century**
    - **CO_2 increased from 280 to 360 ppm**
    - **CH_4 increased from 750 to 1750 ppm**
    - **N_20 increased from 270 to 310 ppm**
  - **The Intergovernmental Panel on Climate Changes (IPCC) says "very high confidence" that human activities have resulted in warming; effects are real**
- ***Carbon – Carbon – Carbon***
  - **Many large U.S. corporations are now calling for GHG legislation that would include a national carbon market. Alcoa, Caterpillar, Duke Energy, FPL, General Electric, and PG&E are among the companies that formed the U.S. Climate Action Partnership.**

The bottom line – Carbon will be a major driver to the formation of a bioeconomy and how we use energy!

I am Suggesting to You – the Paradigm has Shifted

"Toto – this ain't Kansas!"

Where is the Bioeconomy Yellow Brick Road?

Our Future Energy Road?

Short Term Now

- Hybrid or Clean Diesel Vehicles
- Clean Coal Efficiency
- Energy Efficiency Standards
- Renewable Fuel Standards
- Nuclear Plant Relicensing
- Enhanced Oil Recover
- Biological Sequestration
- Methane to Markets*
- Federal Facility Management Plan
- Fuel Economy Standards
- Wind, Solar Tax Incentives
- Climate Leaders
- Climate VISION
- SmartWay Transportation

Mid Term

- Hybrid/Clean Diesel Vehicles
- Clean Coal Gasification
- Renewable/Efficiency Partnership*
- Cellulosic Biomass
- Advanced Nuclear
- Geological Sequestration*

Long Term

- Hydrogen*
- FutureGen*
- Zero Energy Homes & Buildings
- ***Bio-Energy Systems***
- GenIV Nuclear/Fusion*

***** Denotes International Partnership

Source: June 30, 2005 White House Press Release on G-8 Summit

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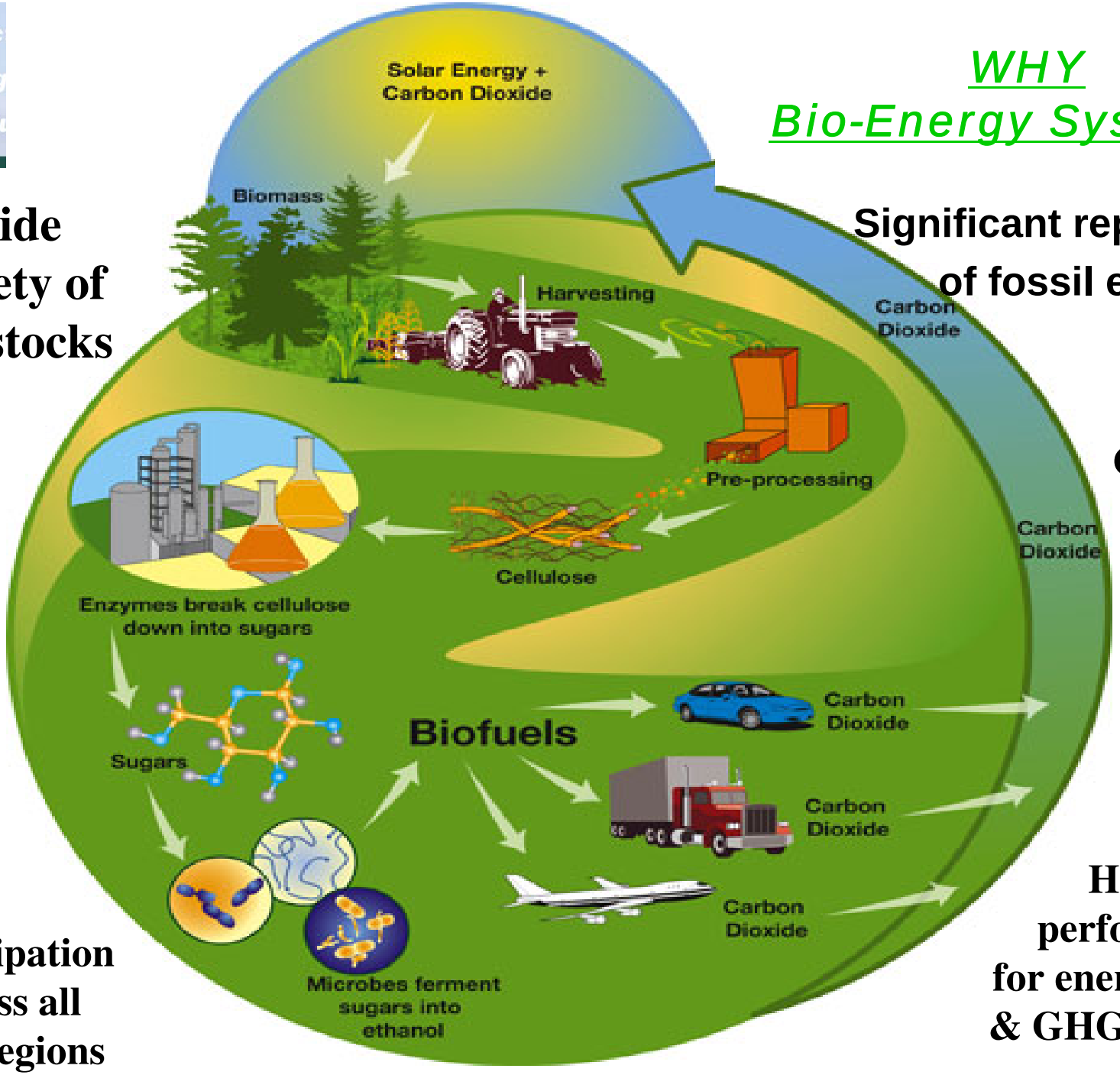
WHY Bio-Energy Systems?

Wide variety of feedstocks

Significant replacement of fossil energy



Multiple Conversion Processes and Products

Participation across all U.S. regions

Higher performance for energy balance & GHG reductions

SCIENCE DRIVES OUR FUTURE

Where is the Science Leading Us in Bioenergy? – USDA - ARS

- **High-quality, cost-effective, cellulosic feedstocks are produced**
  - Molecular genetics
  - Plant physiology
  - Plant breeding

- **Conversion to fuels:**
  - Lipids to fuels such as biodiesel
  - Starches and sugars to ethanol/butanol
  - Cellulosics to Ethanol and Butanol
  - Cellulosics to Other Fuels (e.g., thermo-chemical technologies)

- **Produce bioenergy feedstocks sustainably**
  - Focusing on ligno-cellulosics and traditional grains and oil seeds

- **Co-Products:**
  - Proteins/Fiber
  - Nutrients
  - Nutraceuticals
  - Other Valuable Products

Where is the Science Leading Us in Bioenergy? – USDA - CSREES

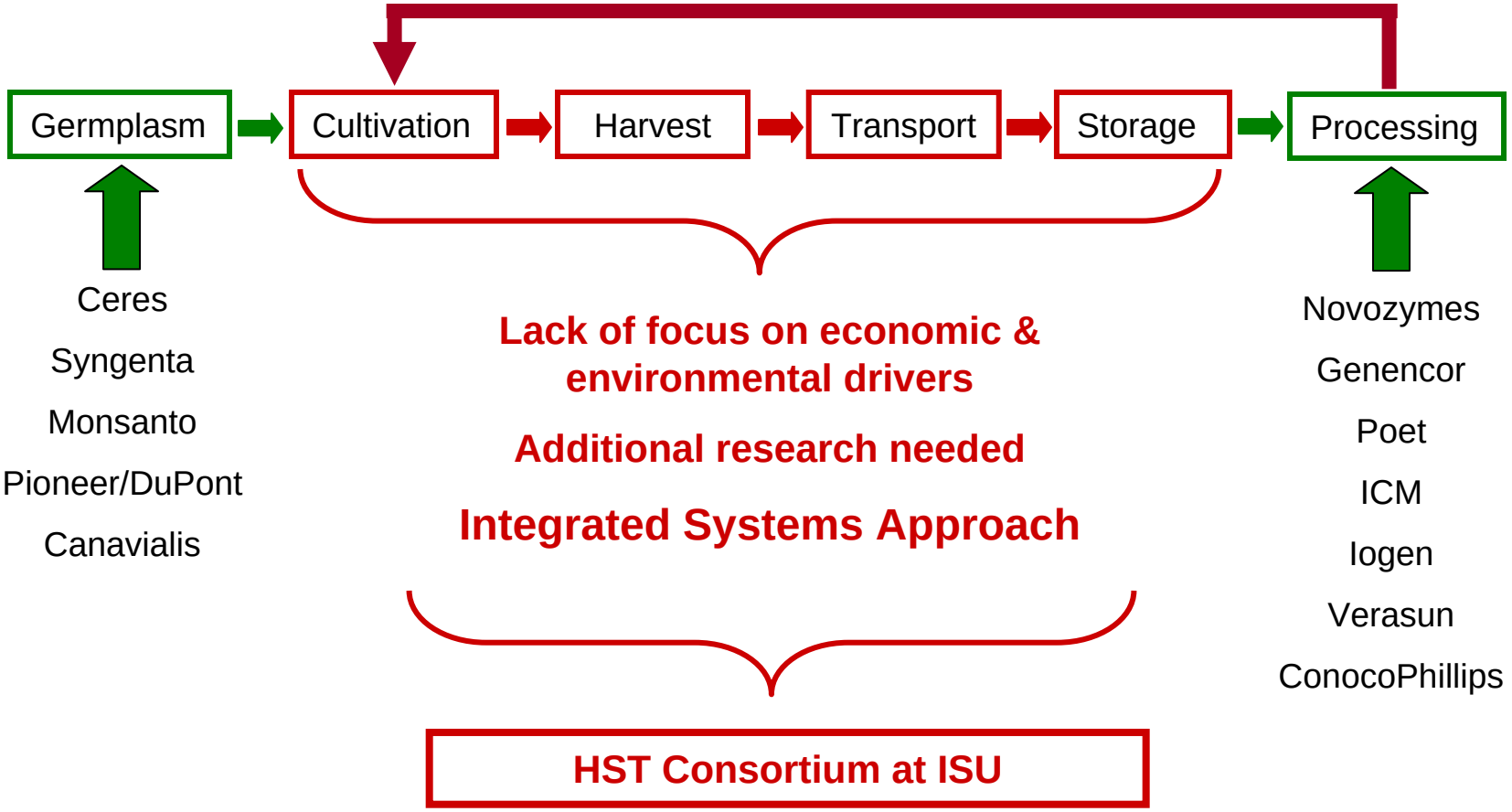
- **Highlights include:**
  - **Genetic Engineering of Yeast for Co-Fermenting all 5 Cellulosic Sugars to Ethanol**
  - **Genetic Engineering of Cellulose Biosynthesis in Trees**
  - **Gasification and fermentation technologies to produce ethanol and chemicals**
  - **Recycling of energy, chemicals, and materials from agricultural processing wastes**
  - **Development of an aviation-grade ethanol**
  - **Innovative non-food uses for ag residuals and underutilized co-products**

Where is the Science Leading Us in Bioenergy? – USDA - ERS

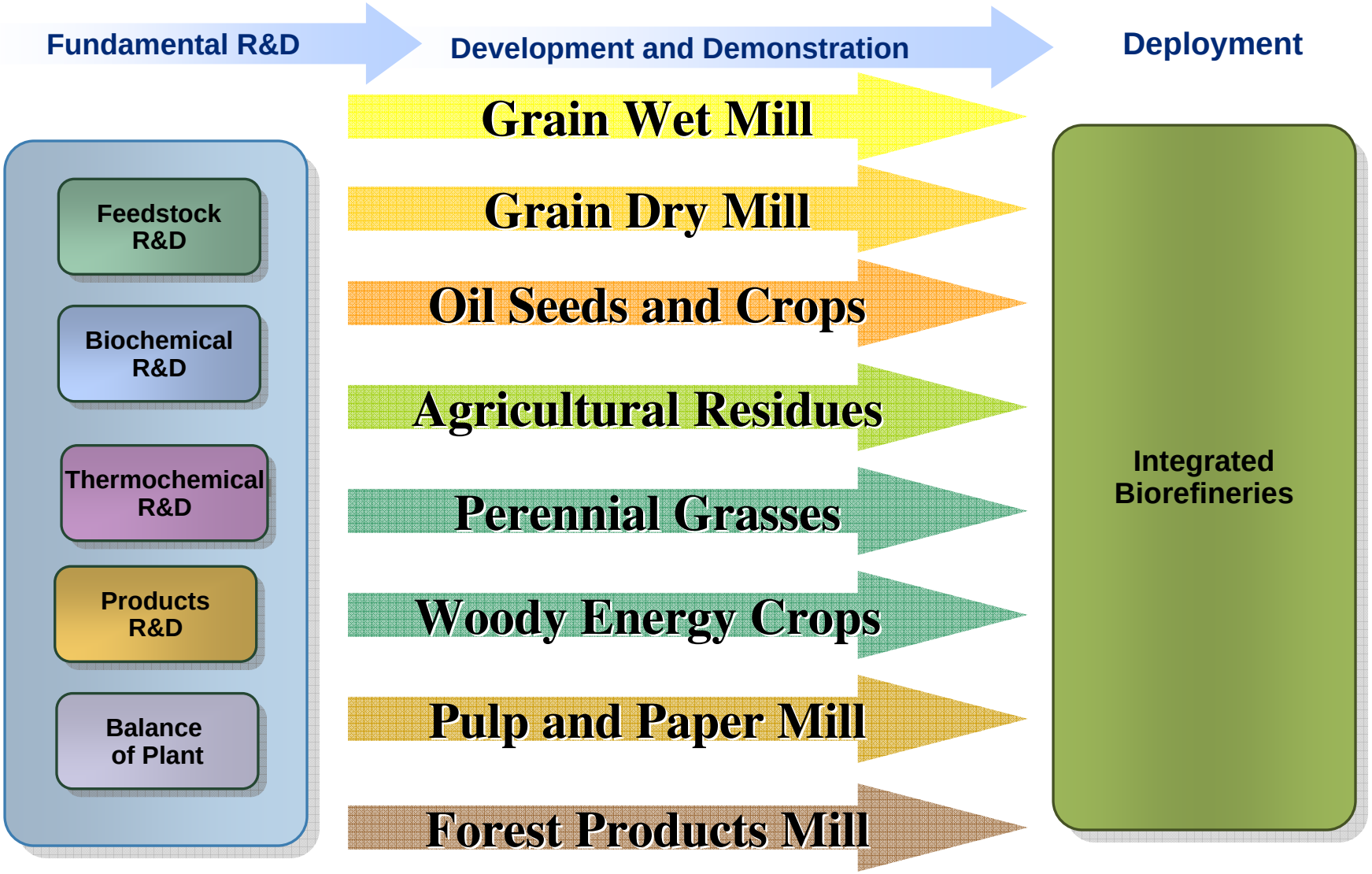
Current research areas include:

- **Bioenergy Long-Term Supply and Demand Factors**
- **Impacts on Domestic Feed and Livestock Industries**
- **Bioenergy Policies: An Economywide Perspective**
- **Bioenergy Policies: A Global Perspective**
- **Impacts of Energy-Induced Land Changes on Conservation Goals and Environmental Quality**
- **Impacts of Bioenergy Development on Rural Communities**
- **Effects of Higher Corn Prices on Retail Food Prices**

Where is the Science Leading Us in Bioenergy– Universities?



Where is the Science Leading Us in Bioenergy– USDOE – EERE Biomass Program?

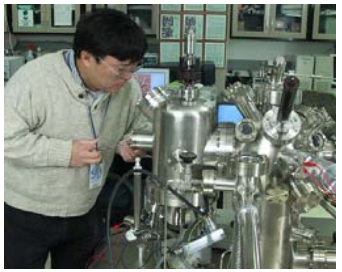


Small-Scale Cellulosic Biorefineries

- The U.S. DOE announced in January 2008 that $114 million will be invested over four years to support the development of small-scale cellulosic biorefineries at 10% of commercial scale
- The new biorefineries are expected to produce about 2.5 million gallons a year of ethanol as compared to the 20-30 million gallons that a full-sized facility can produce.
- Companies and plant locations include:
  - Lignol Innovations, Inc. – Colorado
  - ICM Incorporated – Missouri
  - Pacific Ethanol, Inc. – Oregon
  - NewPage Corporation – Wisconsin

Where is the Science Leading us in Bioenergy Research – DOE Molecular Bioenergy Centers?

- Focus - understand how to reengineer biological processes
- Develop new, more efficient methods for converting cellulose into biofuels.
- Geographically distinct areas
- Different plants for lab research and for improving feedstock crops
- Up to $375 million



Source: http://genomicsgtl.energy.gov/centers/

Where is the Science Leading us down a Yellow Brick Road? – DOE – Office of Science

- **DOE BioEnergy Science Center** Oak Ridge National Lab
  - Focused on the resistance of plant fiber to breakdown into sugars and is studying the potential energy crops poplar and switchgrass.
- **DOE Great Lakes Bioenergy Research Center** University of Wisconsin in collaboration with Michigan State University.
  - Studying a range of plants and, in addition to exploring plant fiber breakdown, aims to increase plant production of starches and oils, which are more easily converted to fuels.
  - Also has a major focus on sustainability, examining the environmental and socioeconomic implications of moving to a biofuels economy.
- **DOE Joint BioEnergy Institute** led by DOE's Lawrence Berkeley National Laboratory.
  - Focus: Will concentrate on "model" crops of rice and Arabidopsis, in the search for game-changing breakthroughs in basic science, and is exploring microbial-based synthesis of fuels beyond ethanol.

Government/Industry Partnerships

DOE - $385M Funding - Total $1.2 B - (FY07–10)

- **Abengoa BioEnergy**
  - **11.4 MGY – Kansas – stover, wheat straw, milo stubble, switchgrass, and other feedstocks**
- **Alico, Inc.**
  - **13 M gallon – LaBelle, Fl – gasification technology – yard, wood, and vegetative wastes and energycane**
- **Bluefire Ethanol**
  - **19 MGY – California sited on a landfill – acid treated green and wood waste**
- **Broin Companies**
  - **125 MGY – Emmetsburg, Iowa - corn, fiber and stover – feedstock 25% cellulose**
- **Iogen Biorefinery Partners**
  - **18 MGY – Idaho – enzymatic conversion technology to process wheat straw**
- **Range Fuels**
  - **40 MGY – Georgia – thermal conversion technology – wood waste and wood crops**

- **Mascoma Corp.**
  - **Business partnership with the U of Tennessee – Niles Ferry Industrial Park in Vonore –**
  - **170 tons/day switchgrass**

Science Rapidly Expanding
Industry travels down the Yellow Brick Road.

- **Cutting edge technologies are:**
  - **reducing energy consumption**
  - **improving refinery efficiency**
  - **developing new co-products**
  - **using current and new feedstocks**
- **First Generation Biorefineries (biodiesel, starch/sugar-based ethanol)**
  - **Corn fractionation**
    - **Increases starch availability for ethanol production**
    - **Increases protein content of DDGS, improved flowability**
  - **Cold starch hydrolysis**
    - **Decreases energy use and production costs**
  - **Corn oil extraction**
    - **A dedicated crude oil source for biodiesel production**
    - **Higher protein feed content, improved flowability**

- **Second generation biorefineries – cellulosic ethanol; butanol**
- **Thermochemical - Gasification, pyrolysis (synthetic diesel, bio-oil, syngas**
- **Engineering microbes designed to make hydrocarbons that closely resemble gasoline, diesel, and even jet fuel - (LS9 and Amyris companies)**

Companies Developing Cellulosic Agrofuel Enzymes and Their Corporate Partners

- **Diversa/Celunol**
  Syngenta, Dupont/Tate&Lyle, Khosla Ventures
- **Iogen**
  Shell, Goldman Sachs
- **Genencor (Danisco)**
  Tembec, Mascoma/Kohsla Ventures, Cargill, Dow, Royal Nedalco
- **Novozymes**
  DuPont, Broin, COFCO. China Resources Alcohol Corp.
- **Dyadic**
  Abengoa, Royal Nedalco

Source: Grain. “Agrifuels and the Expansion of Agribusiness.” SEEDLING. July 2007. http://www.grain.org/seedling_files/seed-07-07-3-en.pdf

Companies with "Synthetic Biology" Activities (Related to Biofuels Production)

- **Amyris Biotechnologies**
  Developing synthetic microbes to produce pharmaceuticals, fine chemicals, nutraceuticals, vitamins, flavors and biofuels.
- **Codon Devices**
  Designing and constructing engineered genetic devices for partners in medicine, biofuels, agriculture, materials and other application areas.
- **Diversa**
  Adds new codons to "optimize" enzymes taken from natural bacteria to apply to industrial processes.
- **DuPont**
  Partnering with Genencor, BP, Diversa and others to develop microbes that will produce fibers and biofuels.
- **LS9**
  Designs microbial factories that produce biofuels and other energy related compounds.
- **Mascoma**
  Develops microbes to convert agricultural feedstock into cellulosic ethanol.
- **Synthetic Genomics**
  Develops minimal genome as chassis for energy applications.

Source: ETC Group, "Extreme Genetic Engineering: An Introduction to Synthetic Biology. January 2007. http://www.etcgroup.org/upload/publication/602/01/synbioreportweb.pdf

Some Transnational Corporations Investing in Agrofuels

- **Agribusinesses:** ADM; Cargill; China National Cereals, Oils and Foodstuffs Import & Export Corporation; Noble Group; DuPont; Syngenta; ConAgra; Bunge; Itochu; Marubeni; Louis Dreyfus.
- **Sugar:** British Sugar; Tate & Lyle; Tereos; Sucden; Cosan; Alco Group; EDF & Man; Bajaj Hindusthan; Royal Nedalco.
- **Palm Oil:** IOI; Peter Cremer; Wilmar
- **Forestry:** Weyerhaeuser, Tembec
- **Oil:** British Petroleum; Eni; Shell; Mitsui; Mitsubishi; Repsol; Chevrom; Titan; Lukoil; Petrobras; Total; PetroChina; Bharat Petroleum; PT Medco; Gulf Oil.
- **Finance:** Rabobank; Barclays; Societe Generale; Morgan Stanley; Kleiner Perkins Caufield & Byers; Goldman Sachs; Carlyle Group; Kohsla Ventures; George Soros.

Source: Grain. “Agrifuels and the Expansion of Agribusiness.” SEEDLING. July 2007. http://www.grain.org/seedling_files/seed-07-07-3-en.pdf

POLICY DRIVES TECHNOLOGY

A Number of Policy Incentives Can Help Spur the Bioeconomy

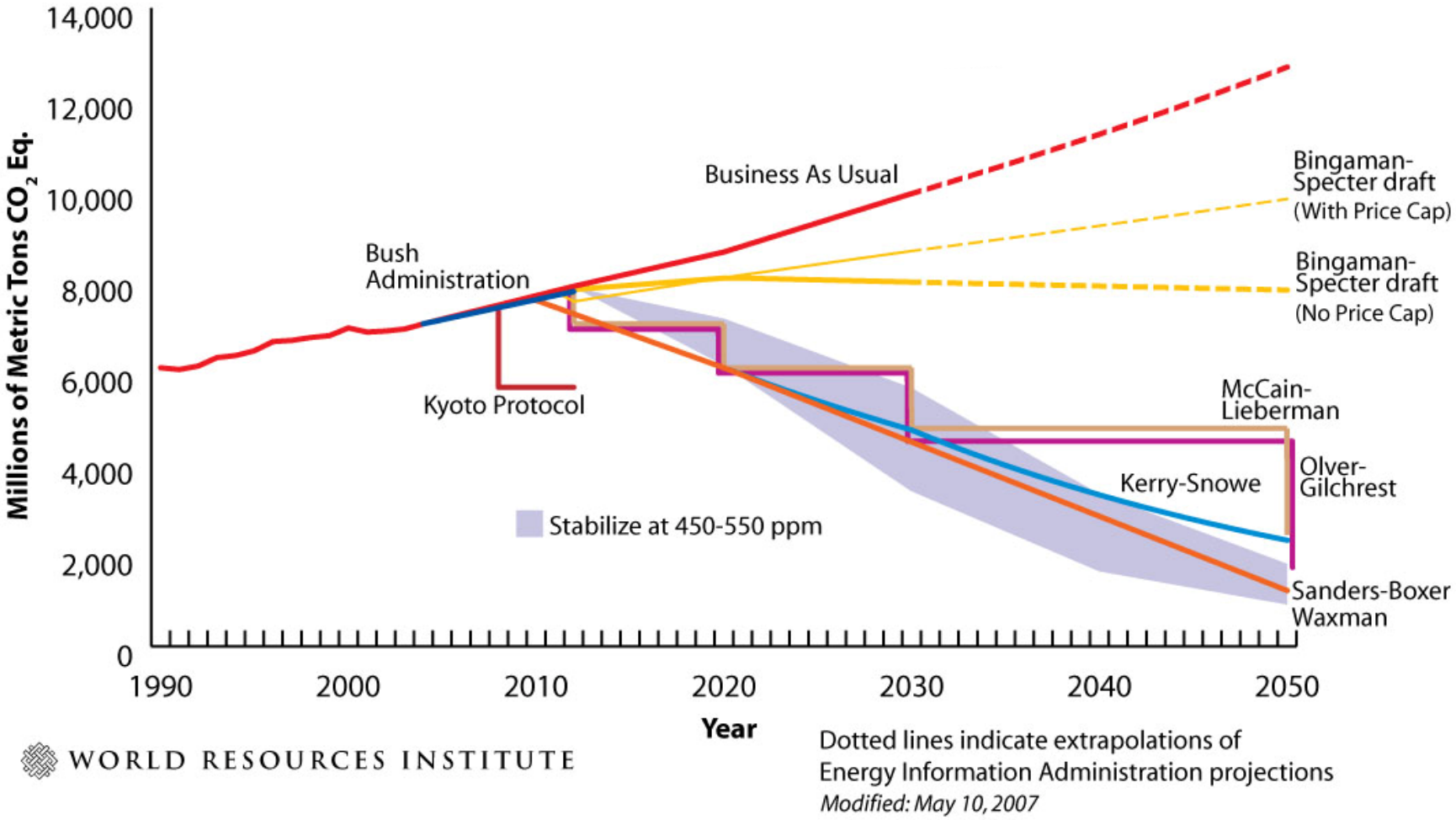
- **Renewable Portfolio Standards (RFS)**
- **Production Tax Credits (PTC)**
- **Renewable Energy Credits**
- **Public Benefit Funds**
- **Greenhouse Gas Reporting and Registries**
- **Climate Action Plans**
- **Biofuels Incentives**

Legislation and Policies are Being Developed

- State & local governments taking action to mitigate carbon emissions. Some prominent examples:
  - California: Passed legislation requiring 25% cut in Carbon emissions by 2020 (emissions to 1990 level)
  - California and 4 other western states agreed in Feb 2007 to form a cap-and-trade carbon market by August 2008.
  - Seven Northeastern states have agreed to mandatory CO2 emissions limits from power plants – goal is to stop increase in emissions by 2009 & reduce them to 10% below 2005 levels, by 2019

- Federal action has been proposed
  - U.S. Supreme Court decided (on April 2nd) that EPA does have authority under the Clean Air Act to regulate greenhouse gases for new cars and trucks.
  - On May 14th, President Bush announced an Executive Order that is a first step in the direction of regulating greenhouse gas emissions from new vehicles. He directed EPA, the DOT, the DOE and USDA to coordinate on possible regulations.
  - A number of climate change bills have been proposed in Congress. Sponsored by names you've heard of, like McCain, Obama, Lieberman, Bingaman, Specter, and others – you know its got legs if presidential hopefuls are making proposals.

Comparison of Economy-wide Climate Change Proposals in 110th Congress 1990–2050



Source: http://www.wri.org/newsroom/topic_content.cfm?cid=4265

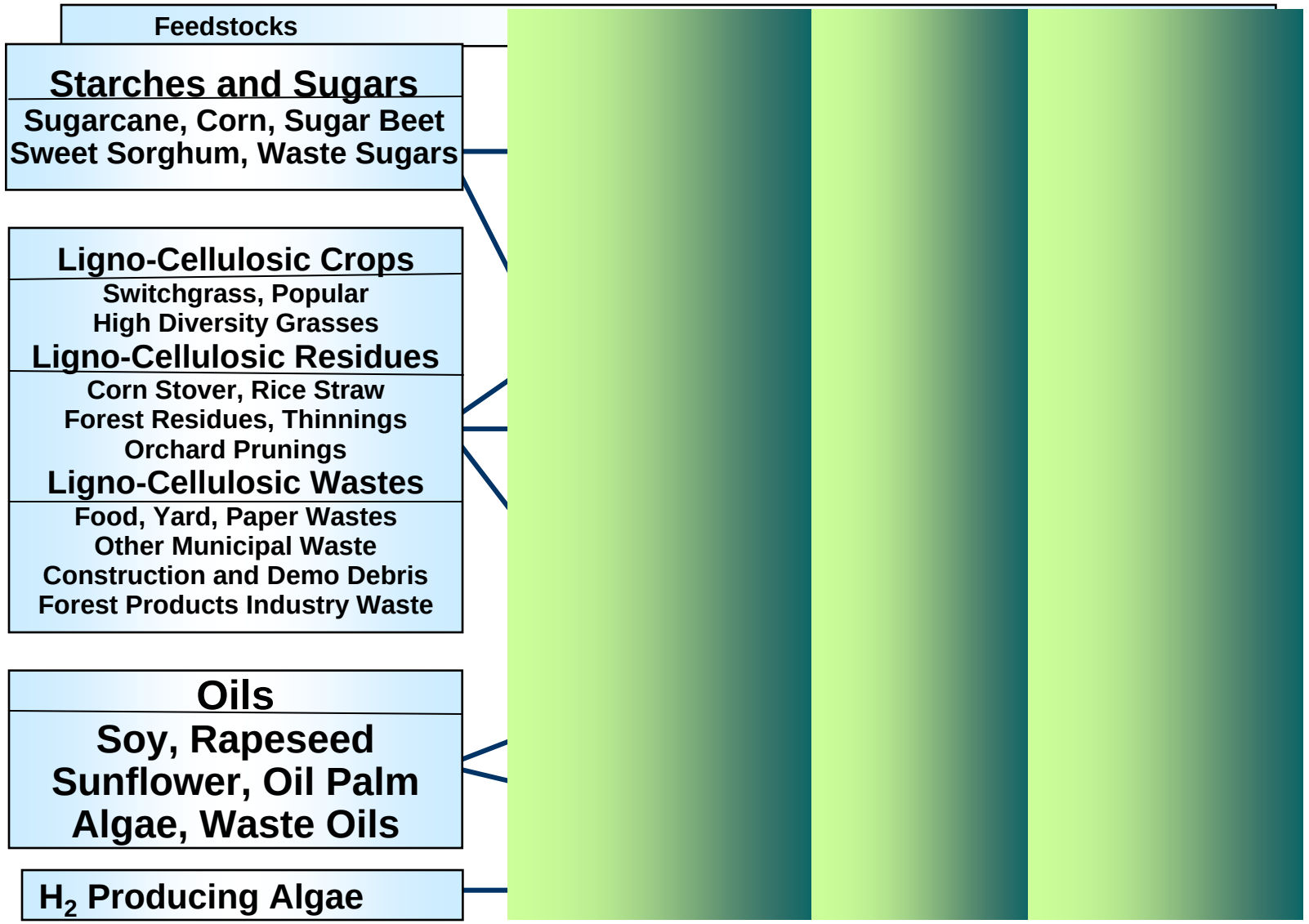
Biofuels Part of Low-Carbon Fuel Standard Strategy in California

- Global Warming Solutions Act passed by California Legislature (2006) – adopted regulations to control GHG emissions, starting no later than 2012.
- Subsequent Executive Order (S-1-07) for the Low Carbon Fuel Standard (LCFS) in January 2007, set a statewide goal to reduce the carbon intensity of California's transportation fuels at least 10 percent by 2020.
- Recent report* states:

"We find it possible to either manufacture a significant amount of low-carbon fuel within California or to import it from outside the state. Many of the low carbon fuels expected to be commercially available in large quantities within the 2020 time horizon are biofuels."

* A Low-Carbon Fuel Standard for California, Part 1: Technical Analysis August 1, 2007, Project Directors, Alexander E. Farrell, UC Berkeley www.its.berkeley.edu/sustainabilitycenter and Daniel Sperling, UC Davis www.its.ucdavis.edu; http://www.energy.ca.gov/low_carbon_fuel_standard/UC-1000-2007-002-PT1.PDF

A Low-Carbon Fuel Standard for California



Source: "A Low-Carbon Fuel Standard for California, Part 1: Technical Analysis, August 1, 2007.

History of Federal Energy and Environmental Policy

1978 – Public Utility Regulatory Policies Act (PURPA)

1978 – Energy Tax Act (ethanol blends $.40/gallon tax exemption)

1992 – Energy Policy Act (tax credit for renewable energy production)

1998 – Energy Conservation Reauthorization Act (included biodiesel credit)

1998 – Alternative Motor Fuels Act (Encouraged cars fueled by alternative fuels)

2000 – Biomass R&D Act (DOE/USDA joint R&D biobased industrial products)

2002 – Farm Bill (First energy title in Farm Bill history)

2002 – Bioproducts and Bioenergy Coordination Council

2004 – Job Bill – (included biodiesel fuel tax credit)

2005 – Energy Policy Act of 2005 (RFS, production tax incentive through 2007)

2005 – USDA Energy Council

2006 – State of the Union – "addicted to oil"

2006 -- Advanced Energy Initiative

2006 – Agricultural Bioenergy and Bioproducts Research, Education and Economics Council

2007 – State of the Union – Twenty in Ten

2007 – Administration's Proposed Farm Bill – Increase Budgets for bioenergy R&D

2007 - Energy Independence and Security Act of 2008

2008 – 2007 Farm Bill?

Adapted from article by Collins & Duffield, CHOICES. Jan. 2006

Energy Independence and Security Act of 2007

- An 822-page document changing U.S. energy policy in many areas
- Purpose of the act is to: “move the United States toward greater energy independence and security,
  - to increase the production of clean renewable fuels,
  - to protect consumers,
  - to increase the efficiency of products, buildings, and vehicles,
  - to promote research on and deploy greenhouse gas capture and storage options, and
  - to improve the energy performance of the Federal Government, and for other purposes.”
- The total amount of biofuels is required to increase to 36 billion gallons by 2022, from 4.7 billion gallons in 2007. The Energy Act further specifies that 21 billion gallons of the 2022 total must be derived from non-cornstarch products (e.g. sugar or cellulose).

Future Directions –

2007 Farm Bill – Title IX

Bioenergy & Bioproducts Research
- $500 Million- 10 years
- Production and sustainability
- Conversion efficiency

Alternative Energy/Energy Efficiency
- $500 million- 10 years
- Direct Assistance

Cellulosic Ethanol
- $210 Million - Loan Guarantees
- $150 Million competitive grants

Areas requiring enhanced coordination across Federal agencies:

1. Feedstock Production
2. Feedstock Logistics
3. Conversion Science & Technology
4. Blending
5. Distribution Infrastructure
6. Environment, Health & Safety
7. Tax Incentives and Policy

Interagency Feedstock Activities

- The Board has commissioned an interagency feedstock working group to address feedstock:
  - availability and cost,
  - sustainability, and
  - greenhouse gas emissions
- The group's initial deliverable due June 2008 will be a feedstock availability and cost study to provide perspective on likely feedstock costs associated with meeting biofuels production targets.
- This group will then develop a long-term integrated feedstock research plan across the Federal government to promote enhanced coordination and collaboration by December 2008.

States with Mandates and Incentives Promoting Biofuels

Renewable Fuels Standards with Biofuel Mandates

Excise Tax Exemptions, Tax Credits, and/or Grants Promoting Biofuel Production and Use

Source: http://www.pewclimate.org/what_s_being_done/in_the_states/map_ethanol.cfm July 2007.

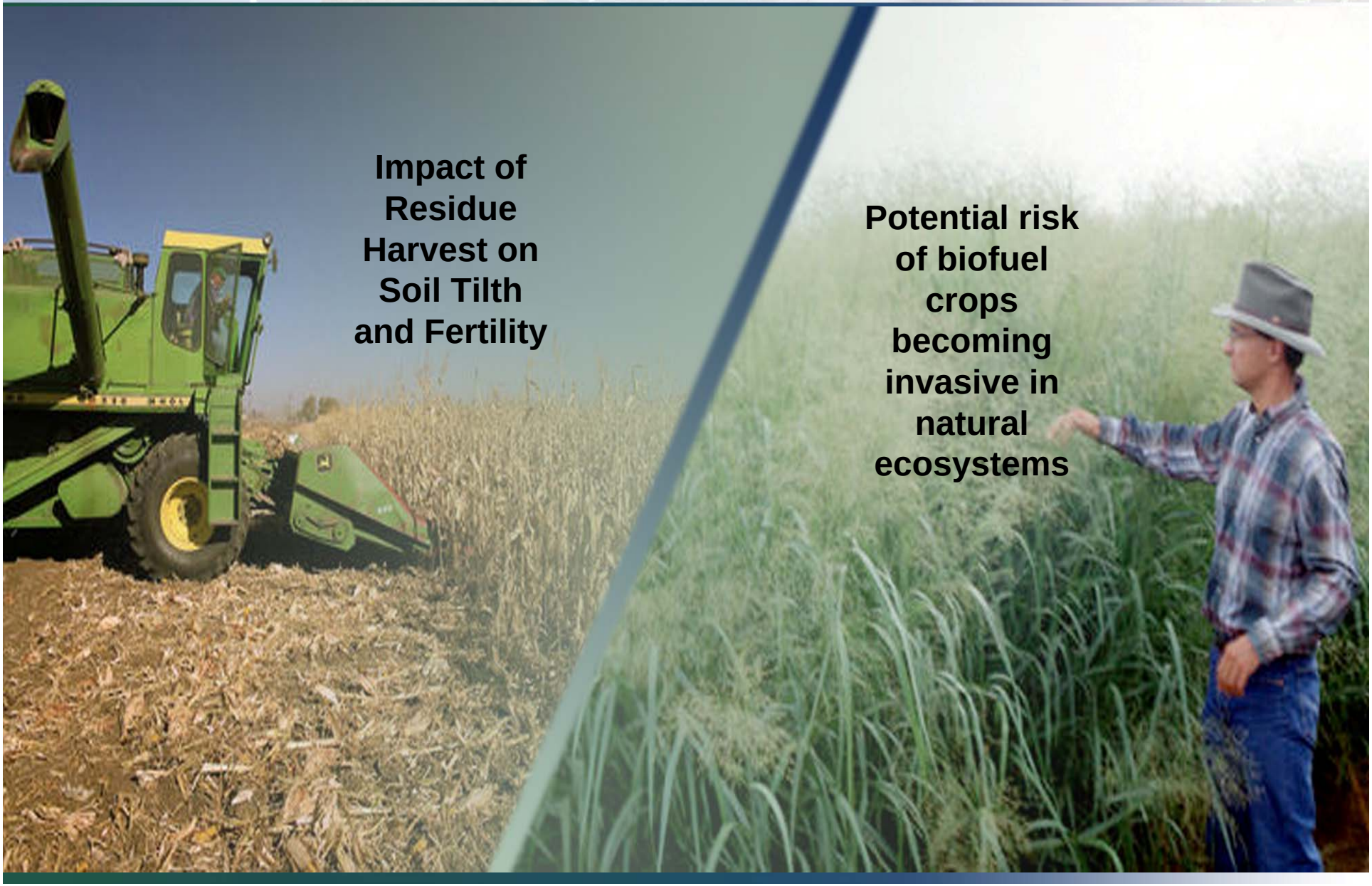
Bio Economy Consortium

- **Members: Extension Directors, Experiment Station Directors, State Secretaries of Agriculture, and Industrial Organizations**
- **Objectives are to promote the interests of partners**
- **Help the DOE/EERE meet its objectives**
- **Help USDA meet its objectives**
- **Grow and develop the bio economy**

ENVIONMENTAL ISSUES DRIVE POLICY

Intersection of Energy and Agriculture

Sustainability Issues & Biofuels



Scaling Up A Sustainable Bioeconomy – Environmental Concerns

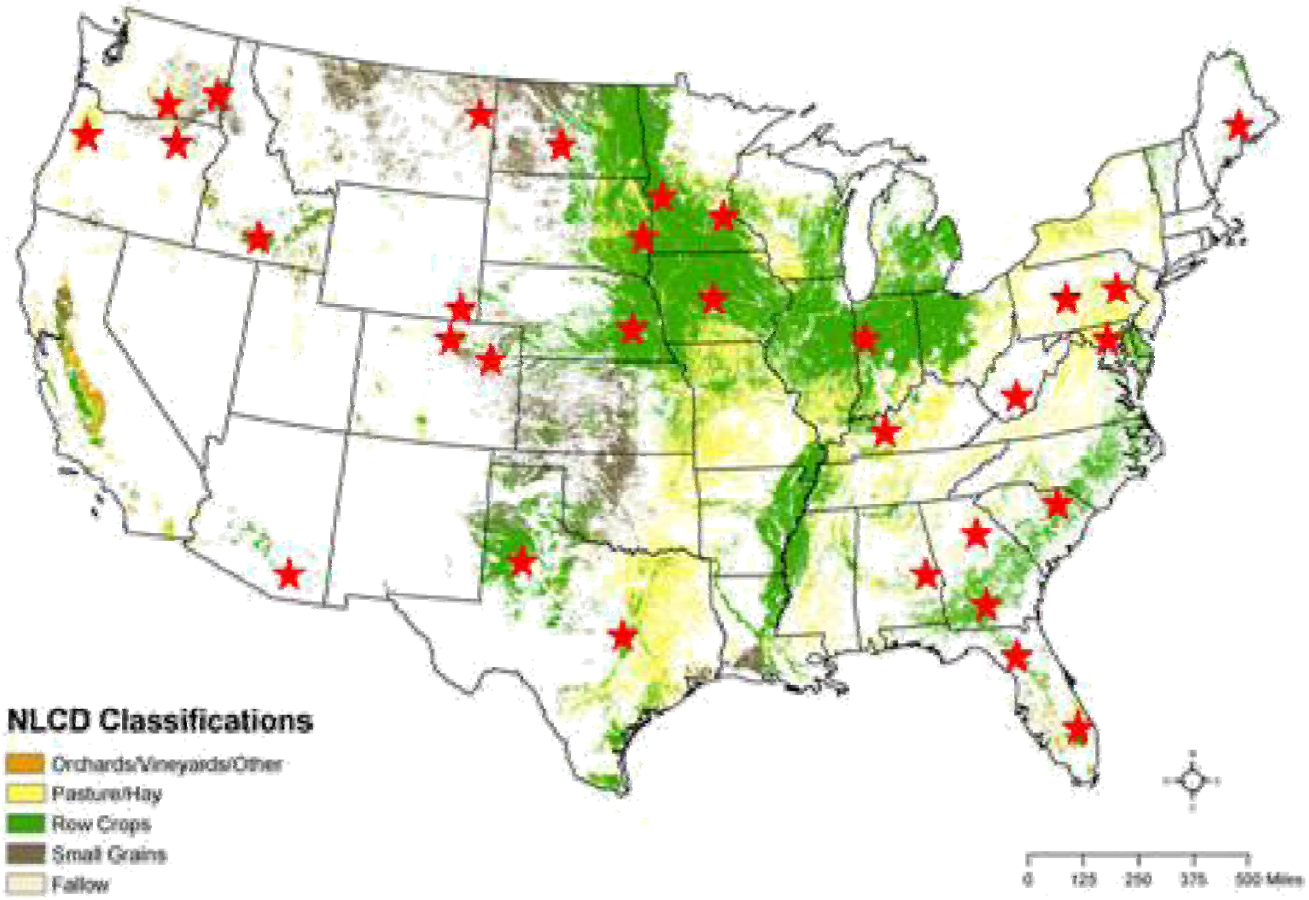
- Challenges include:
  - Better understanding impacts of large-scale production on:
    - land uses,
    - water quality and quantity,
    - carbon sequestration and
    - Ecosystems “ecosystem services”
  - Reducing or eliminating competition between energy crops and commodity crops for land and water resources;
  - Reducing competition for natural resources that other economic sectors, society, and natural living systems are dependent on for their well being. (concern that large-scale biomass production could hasten conversion of forestlands and other wilderness into a fuel source)

Scaling Up A Sustainable Bioeconomy – Environmental Pluses

- Cellulosic ethanol production could generate significantly less pollutants than corn-based processes.
- Land management techniques such as reduced tillage could increase soil's ability to be a CO_2 sink – some policies being considered to pay farmers to store carbon in the soil with utilities and other companies purchasing "agricultural offsets" to meet emission targets

GRACEnet (Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network)

- 30 ARS labs across the U.S. participating in GRACEnet (red stars).
- Project monitoring farmland GHGs emissions and soil carbon storage potential.
- Reduced tillage or fertilizing can save energy and lower GHG emissions and increase soil carbon storage.
- Farms and ranches have the potential to store enough carbon to offset 8-10 percent of total U.S. emissions.



Source: http://arsserv0.tamu.edu/SP2UserFiles/Place/36450000/2007ResearchReport.pdf

Yellow Brick Road?

Any road will get you there if
You do not know where you are going.

THE POWER OF THE EQUAL SIGN

RFS = CORN-BASED ETHANOL

POLICY,
TECHNOLOGY,
ENVIRONMENTAL ISSUES
COME TOGETHER
WITH A PLAN

BIOECONOMY/ ENERGY

Opportunity and Responsibility for

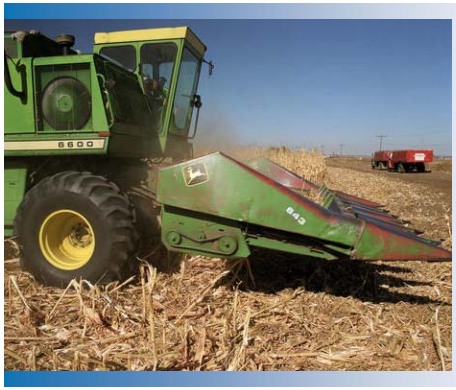
USDA's Research, Education, and Economics Mission Area

ENERGY PLAN

USDA's Role

- ***Lead* Research, Education, and Extension programs for *sustainable production of agriculture-based and natural resource-based renewable energy and efficient use and conservation of energy***

… for the benefit of rural communities and the Nation



Vision . . . . . .

"Growing a clean, efficient, sustainable energy future for America"

"USDA – a recognized leader in innovative energy solutions"

We have a vision that in five years the U.S. will have:

- Agriculture- and natural-resource-based energy that enhances stewardship of our environment.
- Vibrant and energy-efficient rural communities
- Robust partnerships with Federal agencies, universities & private sector
- A fully integrated system meeting national, regional & local needs

Goals
(Our Focus for the Next 5 Years)

Mission Goals

- **Sustainable agriculture and natural resource-based energy production**
- **Sustainable bioeconomies for rural communities**
- **Efficient use of energy and energy conservation**
- **Workforce development for the bioeconomy**

USDA REE: Unique Resources & Capacities

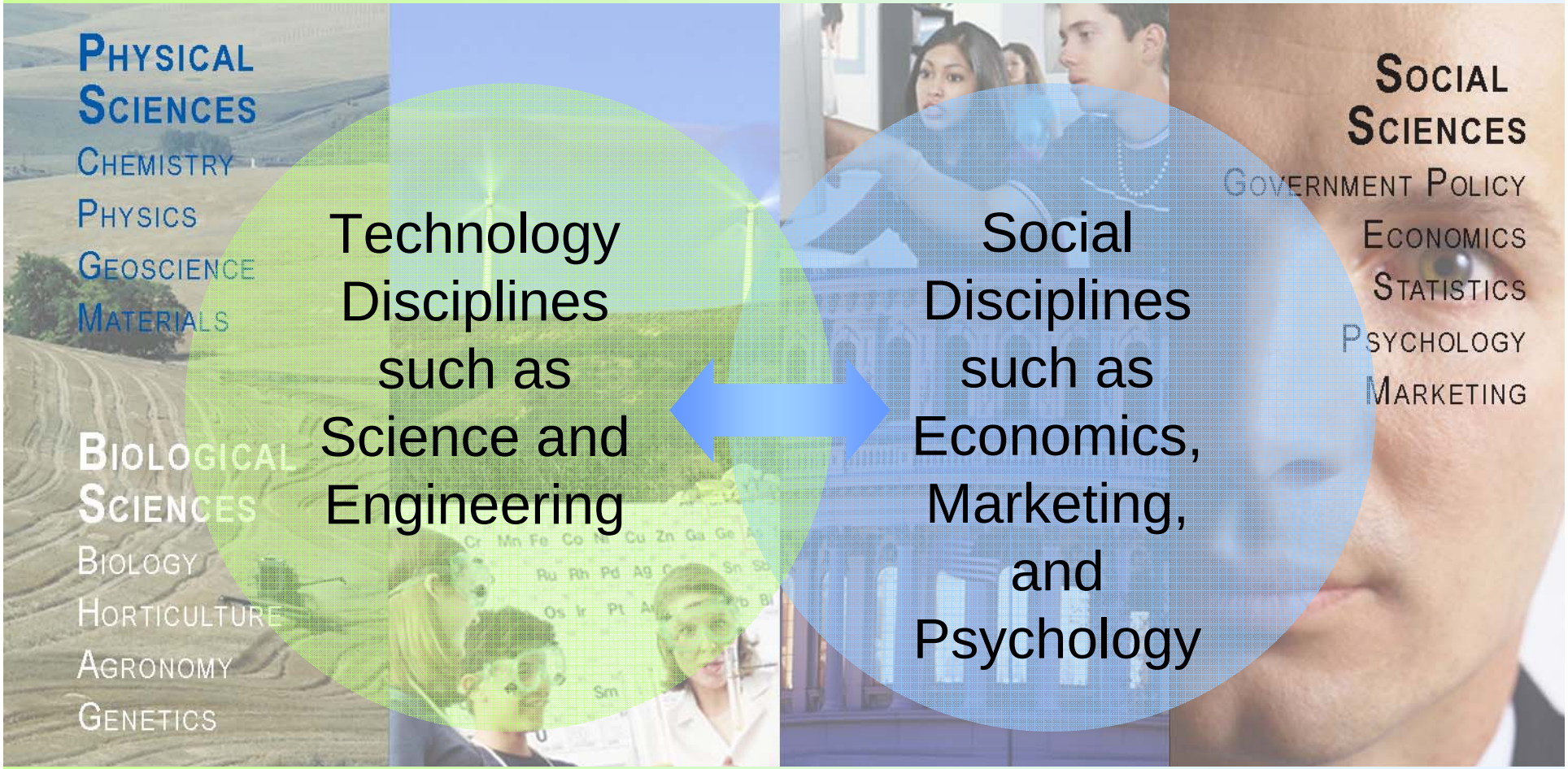
- **Regional and local outreach**
- **Genetic resources, collections and crop breeding/ genetics/genomic expertise for feedstock development**
- **Systems approach to feedstock development, production, and conversion**
- **Feedstock logistics (harvest, transportation, storage, and pre-treatment)**
- **The use of animal manures, crop & forest residues, and other residuals as feedstocks**
- **Development of biobased products and value-added co-products**
- **A network of dedicated laboratories for performing basic and applied research**
- **Integration of basic and applied research, education, and extension in land-grant universities**
- **Integration and coordination of activities among the REE agencies**

Intersection of Energy and Agriculture

Science and Education

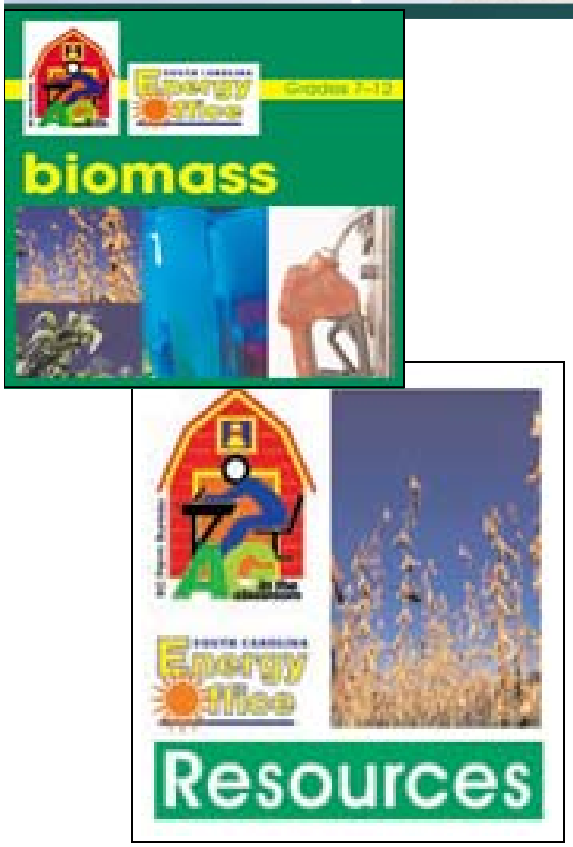
Is The Power to Move us Down the Road of the Future

Renewables – *Geothermal, Solar, Hydrogen, Biomass, Wind*



Energy Efficiency – *Buildings, Vehicles, Industrial & Distributed Energy*

BioEnergy Education Programs Increasing



IOWA STATE UNIVERSITY
Becoming the best.

MICHIGAN STATE UNIVERSITY

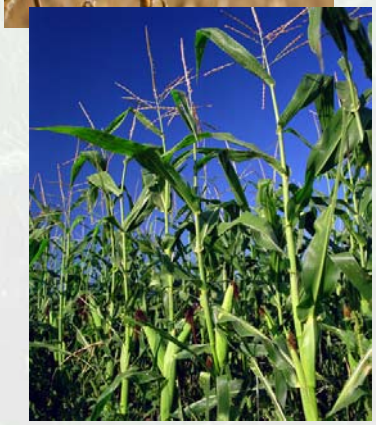
- **K-8:** South Carolina Ag in the Classroom) (SC Farm Bureau)
- **High Schools:**
  - A November *New York Times* article discusses high schools in San Francisco have one of the most sophisticated biotech programs in the country, perhaps because of the city's proximity to thriving biotech companies.
- **Universities:**
  - Kansas State University's Center for Sustainable Energy (consolidating university-wide work on bioenergy)
  - Biorenewable Resources and Technology (BRT) at Iowa State University
- **Workforce Development**: Michigan State University & Lansing Community College providing biorefinery operations training for approximately 600 workers and students in its first two years of operation

Bio Energy Awareness Day (BEAD)

- Annual celebration held on the summer solstice to acknowledge the ultimate source of energy is the sun.
- Demonstrates the photosynthetic capacity of the agriculture and forestry to the bio economy
- First BEAD (BEAD I) was sponsored by USDA's Research Education and Economics Mission Area (REE) and was held June 21, 2007 at the USDA in Washington, DC.
- BEAD II
  - will be held in Washington, DC June 19-21, 2008
  - sponsored by REE in partnership with federal agencies, universities and in cooperation with the 25x'25 Alliance.
  - Three components:
    - Bioeconomy Grand Visioning Challenge at Whitten Building on Mall
    - Research Displays at National Arboretum
    - POWER PLANT Garden at National Arboretum

Intersection of Energy and Agriculture

Candidate Plants for Biofuel Garden and Exhibit



U. S. National Arboretum

Camelina

Castor bean

Peanut

Lesquerella

Mustard

Sugar cane

Switchgrass

Hybrid popular

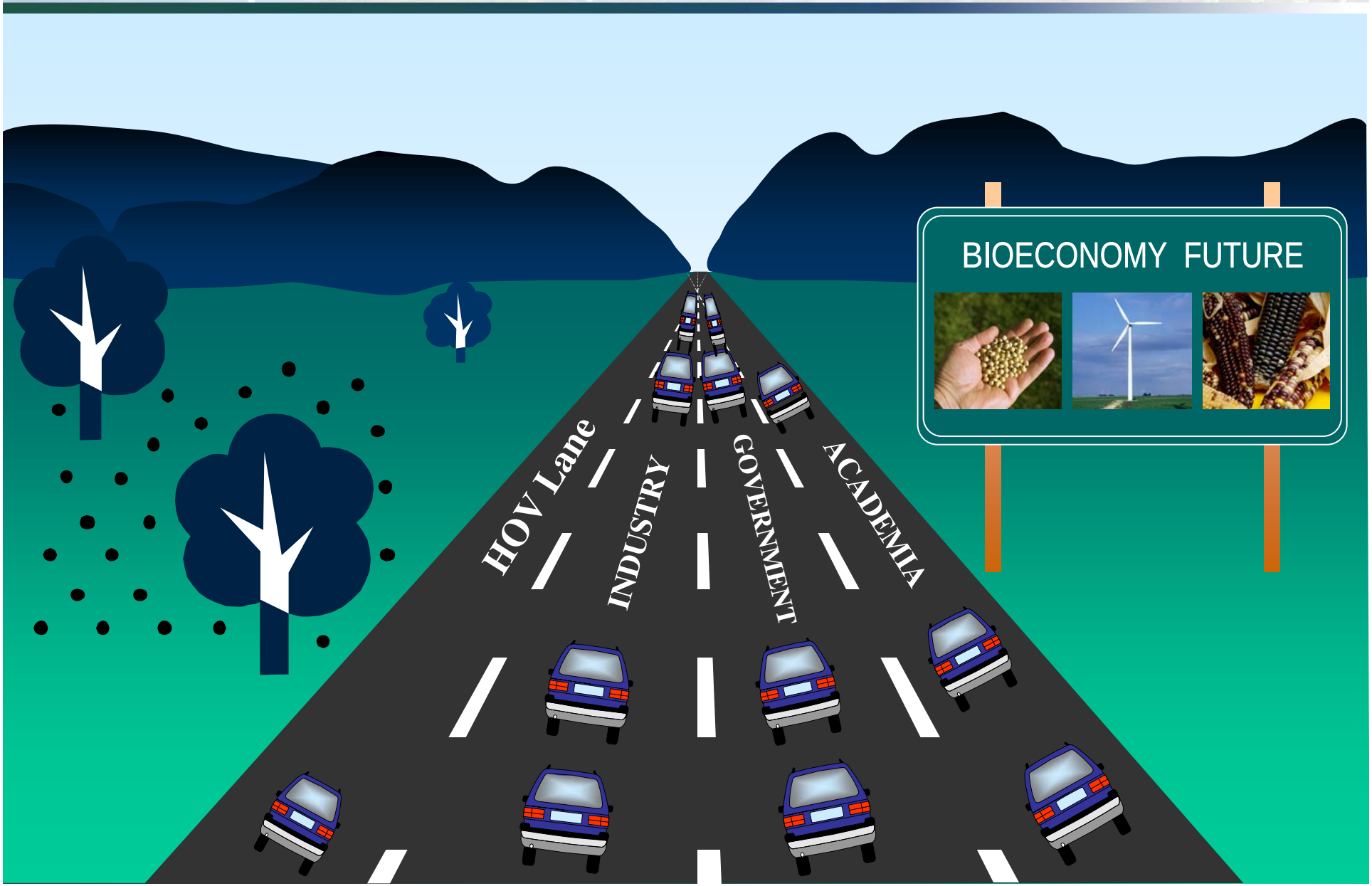
Miscanthus

Desired Outcomes for Agriculture in the Emerging Bioeconomy

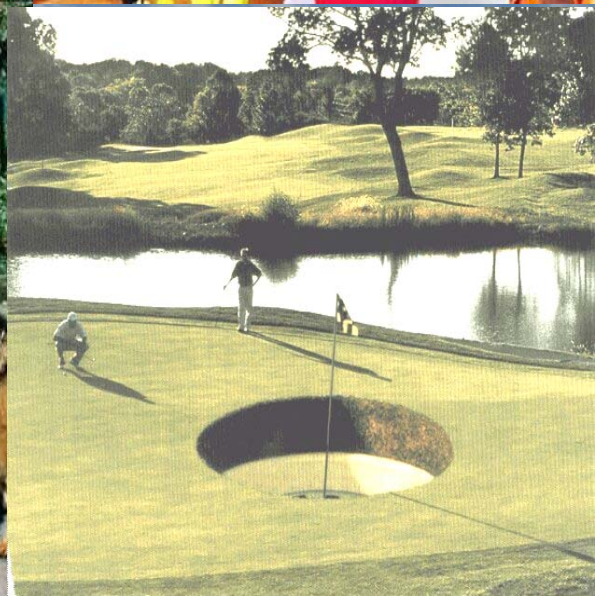
- Improve national ***security*** and the U.S. trade balance
- Help America transition to ***renewable*** sources of energy and other goods
- Realize important ***environmental*** benefits
- Realize significant, new, sustainable ***economic*** opportunities for rural America
- Realize secure sources of energy for ***rural*** America

Intersection of Energy and Agriculture

BUILDING PARTNERSHIPS



Some suggestions to travel our Yellow Brick Road - -




Together –
We Can Build a
Prosperous Bioeconomy Future
Where we will:
✓**Transition to a carbohydrate-based economy**
✓**Produce our products and fuels in biorefineries**
✓**Improve national security and the U.S. trade balance**
✓**Realize important environmental benefits**
✓**Develop significant, new sustainable economic opportunitie**
rural America
✓ **Lead exploiting these technologies to other countries.**