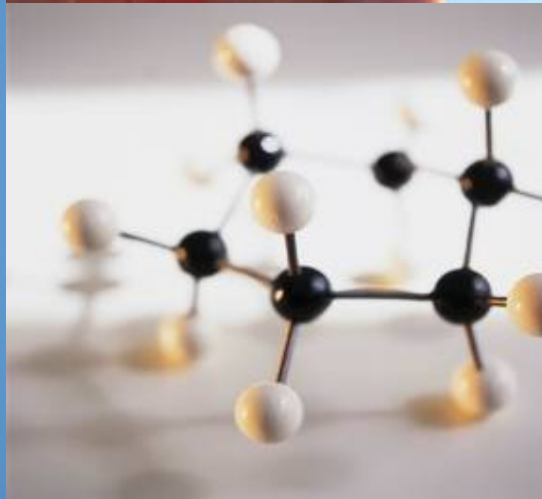


Integrated Biorefinery Overview



Transition to a Bio-Economy

Atlanta, Georgia
February 12, 2008

Lawrence J. Russo, Jr
Biomass Program



The President's State of the Union Address 2007

"Tonight, I ask Congress to join me in pursuing a great goal. Let us build on the work we've done and reduce gasoline usage in the United States by 20 percent in the next 10 years."



The President's State of the Union Address



Current and Projected Motor Gasoline Market

Motor gasoline consumption 140 billion gallons/year in 2005

Motor gasoline consumption 161 billion gallons/year by 2017 according to Energy Information Administration (AEO2007, reference oil price case)

20 in 10:

Increase supply of renewable and alternative fuels

- The goal is to produce 35 billion gallons per year of alternative fuels by 2017 – reducing motor gasoline consumption by 15%

Increase vehicle efficiency

- Reform and modernize CAFÉ to achieve additional 5% reduction in motor gasoline consumption

Program Response:

Develop cost-competitive cellulosic ethanol conversion technologies via two platforms

- Biochemical platform – cellulose destruction and fermentation of the component sugars to ethanol
- Thermochemical platform – gasification to syngas and conversion to mixed alcohols and ethanol
- **Through public/private partnerships – Energy Policy Act of 2005 Section 932 solicitations**

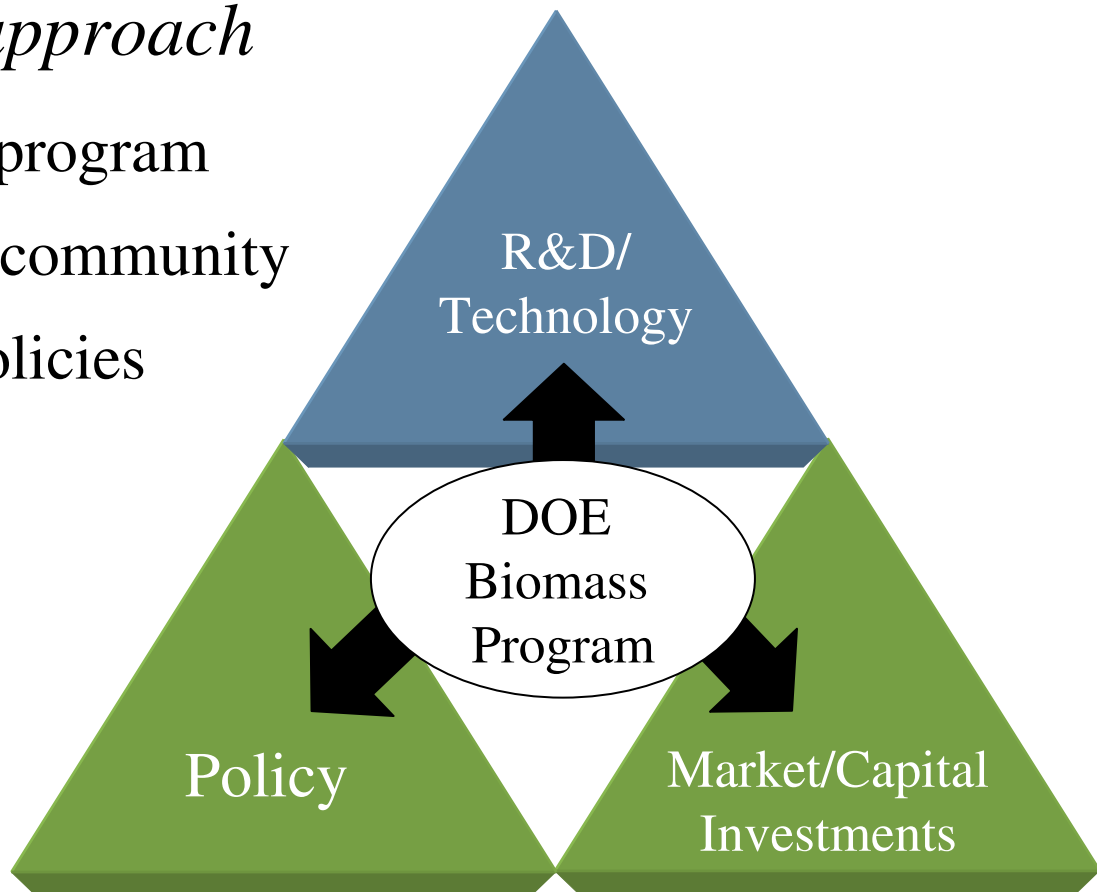


How Do We Achieve These Goals?

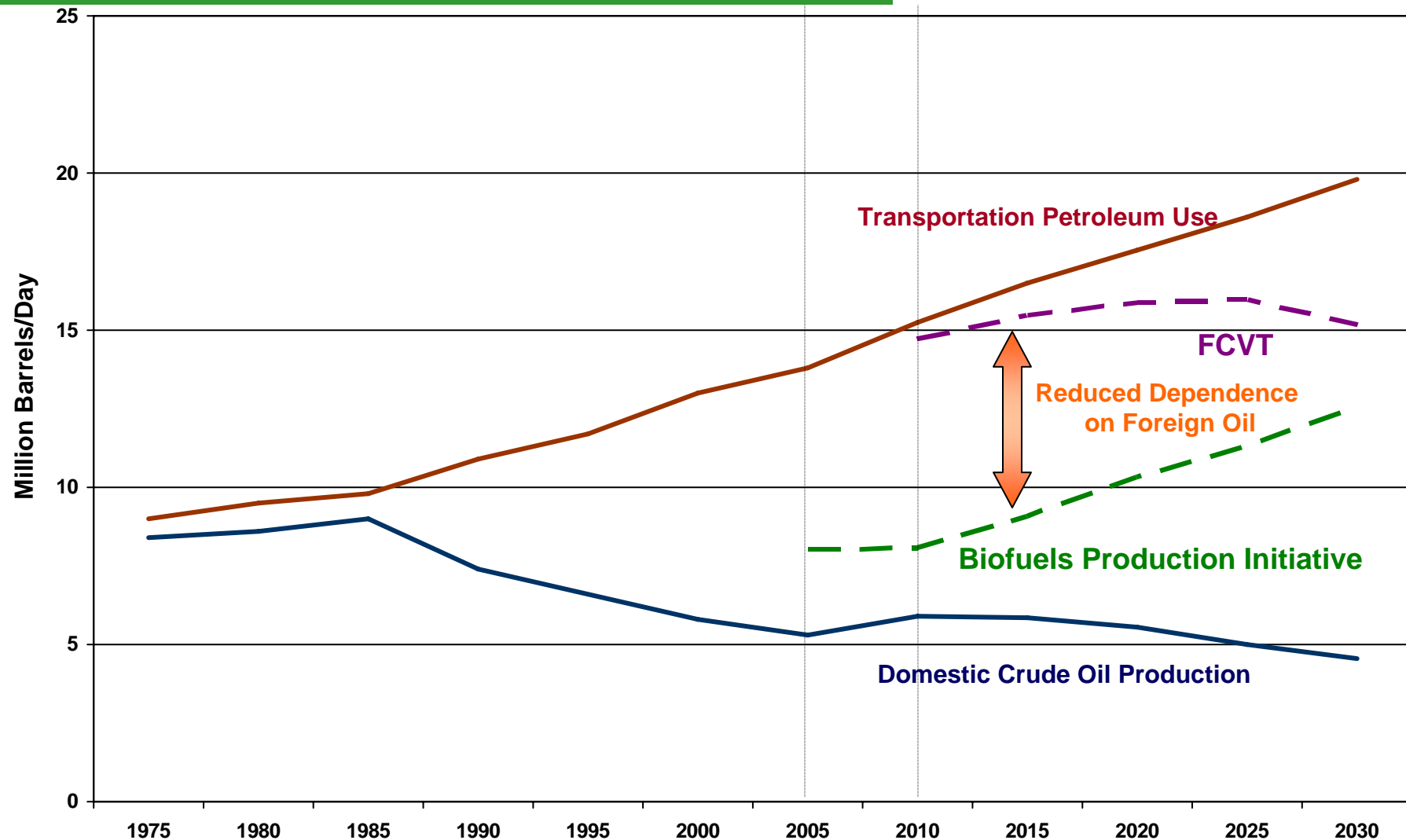


Three-pronged approach

- Effective R&D program
- Leverage financial community
 - Supportive policies



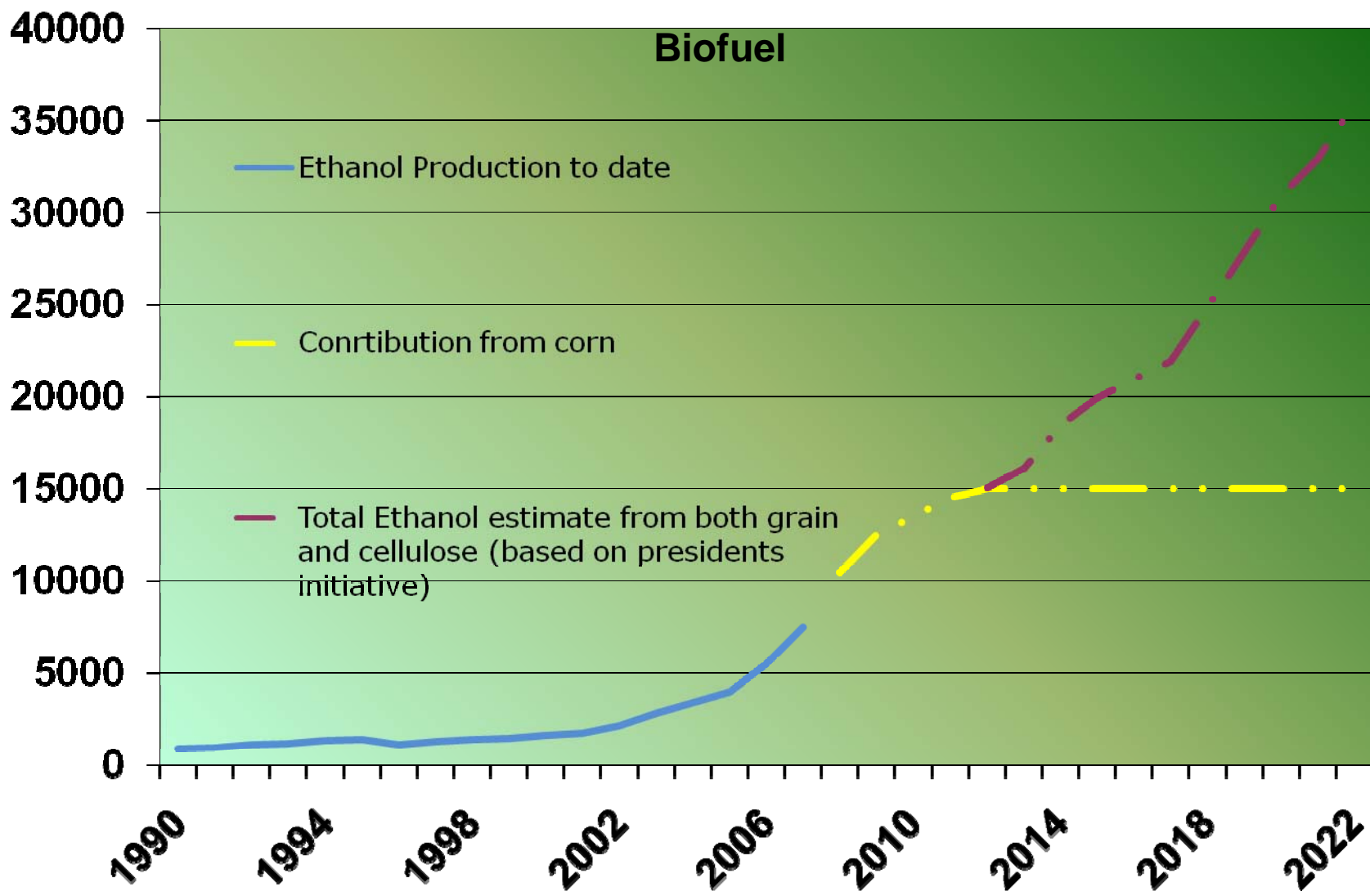
Biofuels Production and Vehicle Efficiency



The combination of increased vehicle efficiency and biofuels production will result in reduced dependence on foreign oil imports.

U.S. Biofuels Production

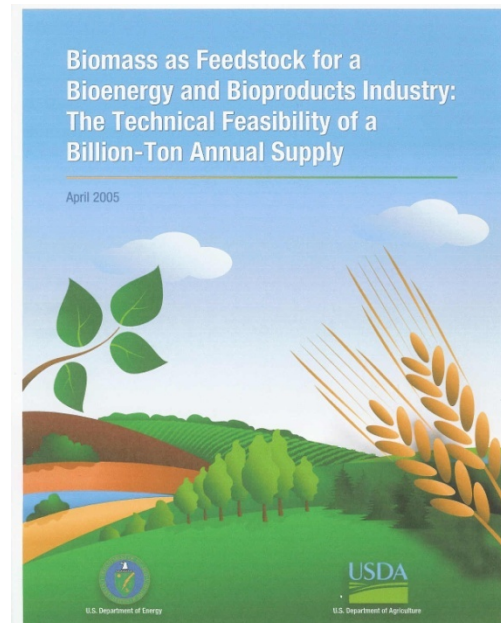
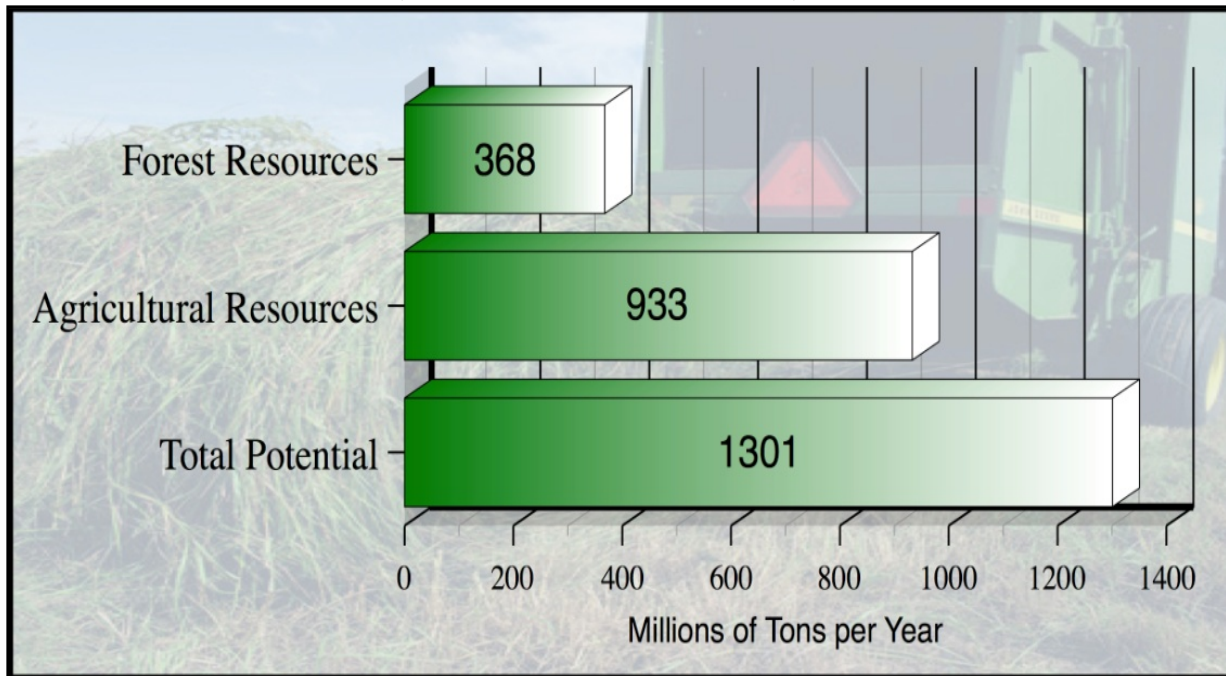
(Million Gallons/Year)



Conversion of Available Feedstocks



- “Billion Ton” study indicates that enough biomass is potentially available to displace > 30% of current U.S. petroleum consumption
- 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.



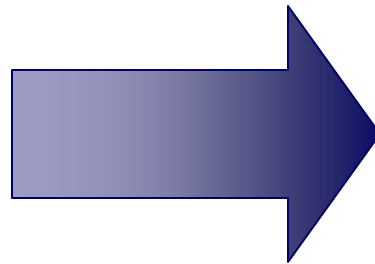
Biofuels Sources



Today (2008)

- Grain Crops (Corn)

~7.5 billion gallons



2022

- Grain Crops (Corn, Milo, Barley, Wheat, etc.)

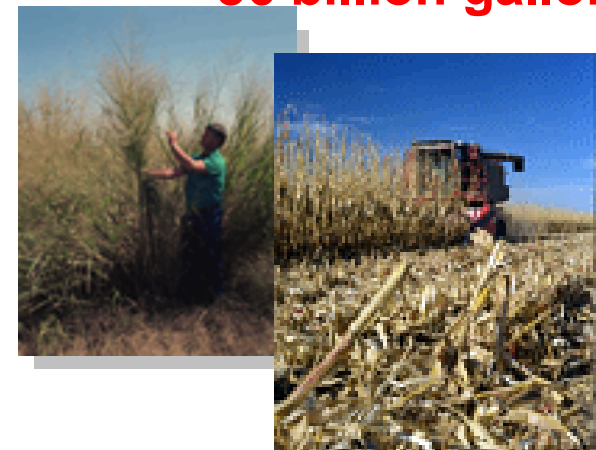
~15 billion gallons

- Corn Fiber

- Switchgrass
- Corn Stover
- Agricultural Residues
- Forestry Residues

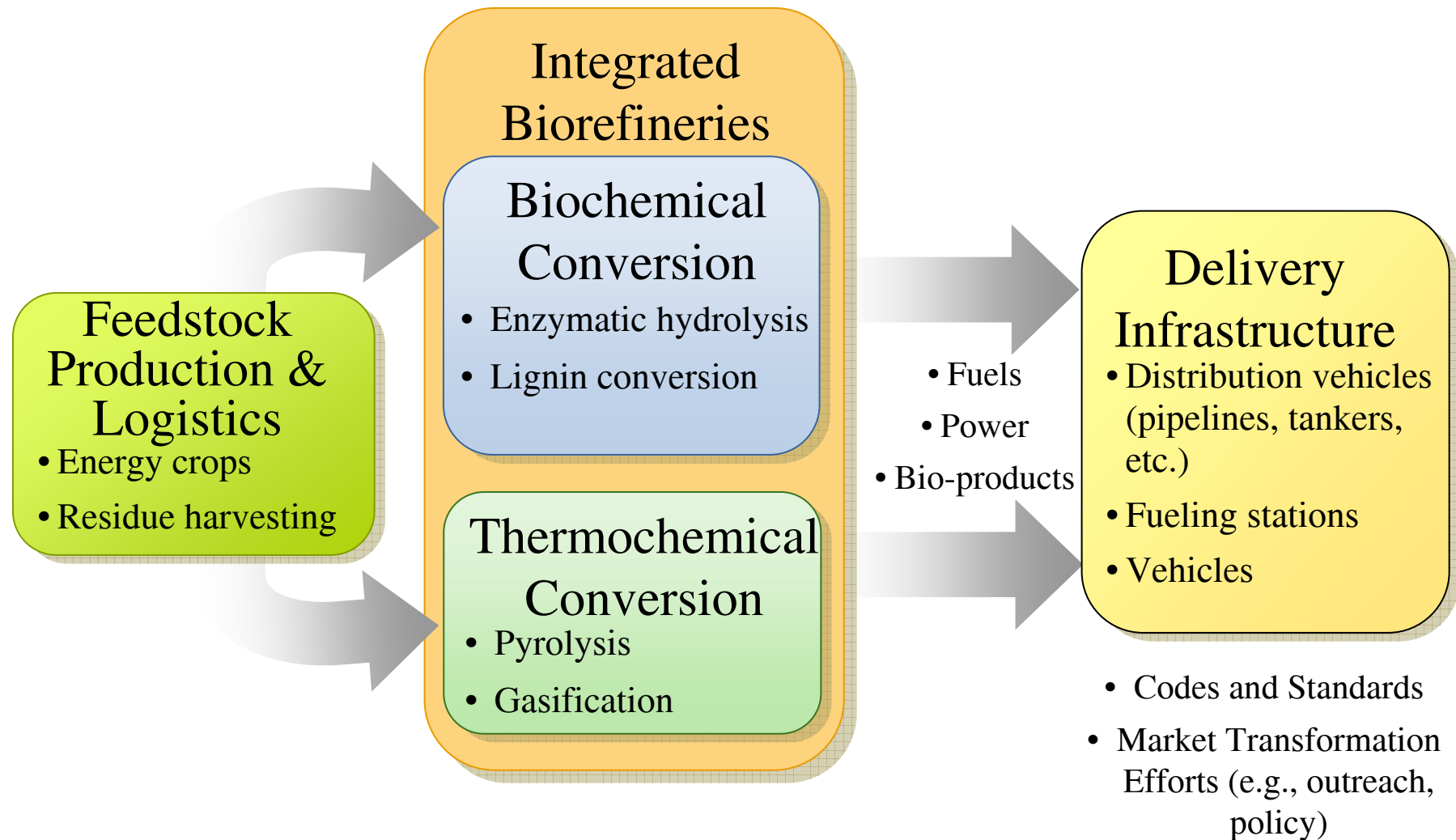
~21 billion gallons

~36 billion gallons



ass

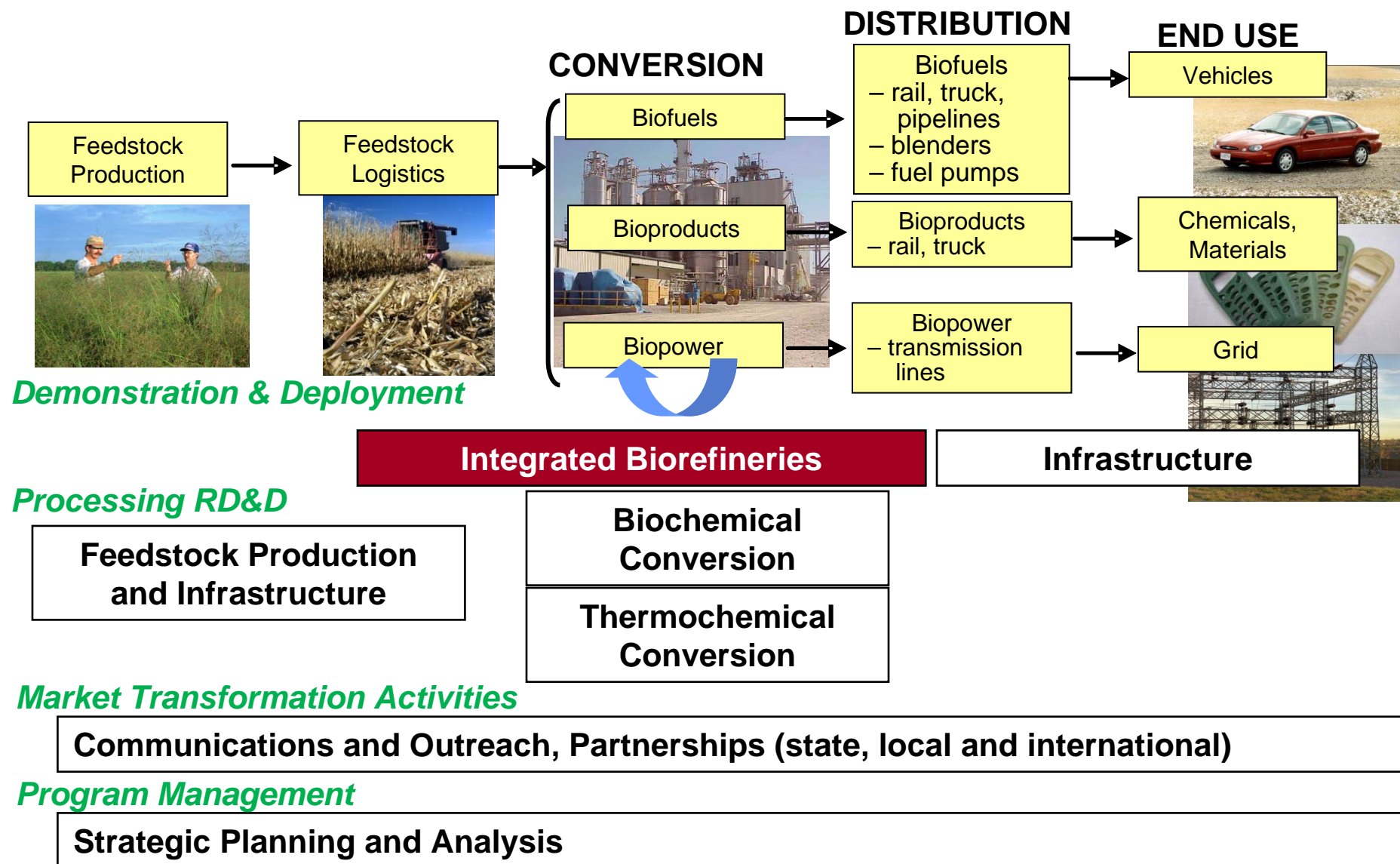
Two Major Paths to Success



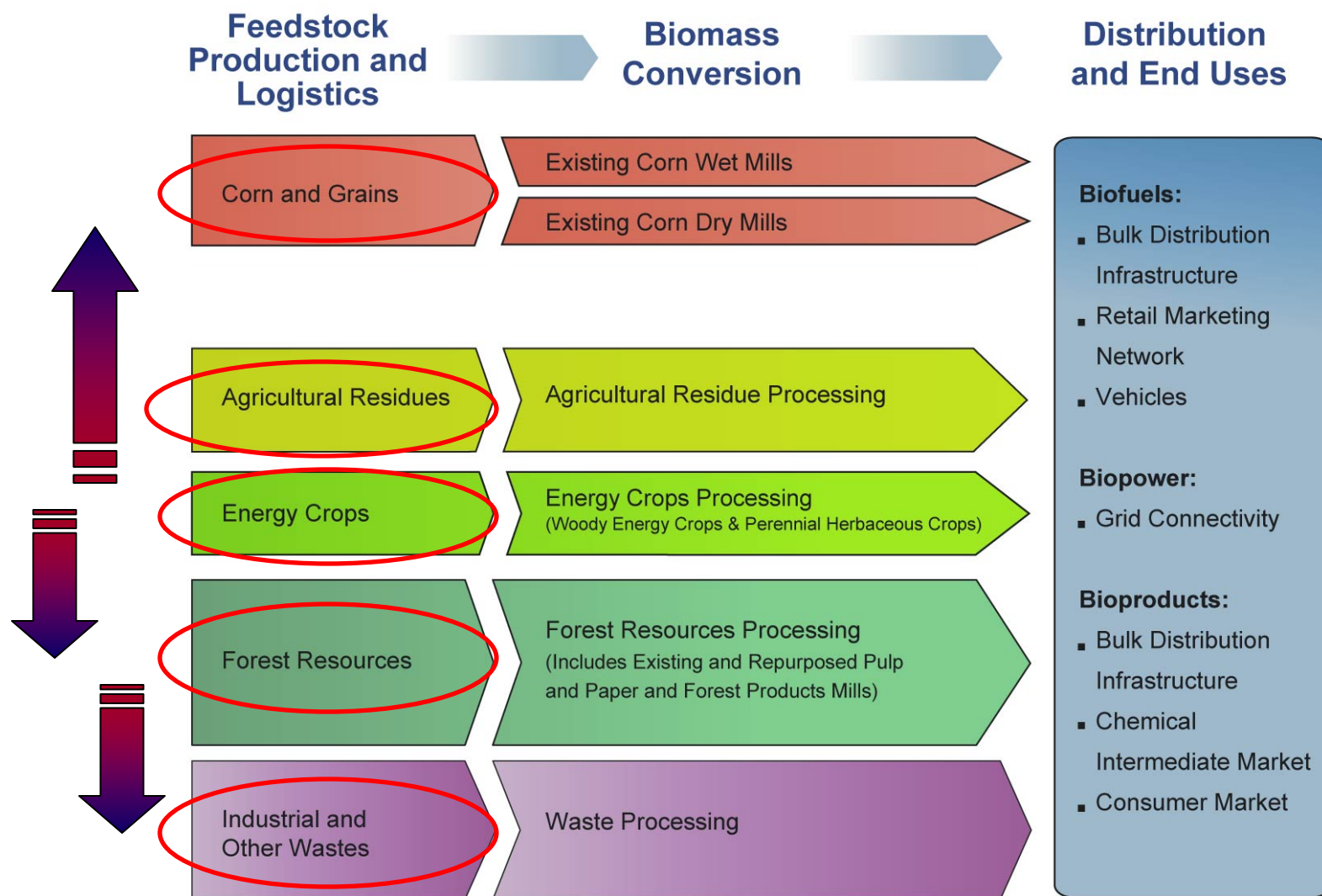
Success relies on simultaneous development of the supply, conversion, and demand infrastructures for cellulosic ethanol

Biomass

Platform Supply Chain Biomass to End Use



Platform Pathway Priorities



U.S. Biomass Resource Potentials



- **Corn** (largest volume grain and source of Ethanol in U.S.)
 - Potential to displace 25% + of our gasoline demand
- **Over 1 billion tons/year of lignocellulosic biomass** (trees, grasses, etc.) could be available in the U.S.
 - Long term potential to displace 50-70% of our gasoline demand (assuming continued research and advanced technology development)

Short-term: improve cost and efficiency of ethanol from corn (corn fiber conversion, biomass to fuel plant, develop potential of protein co-product)

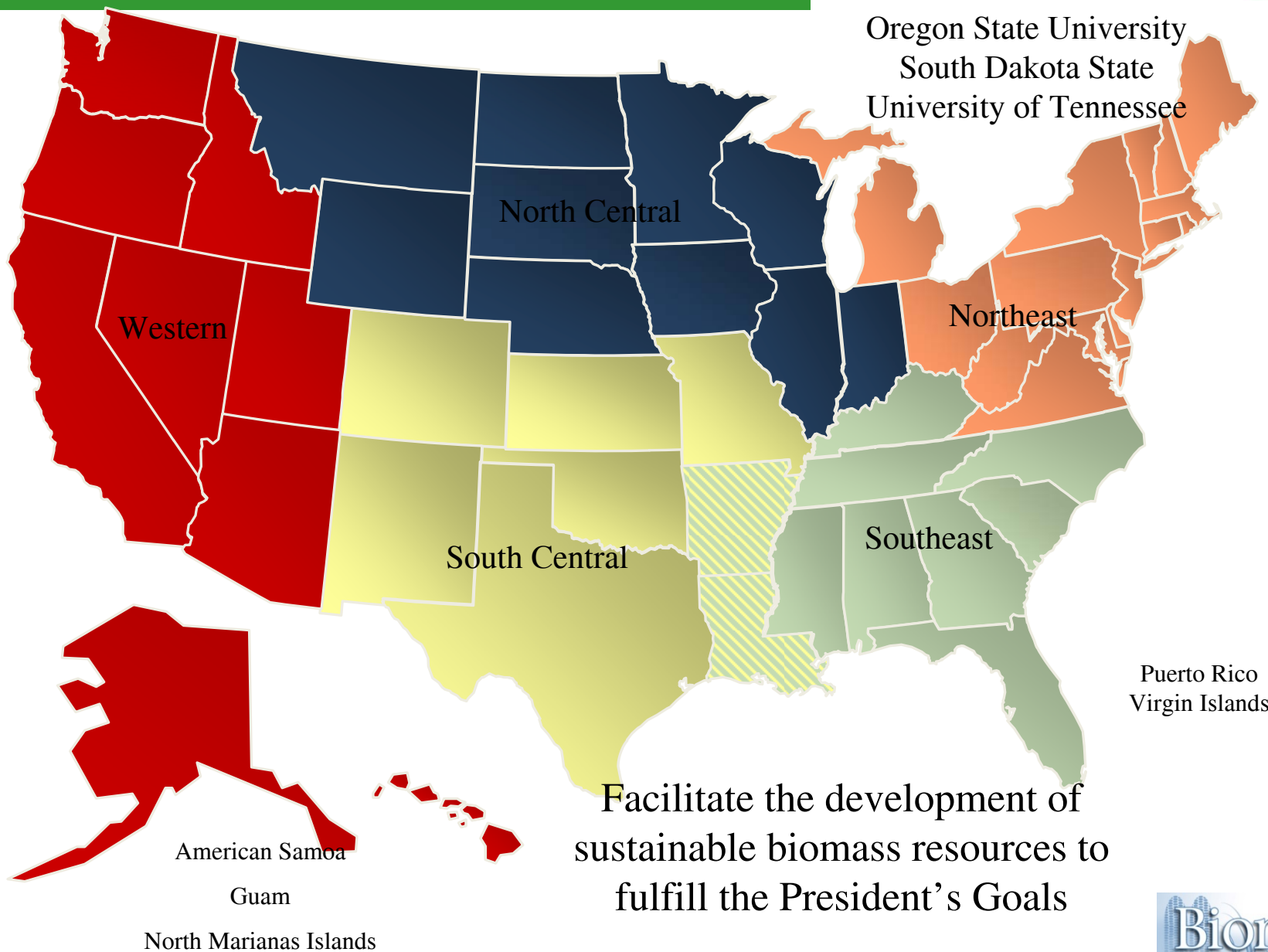
Mid-term: add feedstock diversity to the existing infrastructure (corn stover, agricultural residues)

Long-term: focus on regionally available and sustainable lignocellulose (trees, grasses, & residues) in stand alone facilities

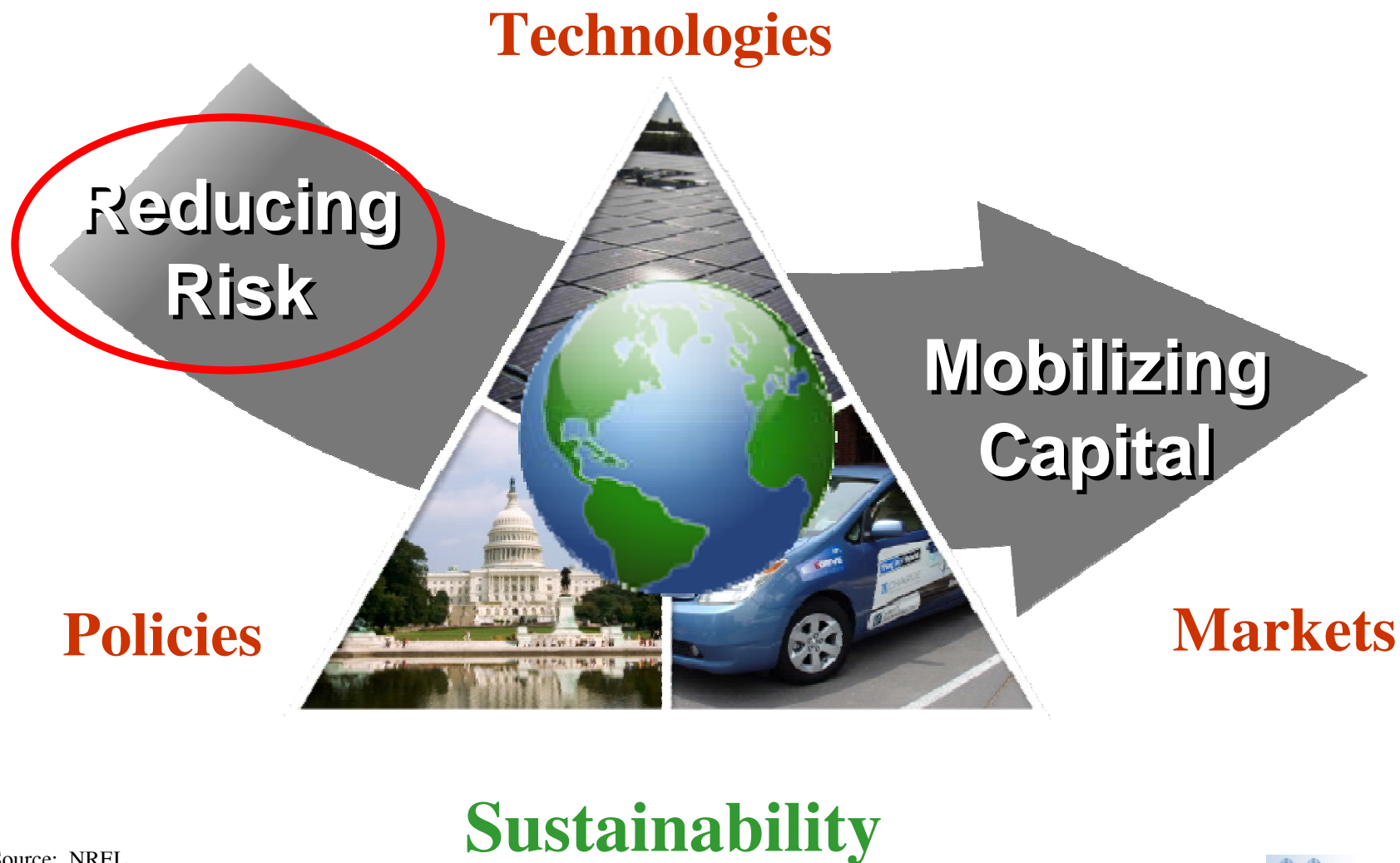
Regional Feedstock Partnerships

Centers:

Cornell University
Oklahoma State
Oregon State University
South Dakota State
University of Tennessee



Getting Biofuels to “Significance” Involves...



Source: NREL



Bigger Rewards /Bigger Risk Need Better Practices



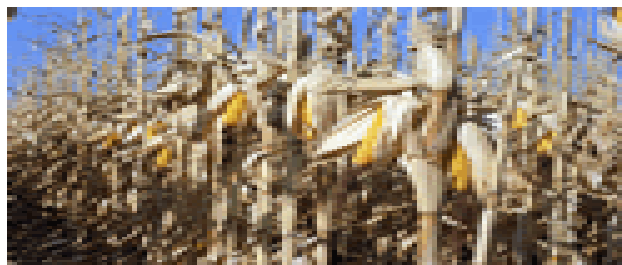
- **Selection**
 - Merit Review Committee
 - Program selection factors
- **Environmental**
 - NEPA Compliance
- **Risk Assessment (Independent Project Analysis)**
 - Help projects identify best practices to minimize risk
 - Are the right processes and procedures in place
- **Execution (Independent Engineer)**
 - Help identify technology, engineering, and construction risks
 - Monitor progress

Cellulosic Biorefinery Investments



Recently announced competitive selections to provide up to \$385 million over four years for cost-shared integrated biorefineries in six states

- **Abengoa Bioenergy Biomass of Kansas**
 - **ALICO, Inc.**
 - **BlueFire Ethanol, Inc.**
 - **Poet (formerly Broin Companies)**
 - **Iogen Biorefinery Partners, LLC**
 - **Range Fuels (formerly Kergy, Inc.)**



Biomass

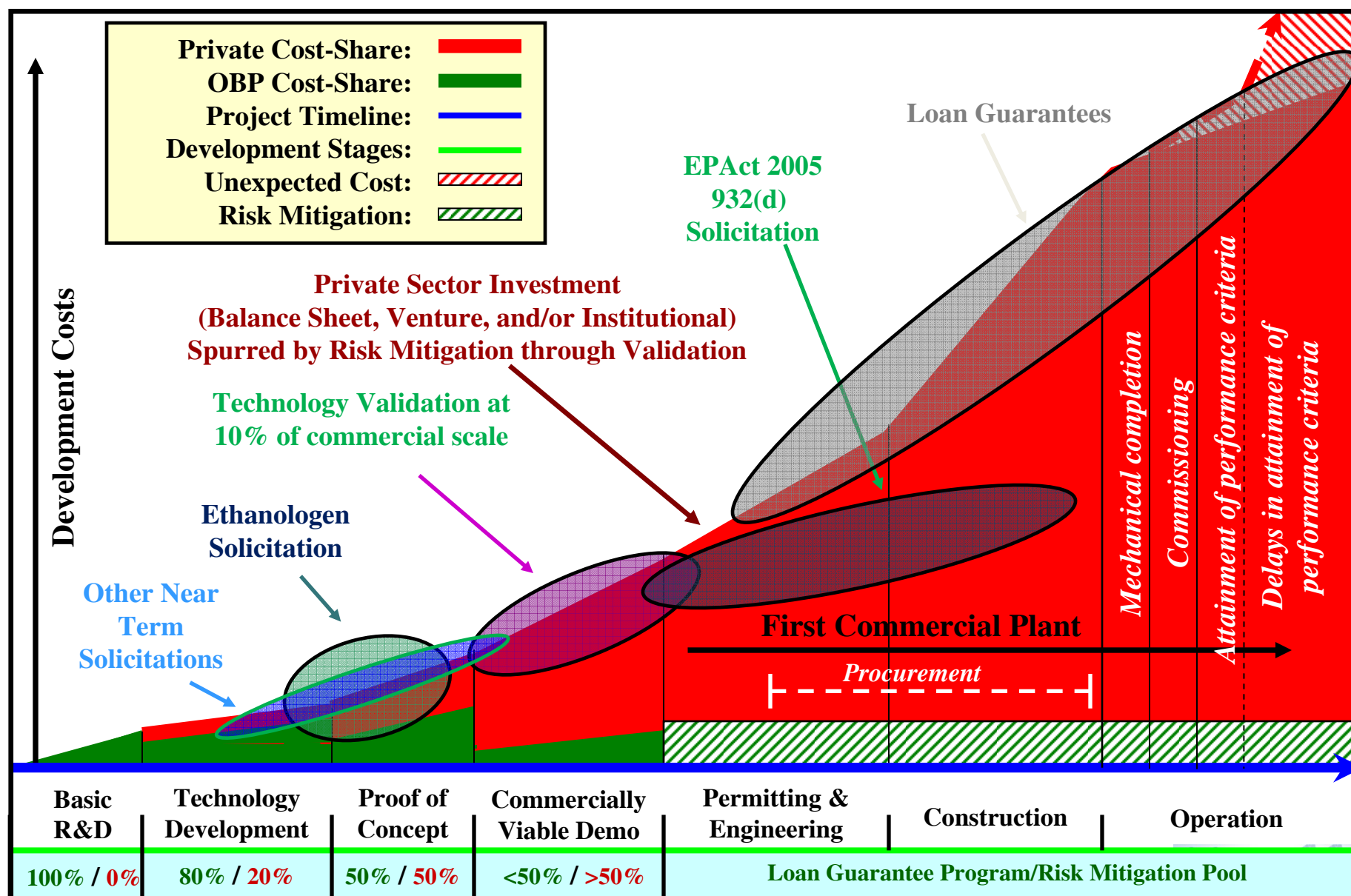
Cellulosic Biorefinery Status



- **Abengoa Bioenergy Biomass of Kansas**
 - 9/30/07 - Phase 1 Cooperative Agreement Awarded (condition subsequent)
- **BlueFire Ethanol, Inc**
 - 9/30/07 - Phase 1 Cooperative Agreement Awarded (condition subsequent)
- **Poet**
 - 9/30/07 - Phase 1 Cooperative Agreement Awarded (condition subsequent)
- **Range Fuels**
 - 11/03/07 - Phase 2 Technology Investment Agreement awarded
- **Alico, Inc.**
 - Phase 1 Cooperative Agreement in negotiation
- **Iogen Biorefinery Partners, LLC**
 - Phase 1 Cooperative Agreement in negotiation



Deployment Barriers and Solutions



Current Solicitations



- **10% Demonstration Solicitation** - “Demonstration of Integrated Biorefinery Operations for Producing Biofuels and Chemical/Materials Products”, up to \$200 million over 5 years, 50/50 cost share, **Closed 8/14/07 – Announcements Pending**
 - One-tenth of the projected scale of a first of its kind commercial facility
 - Integrated biorefinery demonstrations using cellulosic feedstocks and producing a combination of fuels, chemicals, and substitutes for petroleum-based feedstocks and products
- **Joint USDA/DOE Solicitation** - \$18 million grants - R&D of biomass-based products, fuels, and related processes, **Closed 7/13/07 - Announcements Pending**
Technologies to convert cellulosic biomass into intermediaries for biobased fuels (45%)
 - Product diversification (30%)
 - Feedstock production (20%)
 - Analysis for strategic guidance (5%)
- **Thermochemical Conversion Solicitation**: \$7.75 million grants over 4 years, 30% phase 1, 40% phase 2 non-federal cost share, **Closed 8/13/07 - Announcements Pending**
 - Biomass synthesis gas to liquid fuels validation
- **Enzyme Solicitation**: **Closed: 10/30/07 - Announcements Pending**
 - Second phase of cellulase development with cost-sharing industry partners
 - Create commercially available, highly effective & inexpensive enzyme systems for biomass hydrolysis

FY08 Planned Solicitations



Feedstocks Interface R&D:

- Directed Procurement to Land Grant Universities through the Regional Feedstock Partnerships ~ \$4 million

Biochemical Platform R&D:

- **University Call** – 1.5 M
- Pretreatment Reactor Design Solicitation - up to \$16 million over three years. This solicitation will support the design of pretreatment processing equipment aimed at reducing the capital costs by 25%. The research and development will develop equipment designs that would be tested at pilot scale and improve commercial scale viability.

Thermochemical Platform R&D:

- **University Call** - \$1M
- Pyrolysis oils to fuels - A total of \$5M over 3 years. This will request applications to develop technology; and design, construct, and validate processes for production, upgrading and conversion of biomass pyrolysis oils to fungible hydrocarbons (liquid transportation fuels).

Biomass Research and Development Initiative

- USDA- DOE Joint Solicitation - to be determined

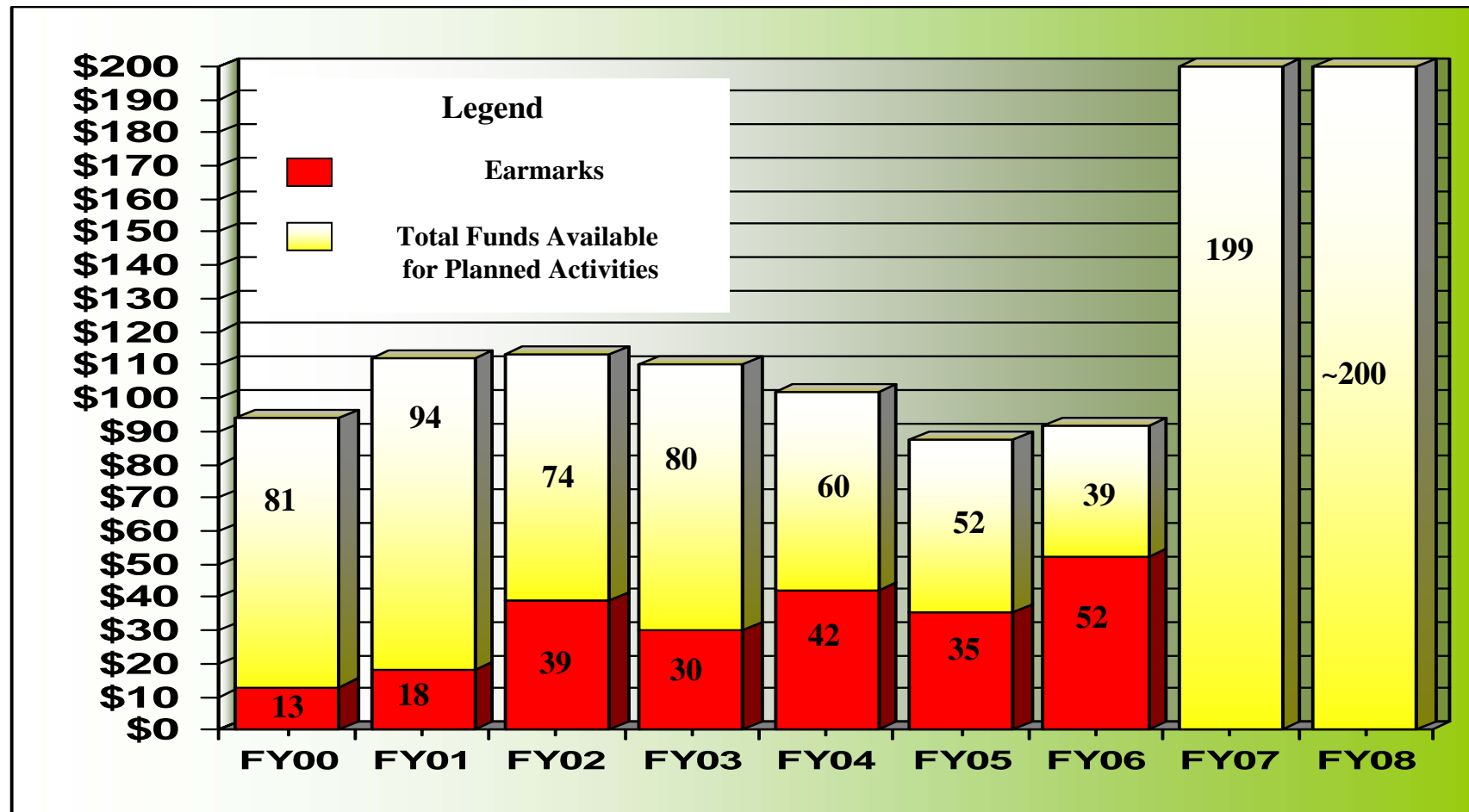
NOTE THAT ALTHOUGH THESE ARE “PLANNED” SOLICITATIONS THEY ARE CONTINGENT ON APPROPRIATED LEVELS OF DISCRETIONARY FUNDS MEETING PROGRAM REQUESTS



DOE Biomass Program Funding



Millions of Dollars per Year



- FY07 CR reflects plus up to support the Advanced Energy Initiative and EPAct 2005
- FY08 and out year request support increased activities as prescribed in 20 in 10 goal

Biomass



Thank
You



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For Open Solicitations

<http://www.grants.gov/>

