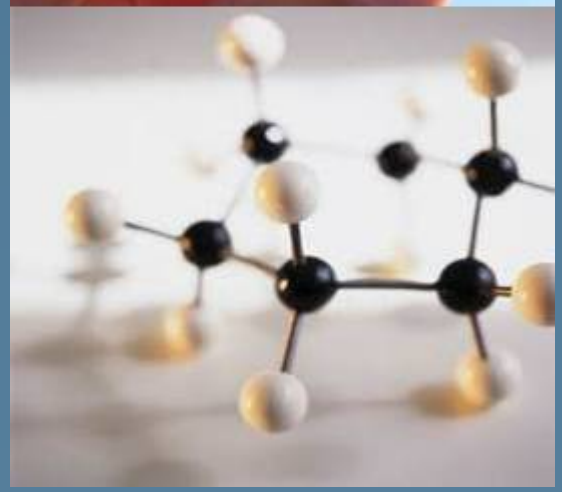





U.S. Department of Energy
Biomass Program

October 1, 2009

Major Biomass Pathways

Million dry ton/yr	Feedstock Production and Logistics	Biomass Conversion
428	Agricultural Residues	Agricultural Residue Processing
377	Energy Crops	Energy Crops Processing (Woody energy crops and perennial herbaceous crops)
368	Forest Resources	Forest Resources Processing (Includes existing and repurposed pulp and paper and forest product mills)
58	Industrial and Other Wastes	Waste Processing
87	Corn and Grains	Existing Corn Wet Mills Existing Corn Dry Mills
48	Oilseeds and Plants	Existing Oil Seed Mills
1366		

End Uses

Biofuels

- Cellulosic ethanol
- Green gasoline
- Green diesel
- Green jet fuel

Biopower

Bioproducts

Chemical Intermediates:

- Organic acids
- 1,4-diacids
- Glycerol
- Sorbitol
- Xylitol

(Top Value Added Chemicals From Biomass, PNNL, NREL, DOE-OBP Analytical Study, 2004 **)**

Yield assumptions:
Corn: 207 bushels/acre by 2043, Energy crops: 8 dry tons/yr by 2030
Fuel Yield Assumption:
1.366 billion dry tons biomass at 100 gallons/ton = 136.6 billions gallons/year

Biomass Program Objectives and Goals

Make biofuels cost competitive with petroleum based on a modeled cost for mature technology at the refinery gate
Forecast to be $2.60/gal gasoline equivalent by 2017

Help create an environment conducive to maximizing production and use of biofuels, 21 billion gallons of advanced biofuels per year by 2022 (EISA)
(14 billion gge)

Research & Development

Feedstock Systems

- Sustainable regional biomass resources: 130 million dry tons/yr by 2012
- Improved logistics systems: $50/dry ton herbaceous by 2012

Conversion Technologies

Biochemical
- Cost of converting feedstocks to ethanol: $1.40/gal gasoline equivalent (gge) by 2012

Thermochemical
- Cost of converting woody feedstocks to ethanol: $1.30 gge by 2012
- Cost of converting woody feedstock to hydrocarbon fuels: $1.50 gge by 2017

Demonstration & Deployment

Integrated Biorefineries

- Validate integrated process technologies
  - 4 commercial scale
  - 8 demonstration scale
  - Up to 20 pilot or demonstration scale*

Infrastructure

- Testing of E15 & E20
- develop biofuels distribution infrastructure
- blend pumps

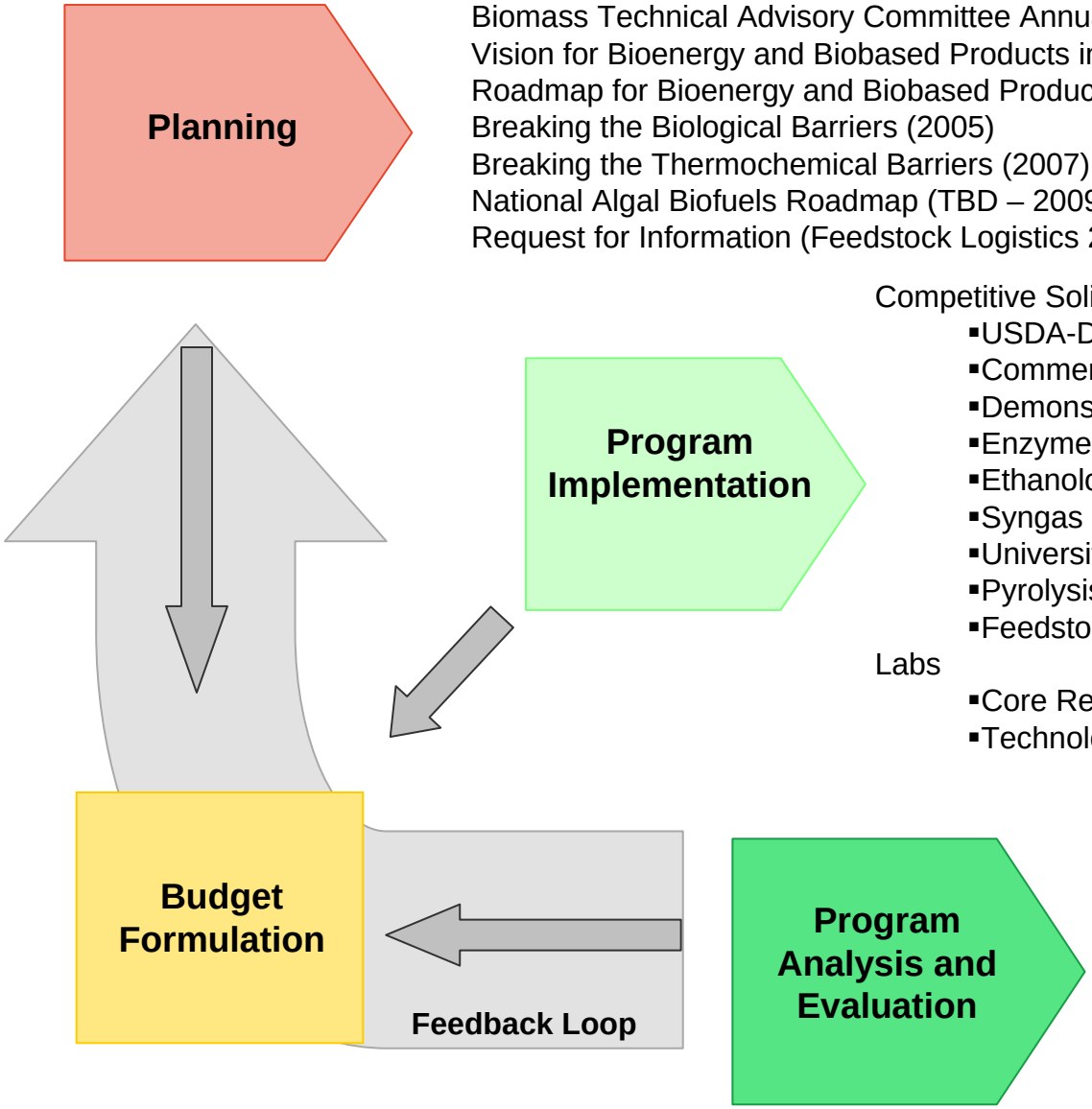
Sustainability & Analysis

Increase understanding of and impacts on:

- GHG emissions
- Water quality
- Land use
- Socioeconomics
- Predictive Modeling
- International

Methodology

Topic Selection, Project & Program Review Processes



Biomass Technical Advisory Committee Annual Reports (2002 – 2008)
Vision for Bioenergy and Biobased Products in the U.S. (2002, 2006)
Roadmap for Bioenergy and Biobased Products in the U.S. (2002, 2007)
Breaking the Biological Barriers (2005)
Breaking the Thermochemical Barriers (2007)
National Algal Biofuels Roadmap (TBD – 2009)
Request for Information (Feedstock Logistics 2008)

Competitive Solicitation

- USDA-DOE Joint Solicitation (2002 – 2009)
- Commercial-Scale Biorefineries (2007) ($272M)
- Demonstration-Scale Biorefineries (2008) ($210M)
- Enzyme Cost Reduction (2008) ($34M)
- Ethanologen Cost Reduction (2007) ($23M)
- Syngas Clean Up (2008) ($7M)
- Universities (2008) ($4M)
- Pyrolysis (2009) ($9M)
- Feedstock Logistics (2009) ($21M)

Labs

- Core Research
- Technology Validations

Stage Gate Reviews
External Biennial Peer Review (2009)*
Steering Committee

Neal Gutterson	Mendel Technologies
Jay Keller	Sandia National Labs, SC Chair
Roger Prince	ExxonMobil
Liz Marshall	World Resources Institute
John May	Stern Brothers (Financial)
Terri Jaffoni	Cargill (Retired)
Susan Schoenung	Bechtel R&D (Retired), SC Co-Chair

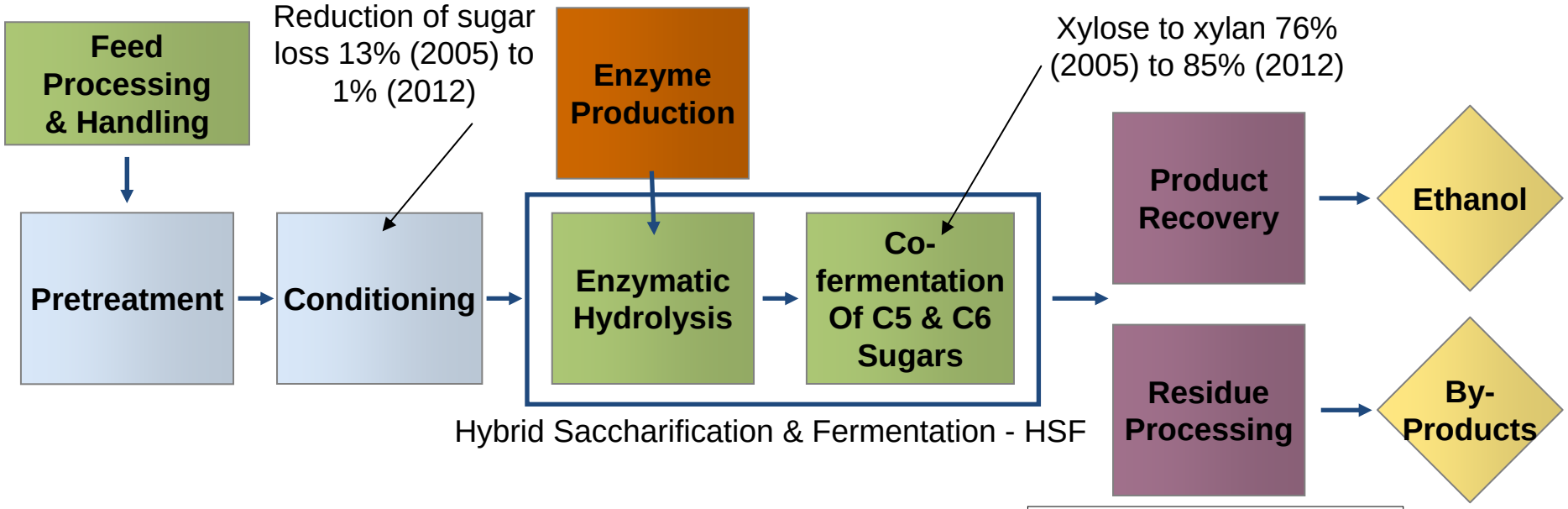
*8 Academics participate as reviewers

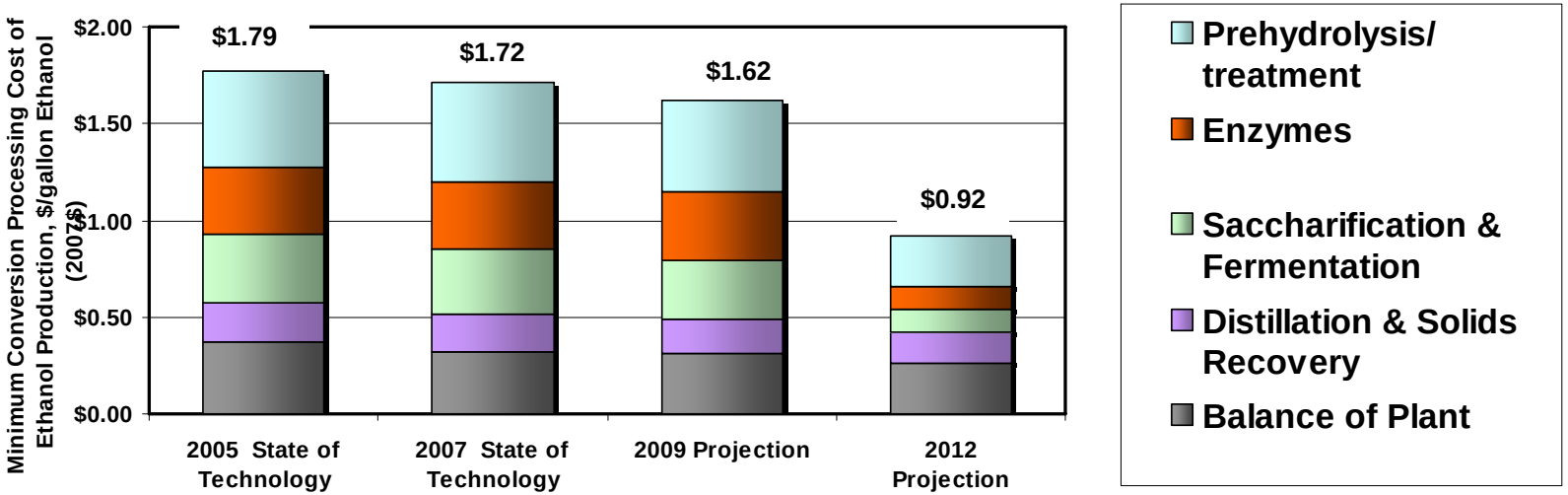
Barriers to Speed and Scale

Barriers	DOE Solution
Pioneer Plants: Incompatibility with Project Finance – no off-take, commodity price risk Credit Enhancements – market risk is not mitigated for ethanol Commercial Readiness – applicants are ill-informed when debt financing should be applied	Resolve loan guarantee program concerns- Higher debt service coverage ratios Higher equity contribution by project sponsor
Pilot and Demonstration Scale Biorefineries: financing uncertainty, NEPA process	DOE cost share; streamline the NEPA process; assist in developing parallel technology solutions
Policy: partial implementation of BCAP, lack of monetization of benefits, no Renewable Portfolio Standard, etc.	Full implementation of BCAP; policy that values carbon & other environmental services; passage of RPS
Feedstock availability & logistics systems	R&D on advanced feedstocks & logistics systems at scale that can support commercial biorefineries (for cellulosic & algal feedstocks)
Conversion technology breakthroughs	R&D on pre-treatment, cost-effective enzymes, pyrolysis oil upgrading, catalyst durability, etc.
Public Acceptance – Sustainability	R&D on GHG impacts, indirect land use, & carbon, nitrogen, phosphorus, & water fluxes; watershed-scale field trials
Near-term: Ethanol Blends; Long-term: Move to hydrocarbon fuels & power	Complete intermediate blends testing by Summer 2010; expansion of advanced biofuels R&D; focus on power & products

Biochemical Conversion/Enzymatic Hydrolysis

Cost of ethanol production, $/gallon ethanol

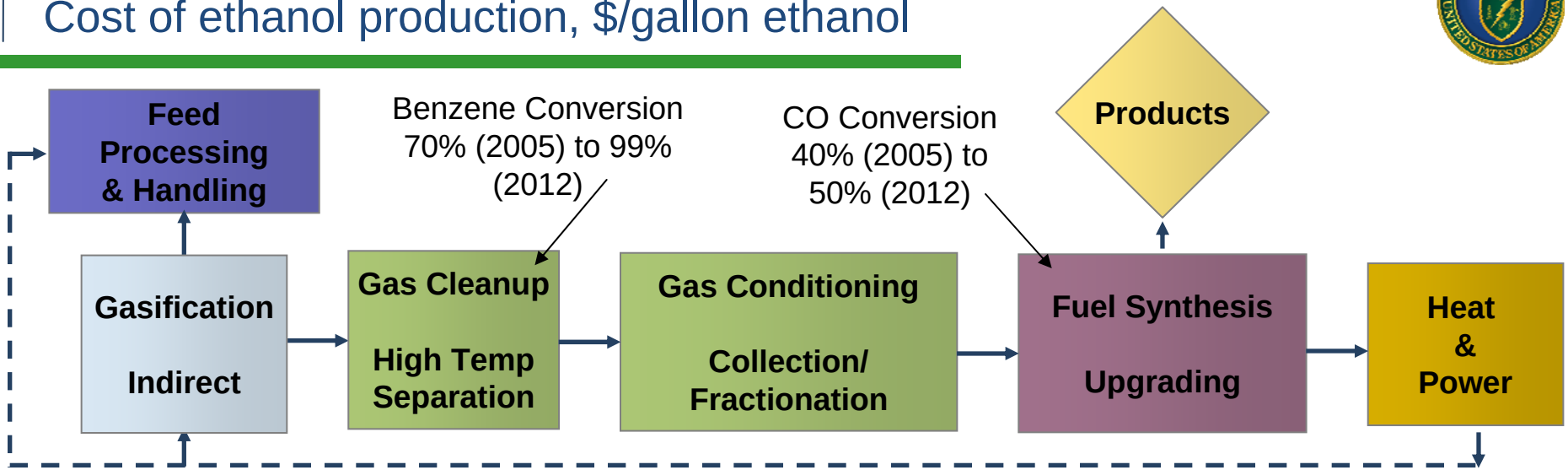


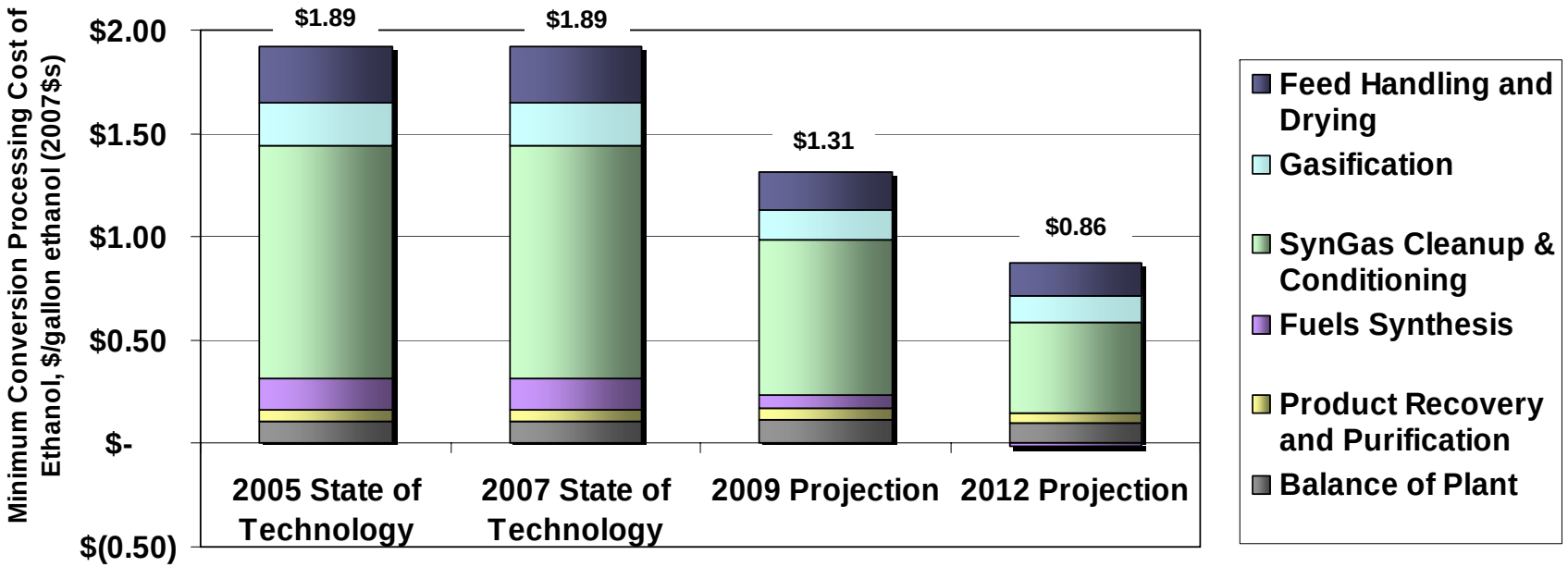


* Conversion costs represented in the figure above are based on conversion of corn stover and equate to an Minimum Ethanol Selling Price $1.49 in 2012.

Major Technology Platform

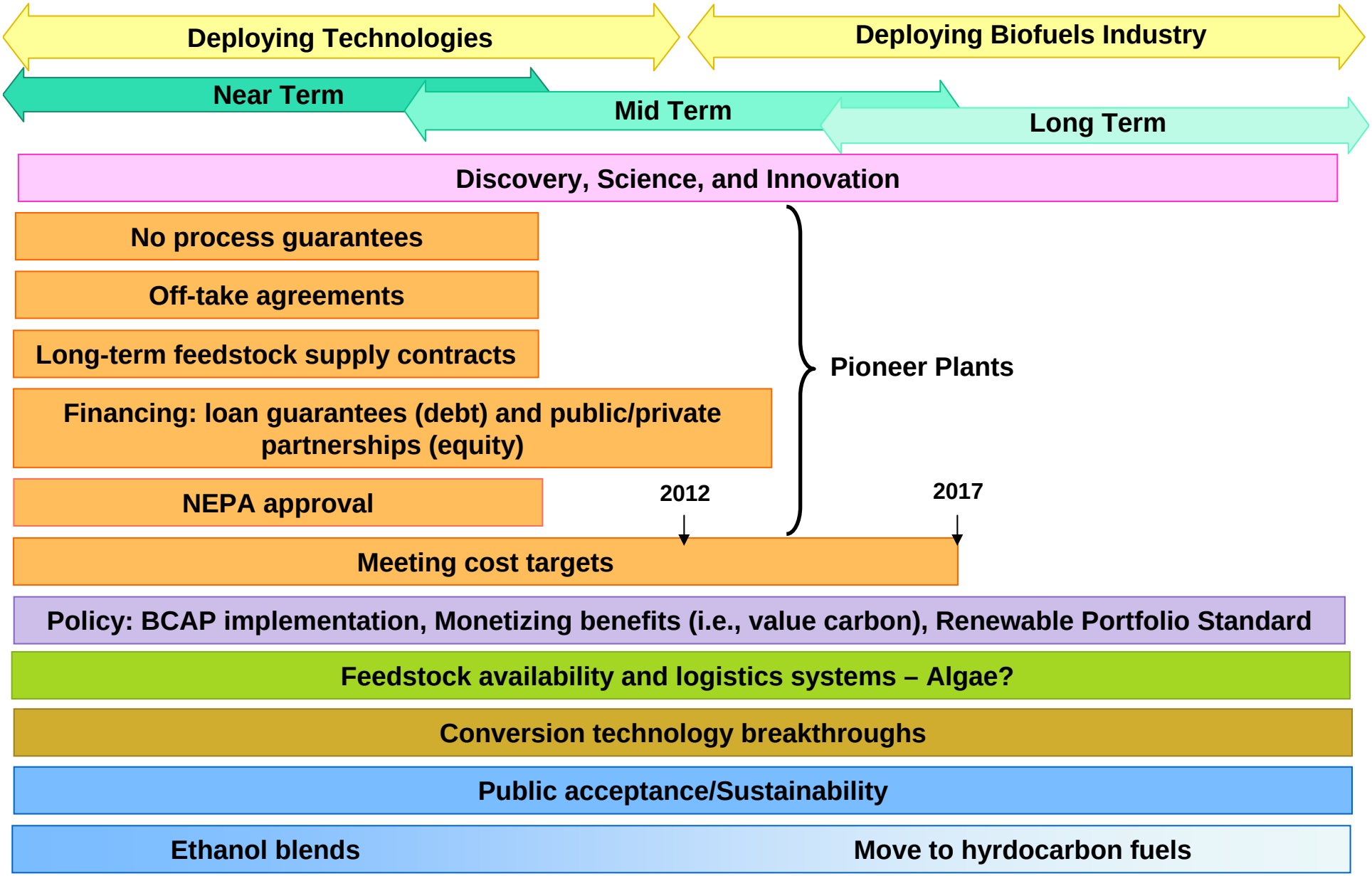
Cost of ethanol production, $/gallon ethanol





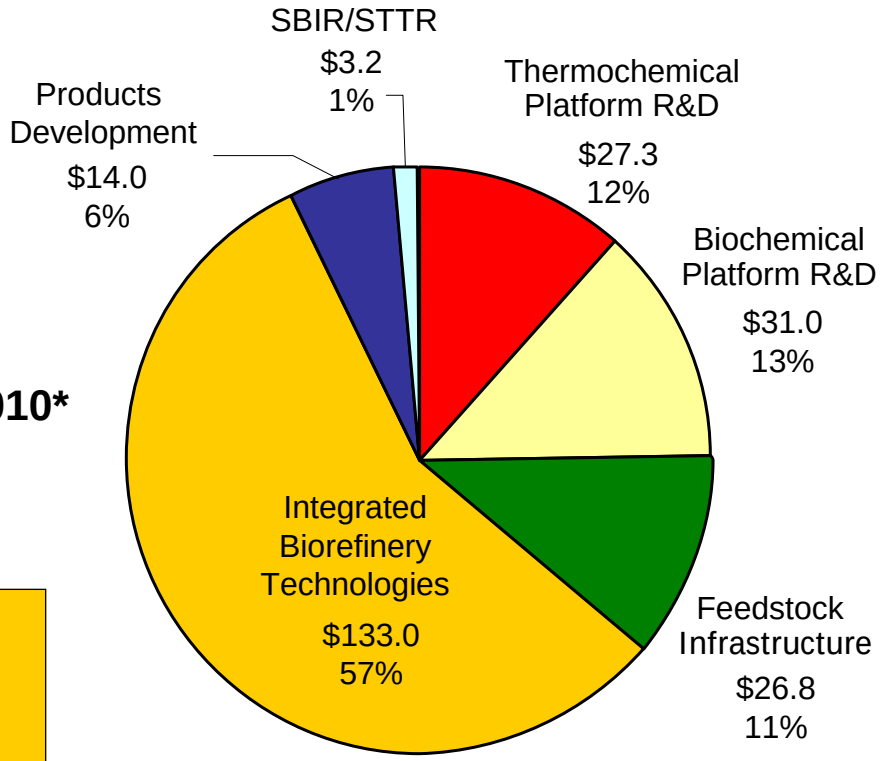
*** Conversion costs represented in the figure above are based on conversion of woody feedstocks and equate to an Minimum Ethanol Selling Price $1.57 in 2012.**

Barriers to Speed and Scale of Technology

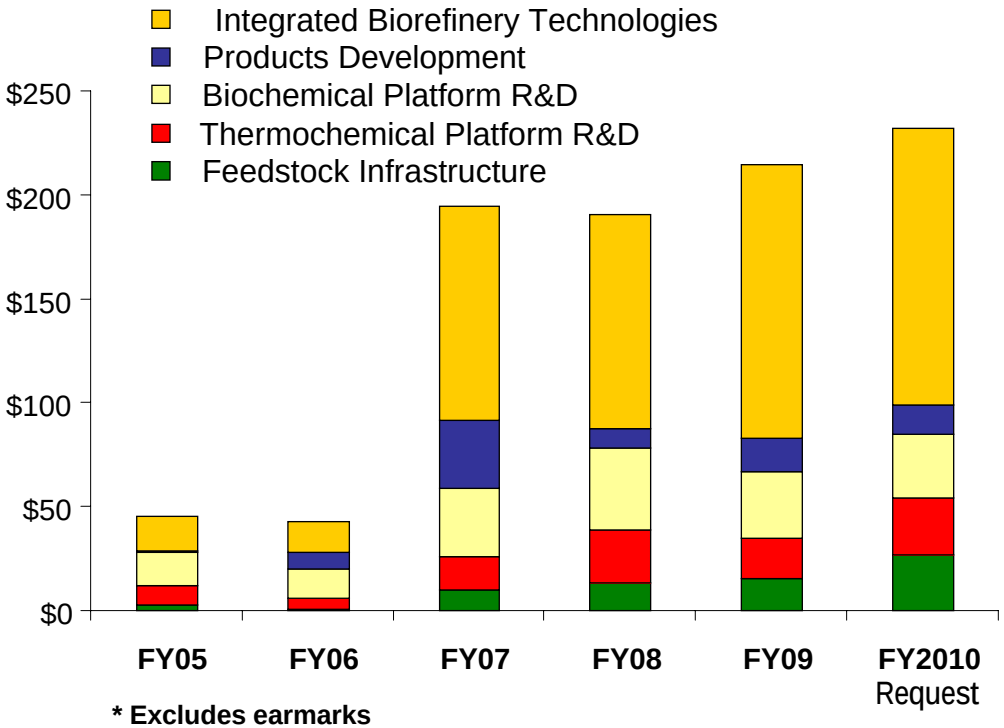


Biomass Program Budget Request, FY2010 (millions)*

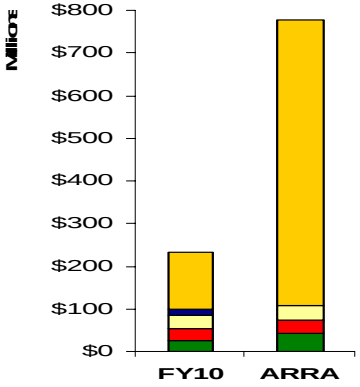
FY2010 budget request reflected increased focus on *Thermochemical Conversion* technology and *Feedstock Infrastructure*.



Biomass Program Budget History, FY2006-2010*



* Excludes earmarks



Key Strategic Relationships

- **May 5, 2009 Presidential Memorandum – Biomass Interagency Working Group**
  - High level with EPA, USDA, and DOE
    - Develop Biofuels Industry
    - Coordinate Interagency Policy
- **Biomass R&D Act of 2000 (amended by legislation)**
  - Biomass Research & Development Board
    - Biofuels Interagency Working Groups
  - Biomass Technical Advisory Committee
- **Bioenergy Research Centers**
  - Joint BioEnergy Institute (LBNL)
  - Bioenergy Science Center (ORNL)
  - Great Lakes BioEnergy Research Center (Univ. of WI)
- **U.S. Feedstock Partnerships**
  - Regional Feedstocks Partnerships
  - Council on Sustainable Biomass Production
- **Global Partnerships**
  - International Energy Agency
  - Conservation International
  - Global Bioenergy Partnership

Recovery Act Funding and Initiatives

Biomass R&D and Demonstration Projects - $800 Million in Funding

$480M **Pilot and Demonstration-Scale Biorefineries**

Validate technologies for integrated production of advanced biofuels, products, and power to enable financing and replication.

10 to 20 awards for refineries to be operational within 3 years:

- Up to $25M for each pilot-scale project
- Up to $50M for each demonstration-scale project

$176.5M **Commercial-Scale Biorefineries**

Increase in funding for prior awards; two or more projects

Expedite construction; accelerate commissioning and start-up

$110M **Fundamental Research**

$20M: Integrated Process Development Unit

$5M: Sustainability research with the Office of Science

$35M: Advanced Biofuels Technology Consortium

$50M: Algal Biofuels Consortium to accelerate demonstration

$20M **Ethanol Infrastructure Research**

Optimize flex-fuel vehicles operating on E85

Evaluate impacts of intermediate blends on conventional vehicles

Upgrade existing infrastructure for compatibility with E85

$13.5M NREL Integrated Biorefinery Research Facility: expand the pretreatment capacity