

**U.S. Department of Agriculture
and
U.S. Department of Energy
Energy Efficiency and Renewable Energy
Office of the Biomass Program**

**RESEARCH AND DEVELOPMENT ACTIVITIES
BY
ROADMAP CATEGORY**

**Prepared for:
Biomass Technical Advisory Sub-Committee**

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Table of Contents:

1.	Purpose	1
2.	Caveats	1
3.	U.S. Department of Energy, Office of the Biomass Program:	2
4.	USDA Agency Summaries:	4
5.	FEEDSTOCK PRODUCTION DOE Project Breakdown: USDA Project Breakdown:	6
6.	PROCESSING AND CONVERSION DOE Project Breakdown: USDA Project Breakdown:	9
7.	PRODUCT USES AND DISTRIBUTION DOE Project Breakdown: USDA Project Breakdown:	14
8.	PUBLIC POLICY MEASURES TO SUPPORT BIOMASS DEVELOPMENT DOE Project Breakdown: USDA Project Breakdown:	17

Appendix:

TABLE 1: Funding In Feedstock Production Roadmap Category ¹	20
Figure 1: FEEDSTOCKS – BY DEPARTMENT	21
Figure 2: FEEDSTOCKS COMBINED DOE/USDA FUNDING	21
TABLE 2: Funding In Processing and Conversion Roadmap Category	22
Figure 3: PROCESSING AND CONVERSION	23
Figure 4: PROCESSING AND CONVERSION – COMBINED FUNDING	24
TABLE 3: Funding In Product Uses and Distribution Roadmap Category ²	25
Figure 5: PRODUCT USES AND DISTRIBUTION	26
Figure 6: PRODUCT USES AND DISTRIBUTION – COMBINED FUNDING	27
TABLE 4: Funding In Public Policy Measures to Support Biomass Development Roadmap Category ³	28
Figure 7: PUBLIC POLICY - DOE	29
Figure 8: PUBLIC POLICY - USDA	30
Figure 9: PUBLIC POLICY – COMBINED FUNDING	31
TABLE 5: TOTAL FUNDING FY03 - FY05	32
Figure 10: TOTAL USDA & Doe Biomass R&D Funding By Roadmap Category	33
Figure 11: Roadmap Categories	34
Figure 12: Roadmap Categories – Combined Funding	35

RESEARCH AND DEVELOPMENT ACTIVITIES BY ROADMAP CATEGORY

1. Purpose

The purpose of this document is to outline the total R&D portfolios of both the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA) in relation to the Biomass Research and Development Technical Advisory Committee's (TAC) Roadmap categories. The R&D credits, incentives and other funding activities summarized in this document include the entire portfolio of DOE and USDA activities related to the Committee's Roadmap, \$1.1 billion in total over FY03 – FY05. Only a subset of this, \$50.2 million, is a result of the joint solicitations between DOE and USDA over the period FY03 and FY04.

The TAC can use this document as a tool to understand where the DOE and USDA are allocating funding in relation to Roadmap categories. After discerning which Roadmap categories need more investment, the TAC can make its recommendations to the departments accordingly. The TAC has influence over the USDA/DOE Biomass Initiative's Joint Solicitation funds only.

What's included in this document:

- Summary of USDA Agencies and DOE-OBP (see pages 2 – 5)
- By Roadmap Category (see pages 6 – 19):
 - TAC objective (from *Roadmap*)
 - Project descriptions for DOE relevant to the Roadmap category
 - R&D focus for USDA agencies relevant to the Roadmap category
- Summary tables and bar charts illustrating the funding by Roadmap category and sub-category for each agency from FY03 through FY05 (20-31).
- Summary table and graphics of DOE and USDA total research funding for FY03 through FY05 broken out by Roadmap category

2. Caveats

- FY03 data are based upon the portfolio analysis performed for the Committee in January 2003 and were not collected at the same level of detail as that collected for FY04 and FY05 in the current effort.)
- Funding for the Joint Solicitation is included for FY03 and FY04.
- The U.S. DOE FY2005 funding estimate does not include \$34.5 million in funds set aside to fund the USDA/DOE Joint Solicitation as well as anticipated Congressional earmarks.
- Many of the DOE's R&D activities cross-cut Roadmap categories but were placed according to primary objectives of the project.

3. U.S. Department of Energy, Office of the Biomass Program

The U.S. Department of Energy Biomass Program (OBP) is helping to meet strategic goals of the Office of Energy Efficiency and Renewable Energy (EERE) including:

1. To reduce dependence on foreign oil by developing biomass based liquid fuels, and
2. To foster the domestic biomass industry.

The mission of OBP is to partner with U.S. industry to foster research and development on advanced technologies that will transform our abundant biomass resources into clean, affordable, and domestically produced biofuels, biopower, and high-value bioproducts. The results will be economic development, energy supply options, and energy security.

Program activities directly support the overall mission and priorities of DOE/EERE. OBP technology development and implementation activities will directly contribute to the creation of a new bioindustry, and will reduce U.S. dependence on foreign oil by supplementing the use of petroleum for fuels and chemicals.

OBP research could help fundamentally change the way we produce and consume energy and industrial products in the United States. Instead of using fossil fuels to produce energy and industrial products, our vast domestic biomass resources can be used to make similar fuels, power (industrial process heat and electricity), chemicals, materials, and much more. To aid in this transition, OBP partners with U.S. industry to foster research and development in advanced biomass technologies.

To reach its two primary goals, the program focuses on five core R&D areas:

Biomass Feedstock Interface

The objective is to develop sustainable technologies capable of providing the necessary large supply of low-cost, high-quality lignocellulosic biomass to biorefineries that produce fuels, combined heat and power, chemicals, and other materials.

Sugar Platform

This involves the breakdown of biomass into raw component sugars using a range of chemical and biological processes. The objective of the Sugar Platform is to develop the capability of biomass to produce inexpensive sugar streams that can be used to make fuels, chemicals, and other materials that are cost competitive with conventional commodities. The residues from this process can also be used for power or to make other products.

Thermochemical Platform

The emphasis is on converting biomass or biomass-derived biorefinery residues to intermediates such as pyrolysis oil and syngas. These intermediates can be used directly as raw fuels or products, or may be further refined to produce fuels and products that are interchangeable with existing commercial commodities such as oils, gasoline, diesel, synthetic natural gas, and high-purity hydrogen.

Products R&D

This broad heading of products includes three market sectors: 1) fuels, 2) chemicals and materials, and 3) power. The products R&D portfolio focuses on bridging the gap between technology development and market demand by maximizing the value of all the components produced by the

Sugar and Thermochemical Platforms. This research also supports the concept of producing multiple products from an integrated biorefinery.

Integrated Biorefinery

This is the ultimate deployment strategy for the Program. A biorefinery embodies a facility that uses biomass to make a range of fuels, combined heat and power, chemicals, and materials in order to maximize the value of biomass. The Program is taking a systems integration approach that translates the technical successes achieved in each of the other four core R&D areas to an integrated market-ready biorefinery. The goal of this R&D area is to establish integrated biorefineries through partnerships with industry and academia.

4. USDA Agency Summaries:

Agricultural Research Service (ARS)

As the in-house research arm of the United States Department of Agriculture (USDA), the Agricultural Research Service (ARS) conducts fundamental and applied research to develop solutions to agricultural problems of high national priority. Research related to biobased products focuses on developing industrial products that expand markets for farm products, replace imports and petroleum-based products, and offer opportunity to meet environmental needs. Activities include development of technologies for biobased degradable plastics, adsorbents and absorbents, improved and lower cost fuels and fuel additives, biopesticides, composites, cotton-based fabrics with versatile new and improved properties, encapsulating agents, fiber crops for specialized uses, polymers and polymer blends, soy ink, functional fluids (lubricants, hydraulic fluids), specialty chemicals, coatings, health care products, and new crops to meet niche market opportunities. ARS conducts most of its new uses/biobased products and biofuels research at four USDA research centers originally funded by Congress more than 60 years ago to develop new uses for U.S. agricultural commodities and byproducts. These centers are located at Albany, CA, New Orleans, LA, Peoria, IL and Wyndmoor, PA.

Cooperative State Research Education and Extension Service (CSREES)

CSREES is USDA's principal link to academia and participates in a nationwide agricultural research planning and coordination system that includes State land-grant universities and the agricultural industry. CSREES promotes research and development for biobased industrial products and bioenergy primarily through its Agricultural Materials Program, National Research Initiative, and Small Business Innovation Research Program. The Agricultural Materials program provides non-competitive funding to land grant institutions through formula funding and special research grants to support a range of basic and applied research topics. Competitive funding is provided through the National Research Initiative (NRI) and the Small Business Innovative Research Program (SBIR). The NRI program provides a bridge between basic research and near-term development, and SBIR supports pre-commercialization activities. Examples of topics supported under all three programs include: plant breeding and genetics, crop production, materials processing, and product development. Products include biobased lubricants, energy, fibers, polymers, chemicals and utilization of agricultural waste.

Farm Service Agency (FSA)

The Farm Service Agency's Bioenergy Program (Program) funded through the Commodity Credit Corporation's (CCC) was extended through Fiscal Year 2006 by the Farm Security and Rural Investment Act of 2002 (the Act). The Program reimburses eligible producers of bioenergy (commercial fuel grade ethanol and biodiesel) for part of their input costs of eligible commodities used to increase bioenergy production over the previous Fiscal Year. The Act made changes including modifying the definitions for biodiesel, conversion factor, eligible commodities and ethanol, extending the program beyond Fiscal Year (FY) 2002, and allowing producers to enter into multi-year contracts for program payments.

Forest Service Research and Development (FS R&D)

Forest Service Research and Development (FS R&D) has had an active research program for almost 90 years in the growth and management of timber, timber removal, and forest products development. Biobased products research is directed toward development of cost-effective feedstock systems for wood fiber that are competitive with non-renewable resources and new technologies to provide low-cost and environmentally acceptable processing and manufacturing of wood-based products. Activities include development in the area of composites, pulp and paper technology, adhesives, wood

engineering, wood processing, wood preservation, harvesting, wood energy systems, and feedstock growth. This work is performed at one National Laboratory in Madison, WI and numerous smaller field locations throughout the United States.

Natural Resources Conservation Service (NRCS)

NRCS provides technical assistance to farmers and ranchers to help insure that the production of feedstocks for bioenergy and bioproducts are produced in an environmentally acceptable manner. The agency is focusing increasing attention on helping producers use animal wastes in energy production, especially to address greenhouse gas problems. Through the USDA's Resource Conservation and Development program, NRCS works at the community or area wide level to help develop enterprises to produce and market bioenergy and bioproducts. Indirect support to bioenergy/biobased products projects developed by local RC&D councils is provided as NRCS coordinators devote some staff time to assist the councils with these projects. No data is available on this limited staff time assistance. NRCS, in cooperation with DOE, administers the Biomass R&D Program, which provides grants for biomass research, development and demonstration projects.

The Office of Energy Policy (OEPNUP)

The Office of Energy Policy and New Uses provides leadership, oversight, coordination, and evaluation for all USDA energy and energy-related activities with the exception of those delegated to the USDA Assistant Secretary for Administration. The Office analyzes existing and proposed energy policies, strategies, and regulations concerning or potentially affecting agriculture. It also evaluates the feasibility of new uses for agricultural products.

Departmental Administration (DA)

For DA, funding covers a portion of salary of a staff person that works on the alternative fuels program in support of the Energy Policy Act of 1992 requirements and Executive Order 13149, Greening the Government Through Federal Fleet and Transportation Efficiency. The focus of this program is to increase the acquisition of alternative fuel vehicles and use of alternative fuels in USDA fleet vehicles nationwide. The agency also supports the biobased products procurement program.

Rural Development (RD)

The Rural Development Mission Area works to make sure that rural citizens can participate fully in the global economy --with technical assistance and programs that help rural Americans build strong economies to improve their quality of life. Rural Development also helps rural communities meet their basic needs by: building water and wastewater systems, financing decent, affordable housing, supporting electric power and rural businesses including cooperatives, and supporting community development with information and technical assistance.

5. FEEDSTOCK PRODUCTION

Committee Roadmap Objectives

1. Biotechnology and Plant Physiology

Objective One – To improve the technical understanding of plant biochemistry and enzymes and develop the ability to engineer enzymes within desired crops

Objective Two – Develop the chemical and chemical/biological pathways necessary to improve the energy density and chemical characteristics of delivered feedstocks

2. Agronomic Practices

Objective Three – Optimize agronomic practices for sustainable biomass feedstock production

3. Feedstock Handling

Objective Four – Optimize logistics for collecting, storing and combining multiple feedstocks that can be applied for diverse applications in an environmentally sound manner

DOE Project Breakdown: FEEDSTOCKS

- **National Corn Grower's Association (NCGA) Arabinose Yeast CRADA Project** – Tasks:
 - 1) NCGA Arabinose Yeast CRADA Project;
 - 2) Oxygenated Emissions Testing Demonstration in California and Nevada Project;
 - 3) Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products Project;
 - 4) Energy from Biomass Research and Technology Transfer Project;
 - 5) E-Diesel Research with the National Corn Growers Association Project;
 - 6) Ethanol Production From Biomass Large Scale Facility Design Project;
 - 7) Mathematical and Computational Analysis of Central Carbon Pathways for Efficient Metabolic Engineering.

A variety of classical genetics, (mutagenesis and selection) and molecular biological methods will be employed to identify the problems and find solutions for those problems.

- **Integration of Leading Biomass Pretreatment Technologies with Enzymatic Digestion and Hydrolyzate Fermentation:** New project leveraging the USDA supported CAFI.
- **Development of Yeast for the Fermentation of Agricultural Feedstocks to Chemicals Project** - Cargill Dow, VTT and UC Davis are collaborating to develop a xylose fermenting microorganism for the production of lactic acid and ethanol by genetically engineering Cargill Dow's acid tolerant microorganism to ferment xylose. The microorganism will facilitate the conversion of non-food agricultural produce to a variety of chemicals including polylactide, propylene glycol, acrylates, ethylene and ethanol.
- **Pretreatment Project** – Project partners: National Bioenergy Center (NBC) - More than 20 years of research have gone into developing pretreatment technologies for enzyme-based hydrolysis processes. The emphasis of the Program's work on pretreatment is, therefore, on evaluation of and improvements to the leading pretreatment concepts that have surfaced during this period. Sub-tasks include: Emerging Pretreatment Options Task and Pretreatment Applications for Corn Mills Task.
- **Collection, Commercial Processing, & Utilization of Corn Stover Project** - Project objectives are to (1) develop and test new technologies that harvest, transport, store, and separate corn stover to consistently supply clean, raw materials to downstream processors in

the bioproducts industry, and (2) engineer a fermentation system to meet performance targets for lactic acid and ethanol manufacturers.

- **NBC Feedstock Infrastructure Project: Harvesting and Collection Task. Biomass Bulk Processing and Storage Task** - The primary objective of this project is to develop single-pass multi-component selective harvest capabilities.
- **Supply System Logistics** - The overall goal of this task is to identify the biomass supply chain options that would enable the reliable delivery of \$35/dry ton biomass feedstock to a biorefinery and to guide research on supply chain components (i.e. approaches to collecting, handling, storing and transporting biomass feedstock).
- **Multicomponent Harvesting Equipment for Inexpensive Sugars from Crop Residue, Iowa State Univ.** - Study and understand gene regulation of lignin synthesis in wheat for the purpose of exploiting lower lignin and increased polysaccharides to make the crop residue stems more adaptable to mechanical harvesting and produce higher fermentable sugar yields.
- **Thermochemical: Center for Catalysis at Iowa State University (CCAT)** - Catalytic conversion of renewable natural resources to industrial materials; Development of new catalysts for the oxidation or reduction of commodity chemicals; Use of enzymes and microorganisms in biocatalysis; Development of new, environmentally friendly reactions of industrial importance.

USDA R&D Focus: FEEDSTOCKS

Agricultural Research Service – Feedstock production research addresses improving technology for genetic modification of feedstock plants; sustainable production of those plants, including harvest, handling, and storage; and characterization of feedstock quality. Examples of activities include:

- Develop an integrated plant molecular, genomics, bioinformatics, plant transformation approach, along with conventional plant breeding, to:
 - Alter plant architecture and cell wall structure for more efficient energy crop production.
- Develop plants that produce large quantities of desired components (such as lipids, polymers, fibers, enzymes, and resins).
 - Develop economically feasible and environmentally sustainable management systems for producing large quantities of biomass feedstock.
- Develop efficient, economical, and environmentally sustainable methods for harvesting, processing, and handling herbaceous crops and plant residues that retain or improve the energy density and quality of these materials as feedstocks for conversion to bioenergy and biobased products.

Cooperative State Research Education and Extension Service – Improving quality of new and traditional crop and forestry materials before harvest using plant breeding, genetic engineering, functional genomics, and cultural practices; fundamental studies of plant and animal structures/properties to enhance product quality and processing characteristics; examples include the development of new industrial crops such as lesquerella, meadowfoam, guayule, hesperaloe, canola, and ricin-free castor.

Forest Service

- Improves our technical understanding of wood biochemistry and enzymes for conversion of woody biomass to desired energy and pulp products - Forest Products Laboratory in Madison, WI (FPL).

- Develops biological pathways and genomic data on short rotation woody crops -Rhinelander, WI.
- Optimizes silvicultural practices for sustainable short rotation woody crop feedstock production - Rhinelander, WI
- Looks at ecological management practices including soil sustainability, land use, water use, impact on wildlife for short rotation woody crop feedstock at several locations across the United States.
- Looks at the ecological impacts of the removal of small diameter timber to reduce fire danger in our nation's forests at many locations throughout the United States.
- Explores the best practices of cost-effective and environmentally sound harvesting, storage, and transport of forest biomass feedstocks - Auburn, AL; Portland, OR.
- Looks at feedstock handling of woody crop systems at multiple operational scales - Auburn, AL

Natural Resources Conservation Service – Projects dealing with changing particle size to increase efficiency of burning biomass for energy production. Development of technology for efficient, economical, harvesting and distribution of biomass.

6. PROCESSING AND CONVERSION

Committee Roadmap Objectives

Thermochemical Conversion:

Objective One – Develop cost-effective, environmentally sound thermochemical conversion technologies to convert biomass feedstocks into useful electric power, heat and potential fuels and products.

Bioconversion:

Objective Two – Develop economically viable and environmentally sound bioconversion processes/technologies for commercial application of a range of biobased fuels and products.

Biorefinery Integration:

Objective Three – Advance the development of biorefineries that 1) efficiently separate biomass raw materials into individual components, and 2) convert these components into marketable products, including biofuels, biopower, and conventional new bioproducts.

DOE Project Breakdown: PROCESSING AND CONVERSION

- **Biomass Power for Rural Development, Iowa Switchgrass** - Development of markets for energy crops in southern Iowa
- **Wet Gasification** - The objective of this project is to perform the process development of a catalytic gasification technology for recovery of energy from wet biomass including unconverted residuals from ethanol fermentation and animal manure.
- **Biomass-Derived Hydrogen From a Thermally Ballasted Gasifier Project** - The goal of this project is to optimize performance of an indirectly heated gasification system that converts switchgrass into hydrogen-rich gas suitable for powering fuel cells.
- **Clean-up & Conditioning Project** – Tasks: Particulate Measurement Task; Tars and Heteroatoms Task - One approach to meeting this objective is to integrate biomass gasification with existing and advanced processes for the production of fuels and chemicals. Considerable gas cleanup and conditioning of biomass-derived syngas is required because chemical contaminants such as tar, ammonia, chlorine, sulfur, alkali metals, and particulates are formed. Gas Cleanliness Verification/ Existing Cleanup/Conditioning, Pilot Slip Stream Catalyst Testing, Pilot Scale Tar Reforming and Catalyst Fundamentals.
- **Trace Metal Scavenging from Biomass Syngas with Novel High-Temperature Sorbents** – Project partners: Southern Research Institute - The objective of this project is to develop technology, based on inexpensive high temperature sorbents and novel applications, to condition hot syngas, while preventing the escape of trace metals through the barrier filter.
- **Biomass Gas Cleanup Using a Therminator** – Project partners: Research Triangle Institute - This project will develop and demonstrate a novel fluidized-bed reactor system (therminator) to remove tar, ammonia and sulfur from raw biomass syngas from a pressurized fluidized-bed biomass gasifier.
- **Catalytic Hydrothermal Gasification for Eastman Kingsport Chemical Production Plant** – Project partners: Antares Group Inc. - The project targets the incorporation of wet waste streams into chemical production processes. It includes an engineering evaluation of the process and process modeling, an economic evaluation and comparison to potential alternatives, and Process Development Unit testing.

- **Thermochemical Conversion of Corn Stover** – Project partners: Bioengineering Resources, Inc. The purpose of this project is to develop and demonstrate at pilot scale an optimal gasification / fermentation process to utilize corn stover.
- **Advancement of High Temperature Black Liquor Gasification Technology** – Project partners: Weyerhaeuser Company - Tasks:
 - 1) Validate the tools (models) and fundamental knowledge generated in other funded and proposed projects.
 - 2) Utilize the "commercial" operation of the facility to evaluate solutions to long term process issues (e.g. scaling and other process integration issues work by implementing and demonstrating solutions at New Bern)
- **Investigation of Pressurized Entrained Flow Draft Black Liquor Gasification in an Industrially Relevant Environment** – Project partners: The University of Utah, Brigham Young University and Simulent, Inc. The project comprises five technical tasks:
 - 1) Droplet formation and burner performance will be evaluated through a combination of experimental droplet imaging studies and computational modeling of droplet formation.
 - 2) Physical characteristics of black liquor will be studied throughout the entire range of conversion, from droplet to smelt bead.
 - 3) Chemical transformations of the liquor and development of the syngas will be studied in detail.
 - 4) Transport and radiative properties of the smelt product will be measured,
 - 5) And properties of the syngas resulting from partial oxidation of liquor in a pressurized gasifier will be characterized.
- **Emerging Thermochemical Biorefineries** - The Department of Energy (DOE) has awarded 4 industrial partnerships valued at \$ 21million for for research, development and prototype demonstration of small modular biomass systems.
- **Thermochemical & Heat and Power Biomass Project** - This project will address barriers relating to integrated biorefineries. Tasks: Vermont Biomass Energy Center Project; White Pine City, NV Public School Heating Project; Regional Biomass Energy Program.
- **Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products Project** - Objectives: Statement of Work: Project History: Newly begun effort in FY04
- **Enzymatic Hydrolysis Project/ NBC Enzymatic Hydrolysis** - This task facilitates and supports through industry-directed applied research the development of a new generation of lower cost cellulase enzymes for hydrolyzing pretreated biomass cellulose at high yield and acceptable cost. / The Program's strategy for near-term work on reducing the cost of cellulose-hydrolyzing enzymes is to cost share and technically support continued enzyme cost reduction efforts by DOE's industrial enzyme partners, including Genencor and Novozymes.
- **NBC Genencor CRADA** - The objective of this CRADA is to characterize new glycohydrolases and glycohydrolase mutants from the NREL collection that may provide functionalities of use in commercial applications. This work as proposed provides a 60% plus cost share by GCI.
- **NBC Fundamentals and New Concepts** - Biomass Structure Task - This work represents an extension of work previously performed in the Industrial Enzymes Support and Fundamentals, the Advanced Pretreatment, and the Enzyme Sugar Platform tasks. Tasks: Chemical Processing Fundamentals Task - A key technical barrier to the commercialization of fuels and chemicals from biomass via a sugar platform route is the high cost and relative inefficiency of producing sugars from lignocellulosic biomass; Biological Fractionation Fundamentals Task; Conversion Concepts Task; Enzyme-Mediated Pretreatment Subtask; Biomass Surface Characterization Task.

- **Mathematical and Computational Analysis of Central Carbon Pathways for Efficient Metabolic Engineering** - The objective of this effort is to develop mathematical and computational models of the CCP in the two model organisms of the bacteria *E. coli* and the yeast *S. cerevisiae*.
- **Fundamentals and New Concepts Project** - The goal of the research for advanced sugar biorefineries is to develop a more fundamental and deeper understanding of the factors and causes underlying the recalcitrance of biomass to biological and chemical depolymerization and the mechanisms of sugar degradation.
- **A New Biorefinery Platform Intermediate Project** - Cargill, through collaboration with their partners Codexis, Inc. and Pacific Northwest National Laboratory (PNNL), will develop a new bio based platform technology to produce a portfolio of products based on 3-hydroxypropionic acid (3-HP) produced by the fermentation of carbohydrates.
- **NBC Sugar Platform Integration** - Task: Enzyme Sugar Platform Task - Our overall objective is to investigate enzymatic cellulose hydrolysis-based biomass-to-ethanol conversion process technology based on a large-scale domestic feedstock (corn stover is the model feedstock).
- **Advanced Catalyst Development for Polyols Production Project** - The objective of this project is to develop an economically viable, aqueous phase catalytic process for the conversion of sorbitol (derived via hydrogenation of glucose) to produce polyols.
- **Engineering New Catalysts for In-Process Elimination of Tars** - The proposed target aims at developing a new methodology for the economical production of commercial quantities of tar-cracking catalysts. These catalysts should meet existing performance criteria and may make use of otherwise unused waste materials.
- **Sugars – Tasks:**
 - 1) Advanced Catalyst Development for Polyols Production Project.
 - 2) Development of Yeast for the Fermentation of Agricultural Feedstocks to Chemicals Project.
 - 3) Acid Catalyzed Hydrolysis of Wastewater Activated Sludge for Recycle and Conversion to Products Project (Eastman ARO).
 - 4) Biomass Biorefinery for Production of Polymers and Fuel Project.
 - 5) Enhancement of Bio-based Products from Sorghum Grain with Optimized Production and Composition Using Advanced Genomics Project.
 - 6) Biobased Products by the New Uses Information and Entrepreneur Development Center Project.
 - 7) Development of Sustainable Biobased Products and Bioenergy from Corn Dry Mills Project.
 - 8) Reactive Distillation for Esterification of Bio-Based Organic Acids Project.
- **Sugar Platform Integration Project** - Our overall objective is to investigate enzymatic cellulose hydrolysis-based biomass-to-ethanol conversion process technology based on a large-scale domestic feedstock (corn stover is the model feedstock).
- **Advanced Biorefining of Distiller's Grain and Corn Stover Blends: Pre-Commercialization of a Biomass-Derived Process Technology Project** - The objective of this project is to develop a novel biomass-derived process technology that utilizes advanced biorefined Distiller's Grain (DG) and Corn Stover (CS) blends to achieve significantly higher ethanol yields while maintaining the protein feed value.
- **Thermochemical Platform Analysis/ Syngas Platform Analysis and Management** - The objective of this task is to perform analysis in order to support the on-going research in the syngas platform. Specifically, this task supports the following research areas: feed process handling, gasification, cleanup/conditioning, and sensors & controls. Analysis helps to provide direction and focus to the research by evaluating the technical, economic, and

environmental aspects of biomass syngas production and conversion to fuels or power. Analysis also helps to set goals and measure progress.

- **Thermochemical/ Pyrolysis Oil Upgrading for Products Project** - The objective of this task is to perform analysis in order to support the on-going research in the syngas platform. Specifically, this task supports the following research areas: feed process handling, gasification, cleanup/conditioning, and sensors & controls. Analysis helps to provide direction and focus to the research by evaluating the technical, economic, and environmental aspects of biomass syngas production and conversion to fuels or power. Analysis also helps to set goals and measure progress.
- **Thermochemical/ Pyrolysis Oil Upgrading for Products Project – Tasks:**
 - 1) Pyrolysis Oil Upgrading for Products Project
 - 2) Use of Bark Derived Pyrolysis Oils as a Phenol Substitute in Structural Panel Adhesives Project
 - 3) Maine Forest Bioproducts Research and Development – Developing an Integrated Forest Products Refinery Project
 - 4) Eastern Nevada Landscape Coalition for Biomass Restoration and Science-Based Restoration Project.
- **New Sustainable Chemistry for Adhesives, Elastomers and Foams** - The team will pursue a biorefinery approach to produce novel soy-sugar polymers. The program will develop products which can replace petrochemical-based polyurethane adhesives, elastomers and foams.

USDA R&D Focus: PROCESSING AND CONVERSION

Agricultural Research Service – Processing and conversion research addresses an improved understanding of the properties and characteristics of agricultural feedstocks and development of efficient, economical, and sustainable technology for conversion of agricultural materials into biofuels and biobased products. Examples of activities include:

- Develop processing technologies for converting animal fats and vegetable oils into fuel and coproducts.
- Develop thermo-mechanical processes for modifying the properties of natural polymers and expand the range of starch-oil composite technology.
- Develop biocatalytic processes for altering the physical and chemical properties of soybean oil and optimize microbial expression systems for bioconversion of low-cost vegetable oils into value-added industrial oils.
- Develop improved technologies for conversion of corn and other grains, corn stover and other plant residues, processing residues, and herbaceous energy crops into biofuels and coproducts.
- Improve retting procedures to obtain fibers from bast plants, such as kenaf and flax, using mixtures containing pectinases, hemicellulases, and other non-cellulase enzymes that facilitate fiber separation from stems.
- Determine the structure and properties of plant microfibrils and polysaccharides, characterize molecular interactions of these materials with polyesters, fibers, polyamides, and minerals, and develop technologies for efficient and sustainable extraction and modification of these materials to create new biobased industrial products, such as building and packaging foams, nanocomposites, molded articles, films, and adhesives.
- Develop processes to improve conversion of hides into leather and develop chemoenzymatic approaches to add value to proteinaceous rendering byproducts.

- Create selective membrane barriers for separation of ethanol and water and develop models to improve separation strategies.
- Develop improved processes for separating carbohydrate, protein and oil fractions from corn, soybean, and rice that are environmentally acceptable, cost effective, and have improved value-added properties.
- Develop separation and purification processes to enhance the utilization of oilseed products with minimum undesirable environmental impact.

Cooperative State Research Education and Extension Service – Biological and thermo/chemical conversion of oils, starches, protein and lignocellulosic residues into fuels, chemical and end-products; examples include chemical conversion of vegetable oils into biodiesel and industrial lubricants, chemical and enzymatic modification of starches for novel products, metabolic engineering to optimize fermentation of sugars to produce ethanol and chemicals, developing formulations for paints, coatings, functional fluids and greases from corn, soybeans, castor and lesquerella; processing and utilization of fibers from hesperaloe, kenaf; wood processing, characterization and improvement in wood and fiber quality, and optimizing conversion of wood-based materials into primary and value-added products.

Forest Service

- Explores the environmental benefits of conversion technologies for woody biomass to energy – FPL
- Looks at economic benefits and improved operating systems, including forest biomass gasification, to produce energy – FPL
- Develops improved enzymatic conversion technologies to produce liquid fuels from woody biomass – FPL
- Develops more effective bioconversion of wood residues into fuels and chemicals – FPL.

Natural Resources Conservation Service – Project to break down dairy manure liquid to component parts and collect and store hydrogen for further utilization.

Rural Development – Rural Development provides funding through grants to farmers to save energy or produce renewable energy on their farms. The 9006 Renewable Energy Program, a non-research program, focuses on improving the net energy balance on farms. Rural Development also provides funding (non-research) for farmers and farmer-owned businesses to add value to their raw agricultural commodities. Production of bio-energy, while not a specific objective of this program, has been the subject of a growing number of grant awards over the first three years of this program. [Rural Development funding amounts provided are not associated with R&D but relate to actual energy production or savings on farm or business operations.]

7. PRODUCT USES AND DISTRIBUTION

Committee Roadmap Objectives

The Biomass R&D Act of 2000 encourages the development of environmentally sound biobased fuels, chemicals, building materials, electric power or heat. However, there are a number of barriers to the development, distribution, and application of these technologies that will require R&D solutions. Moreover, simply increasing the use of biomass to produce electric power, heat, or other useful products is not the ultimate goal. Ultimately, research should enable a higher level of output of useful fuels, power, and products per ton of biomass inputs.

DOE Project Breakdown: PRODUCT USES AND DISTRIBUTION

- **NBC Gasification** - Gasification Fundamentals Task -- The objective of this project is to ensure that biomass gasification technologies are compatible with the production of fuels and chemicals based on technologies currently available through the petroleum industry to facilitate the development of a vigorous industry based on biorefinery concepts to produce liquid transportation fuels and chemicals from biomass
- **Platform Chemicals From an Oilseed Biorefinery Project**
- **NBC Market Studies/ Analysis for Products Technical and Market Analysis Project** - The primary focus for Products R&D analysis will be to identify barriers and core technologies involved with the production of value-added products.
- **Oils – Tasks:**
 - 1) Renewable Diesel Technology Project
 - 2) Development and Optimization of Novel Biodiesel Production Techniques Project
 - 3) Agricultural Bio-Fueled Generation of Electricity and Development of Durable and Efficient NOx Reduction Project
 - 4) Biodiesel Demonstration in School Buses Project
 - 5) Research in Nebraska on Improved Soybean Oil for Biodiesel Fuel Project
 - 6) Support of Biodiesel Development in Brazil through Southern State Energy Board Project.
- **Oils/ Development of Improved Chemicals & Plastics From Oilseeds Project** – Tasks: 1) Development of Improved Chemicals & Plastics From Oilseeds Project 2) Functionalized Vegetable Oils for Utilization as Polymer Building Blocks Project 3) National Agricultural Based Industrial Lubricants Center Project 4)
- **Switchgrass Demonstration Project** - University of TN - Develop 4 year work plan for project that includes 5 year planting and biooil processing or combustion evaluations.
- **Existing Thermochemical Biorefineries**
- **Biomass Biorefinery for Production of Polymers and Fuel Project** - The project objectives are to create a biorefinery for the production of energy and a new family of biodegradable polymers, polyhydroxyalkanoates (PHAs).
- **Emerging Sugar Biorefineries/ Making Industrial Biorefining Happen Project** - The project is a 5-year commercial scale demonstration designed to prove the viability of black liquor gasification technology in the forest products industry.
- **Integrated Corn Based Biorefinery Project** - DuPont will work in cooperation with DOE in a joint project to develop a new form of biorefinery, the Integrated Corn-Based Bio Refinery (ICBR). The ICBR process will bring new technology to the conversion of corn and stover into fermentable sugars for parallel production of added value chemicals such as 1,3 propanediol and fuel ethanol

- **Existing Sugar Biorefineries/ Separation of Corn Fiber and Conversion to Fuels and Chemicals: Phase II, Pilot-Scale Operation Project** – Tasks: Separation of Corn Fiber and Conversion to Fuels and Chemicals Phase II: Pilot-Scale Operation Project; A Second Generation Dry Mill Biorefinery Project; Corn Dry Mill to Ethanol Plant, Jasper County, IN Project; A New Biorefinery Platform Intermediate Project; Black Belt Bioenergy Demonstration Project/ Objectives: The multidisciplinary project team from the National Corn Growers Association (NCGA), Archer Daniels Midland (ADM), and Pacific Northwest National Laboratory (PNNL) intend to economically derive high-value chemicals and oils from lower value corn fiber.
- **A Second Generation Dry Mill Biorefinery Project** - Broin and Associates, Inc. will work in cooperation with DOE [with the assistance of the National Renewable Energy Laboratory (NREL)], in a joint project to research and develop a dry mill ABiorefinery@ process for enhancing the economics of existing ethanol dry mills by creating additional co-products and increasing ethanol yields.

USDA R&D Focus: PRODUCT USES AND DISTRIBUTION

Agricultural Research Service – Product uses and distribution research emphasizes development of products to provide new uses for agricultural commodities and materials and to provide renewable biobased alternatives to products produced from petroleum and other fossil feedstocks. Activities include:

- Develop plant-based lubricating, hydraulic, and cutting oils.
- Develop, from soybean and other vegetable oils and their fatty acids, products with industrial potential as additives, specialty chemicals, physiologically active substances, and major components of cosmetics, lubricants, plastics, surface coatings, and detergents.
- Improve the combustion characteristics and fuel properties of vegetable and other oils and their derivatives for use as alternative diesel fuels, extenders, and additives for use in compression-ignition engines.
- Develop hybrid electric generation systems that include use of biodiesel and that are independent of utility grids.
- Develop commercially valuable products from corn-to-ethanol byproducts that now form distillers dried grains.
- Develop new uses for cotton, including nonwovens, technical textiles, curing agents for epoxies, water purification devices, isocyanates, and composites.
- Develop probiotic feed additives for enhanced animal production and biocontrol agents for use against significant agricultural pests.
- Develop a superior feed additive phytase to reduce the negative environmental effects of high phosphorus levels in the manure from the poultry and swine industries.
- Develop products with high added-value that make use of unique properties of the constituents of new crops.
- Develop bioabsorbents and other industrial products from pectin.
- Develop activated-carbon products from components of agricultural residues, plant byproducts, and animal biosolids that have commercial value to improve air, water, and soil quality.

Forest Service

- Examines development of high valued products from woody biomass feedstocks –FPL, Princeton, WV; Blacksburg, VA.

- Supports development of standards on the performance of wood and wood fiber products – FPL

Natural Resources Conservation Service – Project to produce ethanol from wide array of agricultural products ranging from cheese whey to wine production waste. Development of bio-oil to use as a wood preservative. Project to modify current technologies to allow biofuels to be used in fuel cell applications.

8. PUBLIC POLICY MEASURES TO SUPPORT BIOMASS DEVELOPMENT

Committee Roadmap Objectives

Objective One – Promote the commercialization of successfully demonstrated environmentally-sound biobased technologies.

Objective Two – Outline the institutional and policy changes needed to remove the barriers to economically sound development of sustainable biomass systems.

Objective Three - Ensure that the biomass technologies developed are environmentally sound and move the country in the direction of sustainable biomass systems.

Objective Four - Enhance opportunities for rural economic development

DOE Project Breakdown: PUBLIC POLICY MEASURES TO SUPPORT BIOMASS DEVELOPMENT

- **HQ/Field Office Integration** – Tasks: HQ Support Contracts and Activities & GO Support Contracts
- **National Laboratory Integration** – Tasks: Management, Strategic Support, Partnership Development, Technical Support to GO/HQ
- **HQ/Field-Managed Analysis** - This project provides funding for the crosscutting analysis activities carried out by PBFA in support of all EERE offices including OBP. This includes development and consistent use of standardized tools, models, and analysis methods such as National Energy Modeling System (NEMS), MARKet Allocation system (MARKAL), biomass resource and pathway assessments, benefits analyses, deployment evaluations, market characterizations, market penetration assessments, and other special projects.
- **National Laboratory Crosscutting Analysis** - The integrated engineering and analysis team performs crosscutting analysis that benefits multiple Biomass projects and external collaborators, and provides direction and focus to the overall research program by evaluating the technical, economic, and environmental aspects of biomass utilization via integrated pathways.
- **Regional Biomass Energy Program**
- **NBC Sugar Platform Analysis/ Sugar Platform Integration (Analysis)** - Analysis is performed to support the on-going research in the Sugar Platform. Analysis helps to provide direction and focus to the research by evaluating the technical, economic, and environmental aspects of biomass sugar production and conversion. This analysis also supports OBP's goals and feeds into the Multi-Year Analysis Plan (MYAP). Support is given with three classifications of customers in mind:
 - The Sugar Platform researchers within the National Bioenergy Center.
 - Existing and potential industrial partners.
 - Existing and potential partners in other research organizations. Over the next fiscal year, the primary customers will be the researchers within the NBC.
- **Cost-Benefit Analysis of Gasification for Fuels/Chemicals Production at Kraft Pulp Mills**
- **Supply Forecast and Analysis/ Feedstock Supply Chain Analysis Project** - The objectives of this task are to provide credible, transparent, industry-accessible estimates and

interpretations of current and future feedstock supplies (quantities, physical characteristics, costs, and geographic distribution) from agricultural residues, forest residues, energy crops, urban wood wastes, industrial wastes, and animal wastes.

- **Metabolic Engineering Working Group** – This project is an Interagency Solicitation which
- **Outreach** – Tasks: Communications, NBC Communications, OBP Communications, Buy Bio Initiative Task
- **Education** – Tasks: University Curriculum Development, Education Initiative – Mobile Learning Lab, Biomass Research Initiative for Student Advancement (BRISA), Biomass Rapid Analysis Network (BRAN)
- **Partnerships** – Tasks: State and Regional Partnerships, Small Business Innovative Research (SBIR) Program– Phase I Grants, Small Business Technology Transfer (STTR), State Technologies Advancement Collaborative (STAC) Program, State Energy Program (SEP)

USDA R&D Focus: PUBLIC POLICY MEASURES TO SUPPORT BIOMASS DEVELOPMENT

Cooperative State Research Education and Extension Service – CSREES collaborates with the Office of Energy Policy and New Uses to administer the Biodiesel Fuel Education Program to educate government fleets and the public about the benefits and technical issues related to using biodiesel.

Farm Service Agency – The Bioenergy Program reimburses participating bioenergy (commercial fuel grade ethanol and commercial biodiesel) producers for part of their costs of eligible commodities used in bioenergy production.

Forest Service

- Enhances the economic opportunities for rural communities – FPL; Portland, OR; Princeton, WV.
- Promotes commercialization of successfully demonstrated environmentally sound biobased technologies for short-rotation woody crop with focus on market pull strategies – FPL; New Orleans, LA

Natural Resources Conservation Service – Project to look at economics of small scale and local issues for technology transfer. Other projects in this category deal with training and outreach to the forest industry.

Office of the Chief Economist – The Office of the Chief Economist (OCE) advises the Secretary of Agriculture on the economic implications of Department policies, programs and proposed legislation; to ensure the public has consistent, objective and reliable agricultural forecasts; and to promote effective and efficient rules governing Departmental programs. Under energy policy activities the OCE operated a Biodiesel Education Program and a Federal Biobased Products Preferred Procurement Program, both of which were authorized in the Farm Security and Rural Investment Act (FSRIA) of 2002. The Federal Biobased Products Preferred Procurement Program (FB4P) was authorized in Section 9002 of FSRIA. This program provides for preferred procurement of biobased products by Federal agencies when the products fall within the definition of generic groupings of products designated by rule making. Federal agencies are required to buy the biobased products that fall under designated groupings, unless the products are not reasonably available, fail to meet the reasonable performance standards of the procuring agency, or are available only at an unreasonable price. The act also provides for a voluntary labeling program under which products that meet USDA

determined rules can use a biobased logo and the wording “U.S.D.A. Certified Biobased Product.” Finally, the Act provides for \$1 million of the funds of the Commodity Credit Corporation for each of the FYs 2002 through 2007 to support testing of biobased products to carry out Section 9002.

The Office of Energy Policy and New Uses (OEPNU) transferred FY 2004 funding of \$1 million to the Department of Agriculture’s Cooperative State Research, Education, and Extension Service (CSREES) to fund the Biodiesel Fuel Education Program authorized by Section 9004 of FSRIA. The Act required the Secretary of Agriculture to make competitive grants to eligible entities to educate governmental and private entities that operate vehicle fleets, other interested entities, and the public about the benefits of biodiesel fuel use. The National Biodiesel Board and the University of Idaho were awarded the grants in FY 2003 and FY 2004.

Rural Development – Rural Development provides funding through grants to farmers to save energy or produce renewable energy on their farms. The 9006 Renewable Energy Program, a non-research program, focuses on improving the net energy balance on farms. Rural Development also provides funding (non-research) for farmers and farmer-owned businesses to add value to their raw agricultural commodities. Production of bio-energy, while not a specific objective of this program, has been the subject of a growing number of grant awards over the first three years of this program. [Rural Development funding amounts provided are not associated with R&D but relate to actual energy production or savings on farm or business operations.]

TABLE 1: Funding in Feedstock Production Roadmap Category¹

Roadmap Subcategory	FY03				FY04				FY05 (estimated)				Total FY03-05	
	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE-USDA	%
A. Biotechnology and Plant Physiology	\$2,902,173	\$2,078,000	\$4,980,173	32	\$7,483,000	\$6,004,600	\$13,487,600	39	\$3,511,000	\$7,604,600	\$11,115,639	38	\$29,583,412	44
1. Fundamental Structure of Lignocellulosic Materials					\$5,865,000	\$1,703,000	\$7,568,000		\$645,000	\$1,703,000	\$2,348,000			
2. Cost-effective Pre-delivery Treatment Processes					\$1,618,000	\$4,101,600	\$5,719,600		\$2,866,000	\$4,101,600	\$6,967,600			
3. Other					\$0	\$200,000	\$200,000		\$0	\$1,800,000	\$1,800,000			
B. Agronomic Practices	\$0	\$4,596,000	\$4,596,000	30	\$0	\$4,969,400	\$4,969,400	15	\$0	\$5,272,200	\$5,272,200	18	\$14,837,600	12
1. Soil Sustainability					\$0	\$417,700	\$417,700		\$0	\$761,300	\$761,300			
2. Other					\$0	\$4,551,700	\$4,551,700		\$0	\$4,510,900	\$4,510,900			
C. Feedstock Handling	\$4,314,407	\$1,689,000	\$6,003,407	39	\$3,021,000	\$12,523,243	\$15,544,243	46	\$3,131,000	\$9,406,200	\$12,537,200	43	\$34,084,850	44
1. Feedstock Density					\$0	\$717,319	\$717,319		\$0	\$0	\$0			
2. Sensors					\$0	\$3,999,724	\$3,999,724		\$0	\$0	\$0			
3. Best Practices for Harvesting Storage					\$2,040,000	\$1,007,100	\$3,047,100		\$3,131,000	\$1,007,100	\$4,138,100			
4. Other					\$981,000	\$6,799,100	\$7,780,100		\$0	\$8,399,100	\$8,399,100			
Total	\$7,216,580	\$8,363,000	\$15,579,580	100	\$10,504,000	\$23,497,243	\$34,001,243	100	\$6,642,000	\$22,283,000	\$28,925,000	100	\$78,505,823	100

¹Note: FY03 funding not collected at the sub-category level.

Figure 1: FEEDSTOCKS – BY DEPARTMENT

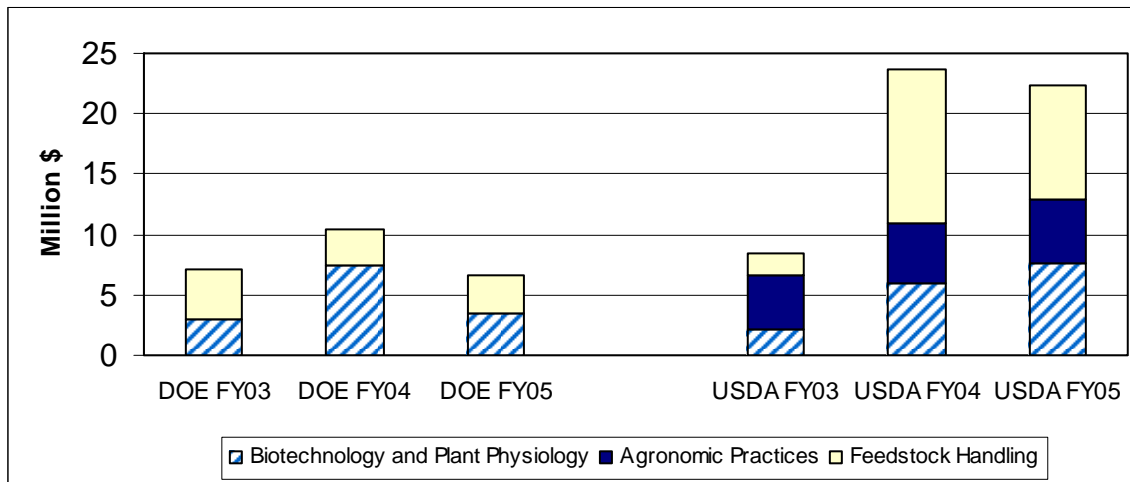


Figure 2: FEEDSTOCKS COMBINED DOE/USDA FUNDING

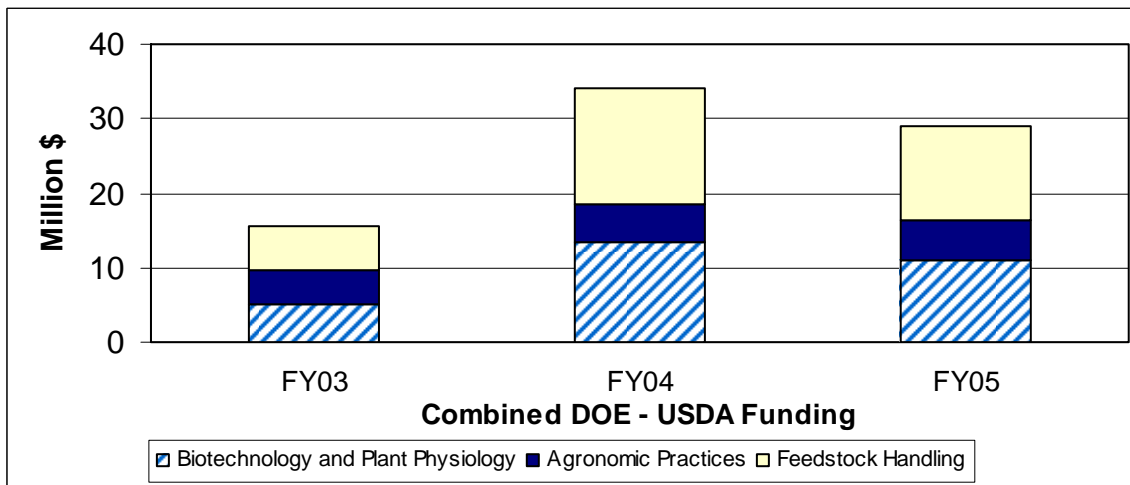


TABLE 2: Funding in Processing and Conversion Roadmap Category

Roadmap Subcategory	FY03				FY04				FY05 (estimated)				Total FY03-05	
	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE-USDA	%
A. Thermo-chem Conv. Pathways	\$24,863,500	\$200,000	\$25,063,500	11	\$31,618,000	\$200,000	\$31,818,011	35	\$2,967,000	\$200,000	\$3,167,000	4	\$60,048,511	13
1. Co-firing					\$2,500,000	\$0	\$2,500,000		\$0	\$0	\$0			
2. Direct Combustion					\$0	\$0	\$0		\$0	\$0	\$0			
3. Biomass Gasification					\$11,243,000 <i>(\$7,758,000)</i>	\$0	\$11,243,000		\$2,600,000	\$0	\$2,600,000			
4. Anaero. Ferm						\$200,000	\$200,000		\$0	\$200,000	\$200,000			
5. Mod. Sys.					\$17,875,000	\$0	\$17,875,000		\$0	\$0	\$0			
6. Other					\$0	\$0	\$0		\$367,000	\$0	\$367,000			
B. Bio-conver.	\$20,464,101	\$141,521,800	\$161,985,901	62	\$20,865,000	\$71,441,462	\$92,306,462	64	\$17,950,000	\$63,013,000	\$80,963,000	96	\$335,255,363	69
1. Phy & Chem Treatment					\$8,235,000	\$1,432,000	\$9,667,000		\$1,400,000	\$695,700	\$2,095,700			
2. Biomass Frac&Sep.Tech					\$0	\$730,600	\$730,600		\$3,762,000	\$626,000	\$4,388,000			
3. Util of Res. Sol. & Liquids					\$0	\$1,884,700	\$1,884,700		\$0	\$1,884,700	\$1,884,700			
4. Chem/Enz Conv. Proc.					\$1,930,000	\$10,333,362	\$12,263,362		\$2,052,000	\$8,439,400	\$10,491,400			
5. Catalytic and Chem. Conv.					\$8,289,000 <i>(\$1,996,000)</i>	\$5,168,700	\$13,457,700		\$1,200,000	\$5,168,700	\$6,368,700			
6. Inhibitory Sub. in Sugar					\$0	\$0	\$0		\$0	\$0	\$0			
7. Separ. & Purification					\$0	\$1,819,700	\$1,819,700		\$0	\$1,819,700	\$1,819,700			
8. Biomass Ferm.&Hydro					\$0	\$2,824,900	\$2,824,900		\$8,133,000	\$2,429,800	\$10,562,800			
9. Syngas Ferm.					\$2,411,000	\$0	\$2,411,000		\$1,403,000	\$0	\$1,403,000			
10. Other		\$77,214,800			\$0	\$47,247,500	\$47,247,500		\$0	\$41,949,000	\$41,949,000			
C. Bioref. Int	\$45,011,650	\$13,909,000	\$58,920,650	27	<i>(\$2,000,000)</i>	\$0	\$2,000,000	1	\$0	\$0	\$0	0	\$60,920,650	14
1. Other					\$0	\$0	\$0		\$0	\$0	\$0			
Total	\$90,339,251	\$155,630,800	\$245,970,051	100	\$54,483,000	\$71,641,462	\$126,124,462	100	\$20,917,000	\$63,213,000	\$84,130,000	100	\$456,224,524	100

Italicized amounts are from Biomass Joint Solicitation \$\$\$.

Figure 3: PROCESSING AND CONVERSION – BY DEPARTMENT

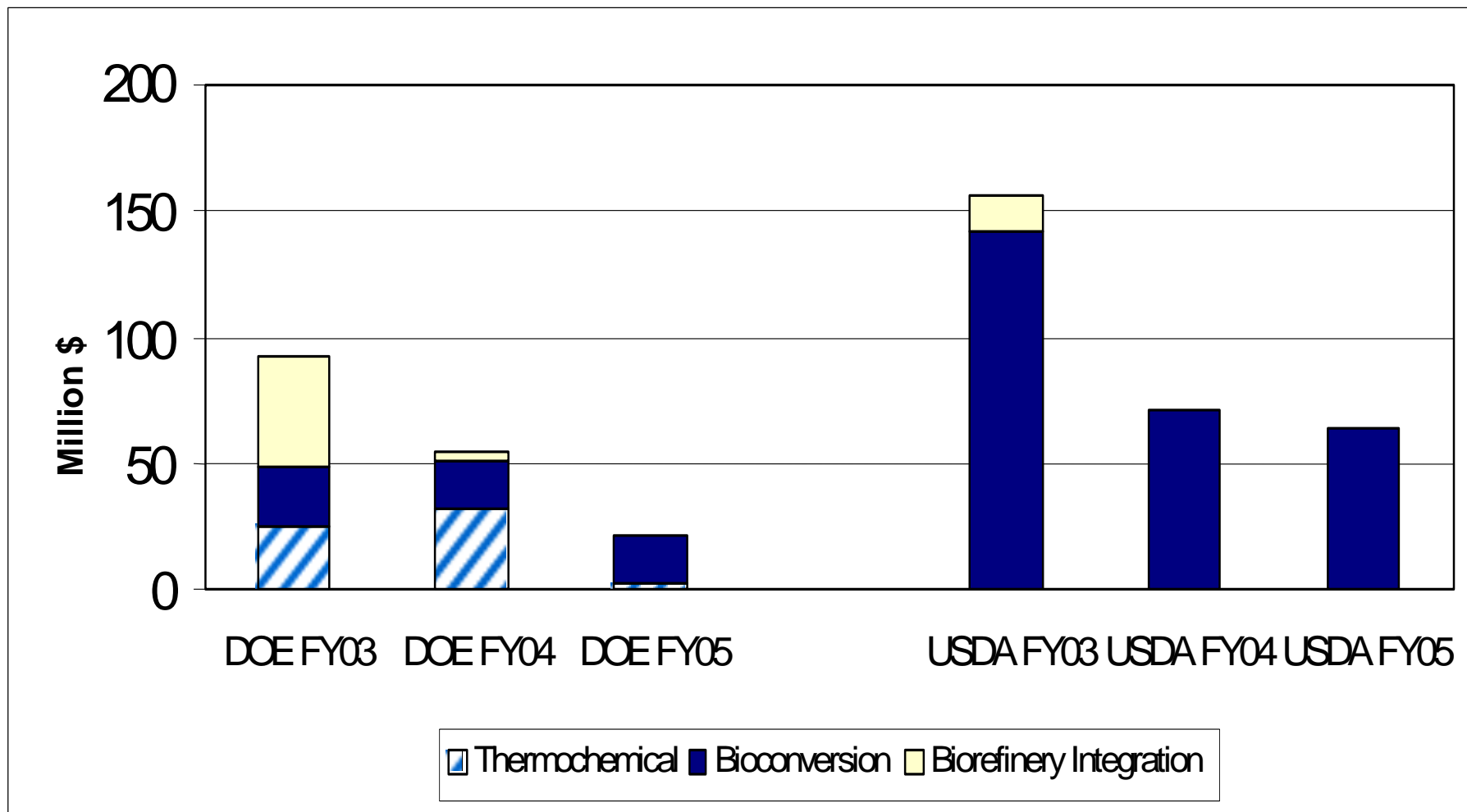


Figure 4: PROCESSING AND CONVERSION - COMBINED FUNDING

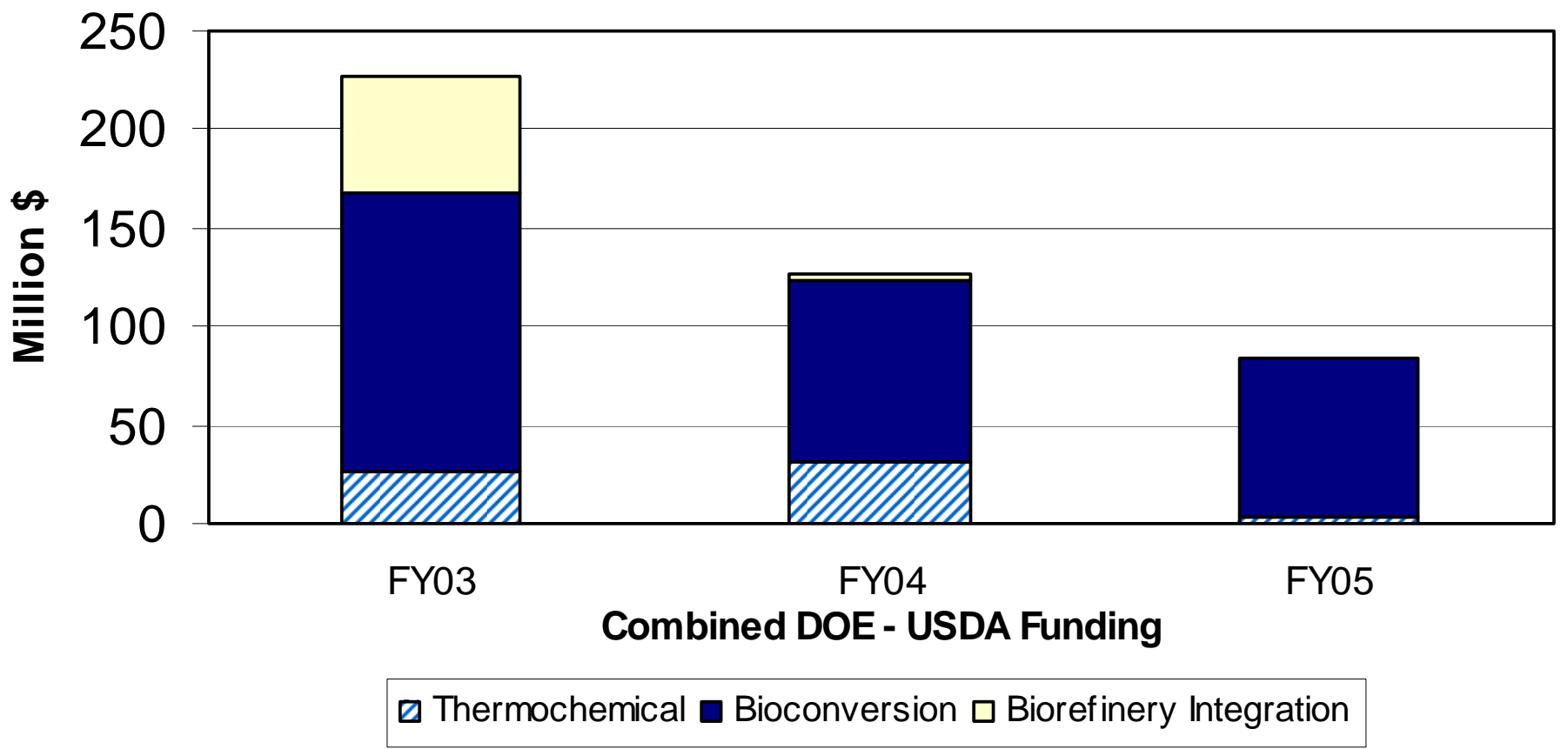


TABLE 3: Funding in Product Uses and Distribution Roadmap Category²

Roadmap Subcategory	FY03				FY04				FY05 (estimated)				Total FY03-05
	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE-USDA
A. End-Products & Distribution Systems	\$3,587,000	\$2,228,000	\$5,815,000	100	\$25,360,000	\$15,365,417	\$40,725,417	100	\$14,218,000	\$15,187,200	\$29,405,200	100	\$75,945,617
1. Biofuels Utilization Research					\$740,000	\$1,268,200	\$2,008,200		\$1,656,000	\$1,281,800	\$2,937,800		
2. Properties of Biofuels					\$5,255,000	\$1,729,961	\$6,984,961		\$0	\$1,751,800	\$1,751,800		
3. Ethanol Distribution in Pipelines					\$0	\$0	\$0		\$0	\$0	\$0		
4. Biorefinery Pilot Plant Demonstration Projects					\$19,365,000	\$2,441,056	\$21,806,056		\$11,089,000	\$2,496,000	\$13,585,000		
5. Gasification					\$0	\$0	\$0		\$0	\$0	\$0		
6. Hydrogen					\$0	\$0	\$0		\$0	\$0	\$0		
7. Standards for Biobased Products					\$0	\$0	\$0		\$0	\$100,000	\$100,000		
8. Other					\$0	\$9,926,200	\$9,926,200		\$1,473,000	\$9,557,600	\$11,030,600		
Total	\$3,587,000	\$2,228,000	\$5,815,000	100	\$25,360,000	\$15,365,417	\$40,725,417	100	\$14,218,000	\$15,187,200	\$29,405,200		\$75,945,617

² DOE does not request funding for policy development activities. FY03 analysis activities that could be used to support policy were listed in this category.

Figure 5: PRODUCT USES AND DISTRIBUTION – BY DEPARTMENT

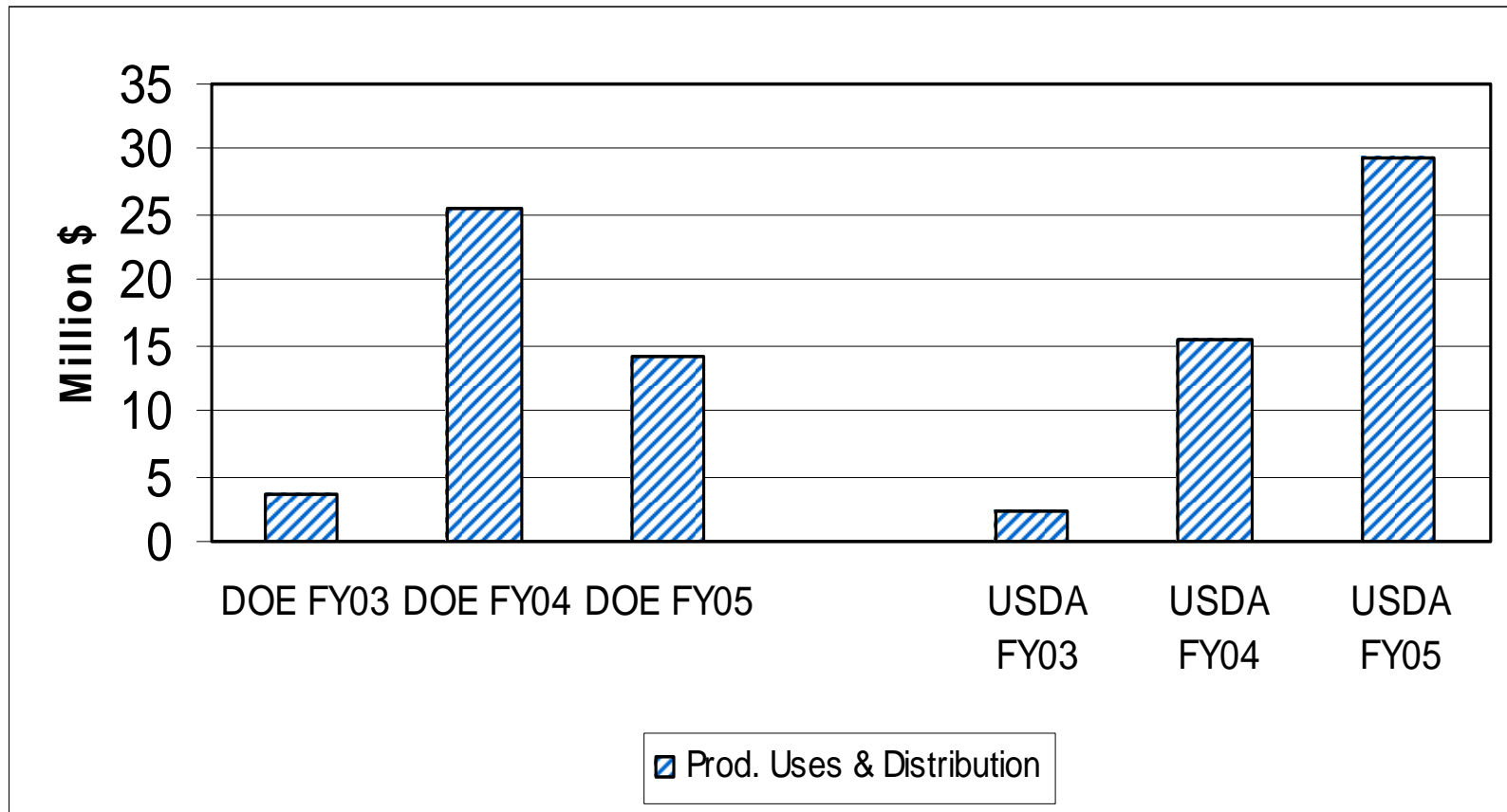


Figure 6: PRODUCT USES AND DISTRIBUTION - COMBINED FUNDING

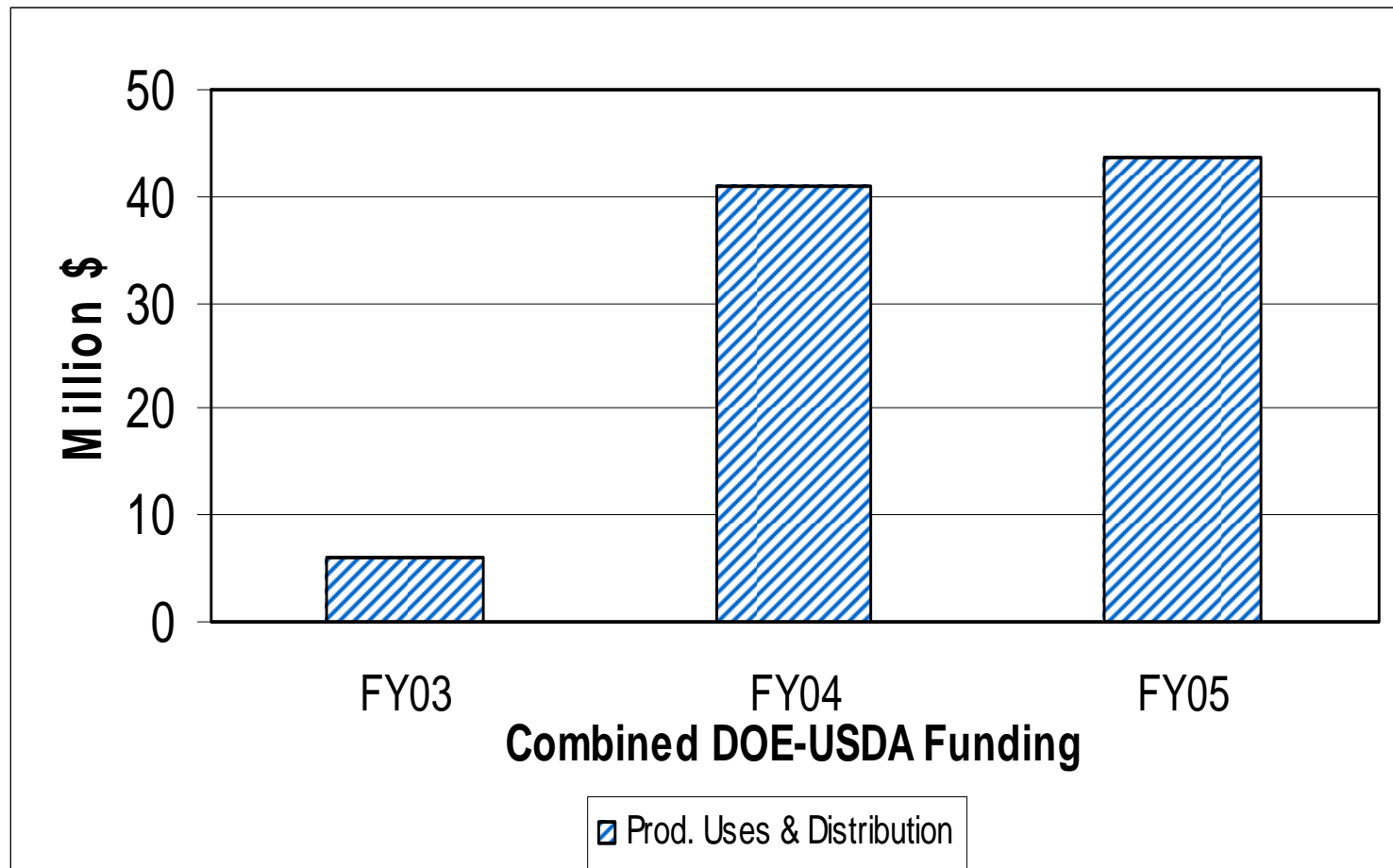


TABLE 4: Funding in Public Policy Measures to Support Biomass Development Roadmap Category³

Roadmap Subcategory	FY03				FY04				FY05 (estimated)				Total FY03-05	
	DOE	USDA	Total	%	DOE	USDA	Total	%	DOE	USDA	Total	%		%
A. Economic Analysis	\$4,514,691	\$250,000	\$4,764,691	15	\$6,363,000	\$700,000	\$7,063,000	4	\$4,300,000	\$687,000	\$4,987,000	4	\$16,814,691	4
B. Life Cycle Assessment	\$0	\$0	\$0	0	\$445,000	\$0	\$445,000	1	\$200,000	\$0	\$200,000	0	\$645,000	0
C. Procurement and Markets	\$100,000	\$250,000	\$350,000	3.1	\$0	\$250,000	\$250,000	0	\$0	\$250,000	\$250,000	0	\$850,000	0
D. Regulatory Measures	\$0	\$1,000,000	\$1,000,000	0	\$0	\$1,169,000	\$1,169,000	0	\$500,000	\$2,969,000	\$3,469,000	3	\$5,638,000	1.2
E. Incentives	\$0	\$147,211,000	\$147,211,000	68	\$0	\$150,000,000	\$150,000,000	91	\$0	\$100,000,000	\$100,000,000	84	\$397,211,000	90
F. Biomass Resource Supply	\$0	\$0	\$0	0	\$0	\$241,933	\$241,933	0	\$0	\$7,889,000	\$7,889,000	7	\$8,130,933	2
G. Education and Outreach	\$3,865,000	\$1,000,000	\$4,865,000	14	\$1,556,000	\$3,397,711	\$4,953,711	3	\$0	\$2,200,000	\$2,200,000	2	\$12,018,711	3
H. R&D Investment	\$0	\$0	\$0	0	\$2,223,000	\$0	\$2,223,000	1	\$0	\$0	\$0	0	\$2,223,000	
Total	\$8,479,691	\$149,711,000	\$158,190,691	100	\$10,587,000	\$155,758,644	\$166,345,644	100	\$5,000,000	\$113,995,000	\$118,995,000	100	\$443,531,335	100

³DOE does not request funding for policy development activities. Funding estimates in Table 4 represent analysis activities that could be used to support policy were listed in this category. *Italicized amounts are from Biomass Joint Solicitation \$\$\$.*

Figure 7: PUBLIC POLICY - DOE

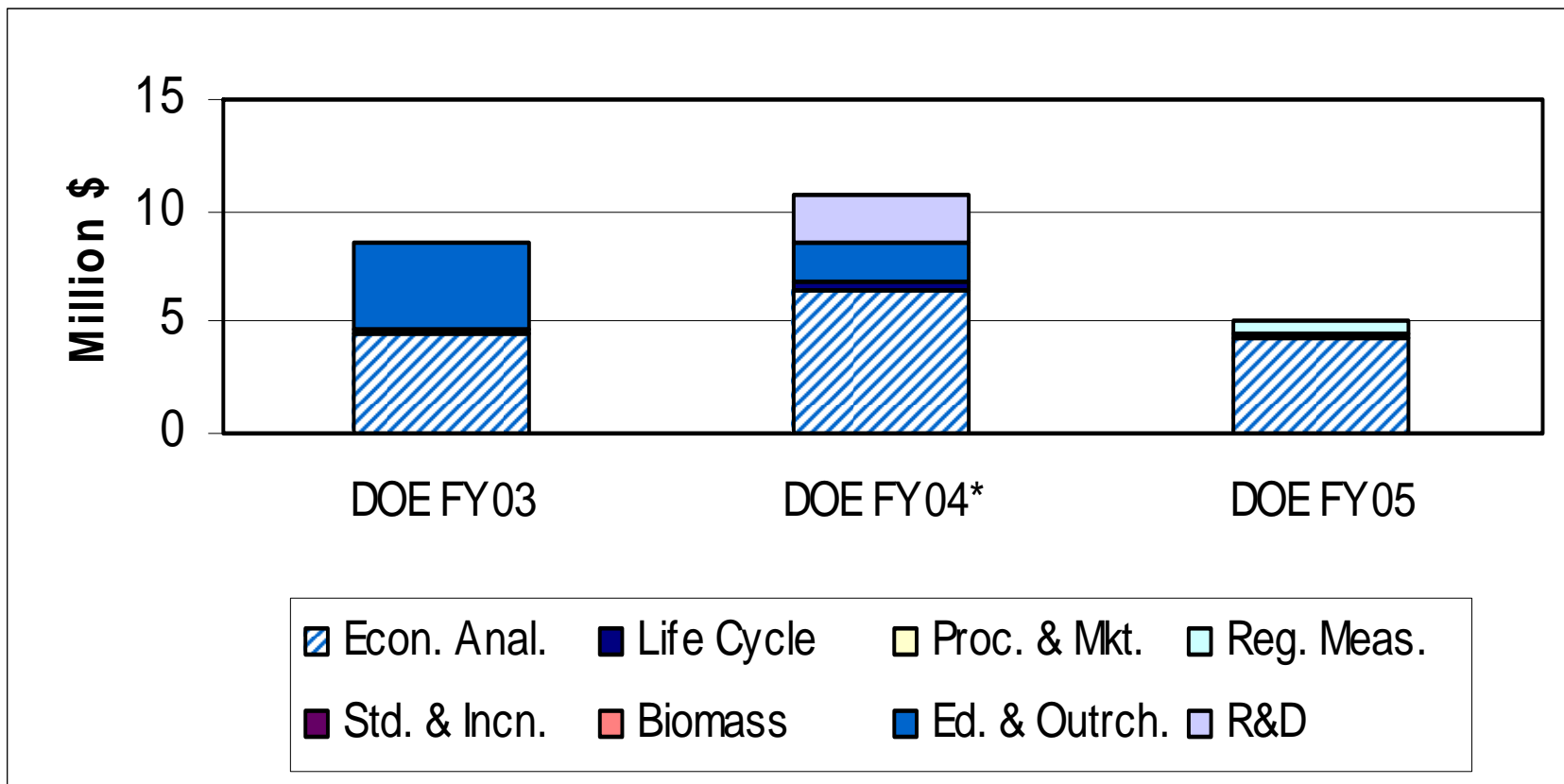


Figure 8: PUBLIC POLICY - USDA

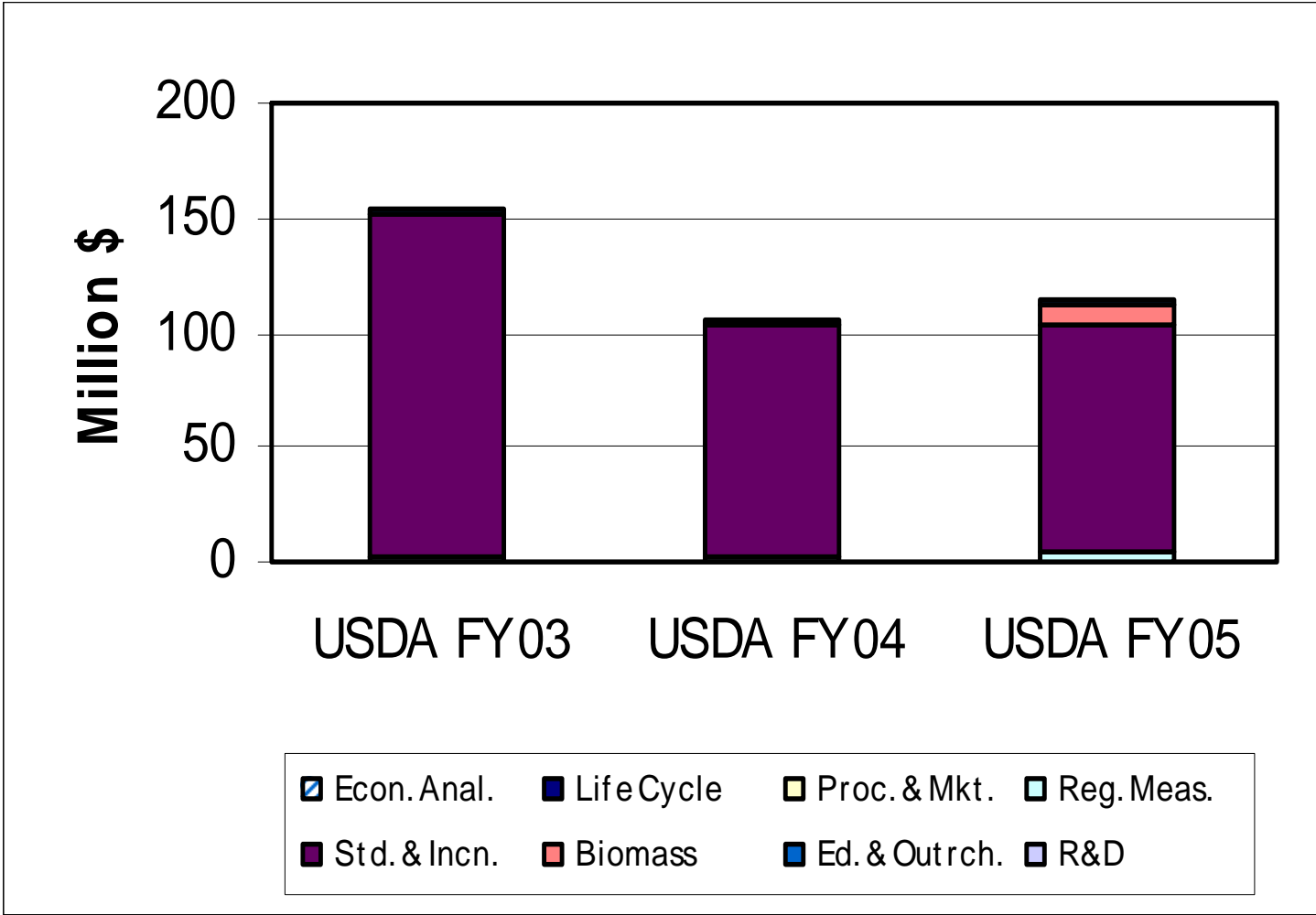


Figure 9: PUBLIC POLICY – COMBINED FUNDING

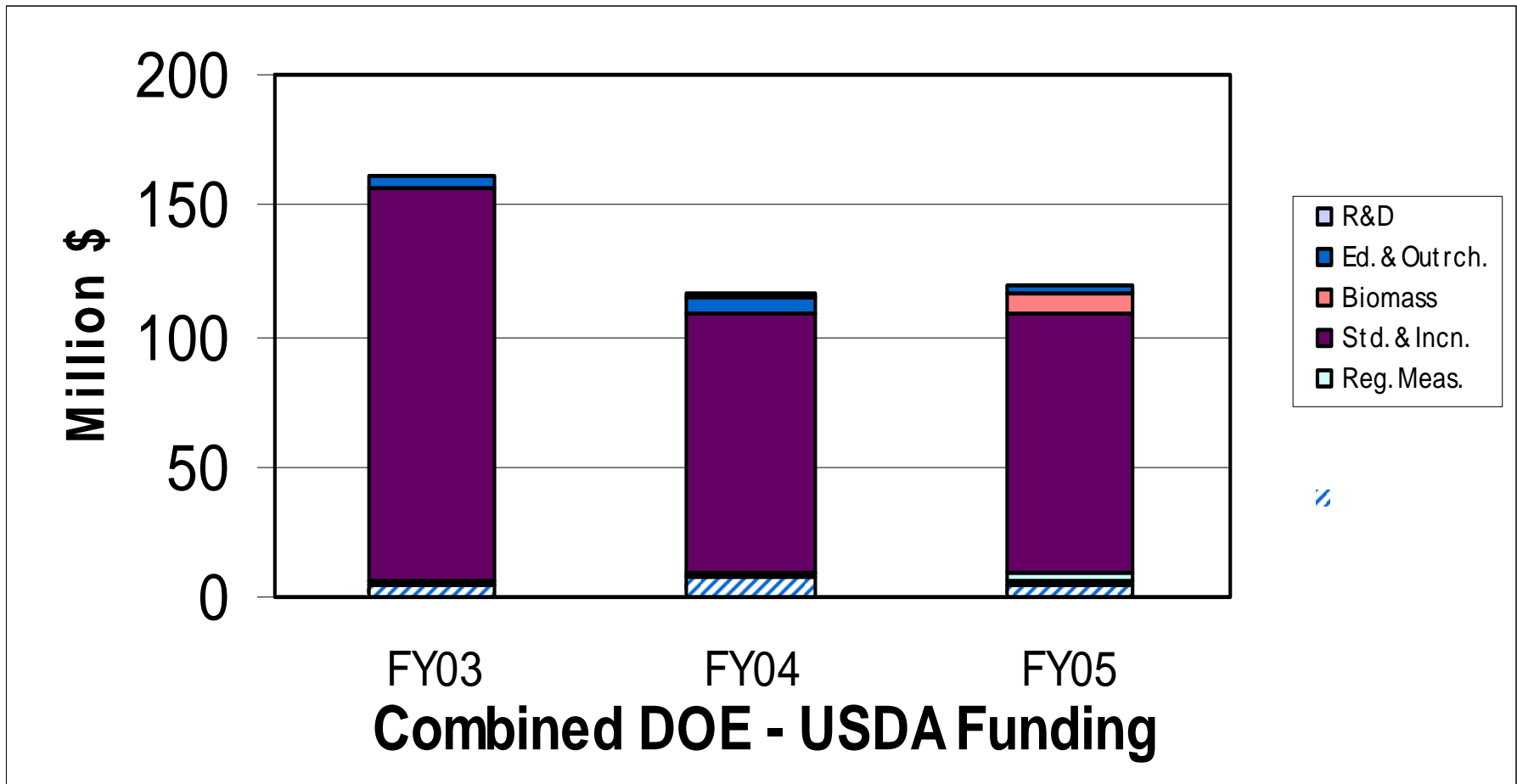


TABLE 5: TOTAL FUNDING BY ROADMAP CATEGORY FY03 - FY05

ROADMAP CATEGORY	DOE				USDA				TOTAL Budget (K\$)	%
	Final FY03 Budget (K\$)	Final FY04 Budget (K\$)	Final FY05 est. Budget (K\$)	DOE FY03-05 Budget (K\$)	Final FY03 Budget (K\$)	Final FY04 Budget (K\$)	Final FY05 est. Budget (K\$)	USDA FY03-05 Budget (K\$)		
TOTAL	\$130,260	\$101,204	\$81,277	\$312,741	\$318,221	\$267,265	\$215,779	\$801,265	\$1,114,006	100
I. FEEDSTOCK PRODUCTION	\$7,216	\$10,504	\$6,642	\$24,362	\$8,363	\$23,498	\$22,283	\$54,144	\$78,506	7
II. PROCESSING AND CONVERSION	\$90,340	\$54,483	\$20,917	\$165,740	\$155,631	\$71,643	\$63,214	\$290,488	\$456,228	41
III. PRODUCT USES AND DISTRIBUTION	\$3,587	\$25,630	\$14,218	\$43,435	\$2,228	\$15,365	\$15,187	\$32,780	\$76,215	7
IV. PUBLIC POLICY MEASURES TO SUPPORT BIOMASS DEVELOPMENT	\$8,479	\$10,587	\$5,000	\$24,066	\$149,711	\$155,759	\$113,995	\$419,465	\$443,531	40
I. OTHER	\$20,638	\$0	\$34,500	\$55,138	\$2,288	\$1,000	\$1,100	\$4,388	\$59,526	5

Figure 10

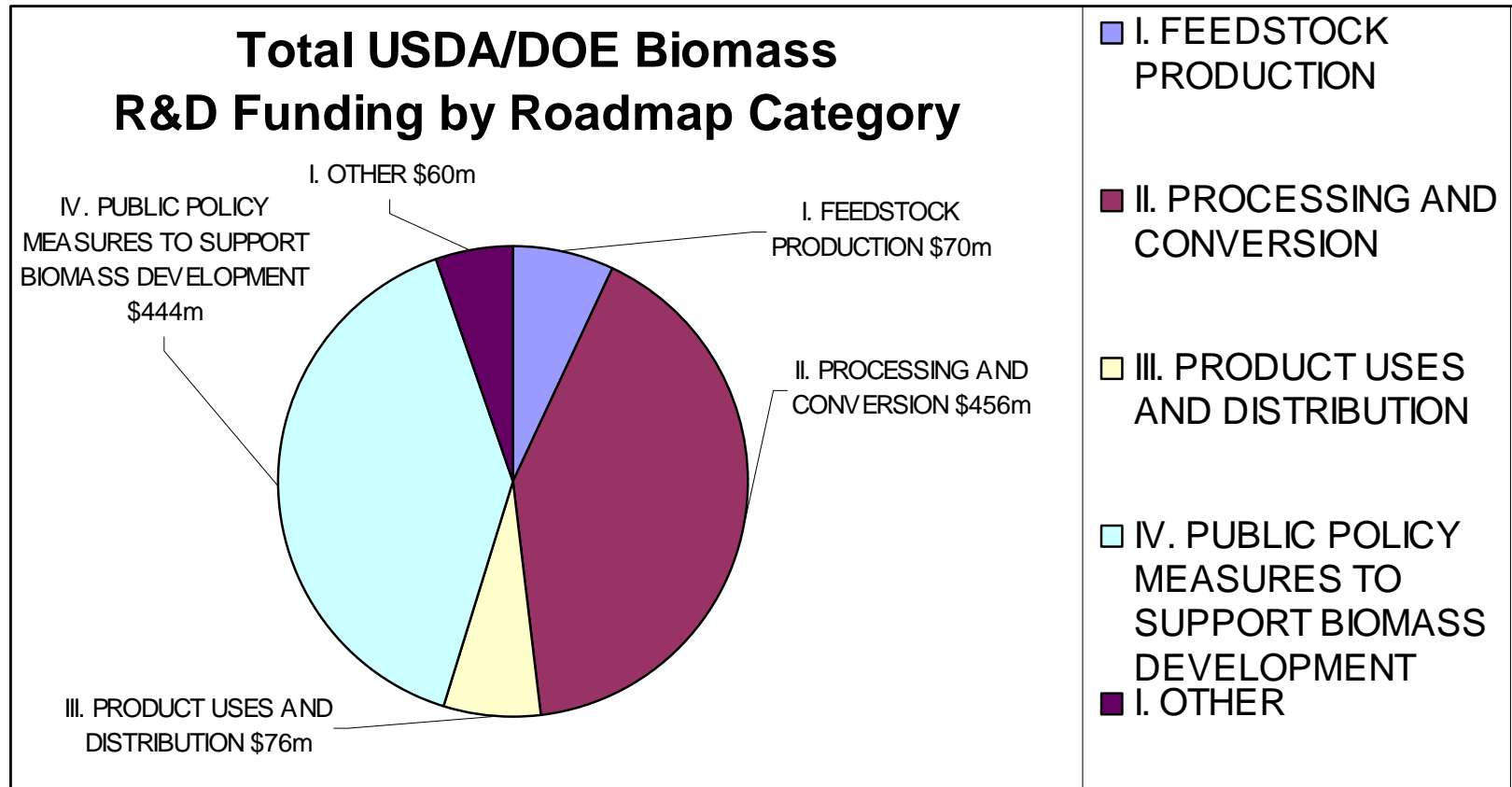


Figure 11: Roadmap Categories

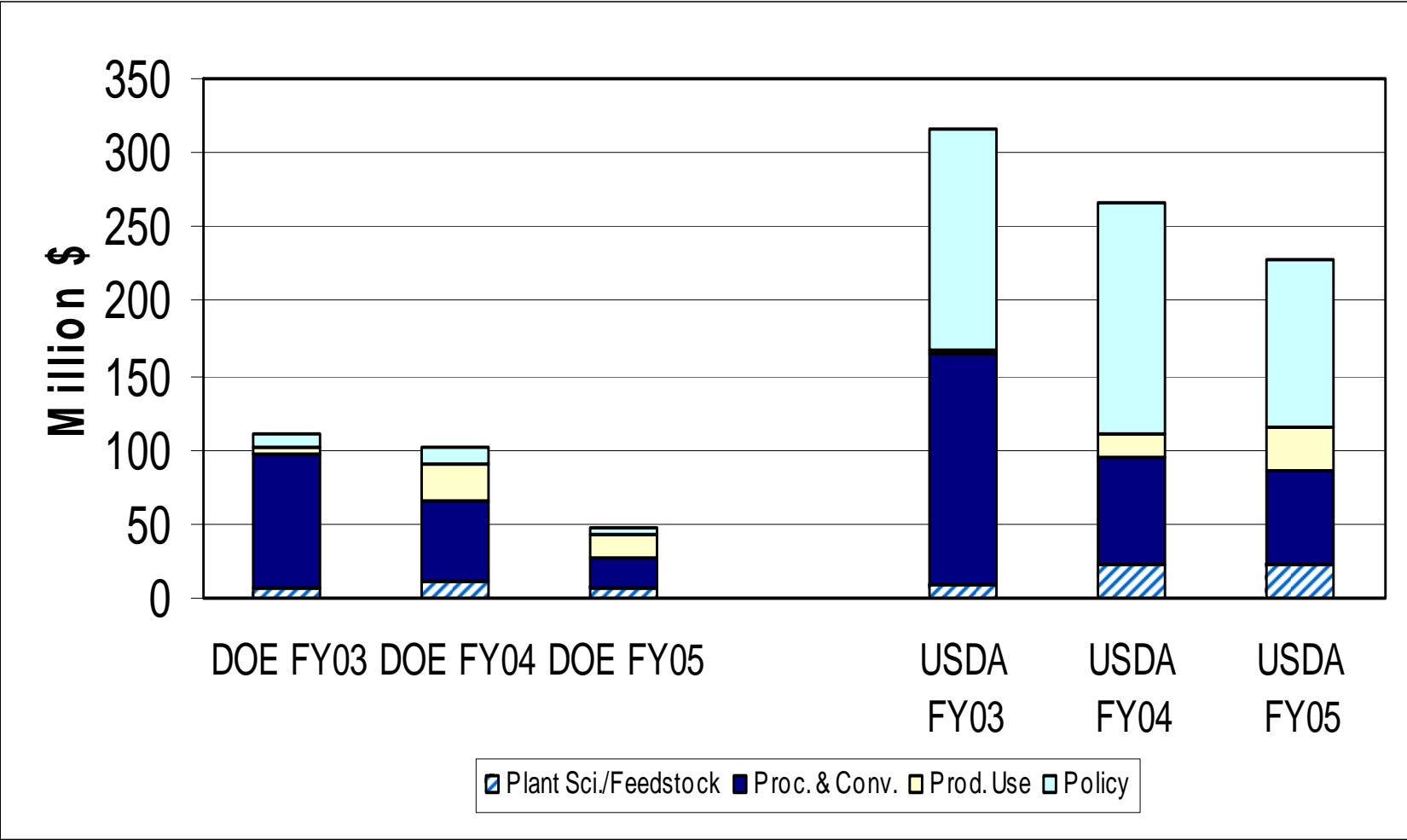


Figure 12: Roadmap Categories – Combined Funding

