

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Bioenergy Technologies Office Multi-Year Program Plan

June 13, 2016

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NREL-Biomass Systems
Integration Lead

2016 Multi-Year Program Plan Update

Agenda

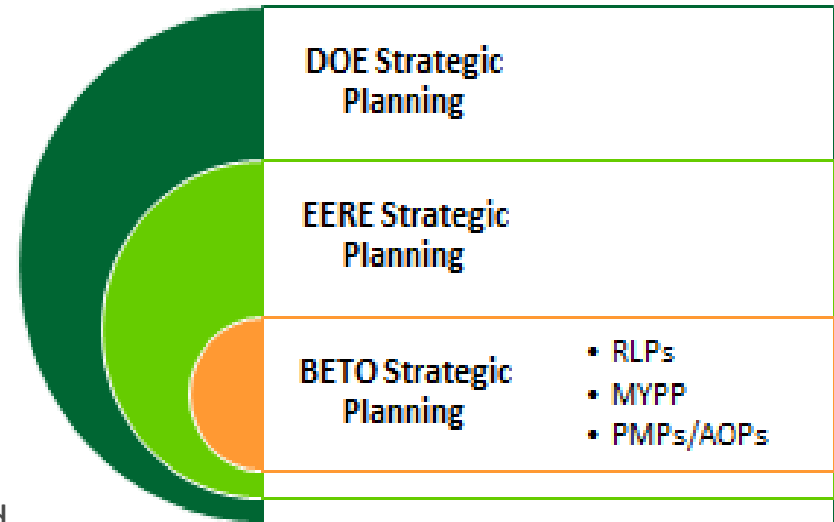
- Planning Overview
- BETO Multi-year Program Plan
 - Latest Update
 - Overview
- Future Direction

Planning - Overview

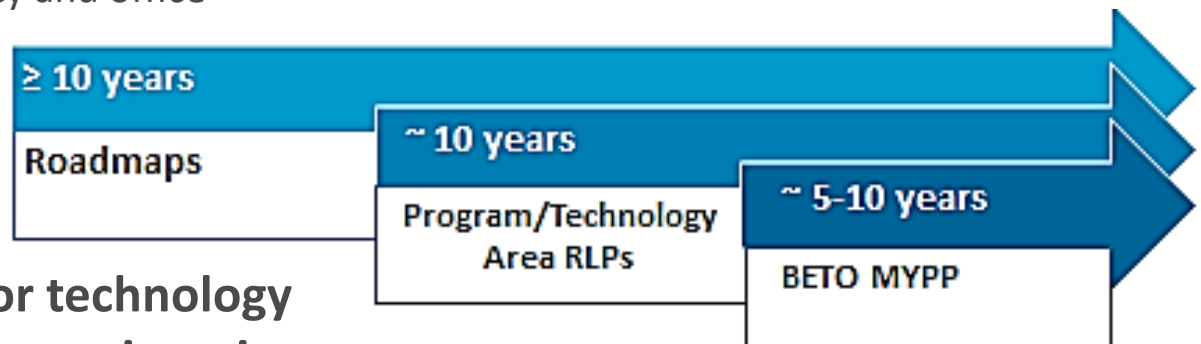
Continuous process

Purpose

- Align Office with EERE/DOE/Federal goals
- Align objectives and activities across multiple stakeholders and interests
- Align Office activities from project level to multi-year goal horizons
- Track progress and integrate learning
- Document goals, current state of technology, and strategic plans
- Focus stakeholder interactions
- Frame inter- and intra-agency and office collaborations/discussions
- Inform budget processes



Based on best practices for technology R&D planning and systems engineering



BETO Strategic Plan Linkages and Alignment



BETO Multi Year Program Plan (MYPP)

Purpose

- Articulate BETO's mission and goals to internal and external stakeholders
- Provide budget request justification
 - Explain how pieces fit together and build to long term goals
- Operational guide
 - To help the Office manage and coordinate its activities
 - Working / living document
- Frame a 5-10 year planning horizon (2022 goals and beyond)
 - Office goals
 - Program plans
 - Integrated across programs
 - Regular updates



Available at:

<http://www.energy.gov/eere/bioenergy/downloads/bioenergy-technologies-office-multi-year-program-plan-march-2016>

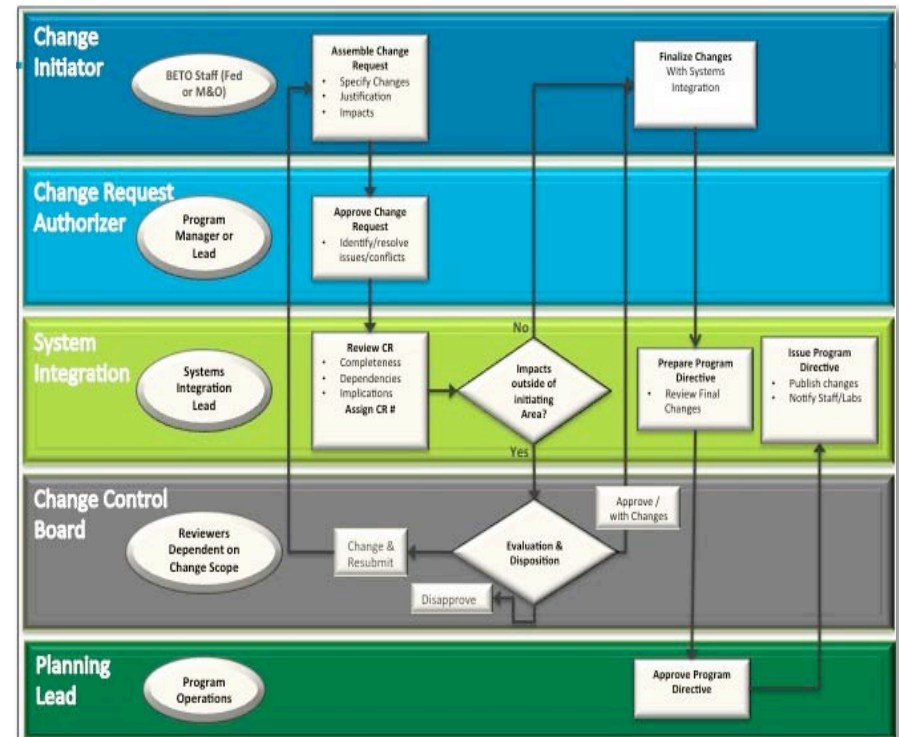
MYPP Updates

Purpose of Annual Updates

- Update strategic priorities and integrate learning
- Help members of bioenergy community understand how they fit within the big picture
- Set clear public goals and track progress over time
- Control public information about goals and accomplishments

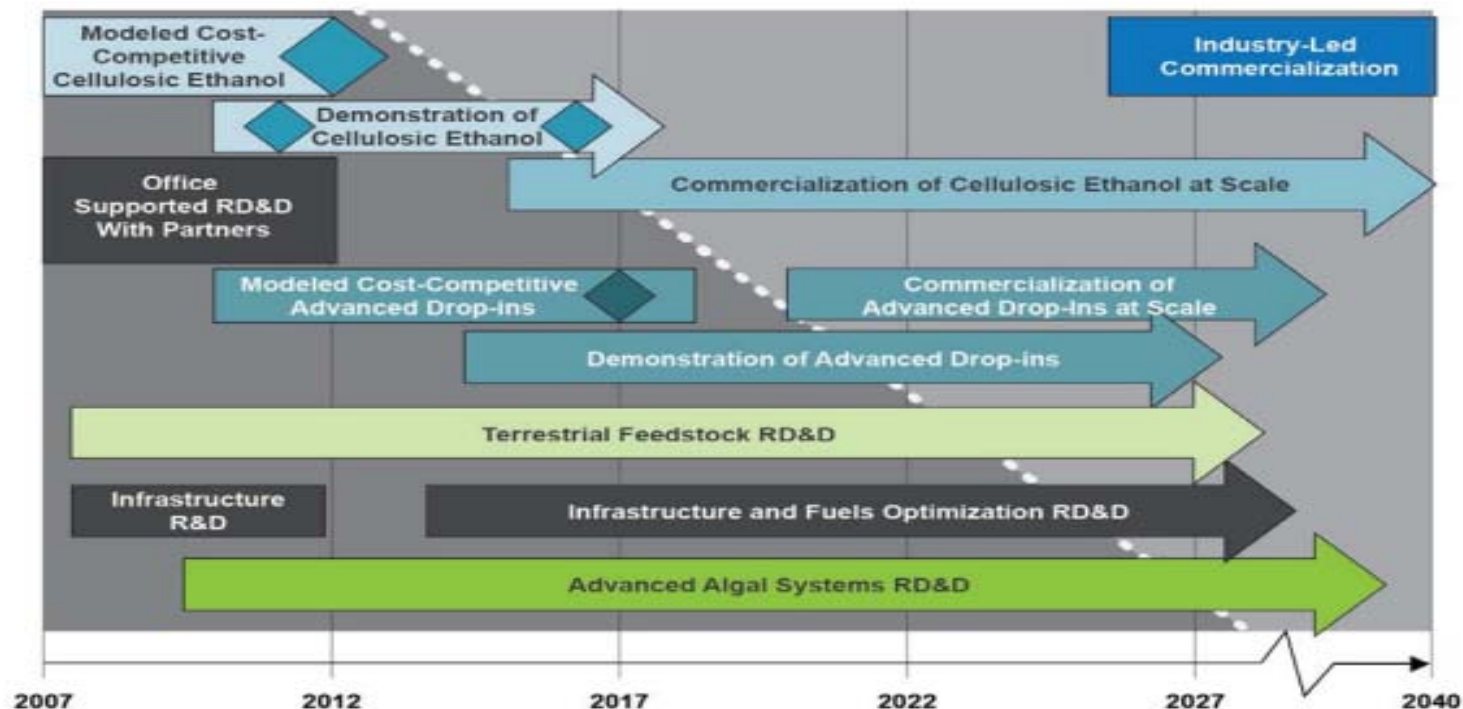
Change Control Process

- Process for initiating, reviewing, and approving changes
- Controls content, versions, and information distribution
- Ensures everyone is working from the same version
- Maintains integrity of MYPP



Objectives for 2015 & 2016 MYPP Updates

- Incorporate new BETO Vision and Mission
- Expand technology focus for attainment of cellulosic hydrocarbon biofuels goals
- Expand investigation into wet waste-to-energy pathways
- Better quantify algae production targets
- Update targets and milestones for demonstration at scale to reflect updated strategy
- Incorporate R&D results for current state of technology progress toward R&D goals



BETO Vision, Mission, and Goals

Vision:

A thriving and sustainable bioeconomy fueled by innovative technologies



Mission:

Developing and demonstrating transformative and revolutionary bioenergy technologies for a sustainable nation



Strategic Goal:

Develop commercially viable bioenergy and bioproduct technologies to enable sustainable, nationwide production of biofuels that are compatible with today's transportation infrastructure, can reduce GHG emissions relative to petroleum-derived fuels, and can displace a share of petroleum-derived fuels to reduce U.S. dependence on foreign oil; and Encourage the creation of a new domestic bioenergy and bioproduct industry

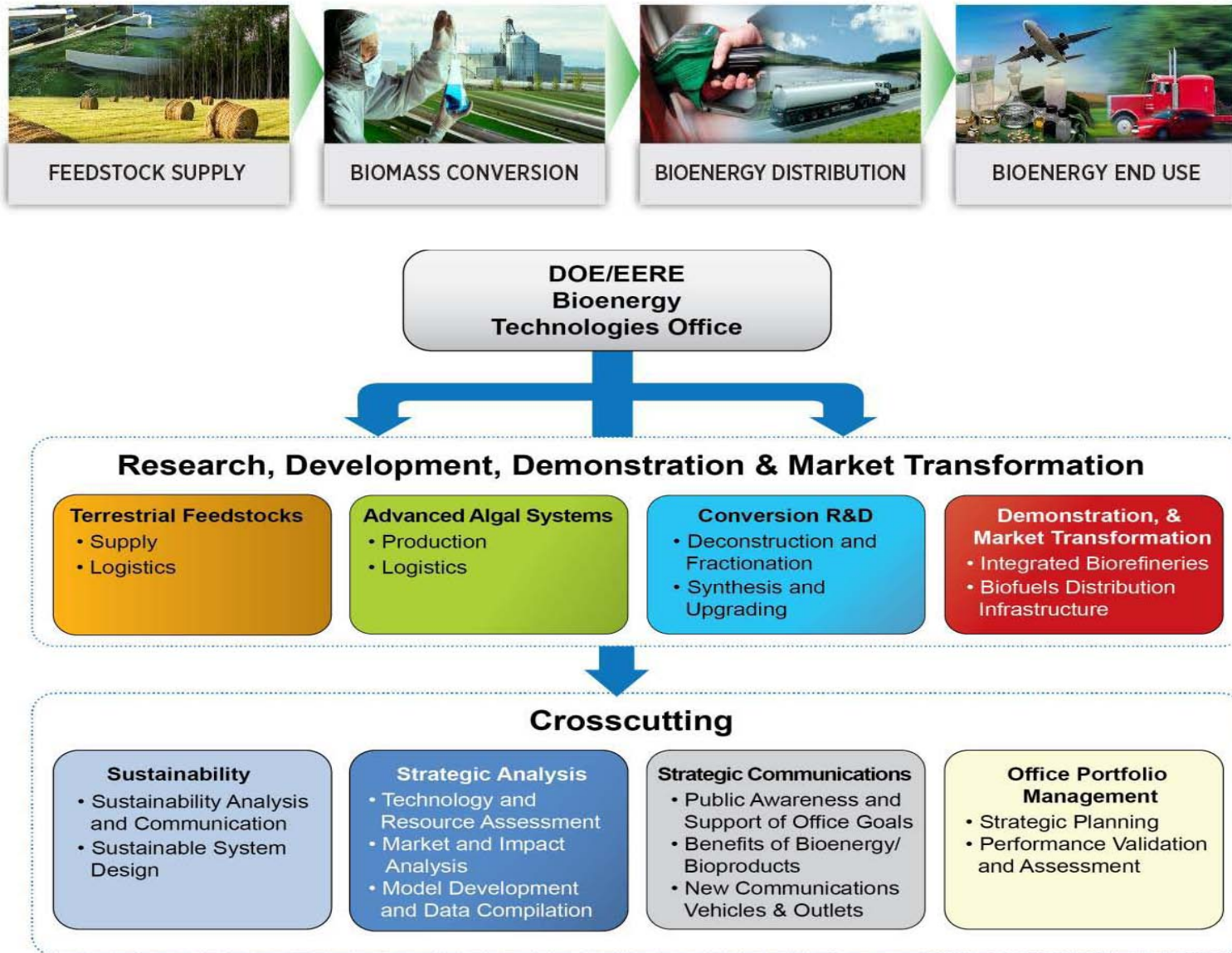


Performance Goal:

By 2017 validate at least one hydrocarbon biofuel pathway at \$3/GGE* with $\geq 50\%$ reduction in GHG emissions

By 2022, validate hydrocarbon biofuels production from at least two additional technology pathways at pilot or demonstration scale.

Organized Around Biomass-to-Bioenergy Supply Chain



Terrestrial Feedstocks Supply & Logistics R&D

Goals:

- By 2017, validate efficient, low-cost, and sustainable feedstock supply and logistics systems that can deliver feedstock to the conversion reactor throat at required conversion process in-feed specifications, at or below \$84/dry ton (2014\$)
- By 2017 establish geographic, economic, quality, and environmental criteria under which the industry could operate at 245 million dry ton per year scale
- By 2022 develop and validate feedstock supply and logistics systems that can economically and sustainably supply 285 million dry tons per year at a delivered cost of \$84/dry ton (2014\$) to support a biorefining industry utilizing a diversity of biomass resources

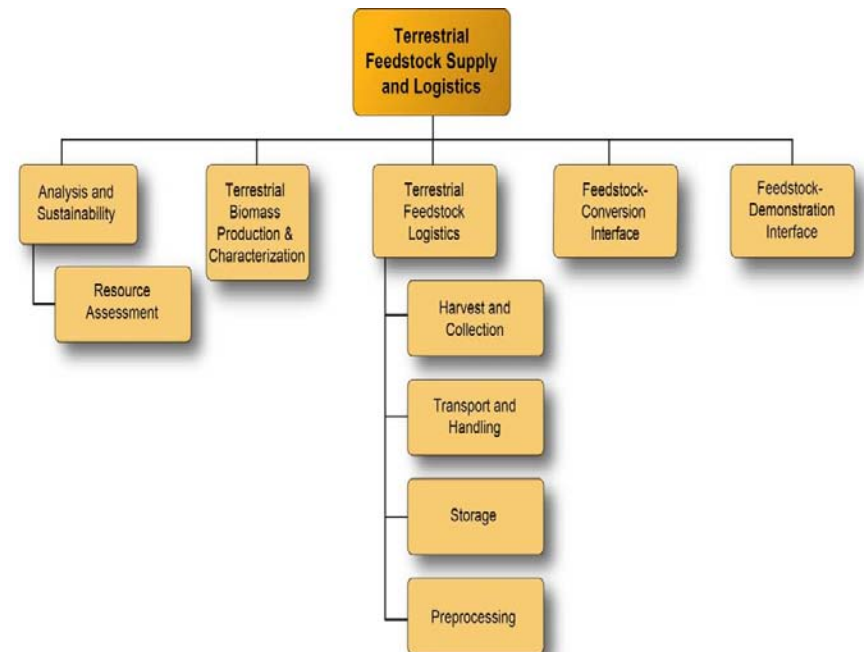


Figure 2-7: Terrestrial feedstock R&D work breakdown structure

Terrestrial Feedstock Supply & Logistics R&D Priorities

- Increase volume of sustainable, acceptable-quality, cost-effective feedstock available by developing advanced supply systems and strategies
- Incorporate sustainability and feedstock supply risk into resource assessments
- Understand range of acceptable physical and chemical in-feed specifications for various conversion technologies
- Develop high-capacity, high-efficiency, low-cost, pilot- or demonstration-scale feedstock supply and logistics systems that deliver stable, dense, flowable, consistent-quality, infrastructure-compatible feedstock.

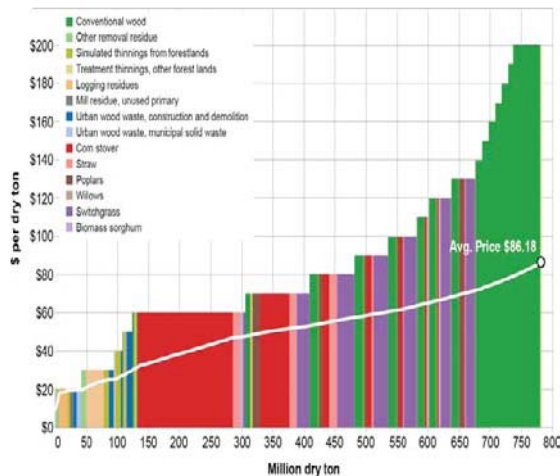


Figure 2-9: Biomass supply projections at marginal prices between \$20 and \$200 per ton in 2022

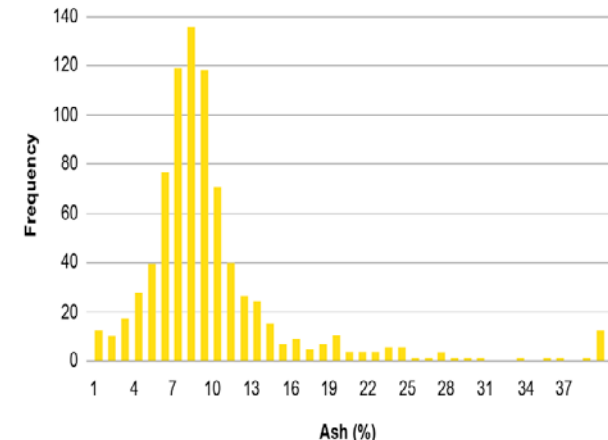


Figure 2-8: Demonstration of the variability in total ash content in corn stover

Terrestrial Feedstocks Supply & Logistics R&D Milestones

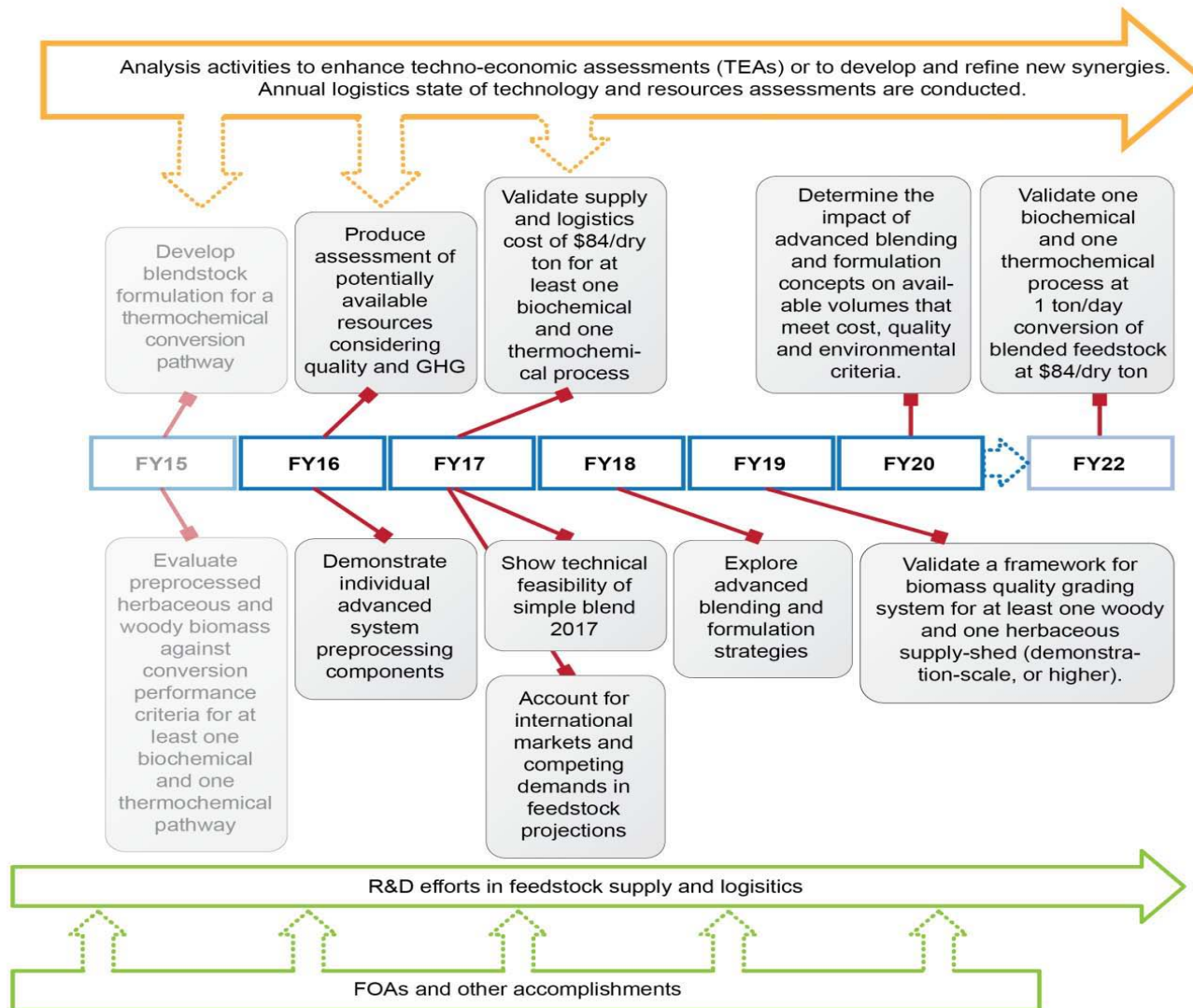


Figure 2-13: Terrestrial feedstock supply and logistics R&D key milestones and activities

Algal Feedstocks R&D

Goals:

- By 2022 demonstrate technologies to produce sustainable algal biofuel intermediate feedstocks that perform reliably in conversion processes to yield renewable diesel, jet, and gasoline fuels in support of the Office's \$3/GGE advanced biofuels goal

Advanced Algal Systems R&D Priorities

- Develop biology and culture management approaches to unlock algal biomass productivity potential and stable cultivation
- Develop low-cost, scalable cultivation systems that maximize reliable annual biomass yield and quality and minimize energy use, water consumption, land use, and nutrient additions
- Develop low-cost, high-throughput harvest technologies that can be integrated with cultivation systems
- Identify critical barriers and evaluate impacts on overall yield to development in biology, cultivation, and processing
- Develop higher-value co-products
- Demonstrate feasible routes and develop rigorous models to decouple the final upgrading of hydrocarbon-based biofuel intermediates to finished fuels and/or blendstocks to take advantage of existing depreciated refining infrastructure.

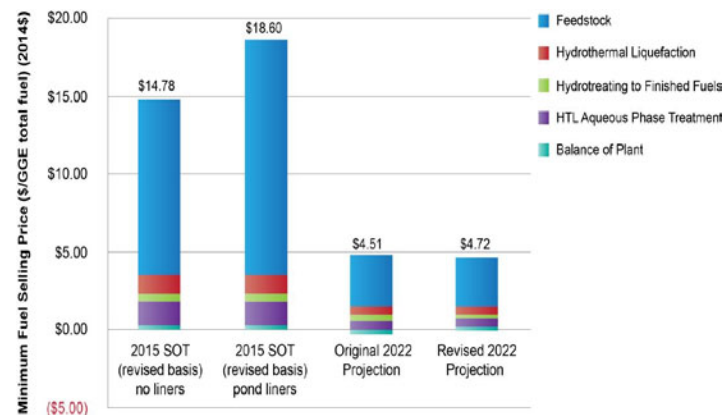


Figure 2-18: Cost contribution by feedstock and conversion process area for HTL Pathway

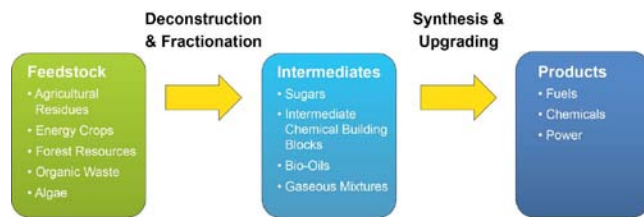
Advanced Algal Systems R&D Milestones

D key milestones and decision points

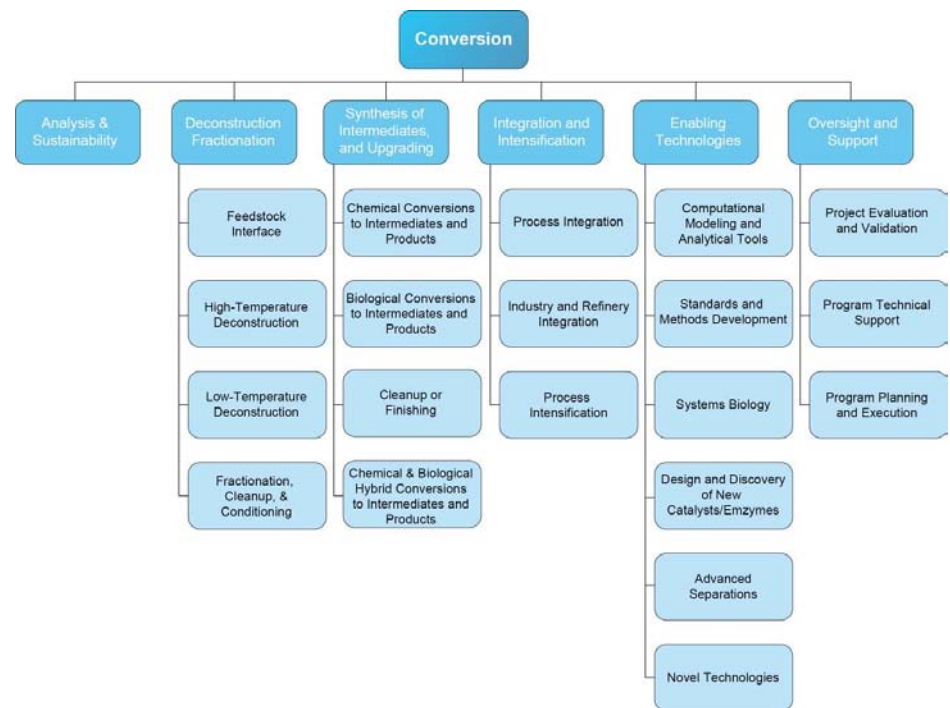
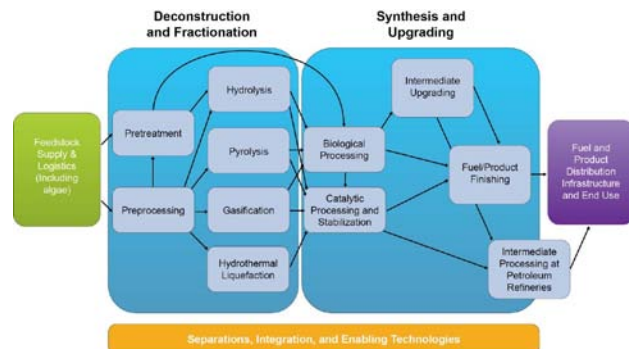
Conversion R&D

Goals:

- By 2017 validate an nth plant modeled minimum fuel selling price of \$3/GGE (2014\$) via a conversion pathway to hydrocarbon biofuel with GHG emissions reduction of 50% or more compared to petroleum-derived fuel
- By 2022, validate an nth plant modeled MFSP of \$3/GGE (2014\$) for two additional conversion pathways to hydrocarbon biofuel with GHG emissions reduction of 50% or more compared to petroleum-derived fuel

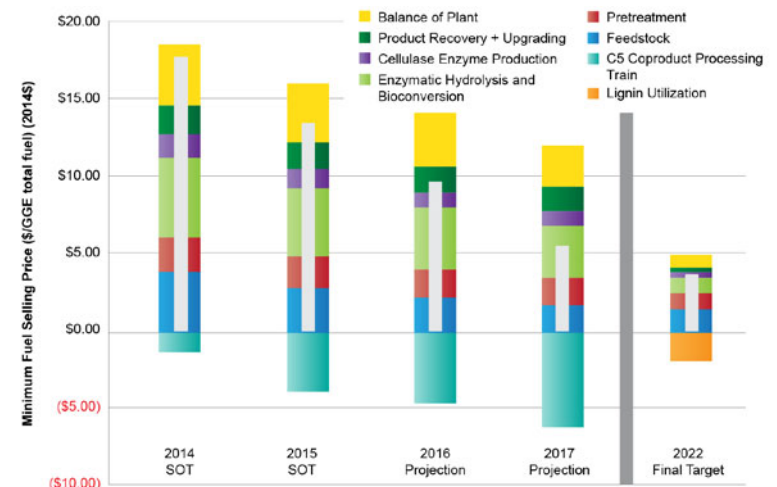
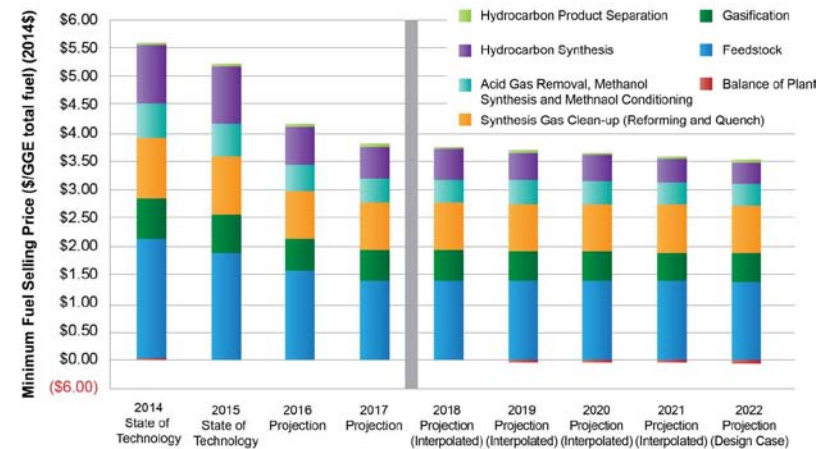


Analysis & Sustainability, Integration & Intensification, Enabling Technologies

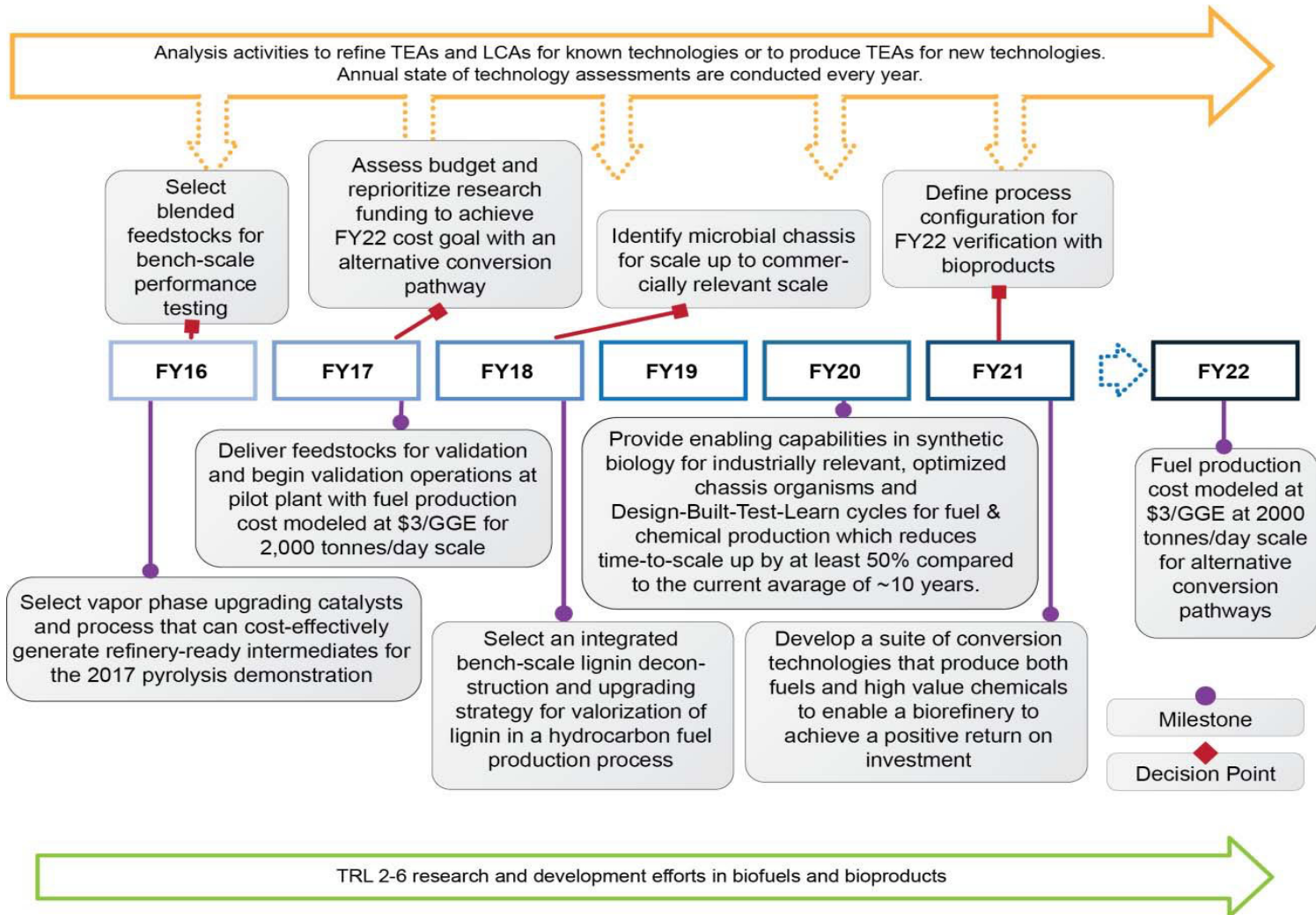


Conversion R&D Priorities

- Develop innovative biomass deconstruction approaches to lower the cost of intermediates
- Enable high-performance separations technologies to increase product yields and decrease cost
- Understand the relationship between feedstock quality and conversion performance
- Develop strategies for conserving carbon and hydrogen in conversion and upgrading processes
- Work with petroleum refiners to address integration of biofuels into refinery processes



Conversion R&D – Milestones



and decision points

Demonstration & Market Transformation

Goals:

- By 2017 validate a mature technology modeled cost of cellulosic ethanol production based on actual integrated biorefinery performance data and compare to the target of \$2.65/gallon ethanol (2014\$)
- By 2027, validate a mature technology modeled cost of infrastructure-compatible hydrocarbon biofuel production based on actual integrated biorefinery performance data and compare to the target of \$3/GGE (2014\$)

Demonstration & Market Transformation Priorities

- Validate proof of performance at integrated pilot, demonstration, and pioneer scales
- Reduce biorefinery capital and operating costs
- Product specification, qualification testing, and off-take agreements

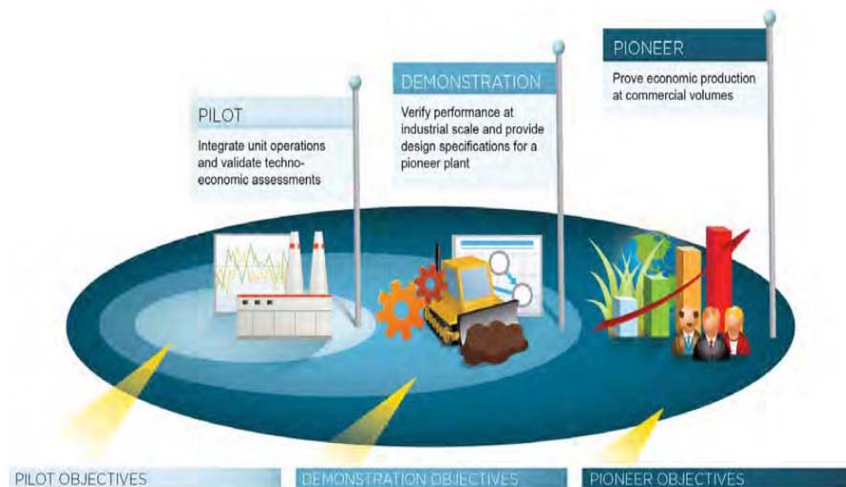


Figure 2-31: Description of key objectives at each integrated biorefinery scale

Demonstration & Market Transformation Milestones

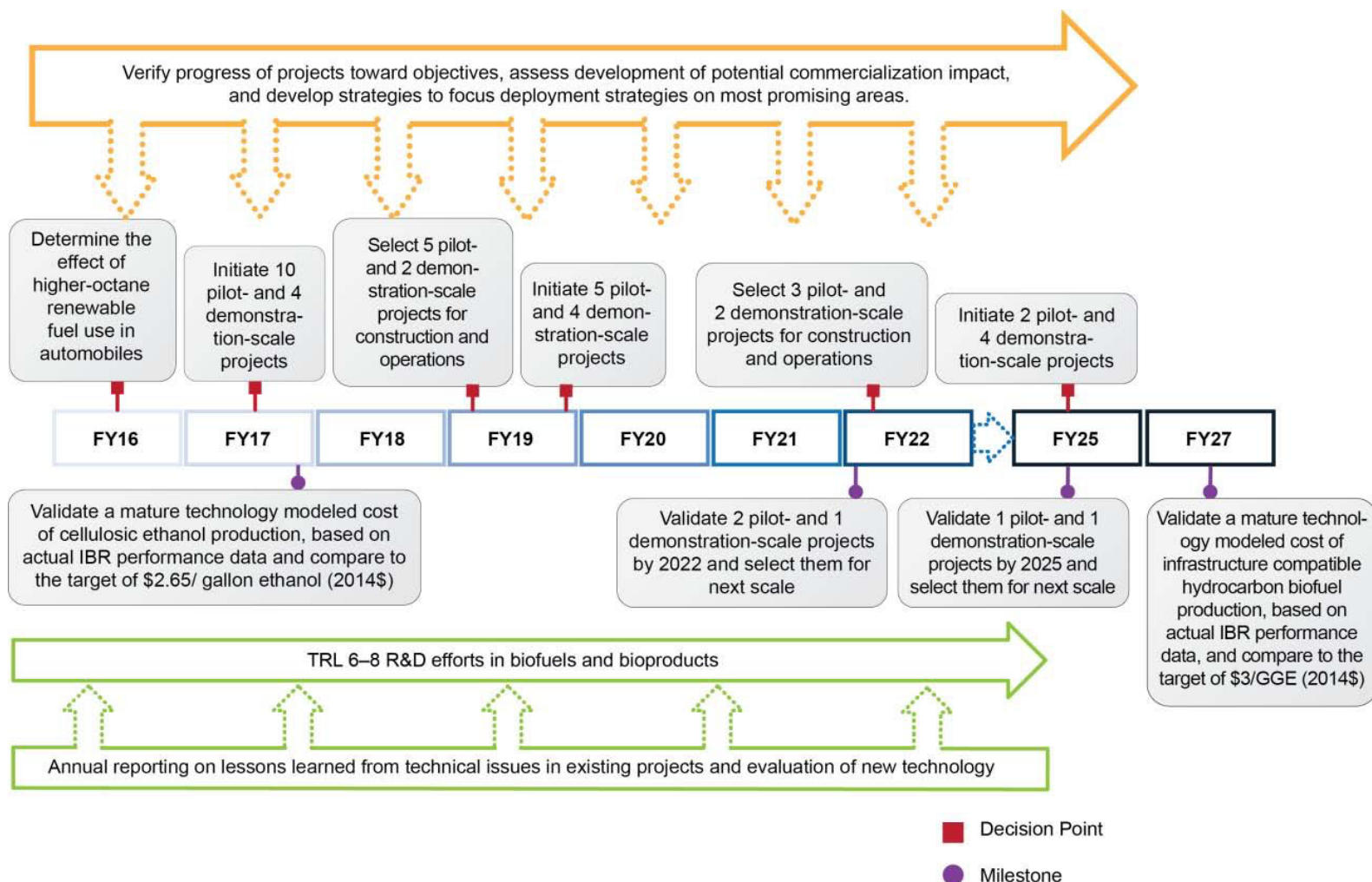


Figure 2-38: Demonstration and Market Transformation key milestones and decision points

Sustainability

Goals:

- By 2017, identify conditions under which at least one technology pathway for hydrocarbon biofuel production, validated above R&D scale at a mature modeled price of \$3/GGE, reduces GHG emissions by 50% or more compared to petroleum fuel and meets targets for consumptive water use, wastewater, and air emissions.
- By 2022, validate landscape design approaches for two bioenergy systems that, when compared to conventional agricultural and forestry production and logistics systems, increase land-use efficiency and maintain ecosystem and social benefits, including biodiversity and food, feed, and fiber production.
- By 2022, evaluate environmental and socioeconomic indicators across the supply chain for three cellulosic and algal bioenergy production systems. Environmental indicators will validate GHG reduction of at least 50% compared to petroleum, water consumption equal to or less than petroleum per unit of fuel produced, and air emissions meet federal regulations. Socioeconomic indicators will validate socioeconomic benefits including job creation.

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Sustainability Priorities

- Advancing scientific methods and models for measuring and understanding bioenergy sustainability across the full supply chain
- Disseminating practical tools for analyses, decision making, and technology development that enhance sustainable bioenergy outcomes
- Quantifying improved environmental performance and social benefits of bioenergy relative to conventional or business-as-usual energy systems.
- Developing landscape design approaches that increase bioenergy production while maintaining or enhancing ecosystem and social benefits

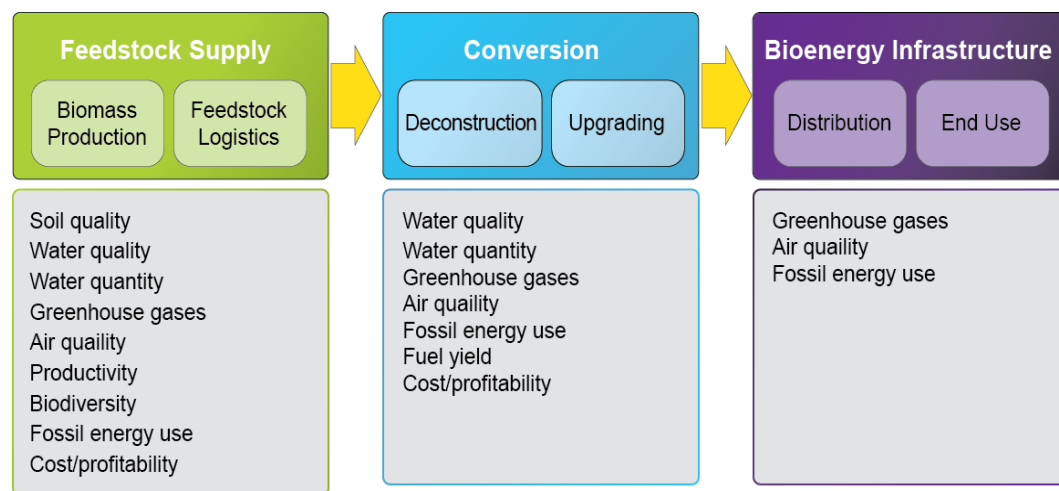


Figure 2-43: Sustainability considerations by supply chain component

Sustainability Milestones

nd decision points

Strategic Analysis

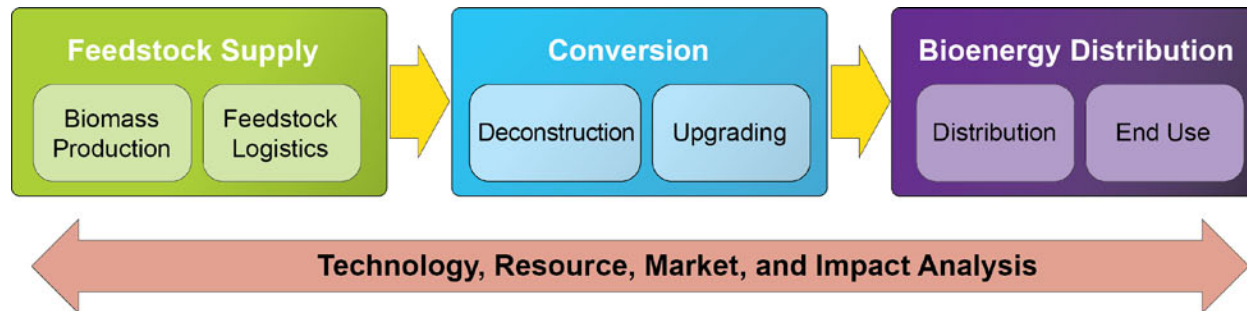


Figure 2-45: Strategic Analysis supports the entire supply chain

Goals:

- Ensure high-quality, consistent, reproducible, peer-reviewed analysis
- Develop and maintain analytical tools, models, methods, and datasets to advance the understanding of bioenergy and its related impacts
- Convey the results of analytical activities to a wide audience, including DOE management, Congress, the White House, industry, other researchers, other agencies, and the general public

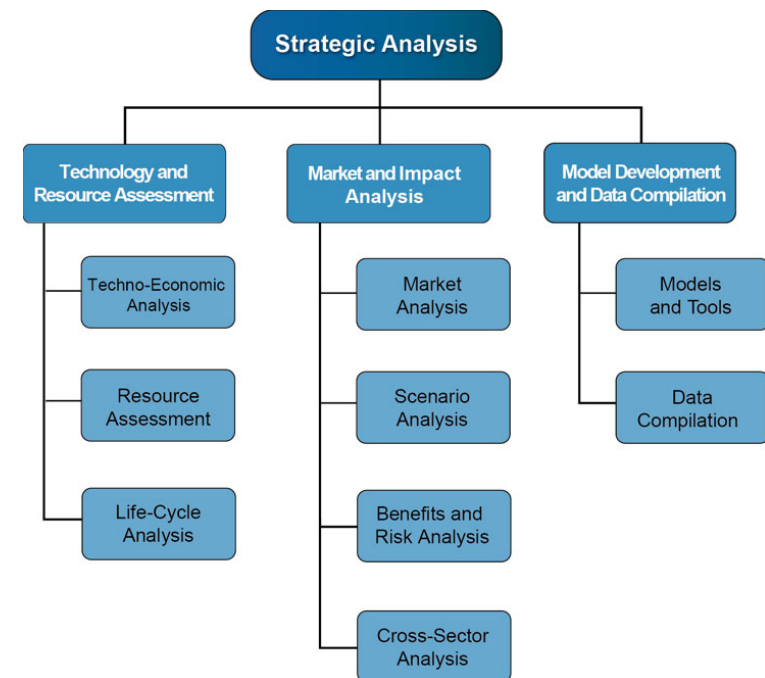


Figure 2-46: Strategic Analysis work breakdown structure

Strategic Analysis Milestones

c Analysis key milestones and decision points

Strategic Communications

Goals:

- Increase awareness of and support for the Office's advanced biomass RD&D and technical accomplishments, highlighting their role in achieving national renewable energy goals
- Educate audiences about the environmental and economic opportunities and societal benefits of biofuels, bioproducts, and a growing bioenergy industry

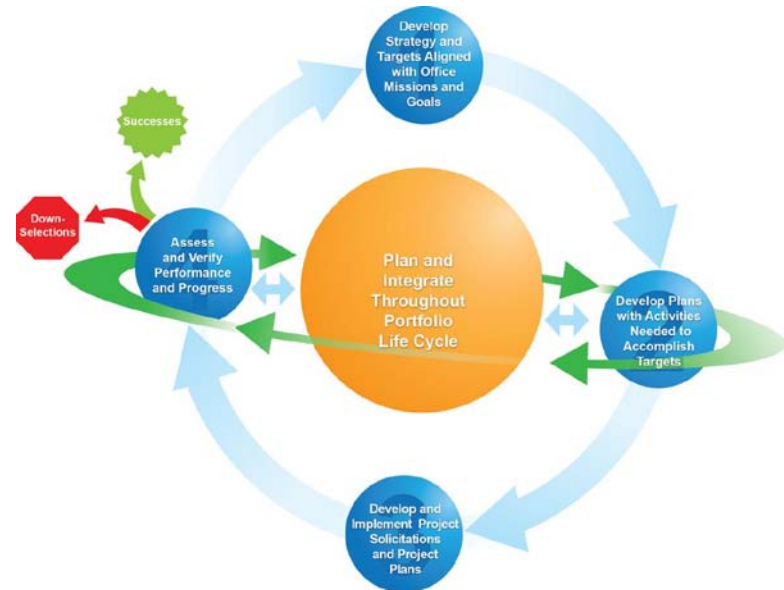
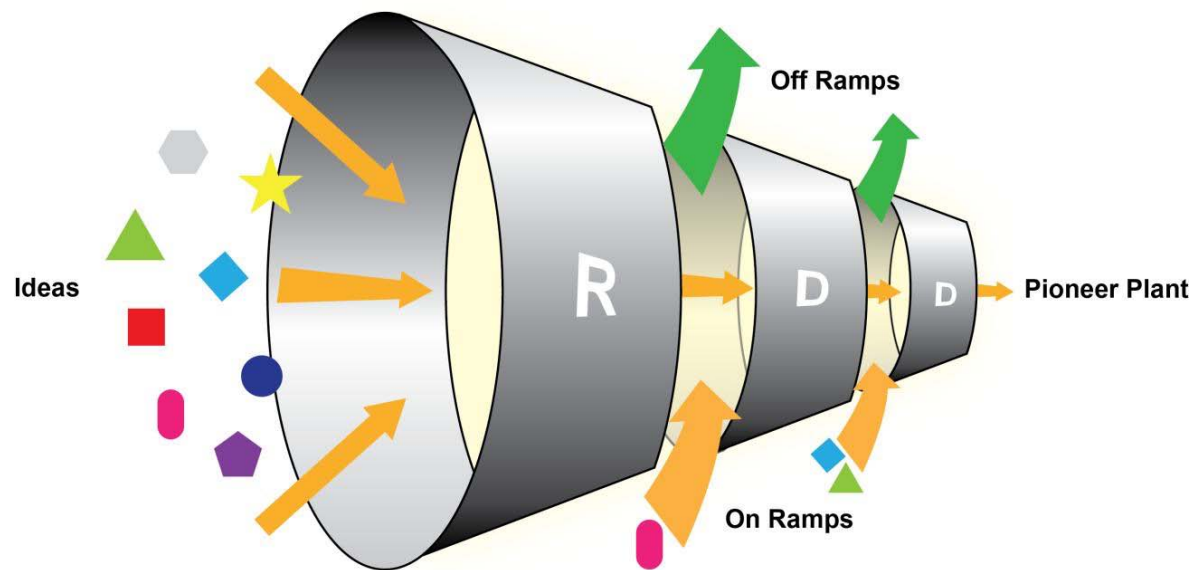


Strategic Communications Milestones

ivities

Section Three: Office Portfolio Management

- Documents Office portfolio management across the development pipeline
- Revised Technology Readiness Level (TRL) definitions
- Substantial revisions and updates throughout



MYPP 2017 Update

- ❑ Next update planned for March 2017
- ❑ Integrate changes from BETO strategic plan and bioeconomy
- ❑ Integrate Billion Ton 2016 Update
- ❑ Expand wet waste-to-energy as strategy clarifies
- ❑ Continue to incorporate learning from RD&D portfolios into direction and goals
- ❑ Incorporate goals and milestones for co-optimization of fuels and vehicles

The MYPP 2016 update is available at:

<http://www.energy.gov/eere/bioenergy/downloads/bioenergy-technologies-office-multi-year-program-plan-march-2016>

Thank you!

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