U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Biomass R&D Technical Advisory Committee Meeting

MYPP Overview – 2014 Update

August 19, 2014

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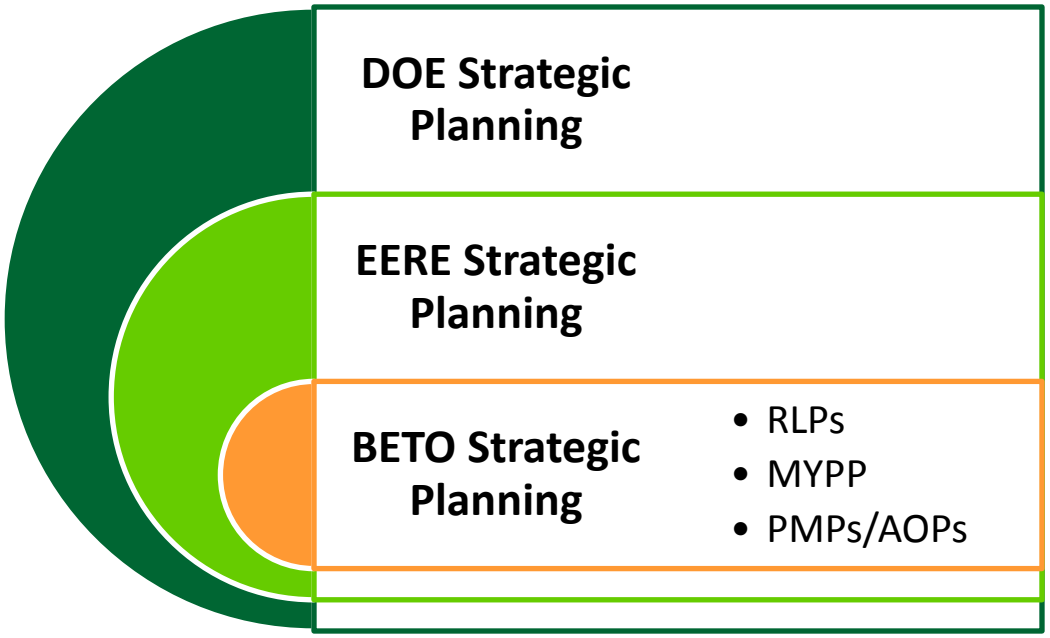
Agenda

- Planning Overview
- BETO Multi-year Program Plan
- Latest Update
- Next Steps/Directions

Strategic Planning

- Continuous process
- Provides framework
  - Alignment with EERE/DOE/Federal goals
  - Interactions with stakeholders
  - Inter- and intra-office collaborations/discussions across technology areas
  - Align Office activities from project level to multi-year goal horizons

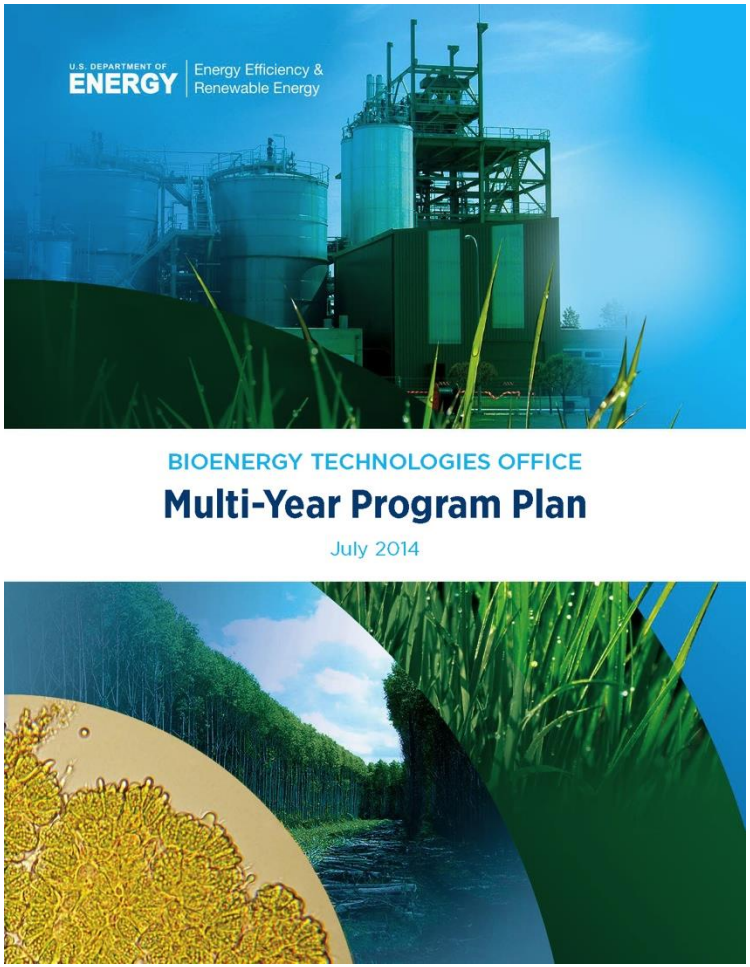


BETO Strategic and Long-term Planning

- Purpose:
  - Align objectives and activities across multiple stakeholders and interests
  - Document goals, current state of technology, and strategic plans
  - Inform budget processes
  - Track progress
  - Integrate learning
- Based on best practices for technology R&D planning & systems engineering

Multi Year Program Plan

- 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
- 5-10 year planning horizon (2022 goals)
  - Office goals
  - Technology Area/Program Plans
  - Integrated across programs
  - Regularly updated using change control



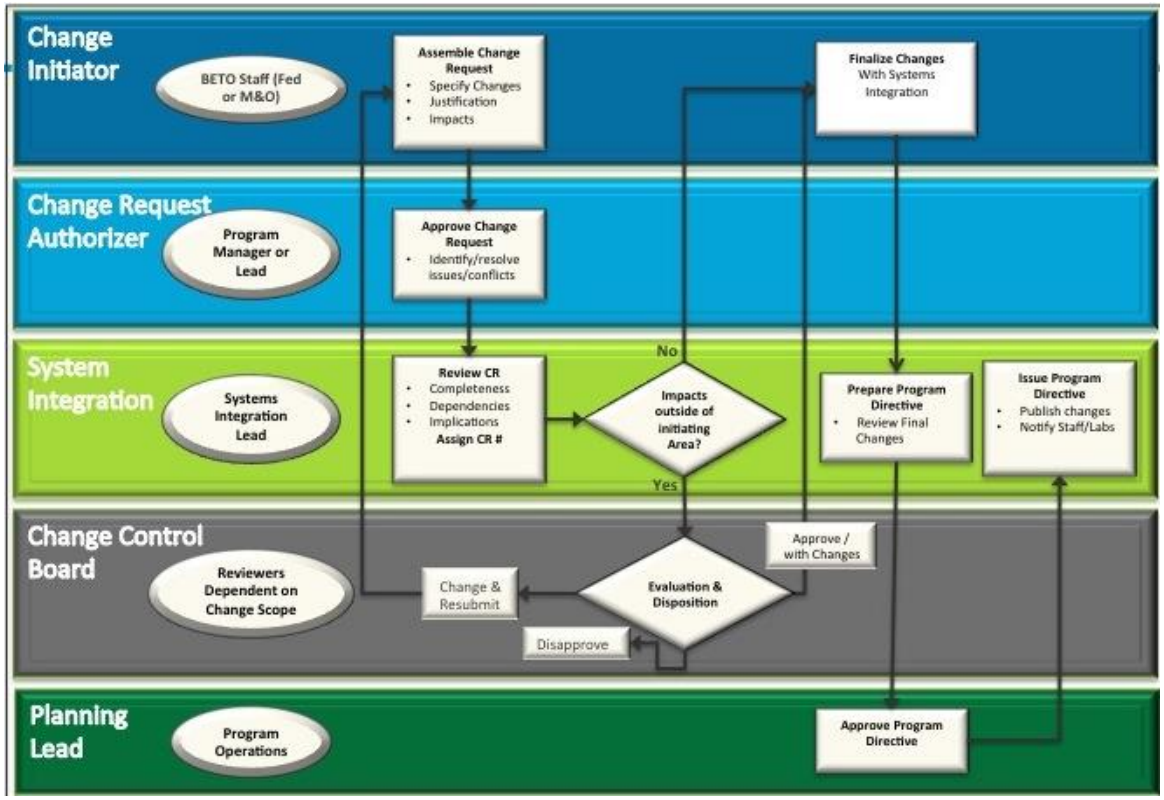
Available online:
http://www1.eere.energy.gov/bioenergy/pdfs/mypp_july_2014.pdf

Purpose of MYPP Annual Updates

- Reflect and align with current strategic priorities
- Help all members of bioenergy community understand how they fit within the big picture
- Set clear public goals and track progress over time
  - Align short-term, narrower/deeper efforts with longer term goals
  - Align across supply-chain
  - Align across development stages
- Control public information about goals and accomplishments

MYPP: Change Management

- Control of programmatic and technical content, versions, and information distribution
- Standardized process initiating, reviewing, and approving changes
- Maintains integrity of MYPP
- Ensures everyone is working from the same version



Objectives for 2014 Update

- Continue strategic reorientation beyond cellulosic ethanol
  - To hydrocarbon fuels
  - To products as enablers
  - To focus on markets
    - Beyond light duty vehicles
- Toward national-scale feedstock volumes
  - Quality specifications – feedstock/conversion interface – toward commoditization
- General Updates
  - Incorporate R&D results and reflect R&D accomplishments
  - Add and update design cases/goals
  - Reflect current Office structure

Focus beyond “biomass” to “bioenergy”

Vision

A viable, sustainable domestic bioenergy industry that:

- Produces renewable biofuels, bioproducts, and biopower
- Enhances U.S. energy security
- Reduces U.S. dependence on foreign oil
- Provides environmental benefits, including reduced GHG emissions
- Creates economic opportunities across the nation and advances the U.S. global competitiveness in renewable technologies

Mission

Develop and transform our renewable biomass resources into commercially viable, high-performance biofuels, bioproducts, and biopower through targeted RD&D supported through public and private partnerships

Explicitly incorporate GHG reduction

Strategic Goal

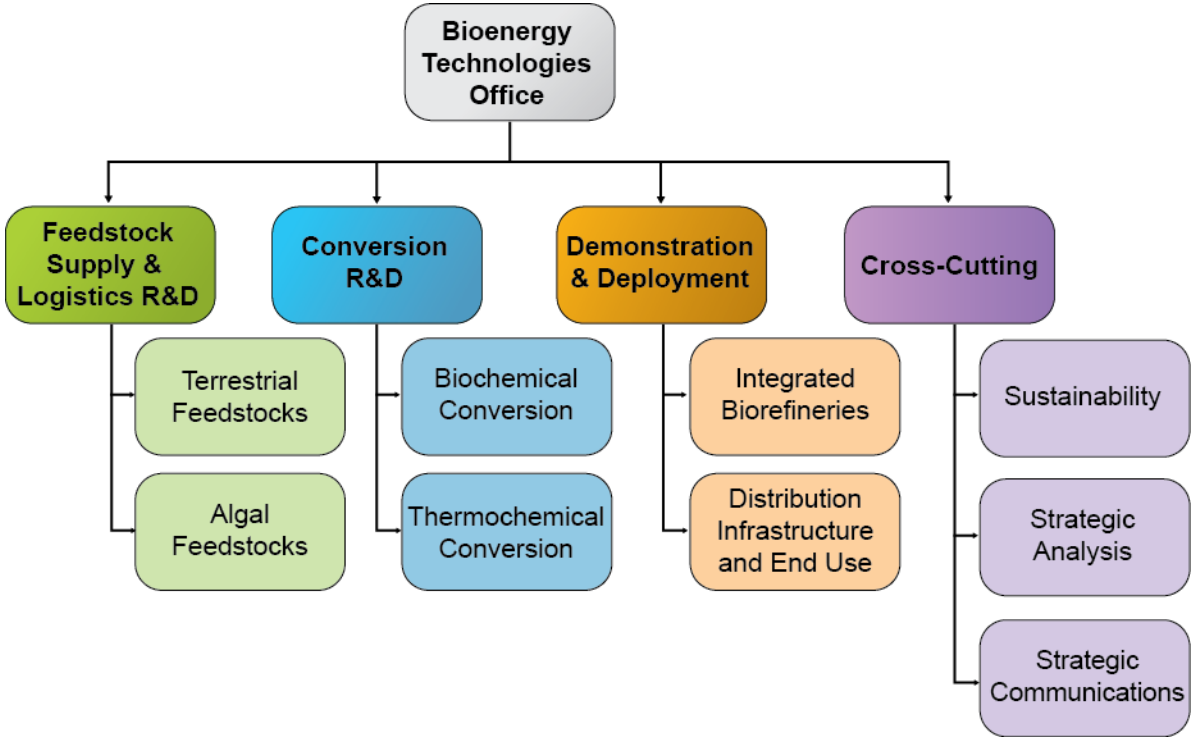
Develop commercially viable bioenergy and bioproducts technologies to enable the sustainable, nationwide production of biofuels that are compatible with today's transportation infrastructure, can reduce GHG emissions relative to petroleum-derived fuels, and can displace a share of petroleum-derived fuels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

Performance Goals

- By 2017, validate at pilot scale at least one technology pathway for hydrocarbon biofuel at a mature modeled price of $3/GGE with GHG emissions reduction of 50% or more compared to petroleum-derived fuel
- By 2022, validate hydrocarbon biofuels production from at least two additional technology pathways at pilot or demonstration scale (>1 ton/day)

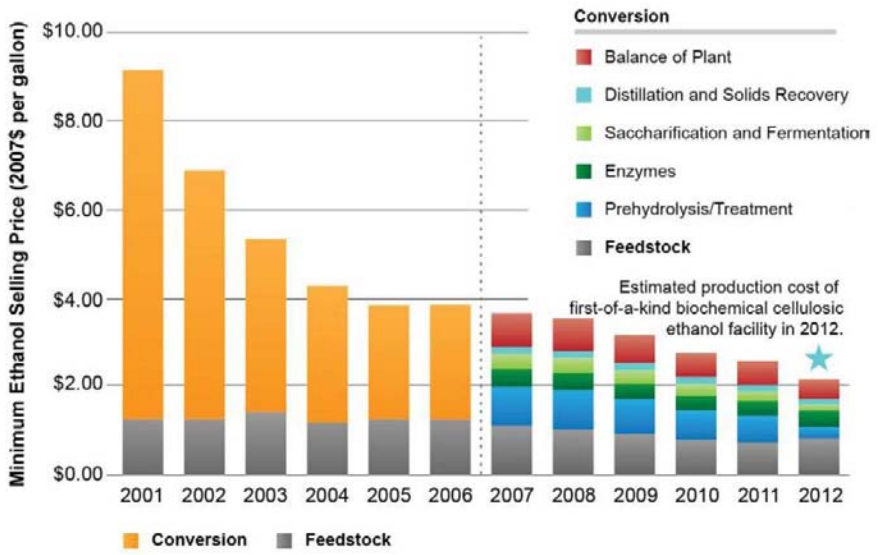
Office Updates

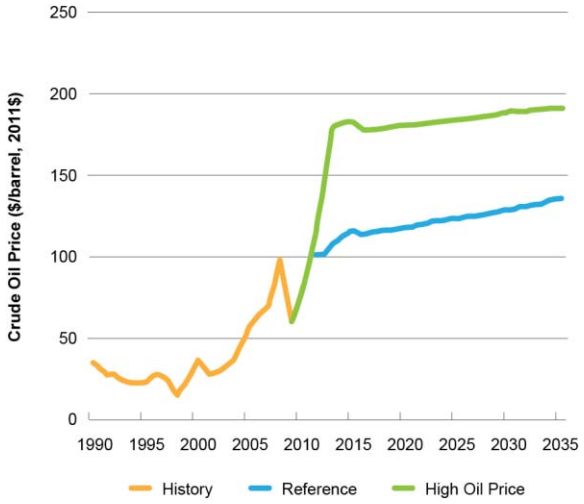
- Algal Feedstocks R&D sub-section
- Thermochemical Conversion R&D
  - Combined Oils and Gaseous Intermediates
- Incorporate Distribution Infrastructure and End Use into Demonstration and Deployment

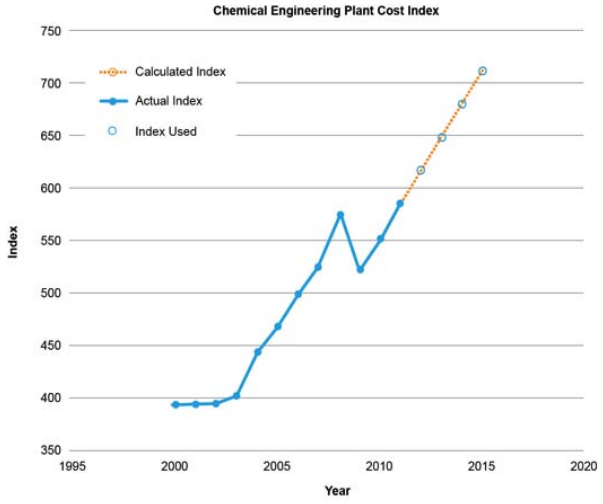


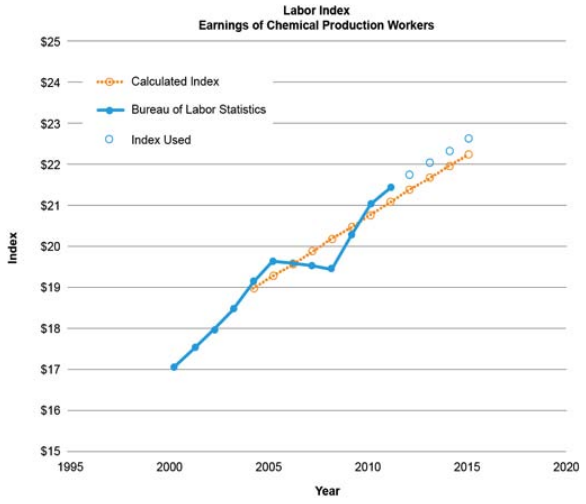
Appendices

- Track goal/target development and accomplishments
- Document approach to setting cost goals
- Document definitions









Defined: Design Case

- Purpose
  - Basis for setting technical targets and cost of production goals (bottom-up) for assessing technology progress and validating processes at increasing scale and integration
  - Prioritize R&D areas
  - Provide justification for budget requests.
- Documented in peer-reviewed design reports
- Representative example of a technology pathway
- Crosses the entire biomass-to-bioenergy supply chain
- Credibly represents a total finished product cost (excluding distribution, taxes, and tax credits)

Defined: Design Case

- Based on
  - Best available information
  - Current projections of nth plant capital and operating costs
- Reconfigured cases reflect technology development over time
- Technical targets and cost goals change
  - Earlier-stage technologies – high-level conceptual, literature-based process flows with material balances
  - More mature technologies – detailed and specified processes with material and energy balances and capital and operating estimates based on actual, experimental data
- Over time the range of uncertainty around technical targets and cost estimates is expected to decrease.

Defined: State of Technology

- Periodic (usually annual) assessment of the status of technology development for a biomass to biofuels/products pathway
- Assesses progress within and across relevant technology areas based on actual experimental results relative to technical targets and cost goals from design cases
- Includes technical, economic, and environmental criteria as available

Terrestrial Feedstocks Supply & Logistics R&D

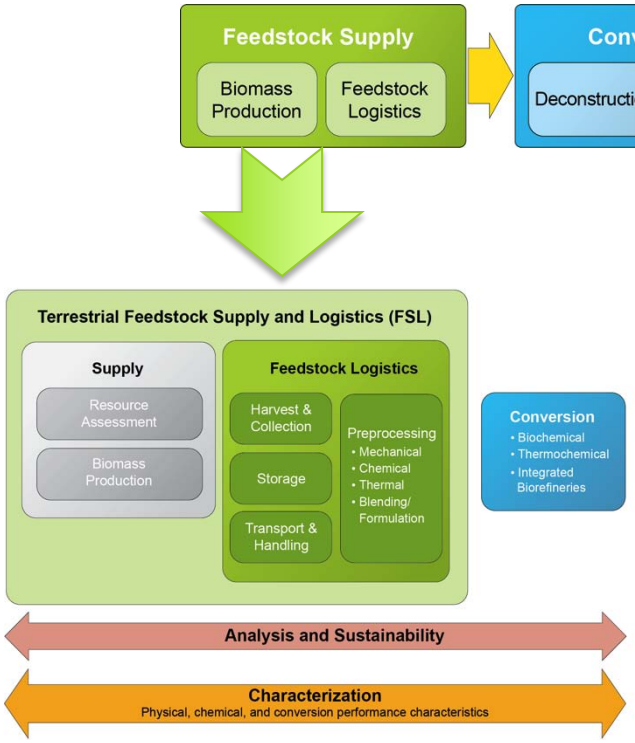


Figure 2-5: Terrestrial Feedstock Supply and Logistics systems diagram

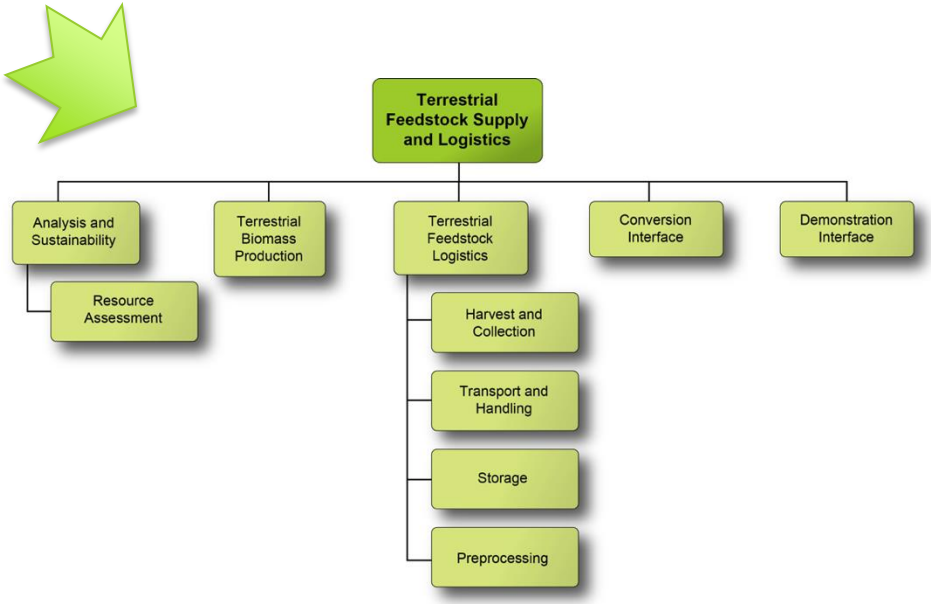


Figure 2-7: Terrestrial feedstock R&D work breakdown structure

Terrestrial Feedstock Supply & Logistics R&D

Increased resource availability

- Cost, volume, **and** quality
- Enabling cost competitive blending/formulation
- Draw in large volumes of diverse materials
- Reduce risk, variability, and uncertainty

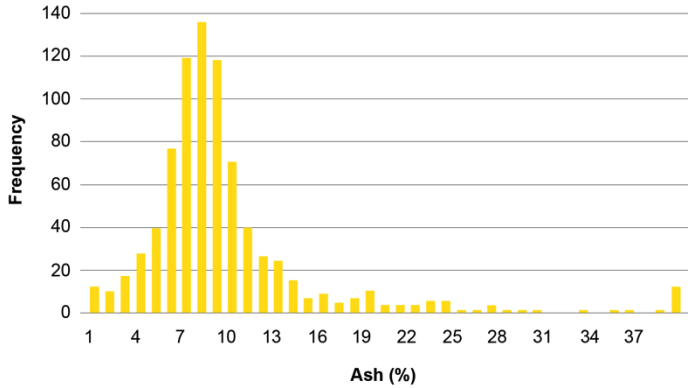


Figure 2-8: Demonstration of the variability in total ash content in corn stover

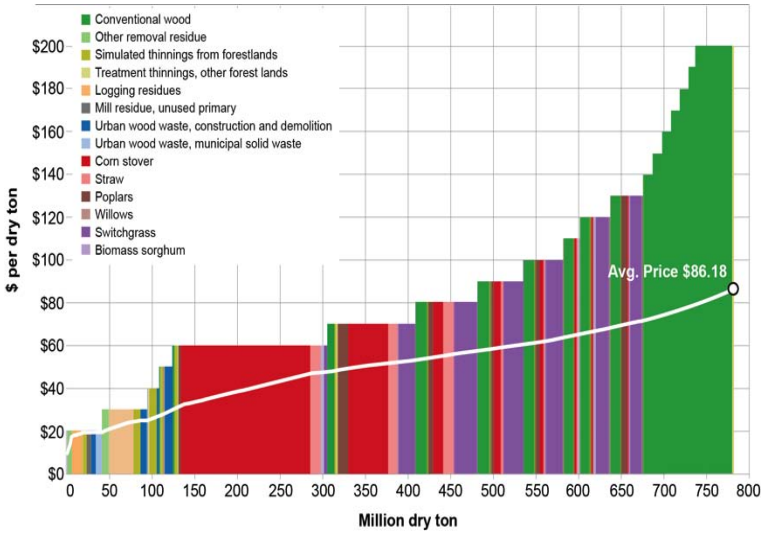


Figure 2-9: Biomass supply projections at marginal prices between $20 and $200 per ton in 2022

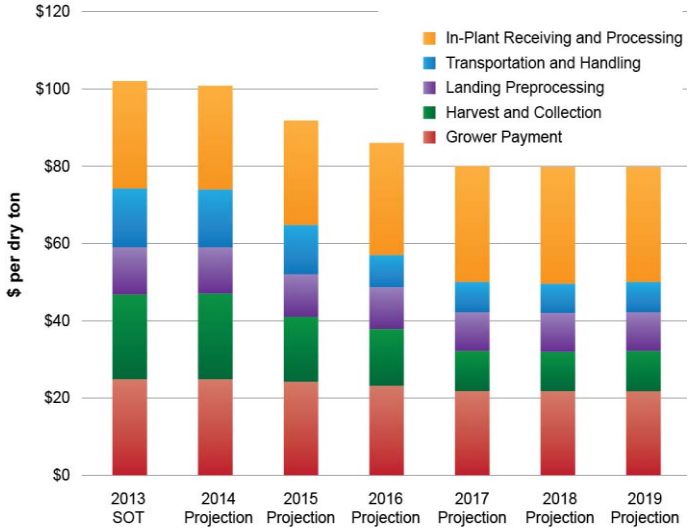
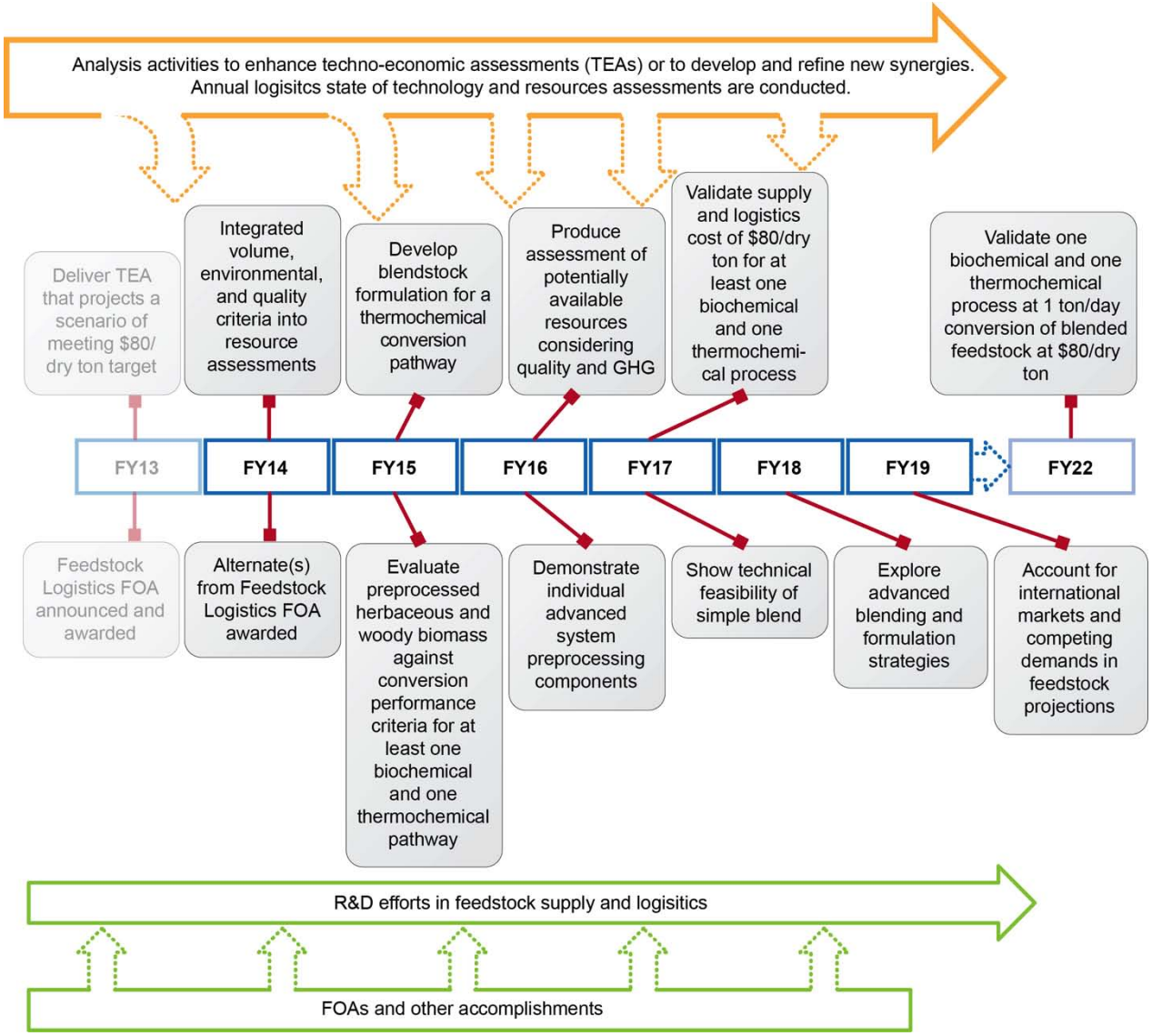


Figure 2-10: Historical and projected delivered feedstock costs, modeled for pyrolysis conversion

Terrestrial Feedstocks Supply & Logistics R&D Timeline



Algal Feedstocks R&D

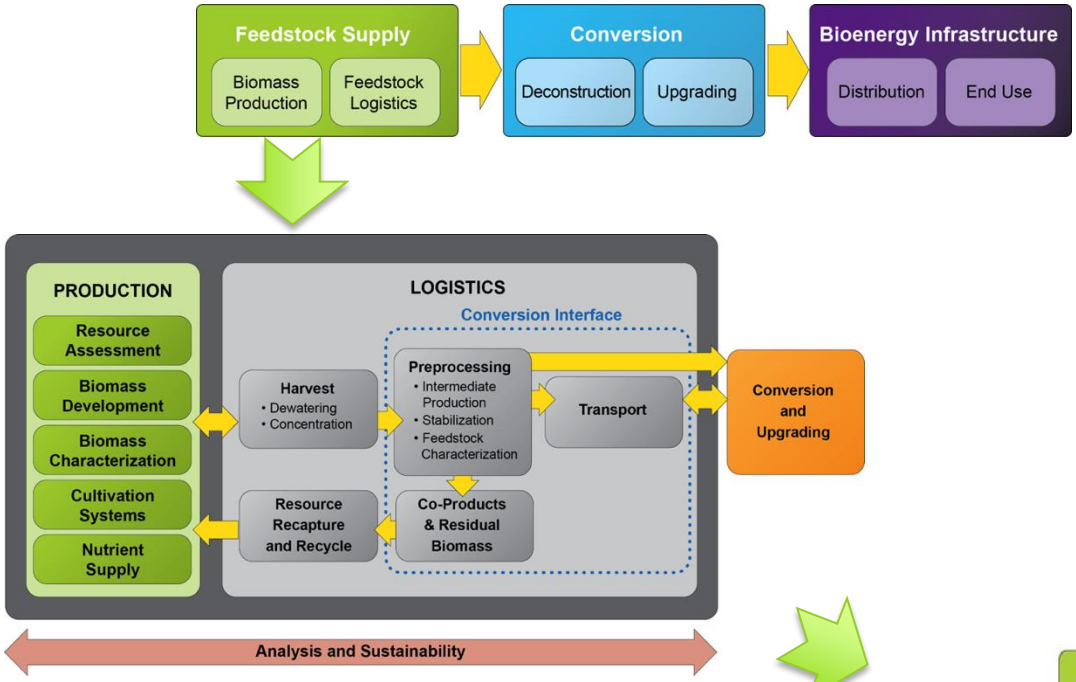


Figure 2-12: Generic algal biofuel intermediate feedstock supply and logistics flow diagram

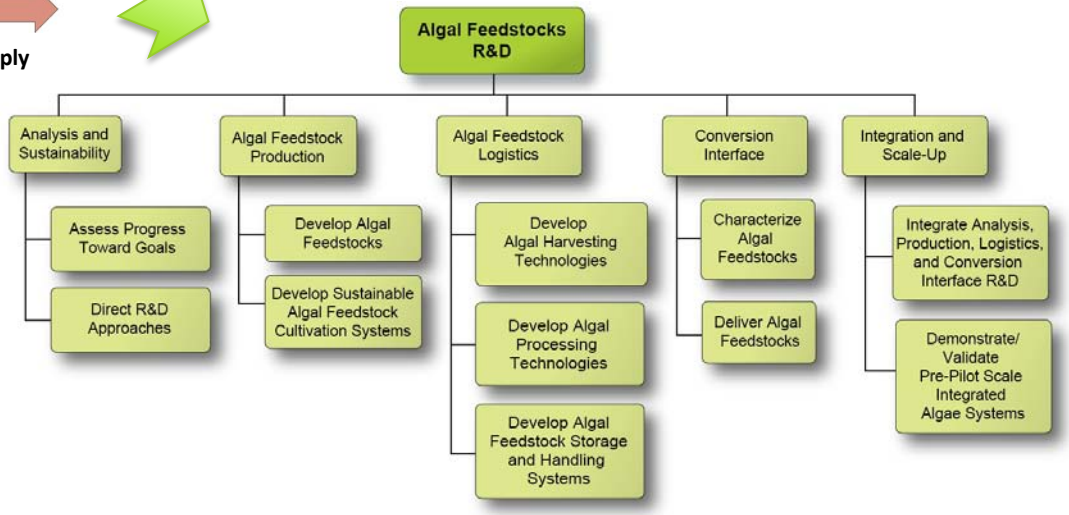


Figure 2-13: Algal feedstocks R&D work breakdown structure

Algal Feedstocks R&D

Changes

- Algal Feedstocks as stand-alone subsection
- Clarifying/adding barriers
- Introducing hydrothermal liquefaction (HTL) pathway
- Developing long term research structure/milestones

Future

- HTL targets and goals

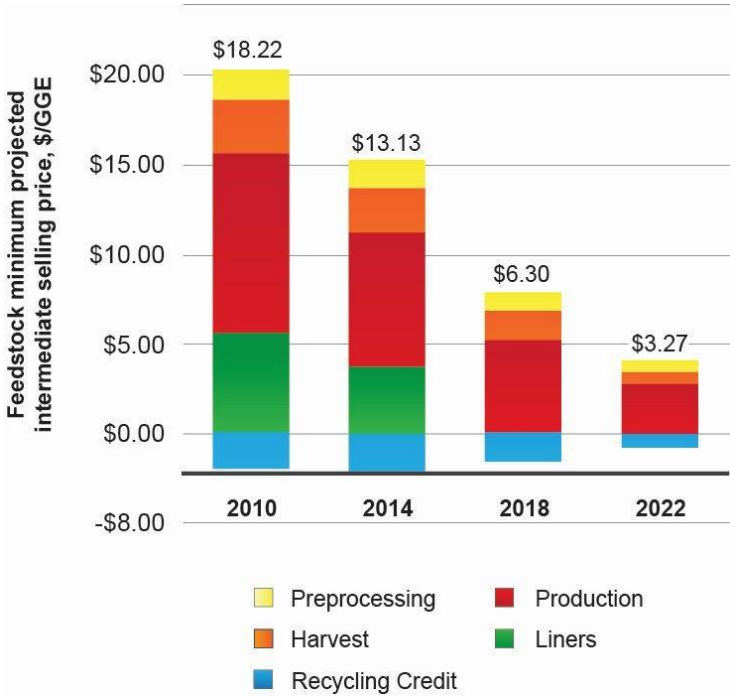
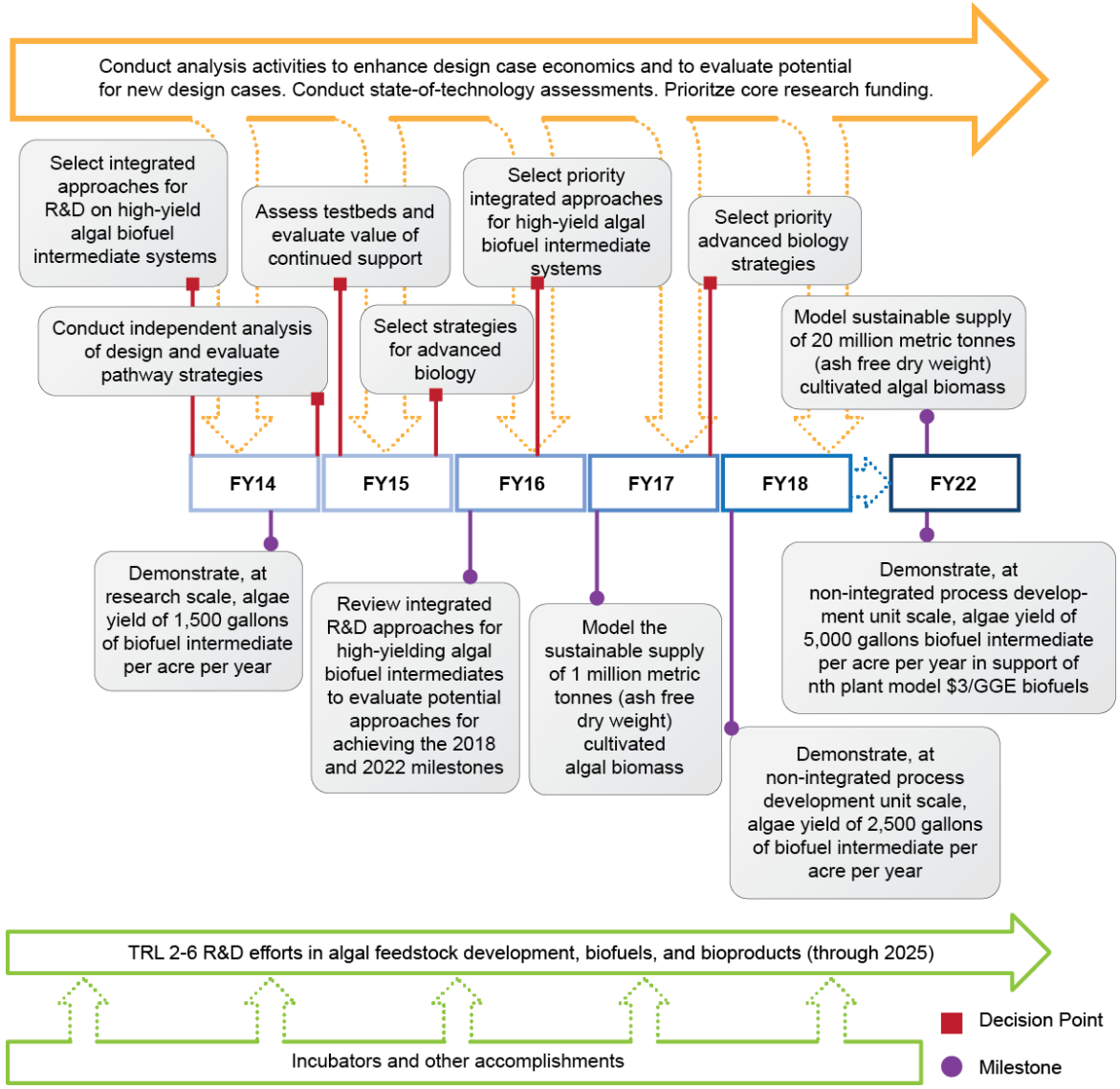


Figure 2-14: Production of high-lipid algal biomass and extraction of neutral lipids

Algal Feedstocks R&D Timeline



Biochemical Conversion R&D

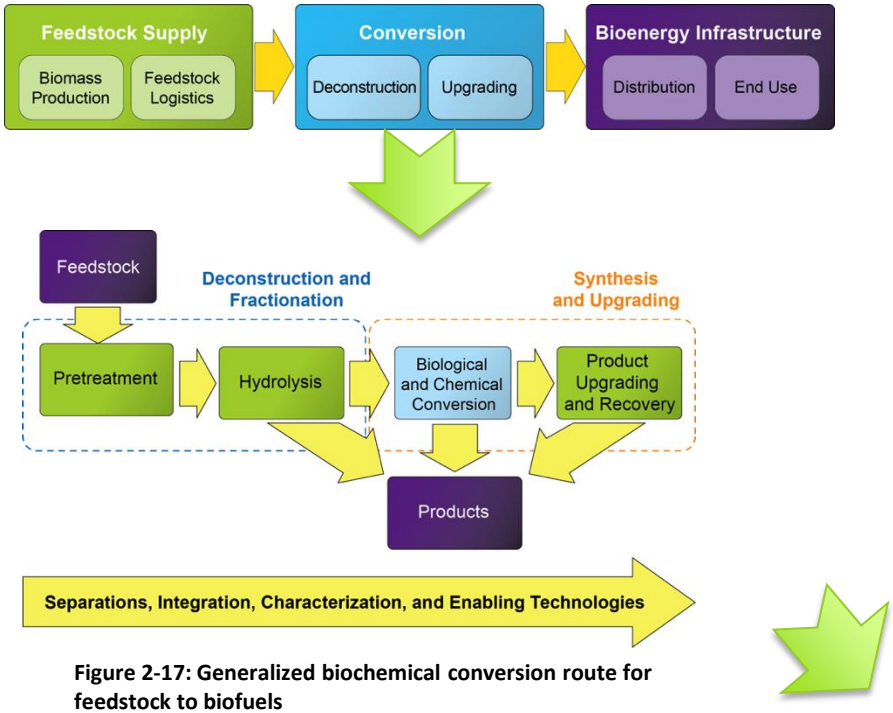


Figure 2-17: Generalized biochemical conversion route for feedstock to biofuels

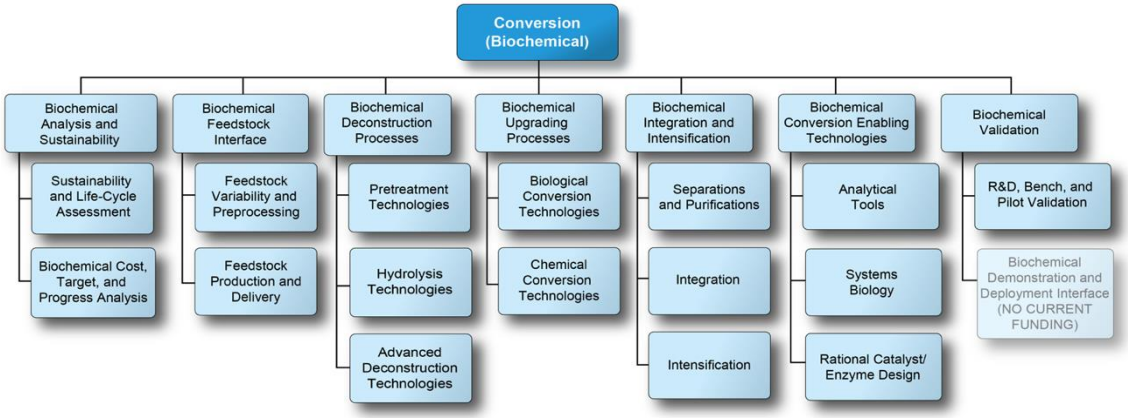


Figure 2-18: Biochemical conversion R&D work breakdown structure

Biochemical Conversion R&D

Shift to leverage cellulosic ethanol

- Update with approach to priority hydrocarbon pathways
- Incorporate biological conversion design cases: WBS, Barriers, milestones, targets and 2017 cost goal
- Co-products as enablers of economics and technology development

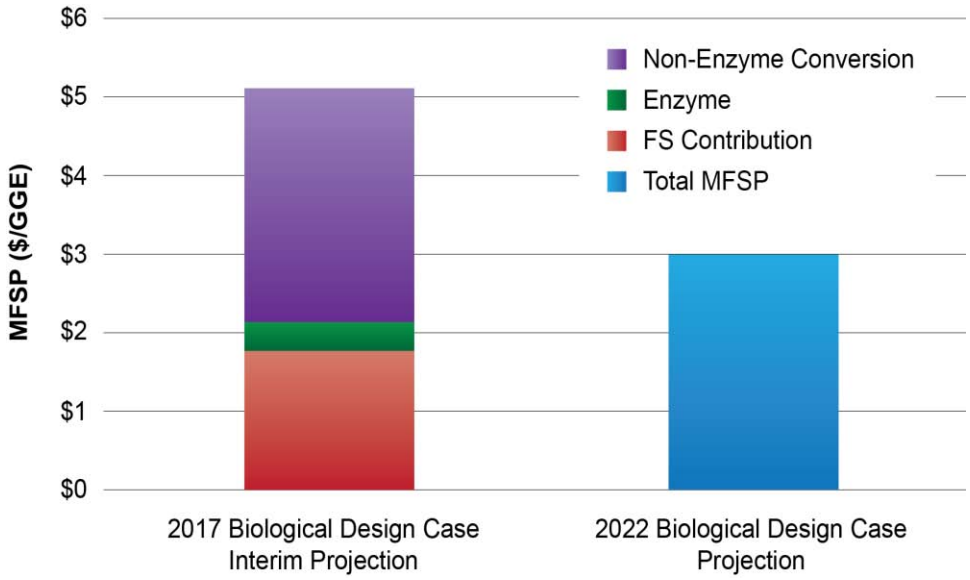
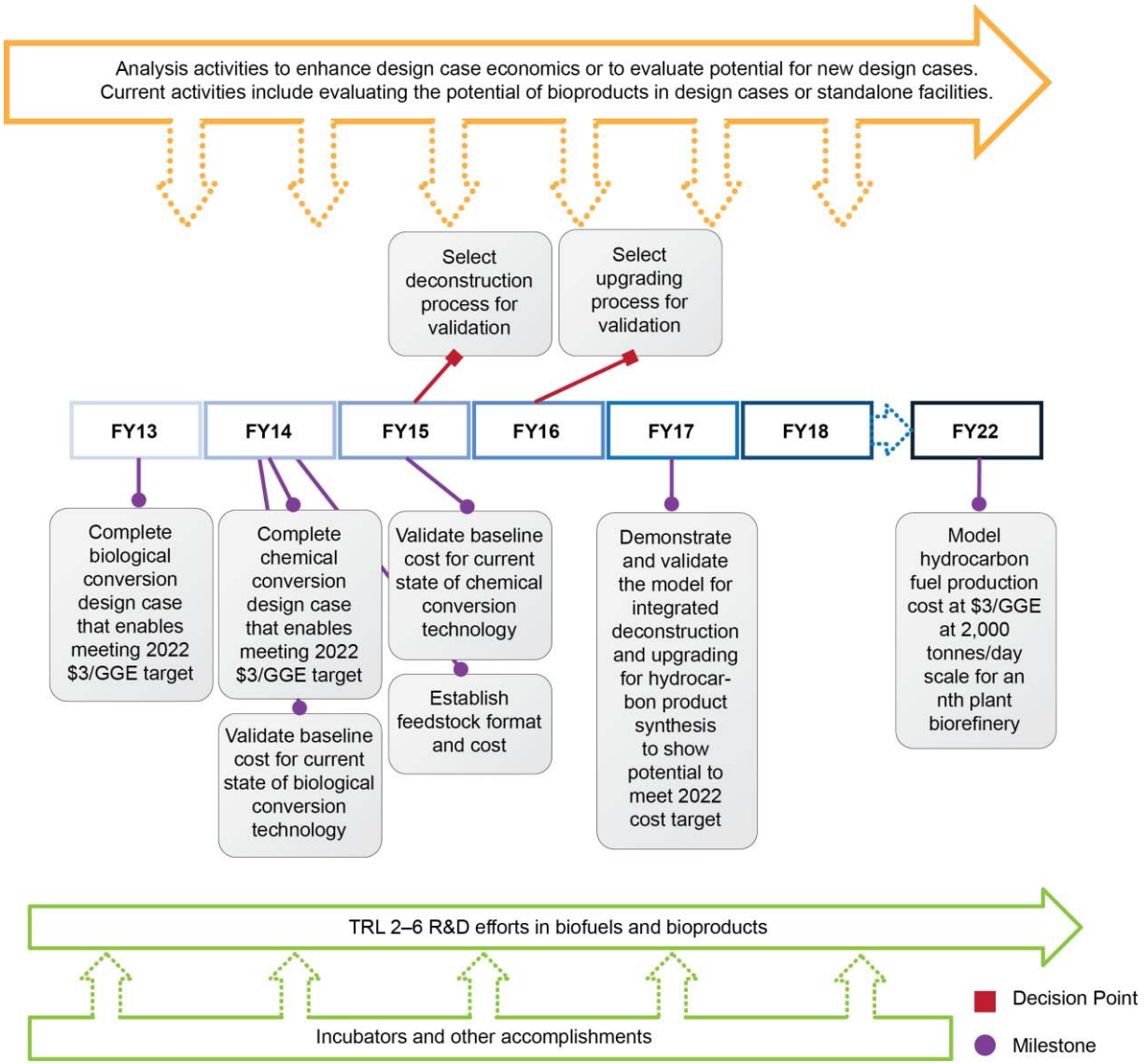


Figure 2-19: Biochemical conversion R&D barrier areas and example metrics

Biochemical Conversion R&D – timeline



Thermochemical Conversion R&D

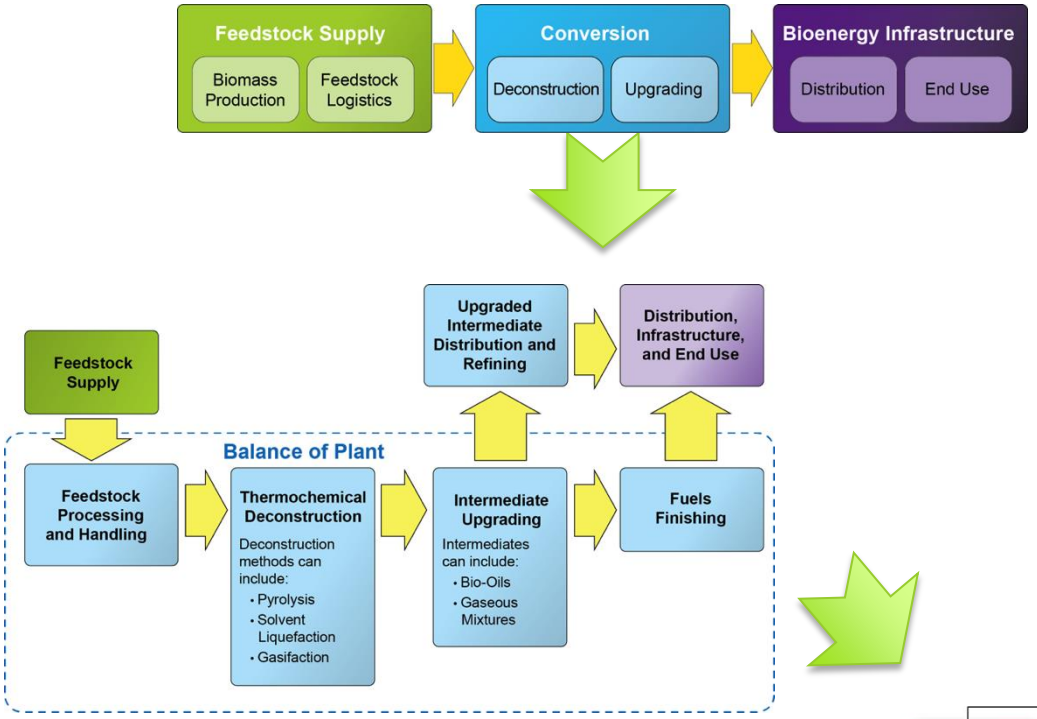


Figure 2-21: Thermochemical conversion process steps for biomass to biofuels

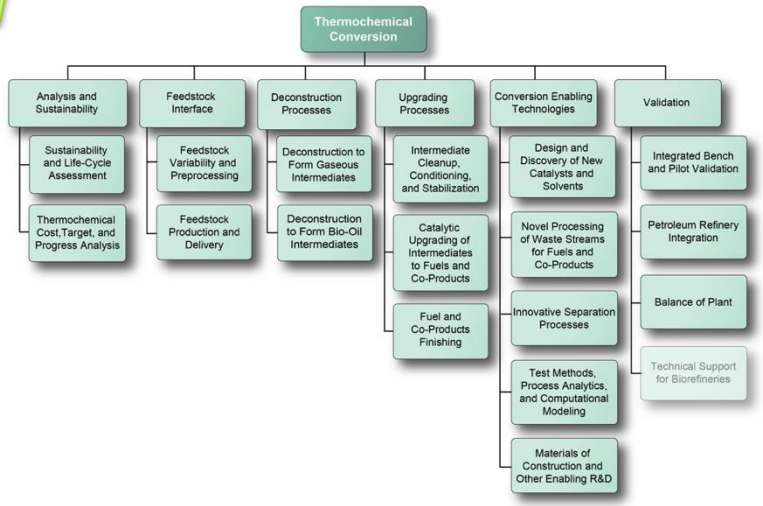


Figure 2-22: Thermochemical conversion R&D work breakdown structure

Thermochemical Conversion R&D

- Comprehensive TC conversion section
  - Combined gasification and bio-oils
- Updated Fast Pyrolysis Design case, targets, and goals
- Sustainability Metrics

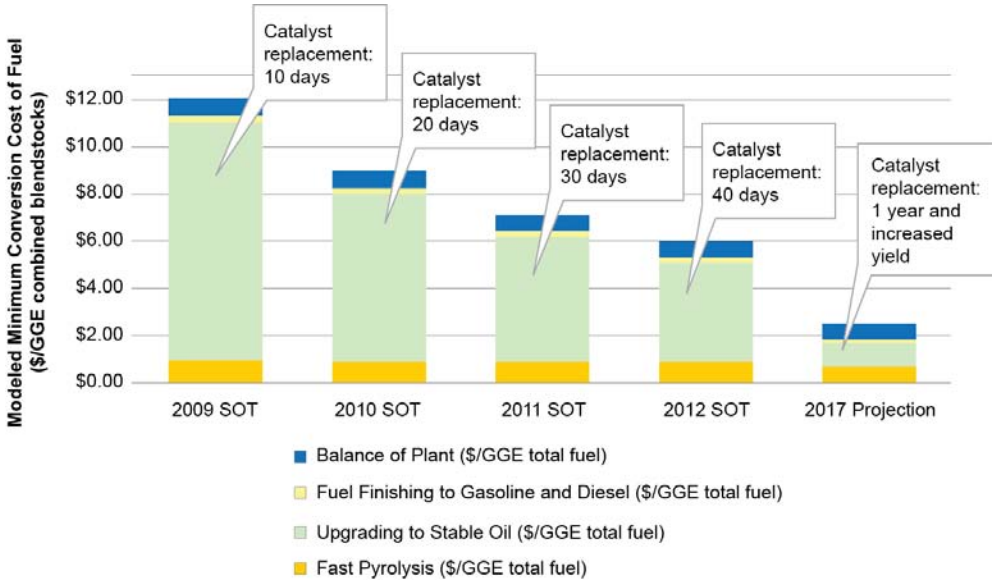


Figure 2-23: Conversion of woody feedstocks to renewable gasoline and diesel finished fuels via fast pyrolysis

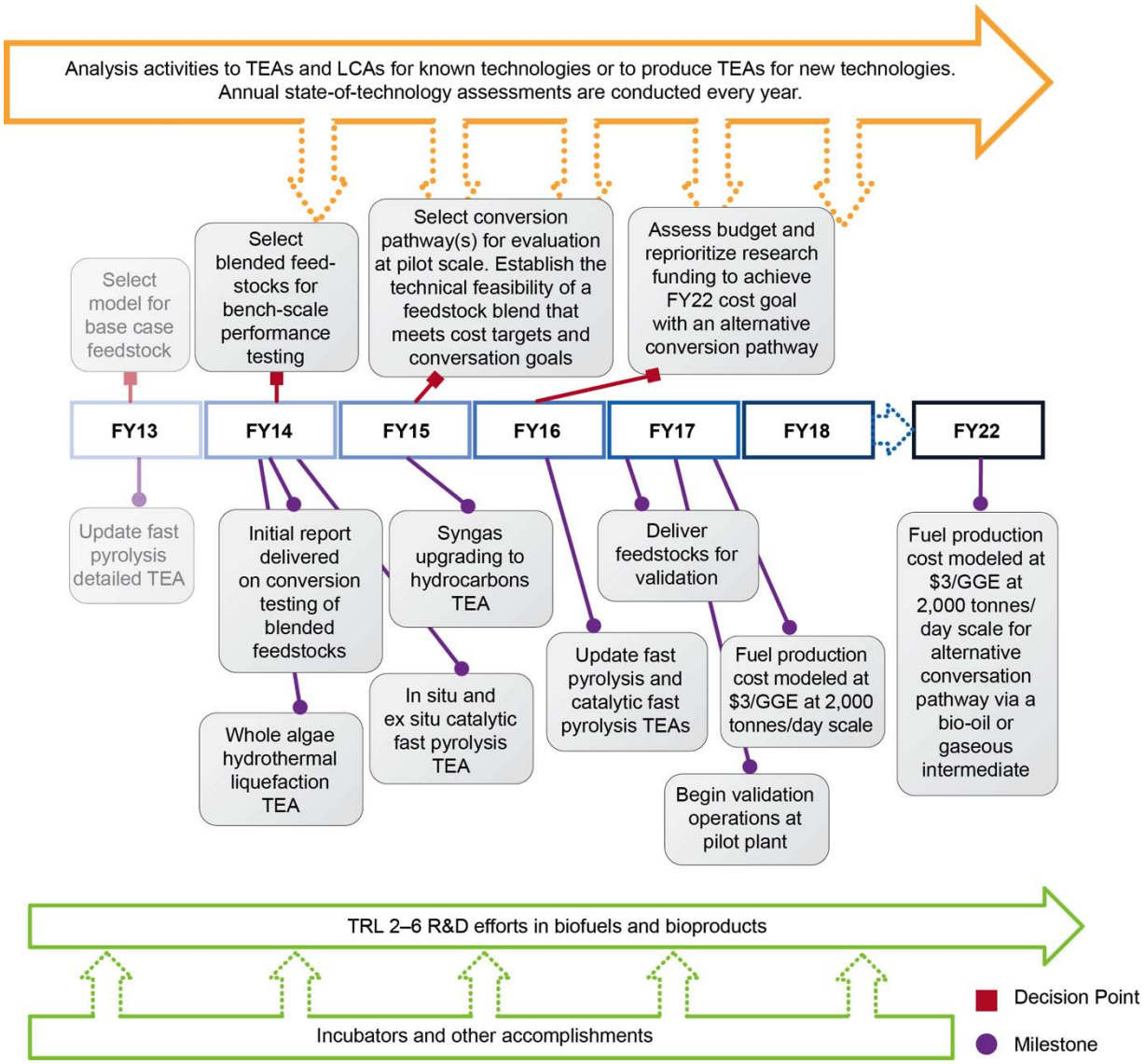
Table 2-9: Environmental Sustainability Metrics for Fast Pyrolysis and Upgrading

Environmental Sustainability Metric	2017 Projected
Greenhouse Gases (g CO_2-e/MJ fuel) – (fossil emission; biogenic emissions)[1]	18.9; 85
Fossil Energy Consumption (MJ fossil energy/MJ fuel product)[2]	0.301
Total Fuel Yield (gal/dry ton wood; GGE/dry ton wood)	84; 87
Biomass Carbon-to-Fuel Efficiency (C in fuel/C in biomass)	47%
Water Consumption (m^3/day; gal/GGE)[3]	1050; 1.4
Wastewater Generation (m^3/day; gal/GGE fuel)[4]	932; 1.3

Table Notes:

1. Biogenic emissions include those contained in the char combustor exhaust, the heat from which is used in the biomass dryer (not part of the conversion plant).
2. Fossil energy consumption does not include grinding of the feedstock prior to the pyrolysis step.

Thermochemical Conversion R&D Timeline



Demonstration & Deployment

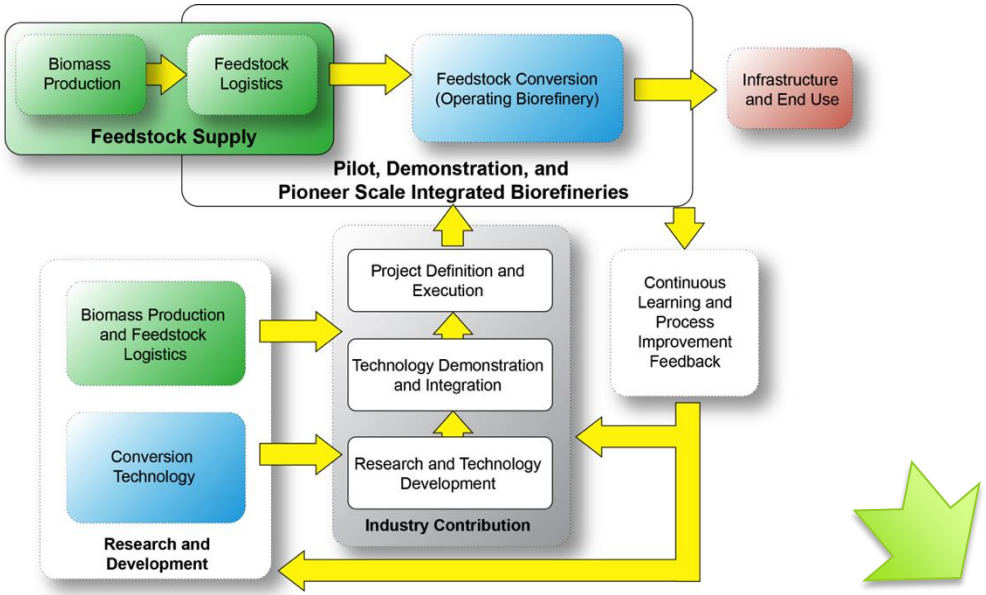


Figure 2-25: D&D technology area scope and connection to R&D efforts

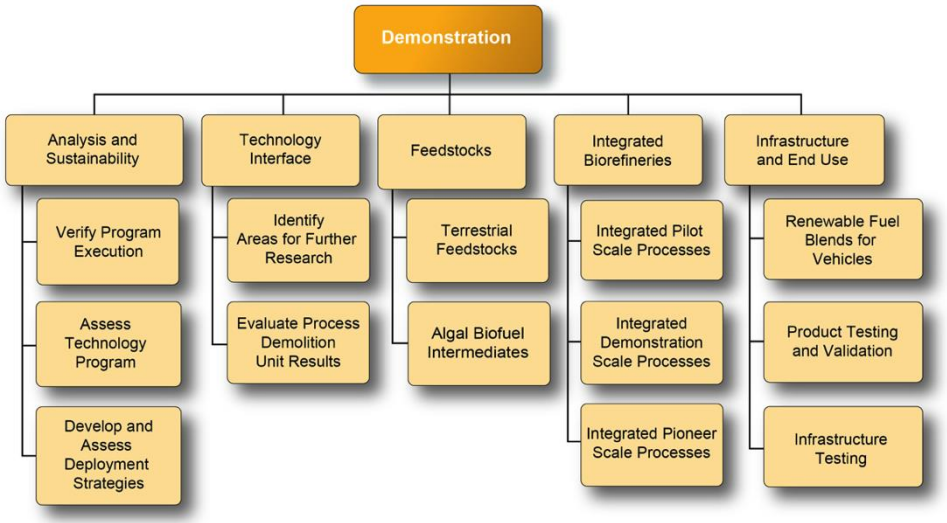


Figure 2-27: Demonstration and Deployment work breakdown structure

Demonstration & Deployment

Shift strategic orientation

- Revised Pilot, Demo, and Pioneer definitions
- Changed goals to validation at scale
- Impact of D&D investments
- Incorporated Infrastructure and End Use
- Broader infrastructure and fuel compatibility testing

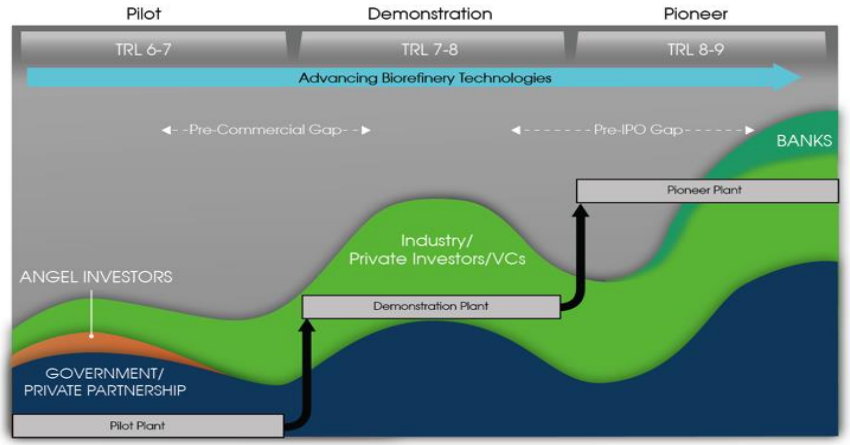


Figure 2-2: Technology development and scale-up to first-of-a-kind pioneer facility

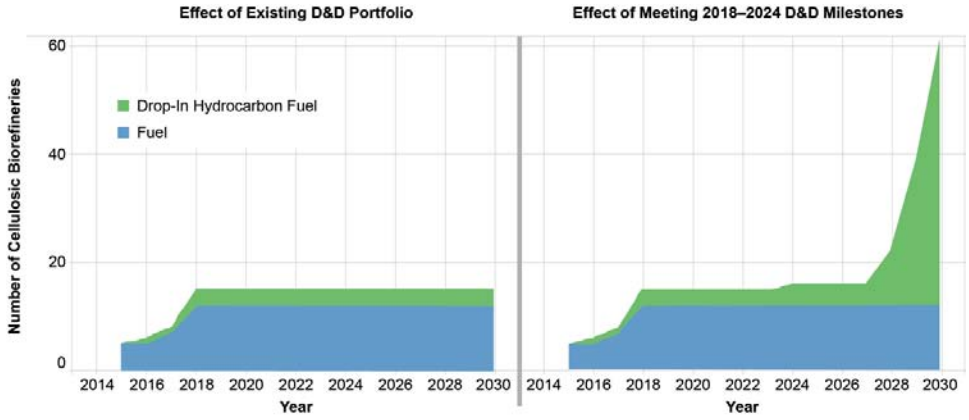


Figure 2-29: Biomass scenario model projection of the number of cellulosic biorefineries enabled by the Office's D&D efforts

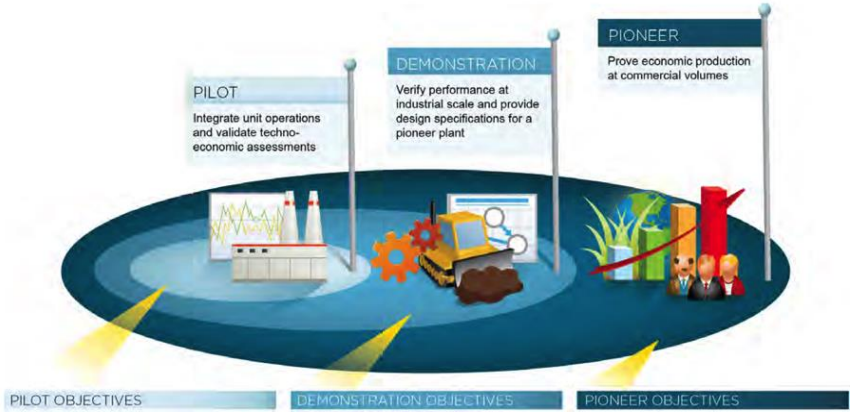
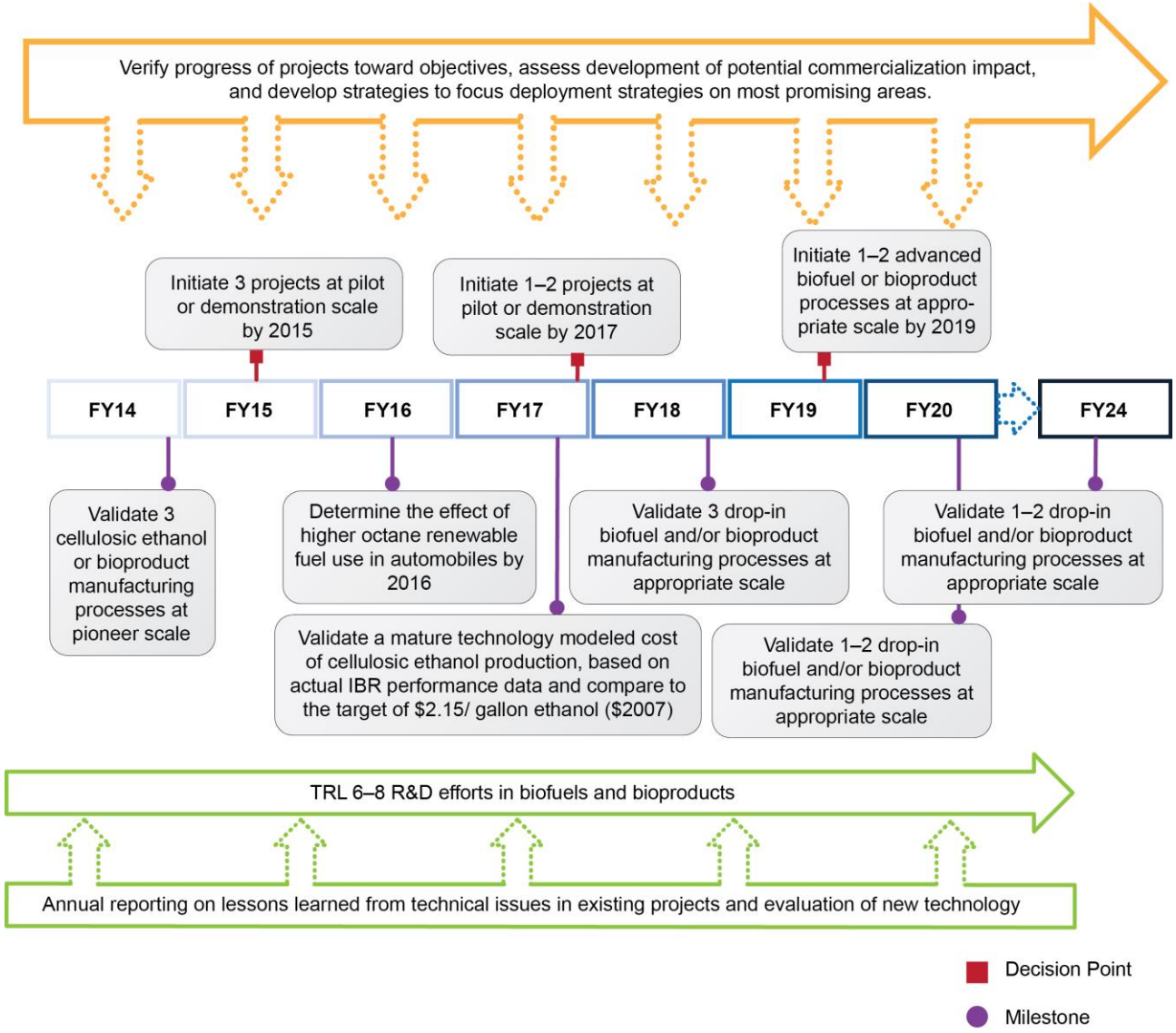


Figure 2-26: Description of key objectives at each integrated biorefinery scale

Demonstration & Deployment Timeline



Sustainability

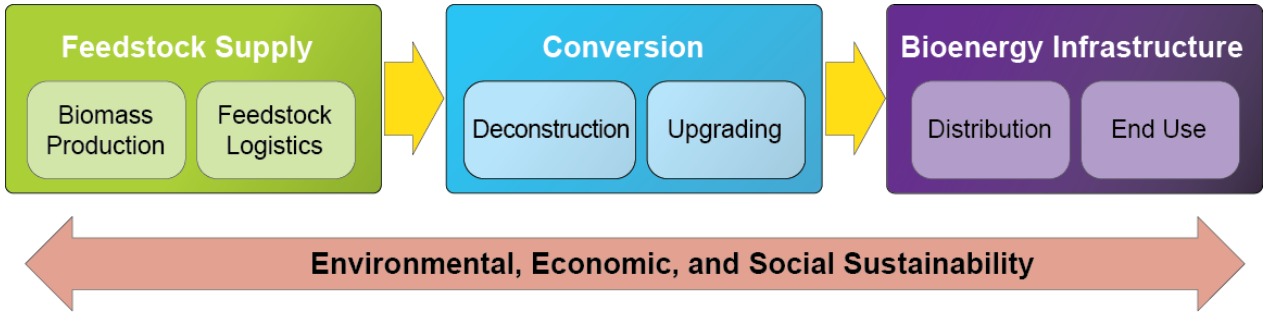


Figure 2-32: Sustainability across the bioenergy supply chain

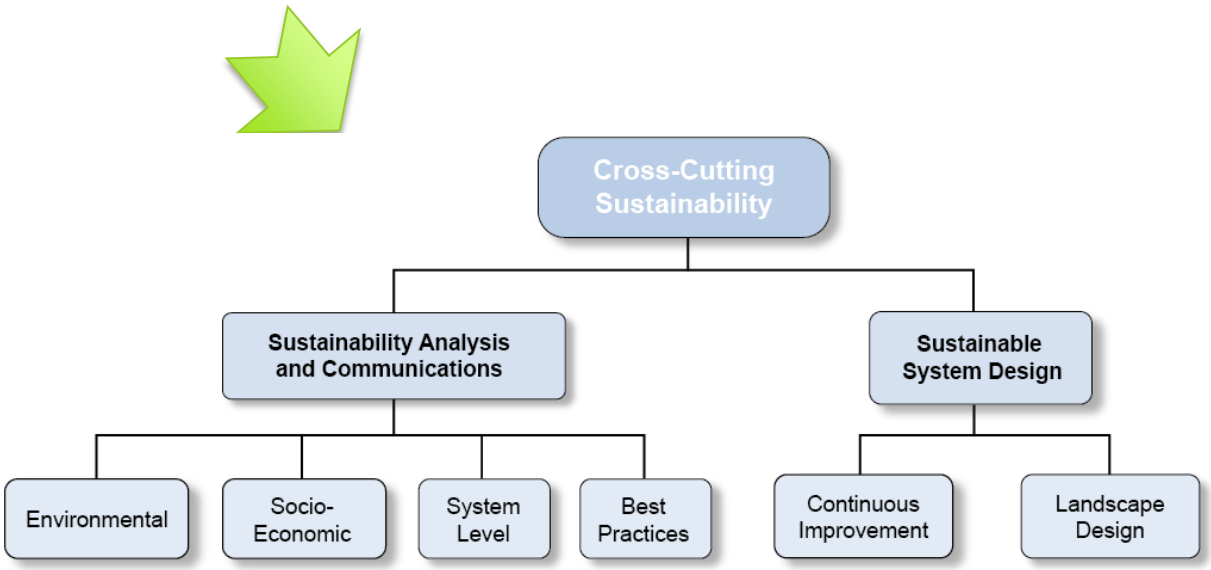


Figure 2-33: Sustainability work breakdown structure

Sustainability

- Changes reflect increasing maturity, data, and consensus towards indicators and metrics
- Focus on sustainable system design

Figure 2-31: Bioenergy Technologies Office sustainability scope

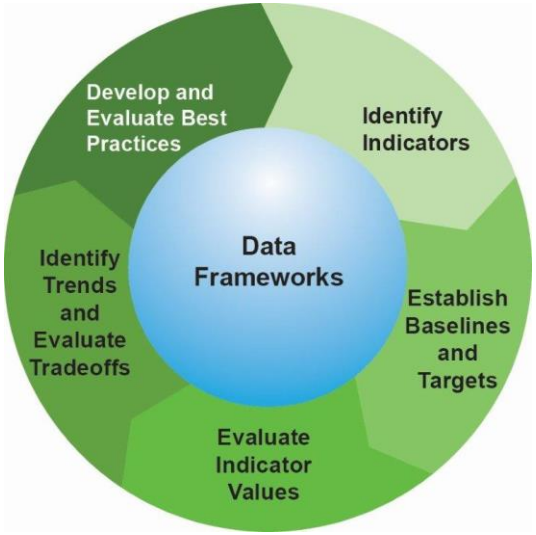


Figure 2-34: Sustainability activities

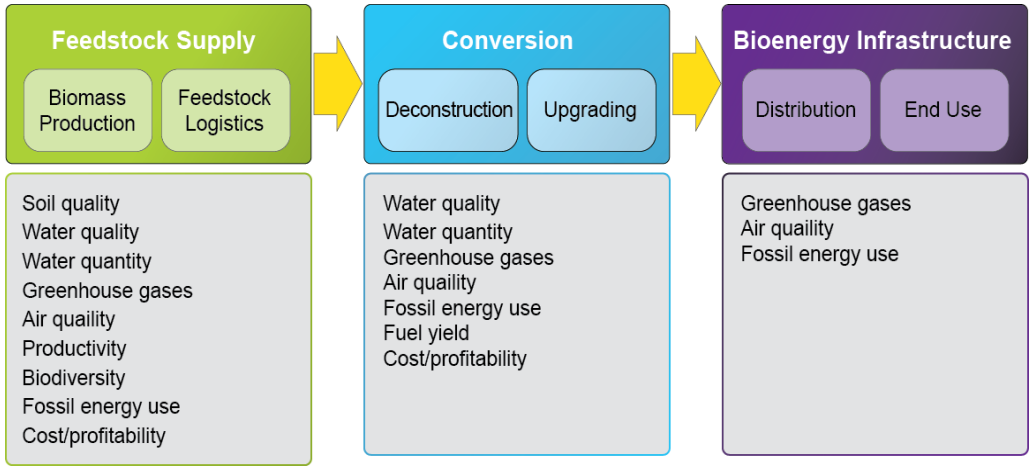
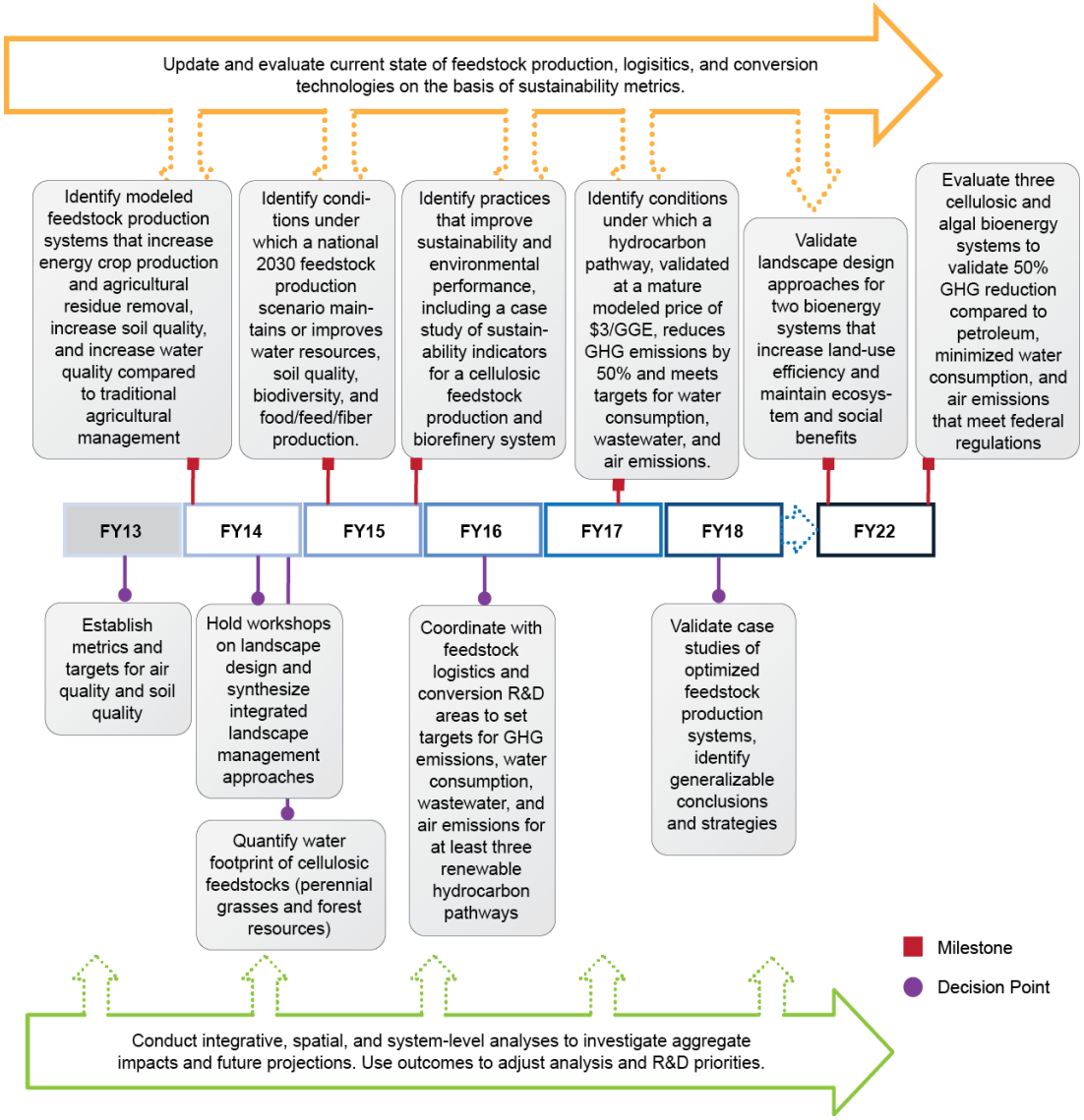


Figure 2-35: Sustainability considerations by supply chain component

Sustainability Timeline



Strategic Analysis

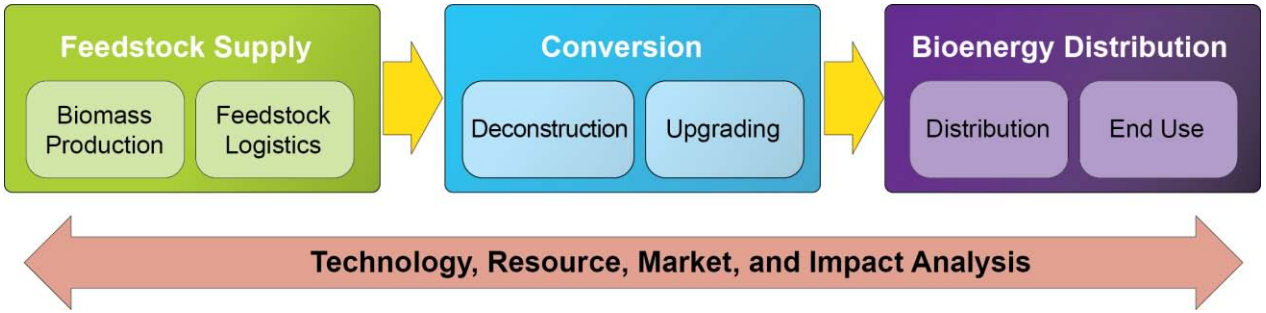


Figure 2-37: Strategic Analysis supports the entire supply chain

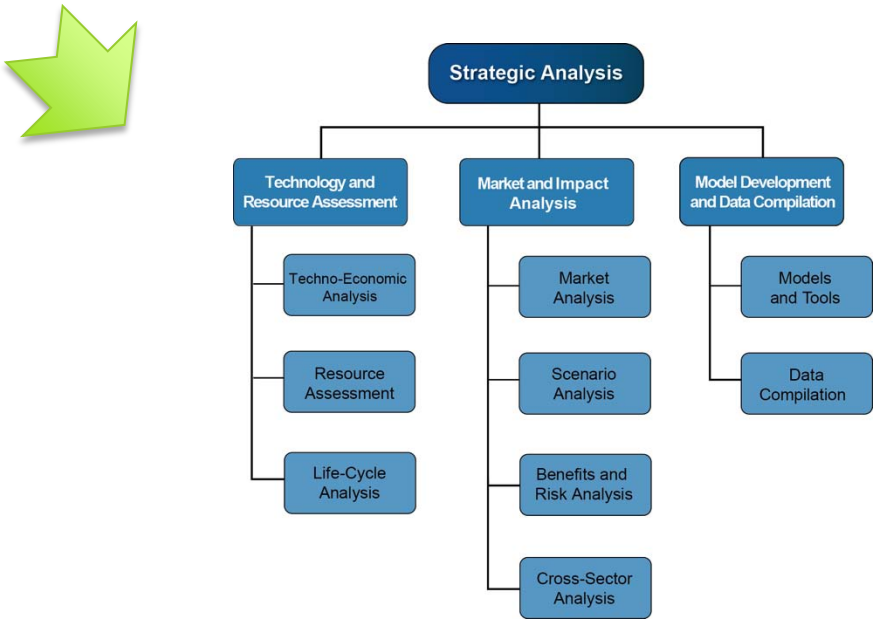
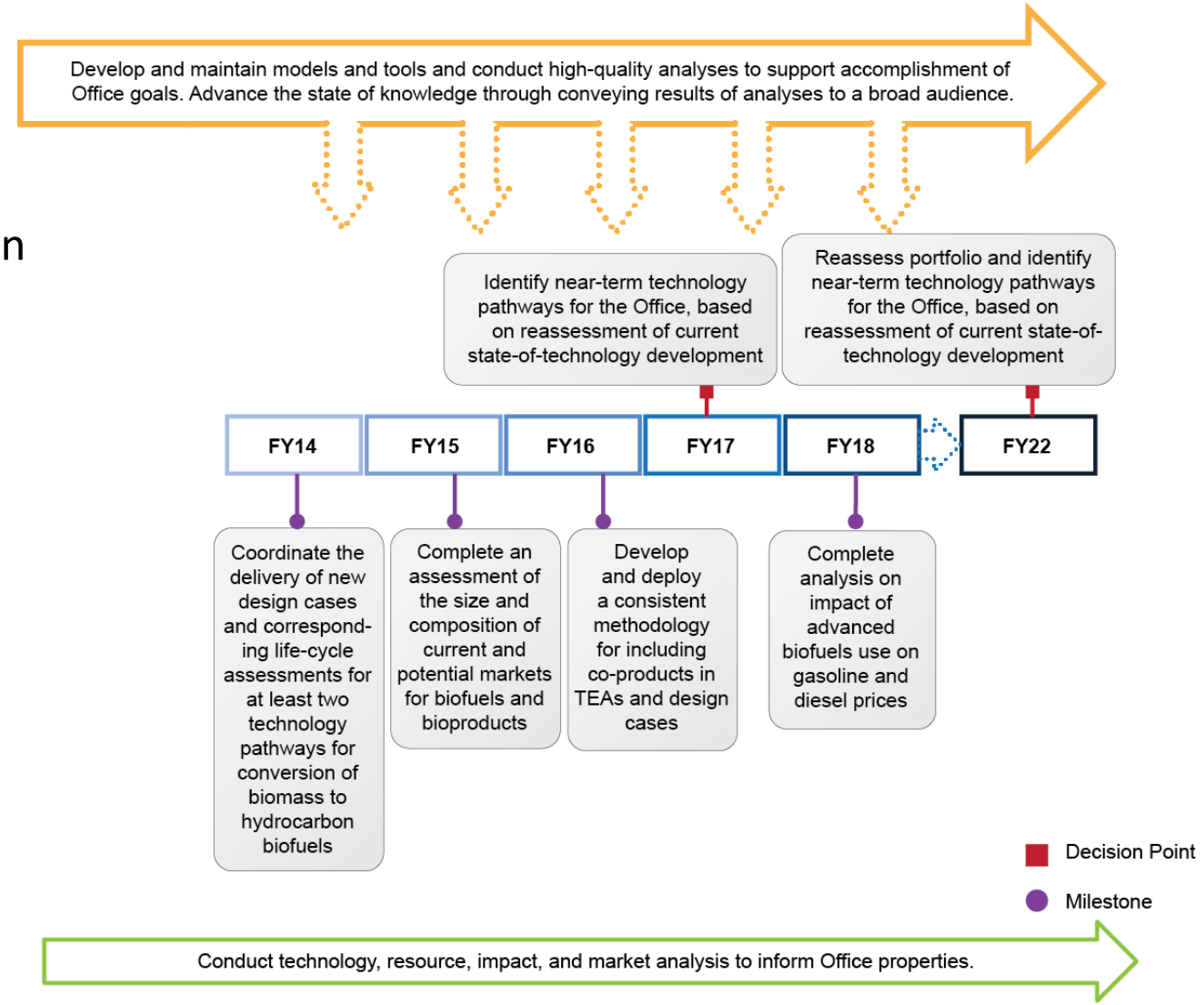


Figure 2-38: Strategic Analysis work breakdown structure

Strategic Analysis

- More strategic, outcome orientation
- Strengthened milestones and timeline



Strategic Communications

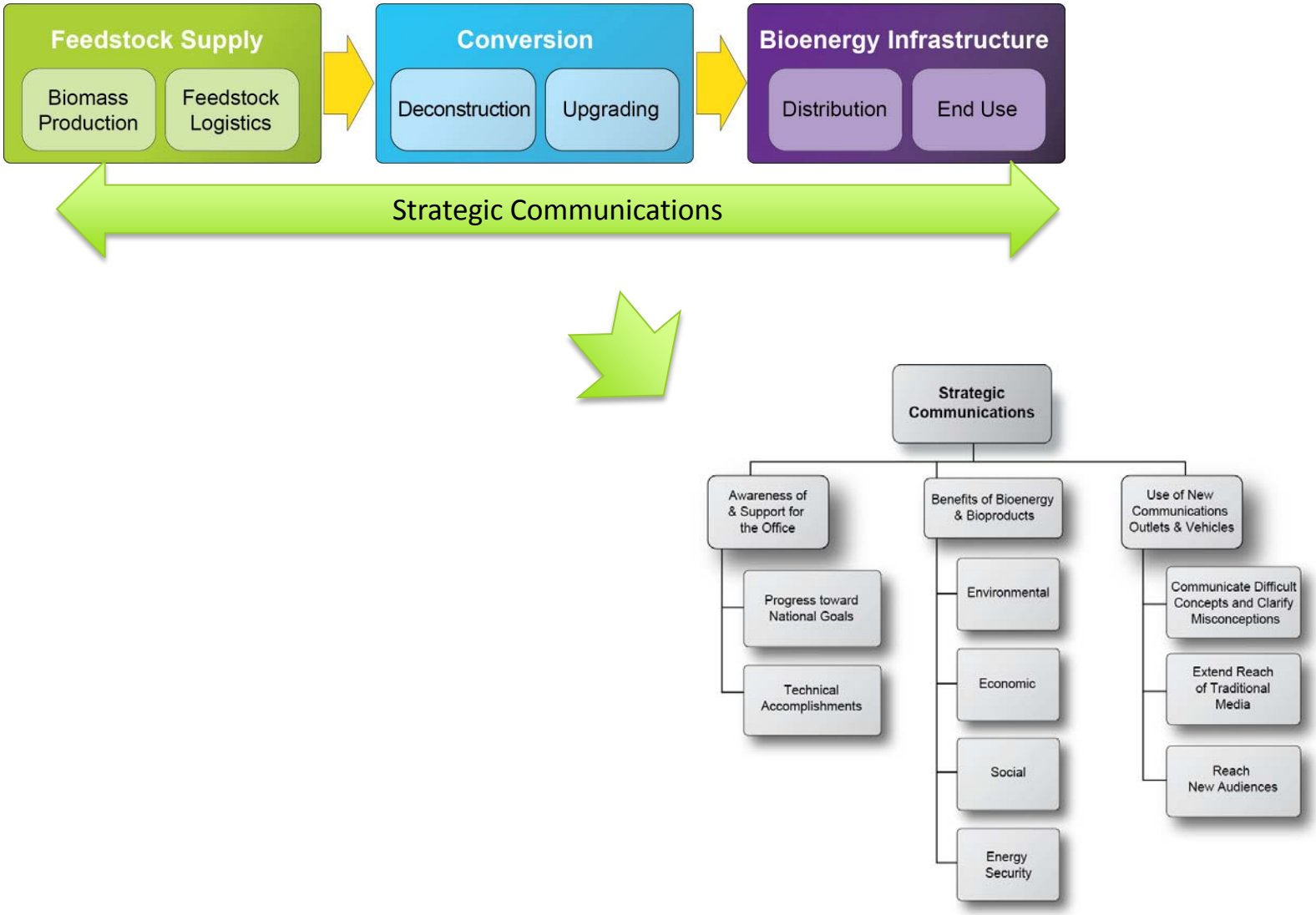


Figure 2-41: Strategic Communications Work Breakdown Structure

Strategic Communications

- Increased emphasis
  - Recognizing successes
  - Communicating impact
  - Stakeholder outreach
- Proactive communication
  - Cellulosic biorefinery industry coming online
  - Future direction

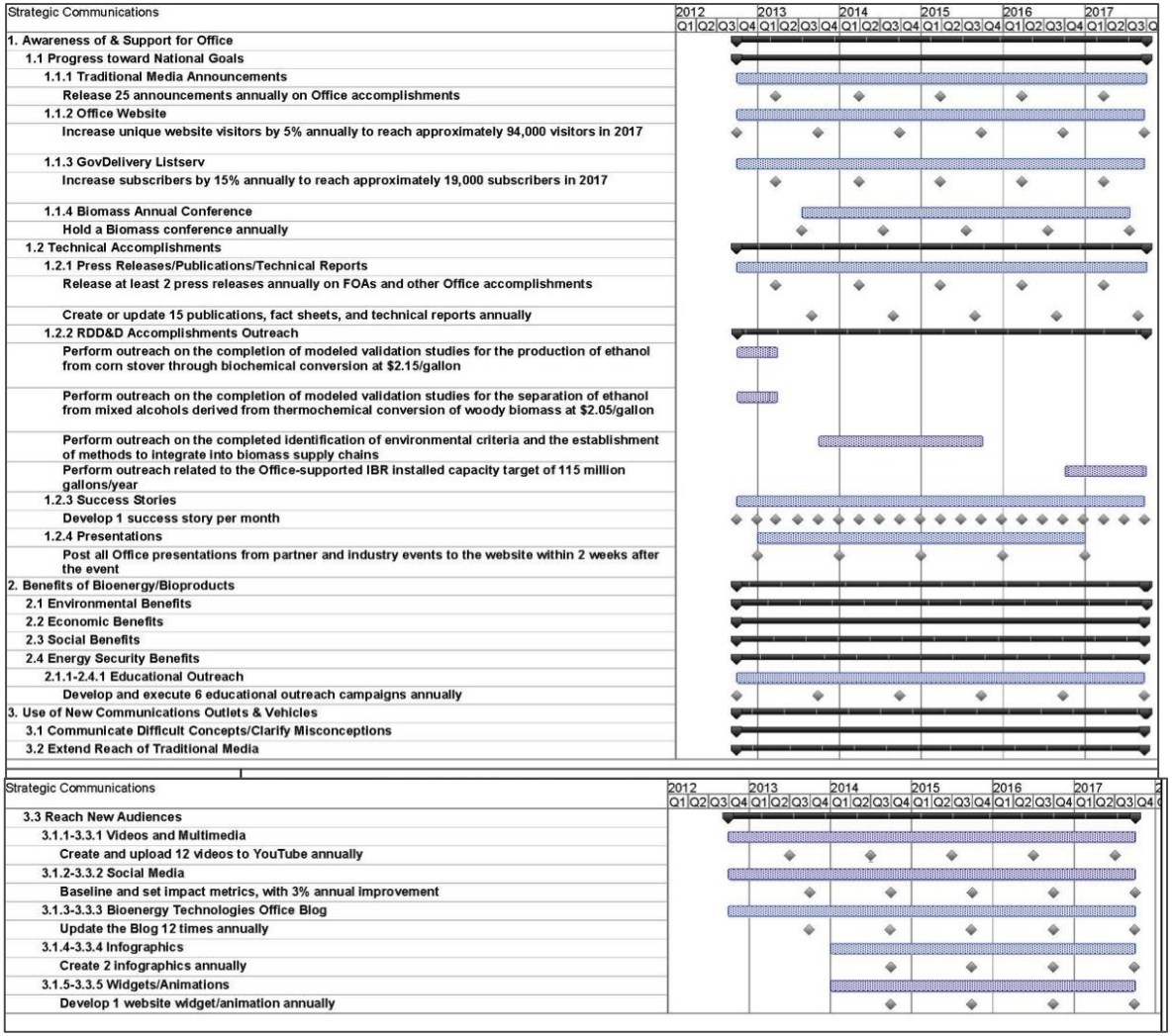
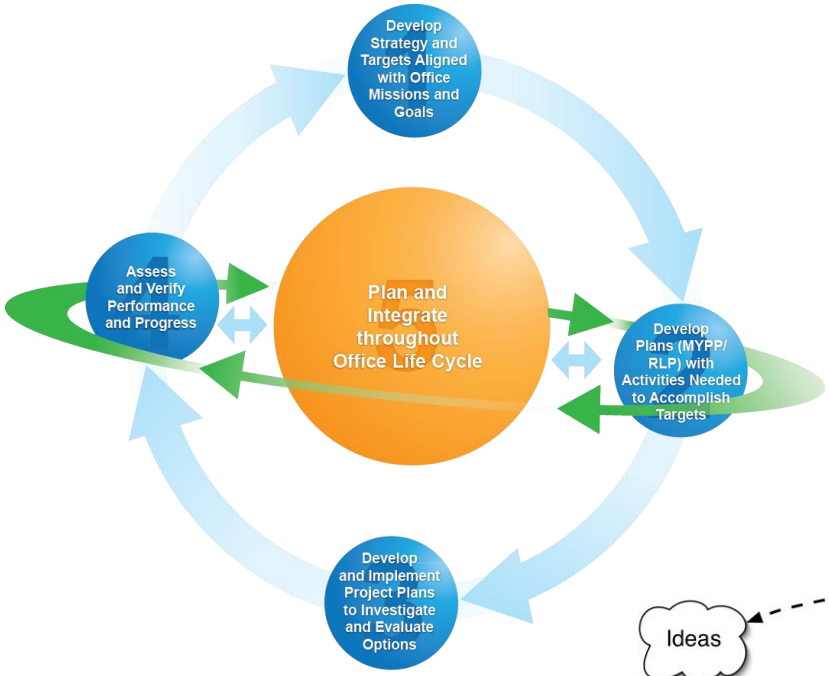
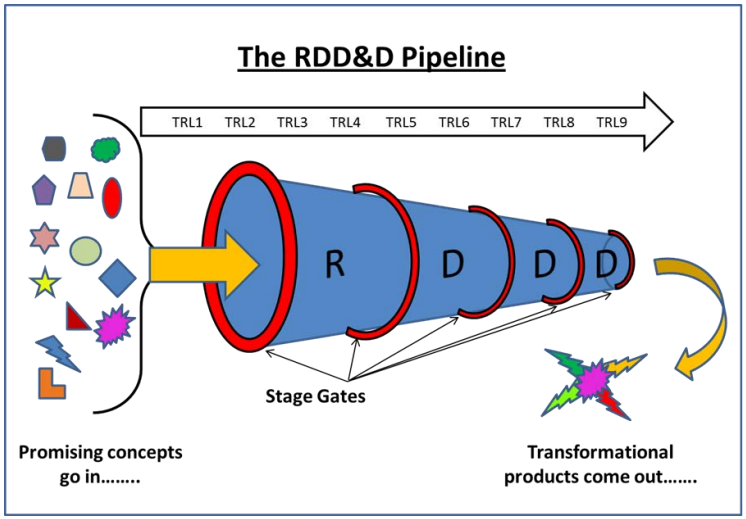


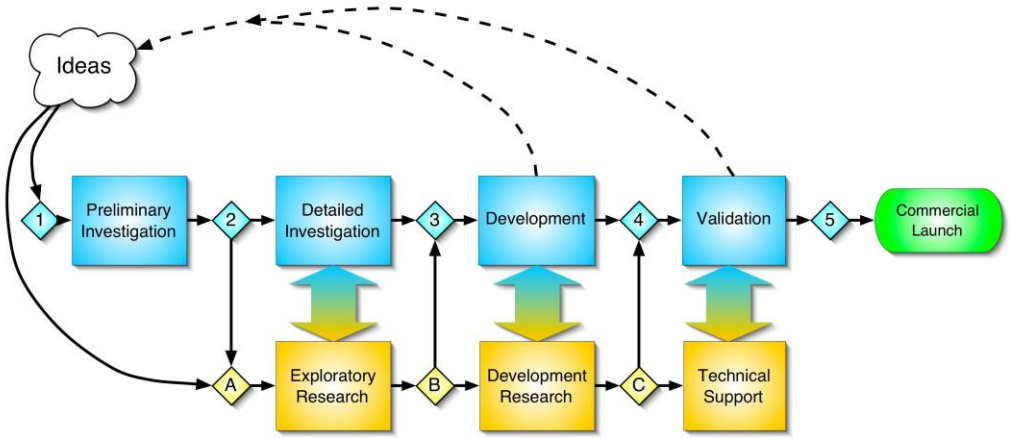
Figure 2-42: Strategic Communications Gantt chart

Section Three: Portfolio Management

- Documents Office portfolio management across the development pipeline
- Updated for IBR Comprehensive Project Reviews







Future Changes

- New technology pathway design cases/goals and targets
- Expanded role of products as enablers to biofuels
- Expanded focus on markets beyond light duty vehicles

Multi Year Program Plan Available online:

http://www1.eere.energy.gov/bioenergy/pdfs/mypp_july_2014.pdf