

2017 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BIOENERGY TECHNOLOGIES OFFICE

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

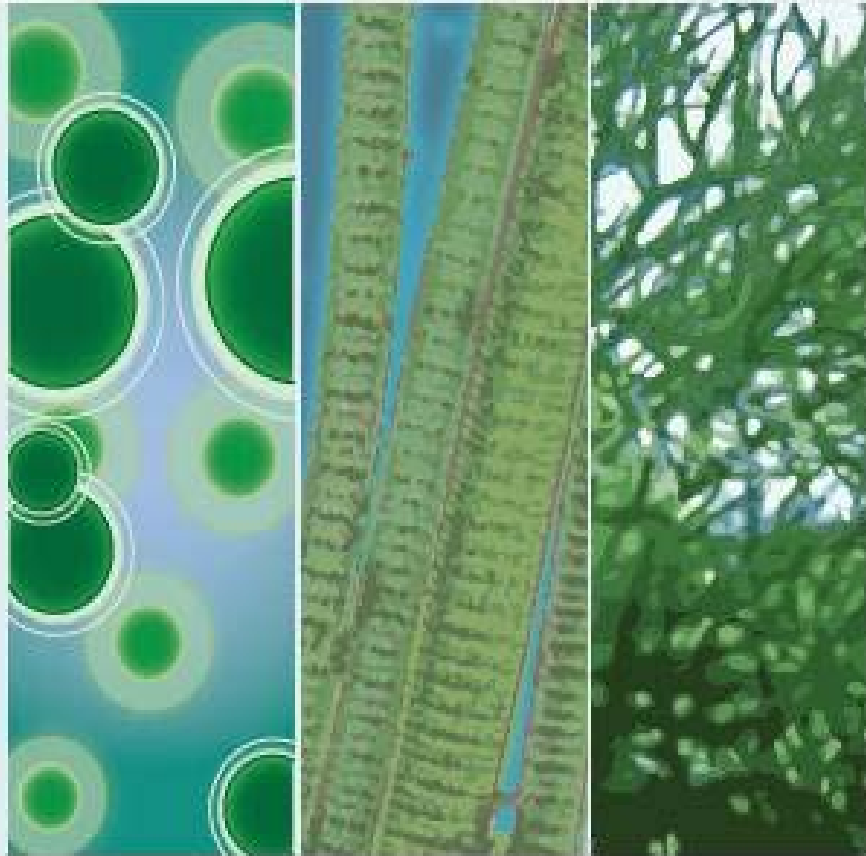


Advanced Algal Systems

Alison Goss Eng

Program Manager

Advanced Algal Systems Program Overview



- **The Team**
- **Goals**
- **Focus Areas**
- **Strategic Approach**
- **Funding History**
- **Key Accomplishments**
- **Upcoming Activities**

Introductions – The Advanced Algal Systems Team



Alison Goss Eng



Daniel Fishman



Christy Sterner



Devinn Lambert



Mike Resch



Colleen Tomaino



Evan Mueller



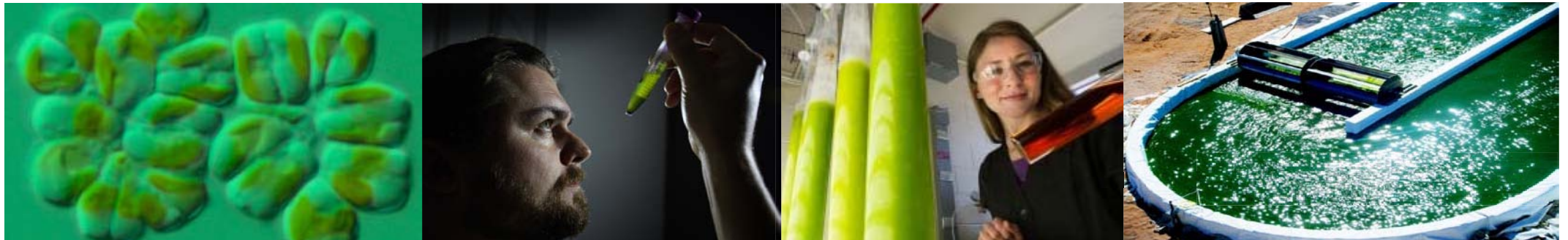
Brendan Scott

Advanced Algal Systems – Goals and Approaches

Strategic Goal: *Develop algae production and logistics technologies that, if scaled-up and deployed, could support the production of 5 billion gallons per year of sustainable, reliable, and **affordable** algae-based advanced biofuels by 2030.*

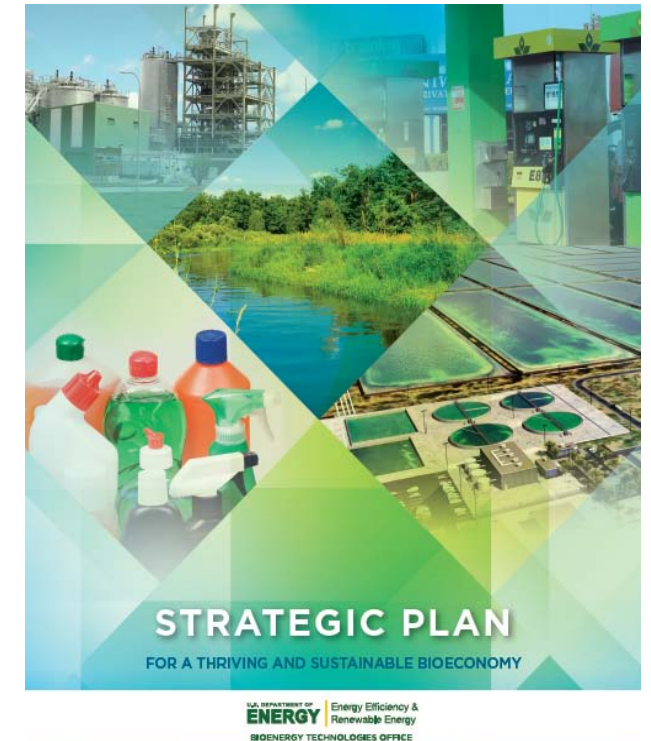
Approaches:

- Advanced biology and culture management to increase productivity
- Low-cost, scalable cultivation and harvesting systems that minimize use of energy, water, land, and nutrients
- Integrative analyses to identify critical technical and financial barriers
- High-value co-products that can be produced along with biofuels.



BETO Strategic Plan – Key Algae Goals and Strategies

- *Reduce delivered cost and risks associated with feedstock quality and volume to accelerate widespread commercialization of sustainable biomass supply chains for a broad range of markets.*
- *Incorporate sustainability as a market enabler by establishing the value of ecosystems services.*
- *Accelerate mobilization by enabling coproduct and value-added technologies.*



By 2022, at non-integrated pre-pilot scale, demonstrate algal yield of 5,000 gallons of biofuel intermediate per acre per year via an outdoor R&D cultivation volume of 60,000 liters (or equivalent for non-open pond cultivation systems), in support of nth plant model \$3/gge algal biofuels.

Algae Focus Areas

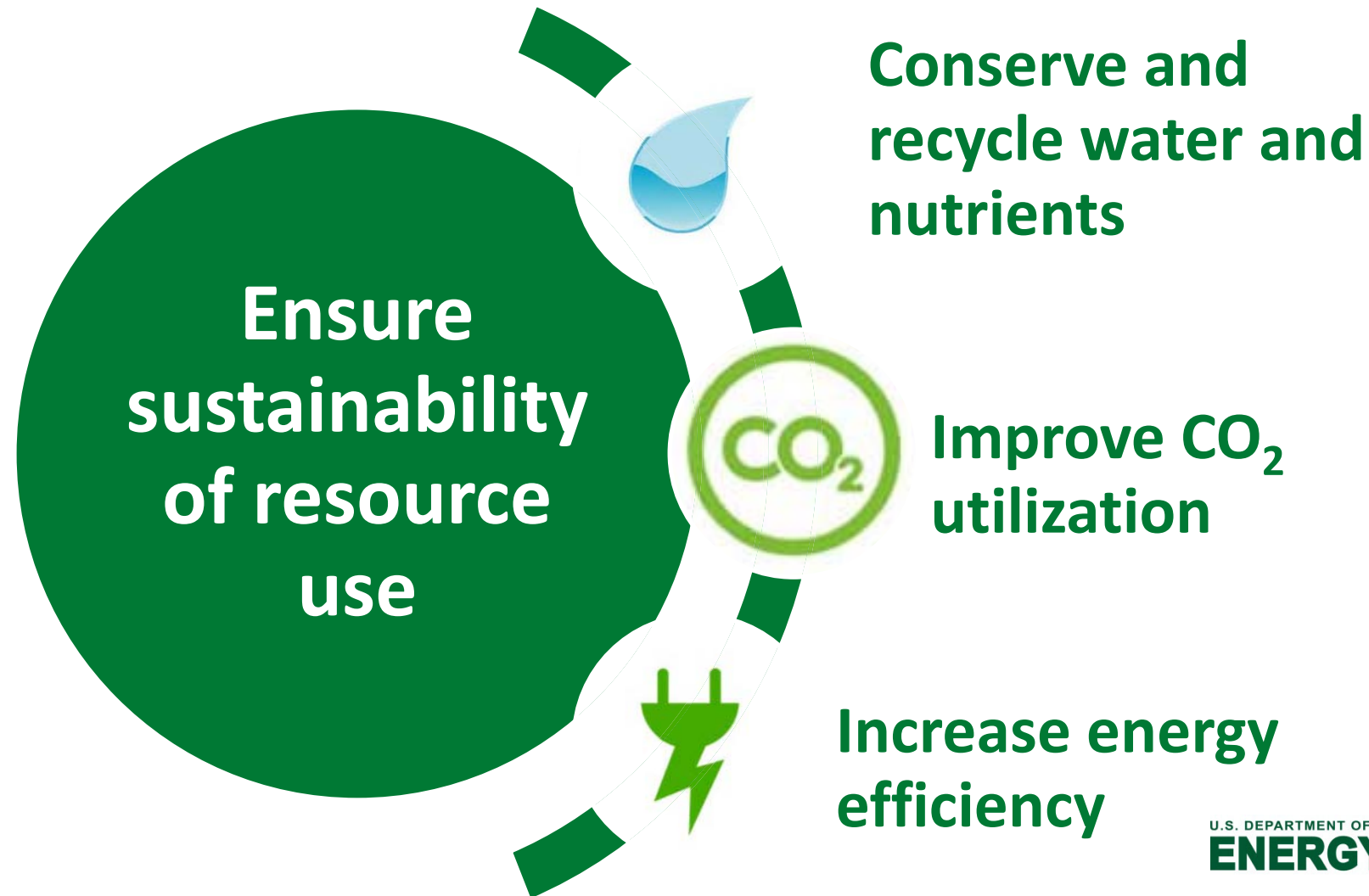


Increase Value
of Biomass

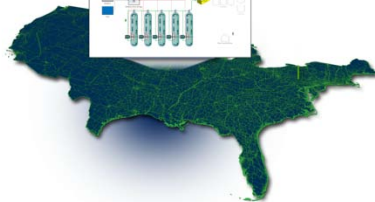
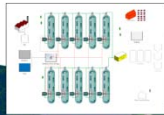
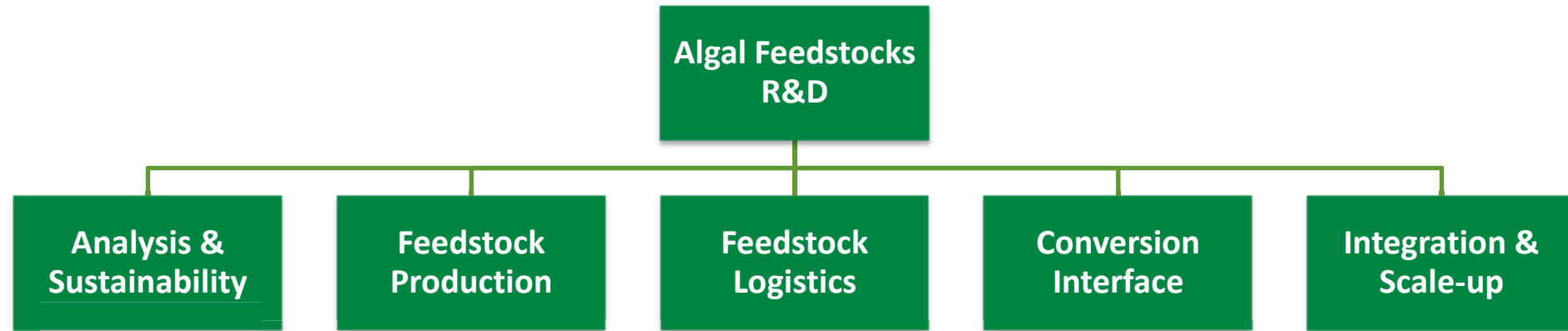
Reduce Costs
of Production

Strategies focus on improving biomass **productivity** and **yield**, and increasing the value of the biomass with **co-products**.

Algae Focus Areas



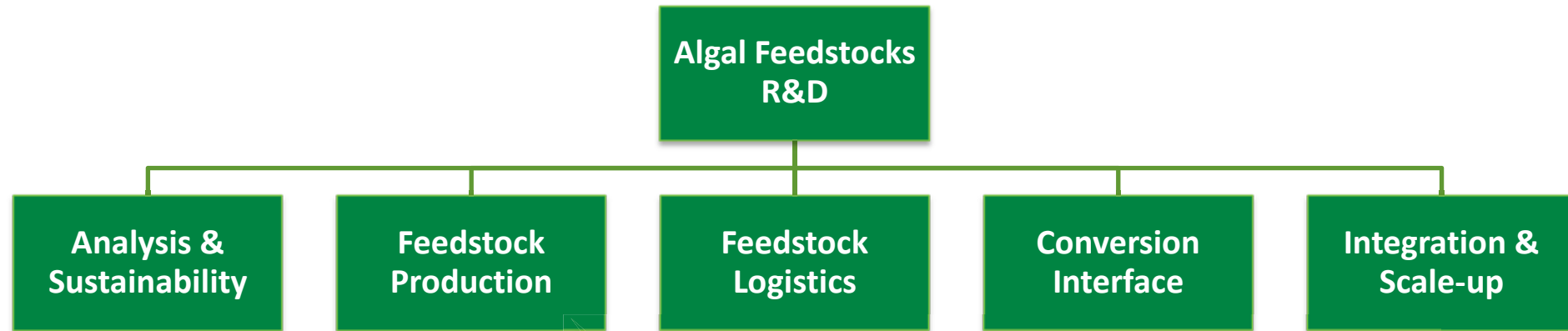
Algae R&D Strategy: Work Breakdown Structure



Conduct integrated:

- *Techno-economic analyses,*
- *Resource assessments, and*
- *Life-cycle assessments*

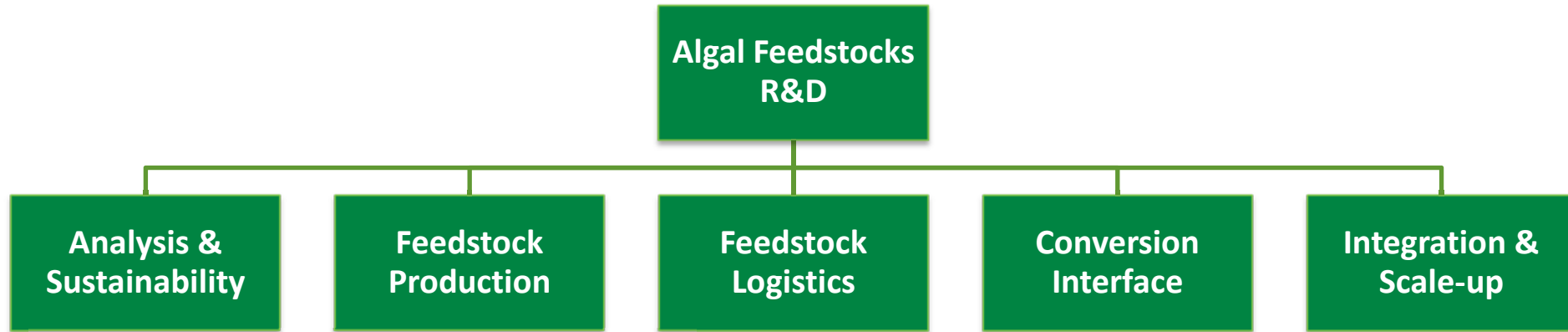
Algae R&D Strategy: Work Breakdown Structure



Develop stable algal cultures that:

- *Produce high yields,*
- *Resist predators, and*
- *Are suitable for cultivation in farming operations*

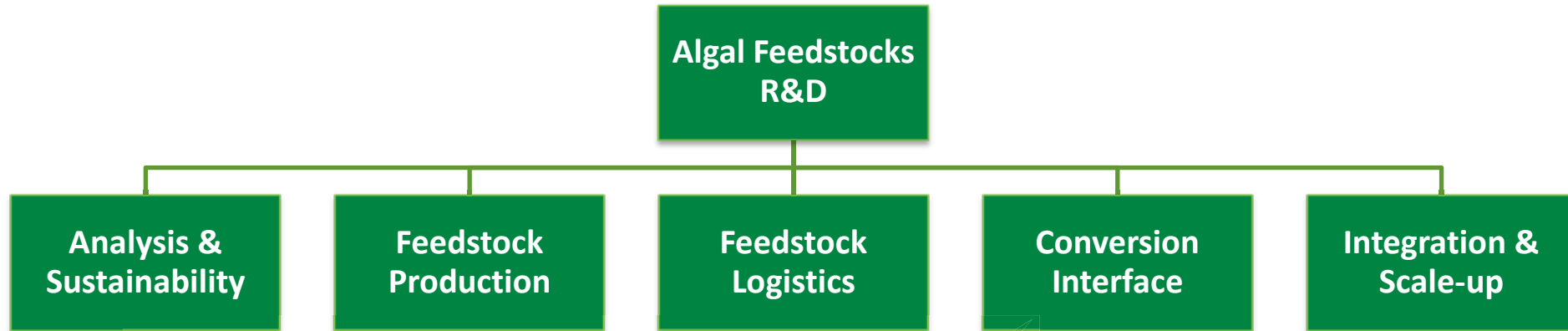
Algae R&D Strategy: Work Breakdown Structure



Reduce costs and improve efficiencies of:

- *Algae harvesting,*
- *Processing, and*
- *Stabilization and transport*

Algae R&D Strategy: Work Breakdown Structure



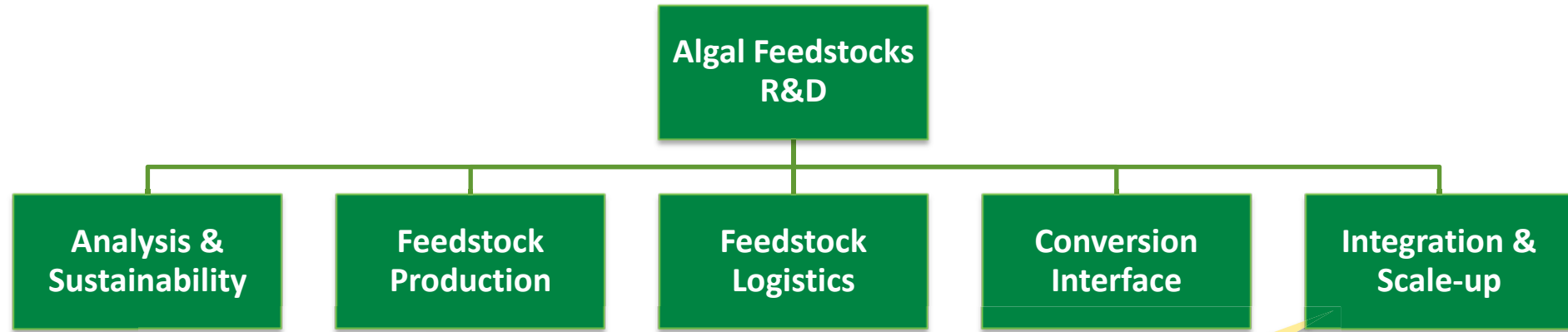
Examine the integration of feedstock production and preprocessing and conversion technologies, such as:

- *Lipid extraction*
- *Fermentations*
- *Hydrothermal liquefaction*
- *Co-products development*



Photo courtesy of PNNL

Algae R&D Strategy: Work Breakdown Structure

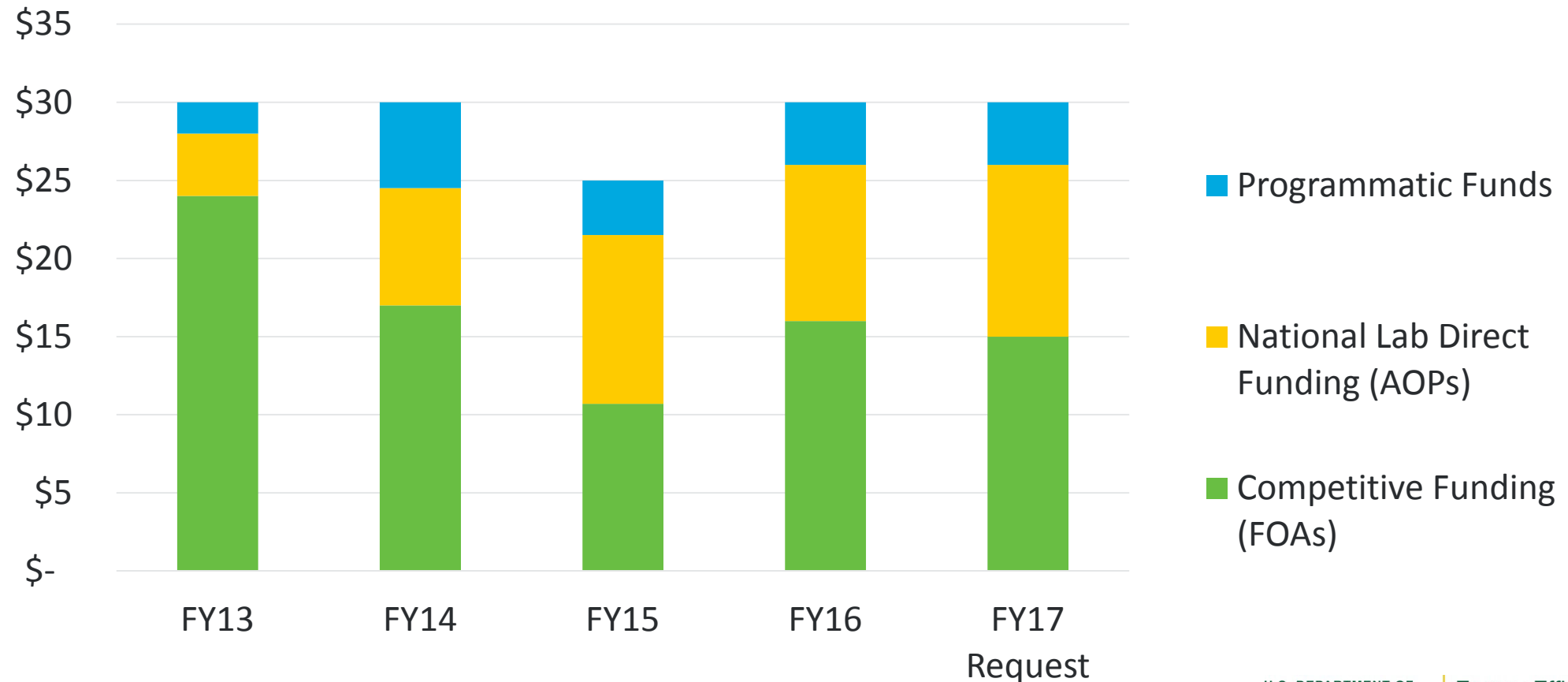


Conduct experiments in outdoor test environments as part of an iterative development process to validate improvements



Algae Funding: Stable over time

Advanced Algal Systems R&D Funding, in millions



Algae R&D Strategy: Competitive Funding

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

Advancements in Sustainable Algae Production

Advancements in Algal Biomass Yield

Targeted Algal Biofuels and Bioproducts

Advancements in Algal Biomass Yield Phase 2

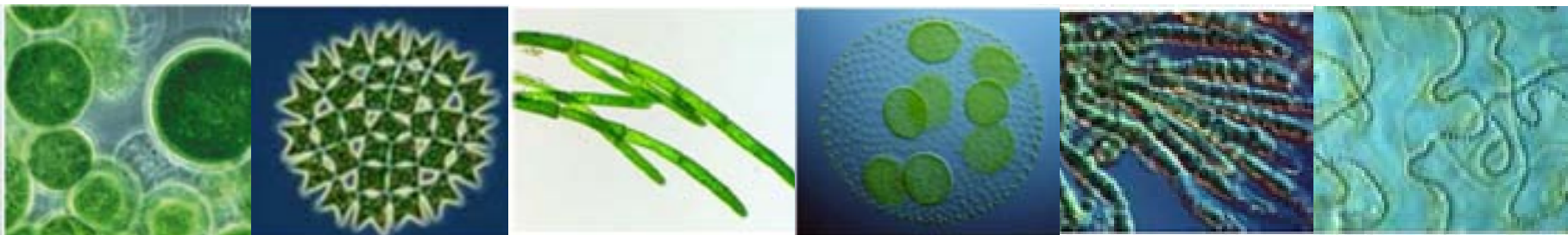
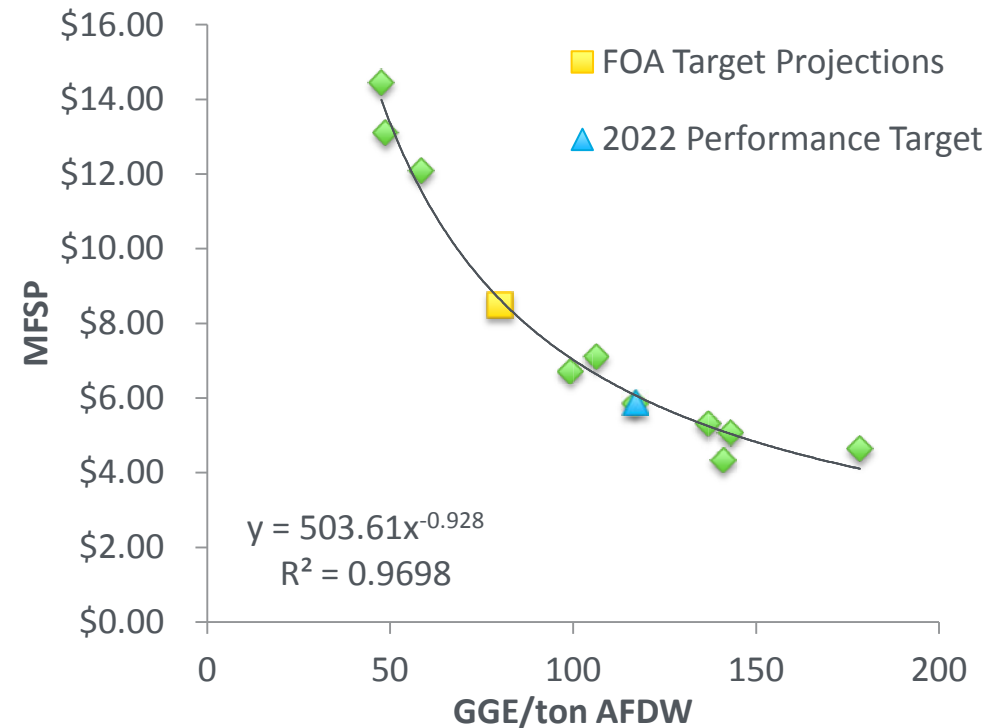
Productivity Enhanced Algae and ToolKits

Productivity Enhanced Algae and tool-Kits (PEAK) FOA

PEAK will advance the algal biofuels state of technology via:

- biological strategies to improve to **productivity** and **yield**
- and novel algal **toolkits** and methods

Up to \$8M for 2-4 projects, anticipated in June



Key Accomplishments



Market Transformation

The Consortium for Algal Biofuel Commercialization (CAB-Comm) developed genetic tools for green algae, cyanobacteria, and diatoms that are now available for purchase online through Life Technologies.



Significant Biomass Yield Improvements

Projects in the FY13 Advancements in Algal Biomass Yield (ABY) Phase 1 portfolio met a crucial milestone, demonstrating their ability to produce 2,500 gallons of biofuel intermediate per acre on average annually.



Workforce Development

Algae Technology Education Consortium (ATEC) developed a certificate program for students who want a specialized degree in algal sciences.



Industry Standards

The Algae Testbed Public-Private Partnership (ATP3) collected unified field data from diverse geographic sites to inform national laboratory analyses. NREL published standardized laboratory methods for industry use.

Key Accomplishments

National Algal Biofuels Technology Review

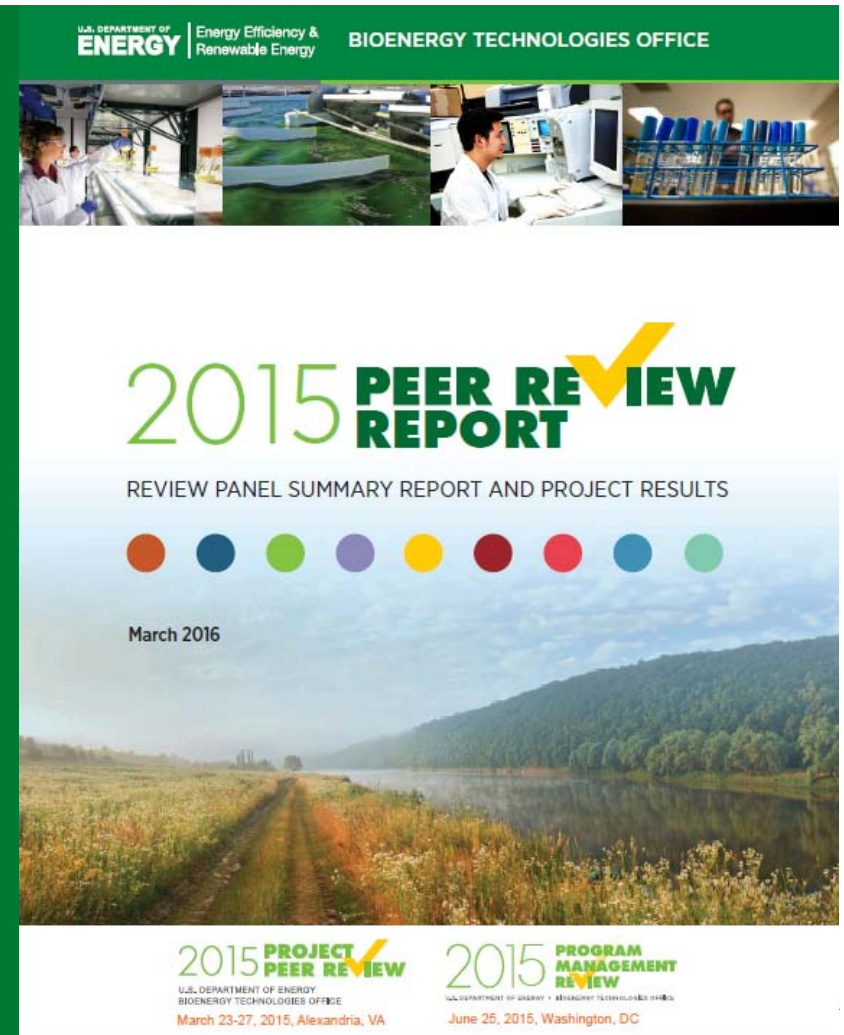
BETO hosted multiple public workshops, worked closely with research partners, and received review and comment from over 76 independent subject matter experts to summarize the state of technology for algae-based fuels and document the research and development challenges associated with producing them at a commercial scale.

This 2016 report is a valuable resource to the research and development community.



Key Changes Since 2015 Peer Review

- ✓ Formalized the incorporation of a bioproducts strategy
- ✓ Directed work on non-freshwater strains
- ✓ Increased investment in biomass yield and productivity improvements



Upcoming Activities

- Support implementation of **BETO Strategic Plan**
 - Incorporated co-products strategy into MYPP cost targets
- Coordinate with DOE **Fossil Energy** on carbon capture and utilization activities
 - Host a **workshop** in spring 2017 on this topic!
- Initiate next phase of research on yield improvement towards FY20 goal of 3,700 gal of intermediate/acre/year via the **ABY2 FOA selections**.
- **Make PEAK FOA selections this summer (aspirational)!**
- Achieve FY17 goal of modeling the sustainable supply of 1 million metric tonnes (ash free dry weight) cultivated algal biomass. (Harmonization effort among NREL/ANL/PNNL/ORNL)

Introductions – Peer Reviewers

- **Eric Jarvis, Nexajoule (Lead Reviewer)**
- **Toby Ahrens, NIFA USDA**
- **Louis Brown, Synthetic Genomics**
- **Bill Crump, Leidos**
- **Rebecca White, Qualitas Health**
- **Sarah Smith, Scripps Institution of Oceanography**

THANK YOU, REVIEWERS!