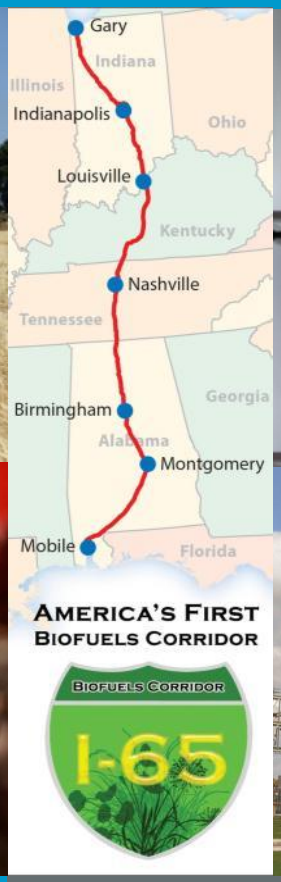
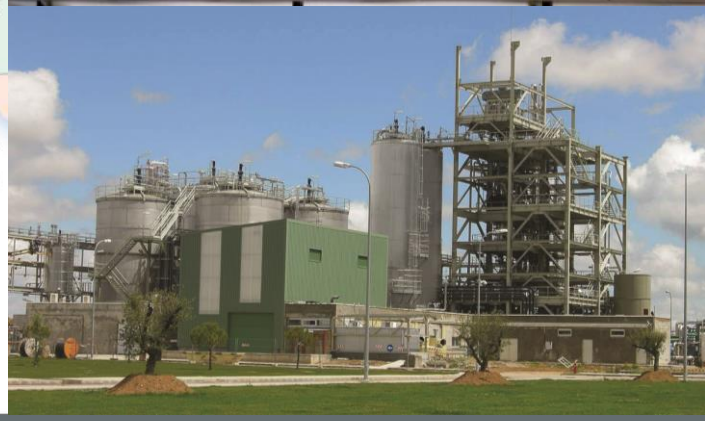
BIOENERGY TECHNOLOGIES OFFICE

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





Program Management Review
June 25, 2015

Jonathan Male

Director, Bioenergy Technologies Office (BETO)

Outline

I. BETO Portfolio
II. Coordination of Technology Areas
III. Synergies
IV. Project Impacts
V. Technology Pathways
VI. Budget Priorities
VII. Other Technologies & Market Trends
VIII. New Initiatives

BETO Portfolio

- **Integration of lessons learned for IBRs**
  - *BETO's IBR Investment Report has been finalized and will be published soon*
  - *DOE released an RFI on IBR lessons learned in July 2013, and had a workshop in March 2014, to gather information from diverse stakeholders*
- **Lack of new IBR projects**
  - *DPA projects are getting underway (more detail on next slide)*
  - *Plans for a Pilot & Demonstration FOA to be released later this year*
- **Expand communications strategy**
  - *Engaged in robust communications and outreach strategy – new documentary on sustainability; annual conferences, the Bioenergy Quiz, BioenergizeMe Initiative, educational tool box for diverse audiences and age groups*
- **Increase opportunities & strategically collaborate with stakeholders**
  - *The "Pitch" session at Bioenergy 2015, Small Business Vouchers, Tech-to-Market, Lab engagement strategies*

Defense Production Act (DPA) Initiative

In September 2014, 3 projects were selected under the DPA Initiative to build commercial biorefineries to produce:

- Drop-in fuels for military applications
- Domestic fuels from non-food biomass feedstocks
- Cost-competitive biofuels (w/o subsidies)

Company	Location	Feedstock	Capacity	Groundbreaking	Off-Take Agreements
Emerald Biofuels	Gulf Coast	Fats and Greases	82.0 MM g/y	TBA	TBD
Fulcrum Bioenergy	McCarran, NV	MSW	10.0 MM g/y	Spring/Summer of 2015	Cathay Pacific
Red Rock Biofuels	Lakeview, OR	Woody Biomass	12.0 MM g/y	TBA	Southwest Airlines

Interagency initiative to produce more than 100 MM g/y of advanced biofuels

BETO Portfolio

- **Increase emphasis on high value co-products**
  - *TABB FOA, plans for new Pilot/Demo FOA in FY15 Q4, and the upcoming Bioproducts to enable Biofuels Workshop (July 16)*
- **Need to support distributed business models and depots**
  - *(1) Advanced Feedstock Supply System/"Depots" and (2) centrally manufactured, small modular reactors for distributed conversion*
- **Less emphasis on algae conversion technologies and more emphasis on algal biomass production technologies**
  - *Need to address multiple supply chain components – production, harvesting/logistics, conversion to develop cost-competitive technologies*
- **Additional improvements needed on social aspects of bioenergy, including water and public health impacts**
  - *Sustainable Landscape Design FOA focused on social, environmental, and economic aspects of bioenergy at the community and landscape level (detail next slide)*

Landscape Design FOA

Landscape Design Funding Opportunity Announcement (FOA)

- Released on October 20, 2014
- DOE announced up to $14 million to support landscape design approaches that maintain or enhance the environmental and socio-economic sustainability of cellulosic bioenergy
  - Examples might include growing energy crops on marginal lands to improve both agricultural productivity and water quality, or utilizing agricultural residue in a way that enhances both profitability and soil quality
- Previous DOE projects have shown the potential for improved sustainability by strategically placing bioenergy feedstock production within a landscape
- Applications were submitted on January 26, 2015
- Evaluation of applications is currently underway

The Value of Advanced Feedstock Supply Systems (AFSS)

Adding value to biomass

- Develop cost-effective and high-volume handling methods through preprocessing and storage systems for producing uniform feedstocks of specific quality, while creating additional value for the producer and cost-savings for the biorefinery.

"Depot" refers to "a system or set of processes sized at the characteristic scale of biomass (i.e., small, modular and distributed) that transforms biomass resources into merchandisable, tradable, and aggregatable intermediates." Depots must become an economically independent business unit regardless of vertically integrated association with the biorefinery in order to create market pull.

Mitigating Risk

- Provide the "active" processes necessary to mitigate feedstock supply system risks for current biorefineries (e.g. ,fire, shrink, out of spec quality, weather impact, etc.)
- Stabilize and ensure supply to end users

The depot concept provides for a "transitional" strategy of value-added preprocessing such as blending, formulation, torrefaction, and other approaches to produce intermediate products that serve biorefining and other markets.

Developing feedstock into a commodity

- "Mobilize" biomass resources into the market place and produce value-add merchandisable biomass intermediates
- A commodity-scale resource will pull the cellulosic biorefining industry into existence for intermediate blends and beyond. Without it, the expanding biofuels market will continue to be predominately met with corn grain.

Outlook for development of Advanced Feedstock Supply Systems

	Short-term	Medium-term	Long-term
Ownership	Biorefineries (upstream investment)	+ Farmer cooperatives (prevent dockage fee)	+ Third-party (proven business model)
Location	At the biorefinery	+ High-yield areas, centralized location	+ Decentralized, low-yield, stranded feedstock areas with conglomeration in terminals
Single- vs. multi-feedstock	Single feedstock	+ Specialized depots, high-yield producing regions	+ multiple feedstock, blending option
Sizing	Pilot and small-scale (<40,000 tons p.a.)	+ Medium to large-scale (> 80,000 tons p.a.)	
Preprocessing intensity	Conventional pelleting	+ Advanced (multiple markets)	
End-use markets	Biorefineries	Multiple U.S. markets, e.g., cattle feed, biorefineries	Multiple international markets

Coordination of Technologies Areas

- **Significant need for greater interagency cooperation and coordination**
  - *Landscape Design FOA, BRDI, and plans for new collaborations and partnership between DOE/USDA*

- **Need for enhanced coordination between R&D and lessons learned**
  - *Appropriate balance between lessons learned and giving companies competitive advantages*

Synergies

- **Need to understand outcomes from previous projects and translate research questions into new lab AOPs/FOAs**
  - *Purpose of the peer review and active project management process*
  - *Ex: Expanded effort on feedstock conversion interface*
- **Many scale-up issues cannot be identified without operating pioneer commercial-scale facilities**
  - *Lack of DOE funding for pioneer scale biorefineries; BETO looking to other DOE and USG partners*
  - *Additional insights are needed on how these issues can be identified at the demonstration-scale*
- **High turnover in DOE/BETO creates risks that learnings may not be captured or retained for future use**
  - *Working on improved hiring with DOE as well as mentoring for new staff*

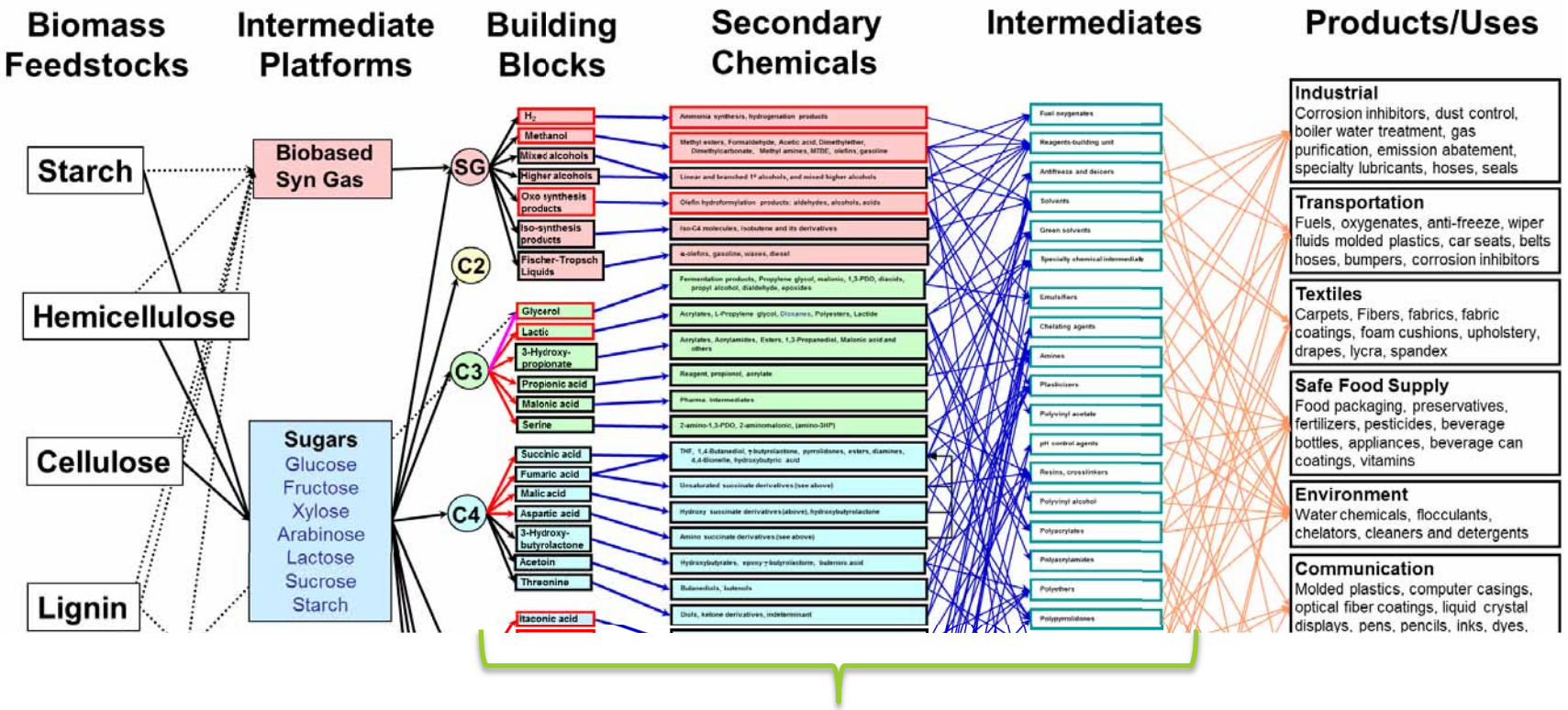
Project Impacts

- **Continue to support high-risk, unconventional research**
  - *NOI for Incubator Phase 2 was announced at Bioenergy 2015*
  - *Working with NSF, Office of Science, and ARPA-e*
- **Many projects focus on studying problems rather than solving them**
  - *Active Project Management is becoming increasingly focused on impacts, meeting milestones, and alignment with the MYPP*
- **Need to understand international finance and policy drivers that drives off-shoring of biorefineries**
  - *All international collaborations must emphasis tangible benefits to the U.S.*
  - *BETO looks to better understand policy/market drivers pushing companies out of the U.S.; ex. recent plenary session at Bioenergy 2015*

Technology Pathways

- **Waste streams to energy needs to have significantly more investment**
  - *Multiple waste-to-energy workshops, including wet waste (more detail on next slide)*
- **Identify and improve support for relevant co-products that improve economics and sustainability for each pathway**
  - *BETO projects on new uses for lignin and the production of succinic acid and other products (more detail on next slide)*
- **Promote petroleum refinery co-location and other site-leveraging opportunities**
  - *Multiple workshops and trainings for BETO staff; leveraging results of the BOSC FOA.*

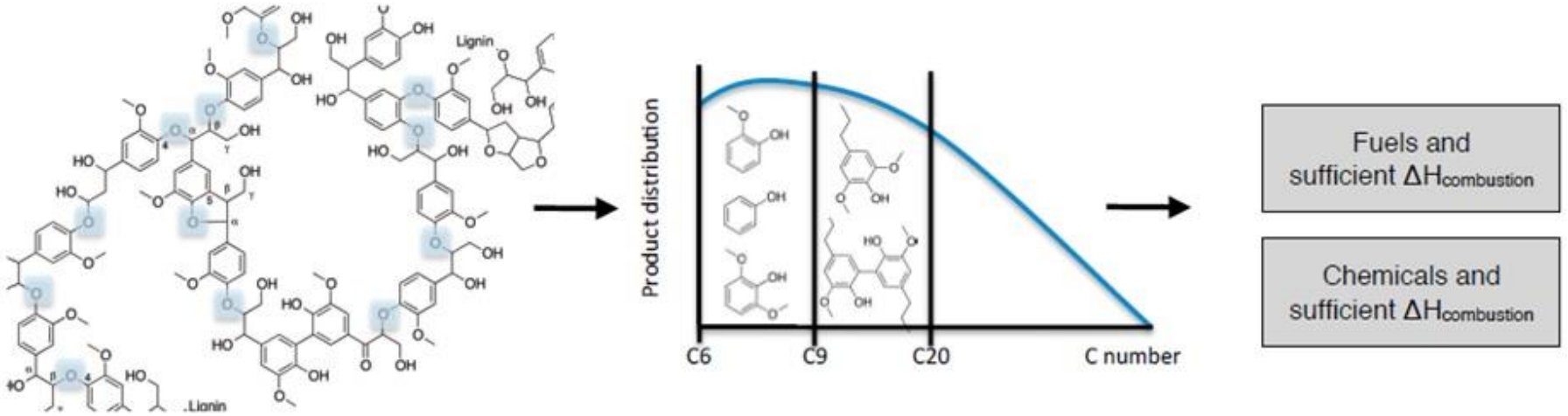
Bioproducts to Enable Biofuels



- Innovative approaches for bioproducts:
  - Molecular replacements for petroleum derived chemicals
  - Performance replacements for petroleum derived chemicals
    - Infancy stage – play to the strength of the oxygenated polymers in biomass
  - Lignin and waste streams to value added products (X2 the cost of biofuels on a mass basis)

Lignin Valorization at NREL

TEA shows that lignin utilization is essential to meet $3/gge target in 2022 (Davis et al., 2013)



Depolymerization
- Obtain lignin in liquid phase at high yield
- Quantify/understand impact to polysaccharides

Upgrading
- Convert lignin to fuels and chemicals
- Leverage known deconstruction methods
- Develop new upgrading processes

De-polymerization and upgrading (from NREL - Lignin valorization through integrated deconstruction, biological funneling, and catalysis, Gregg T. Beckham) Linger, Vardon, Guarnieri, Karp, *et al., PNAS,* 2014

Wet Feedstocks of Interest

- **The non-recyclable wet organic fraction of landfill solid wastes**. The dry fraction is already included as a Terrestrial Feedstock. Food wastes from landfills are a particularly interesting subset, as they constitute the largest single fraction of currently unrecovered wastes
- **Biosolids and sludges** from municipal wastewater treatment processes. While the wastewater industry is undergoing a paradigm shift towards viewing themselves as water resource recovery facilities, much work remains to realize this vision
- **Manure** slurries from concentrated livestock operations
- **Organic wastes from industrial operations**, including but not limited to food and beverage production and cellulosic biorefineries. Other industries such as pulp and paper, forest products, and pharmaceuticals also generate streams that might be suitable for incorporation.
- **Landfill biogas** – did not get included in this MYPP round, but should be considered in the future.

Budget Priorities

- **Funding for conversion technologies versus feedstocks is very skewed**
  - *Working to decouple funding for terrestrial feedstocks with respect to algal funding which historically has been mandated by Congress*
- **More dissemination of accurate information to educate public and decision makers**
  - *Technology area fact sheets, state fact sheets, and regular briefings to Congressional committee, staffers, and DOE leadership*
- **More focus on analysis around social and community aspects, siting, environmental permitting etc.**
  - *Environmental regulations not controlled by DOE, but BETO will look for new ways to support data gathering efforts as well as improve understanding of social aspects of bioenergy.*

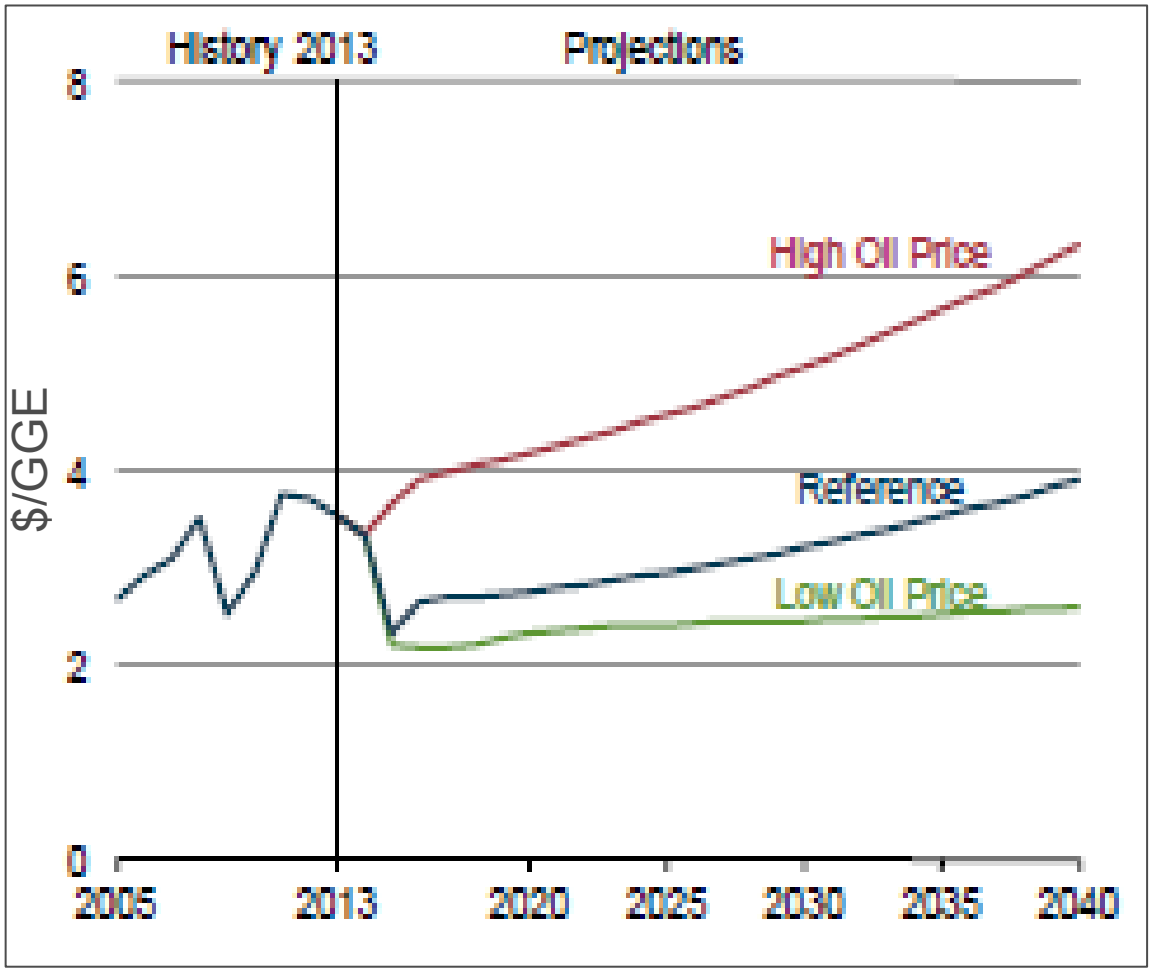
Other Technologies & Market Trends

- **Responding to the speed and magnitude of price volatility**
  - *Plan for and communicate the "long view" – IEA Energy Outlook (next slide)*

- **More work to increase market acceptance of biofuels**
  - *Expanding communications strategy and initiating new work on the co-optimization of fuels and vehicles (more information on next slide)*

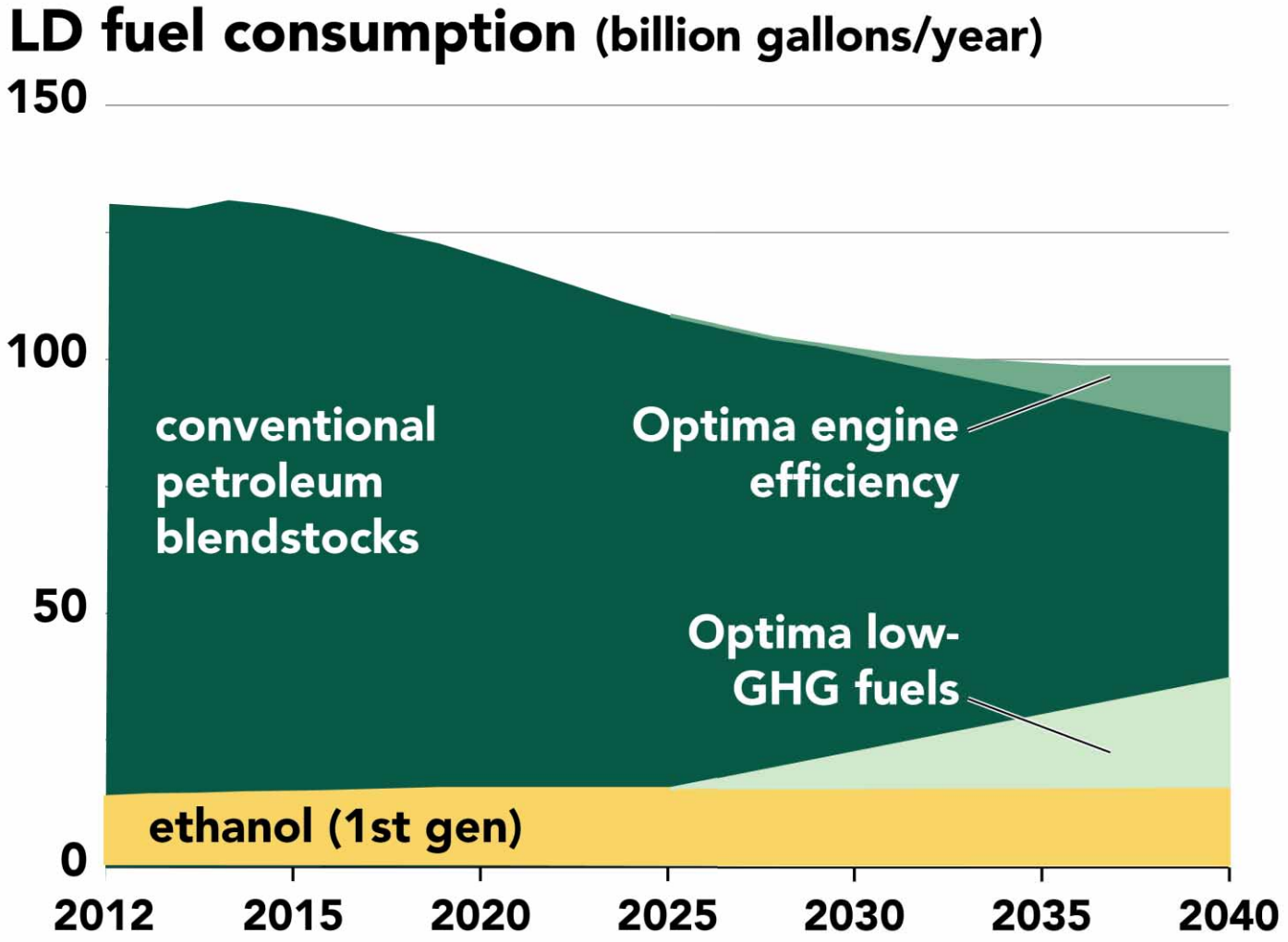
EIA 2040 Fuel Prices Outlook

- Key is to focus on the "long view" of fuel prices due to volatility in the fuels market.
- Need to be able to communicate the "long view" and its importance to the public.



Vehicle-Engines Optimization

Reductions from efficiency displacement



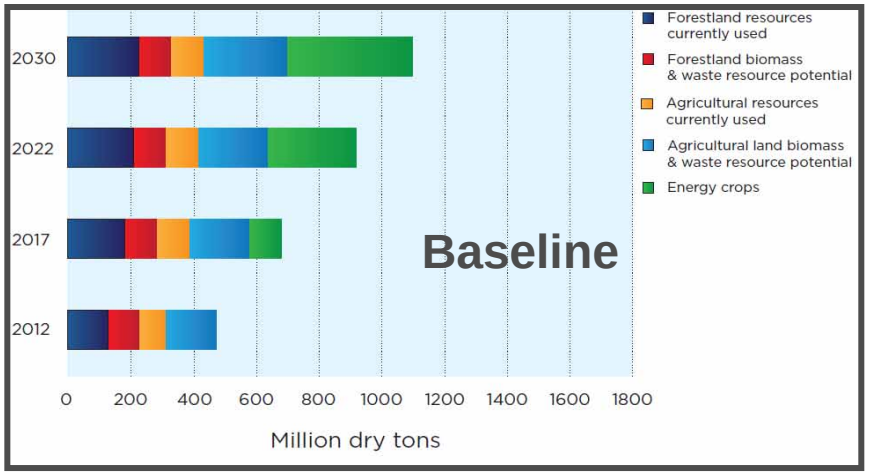
source: EIA 2014 reference case

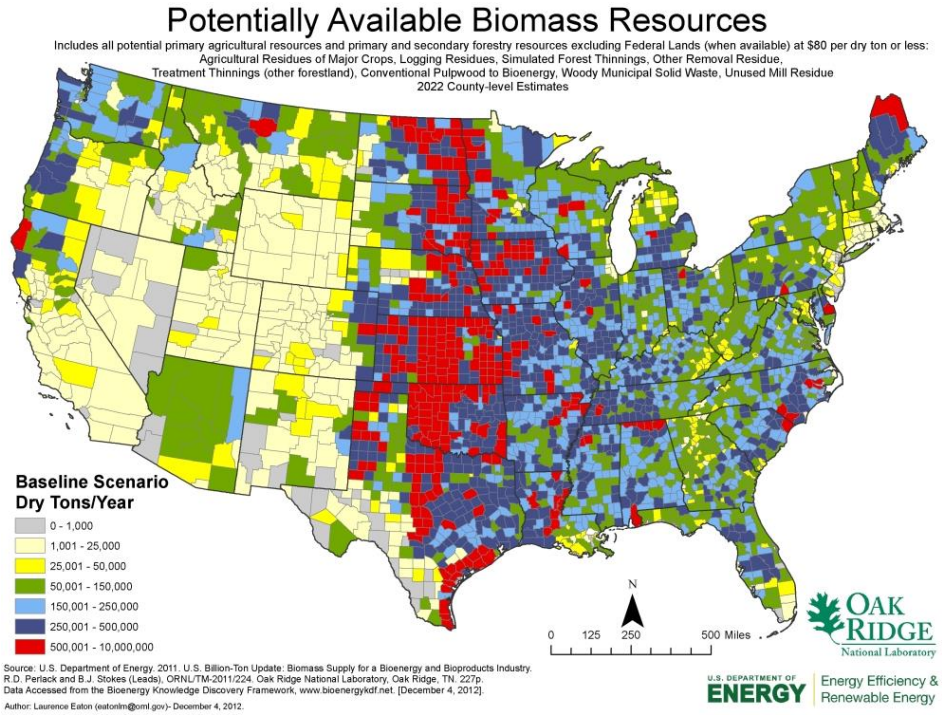
Goals of 2016 Billion-Ton Report (BT16)

- Assess current demand of commercial biomass-to-energy feedstock

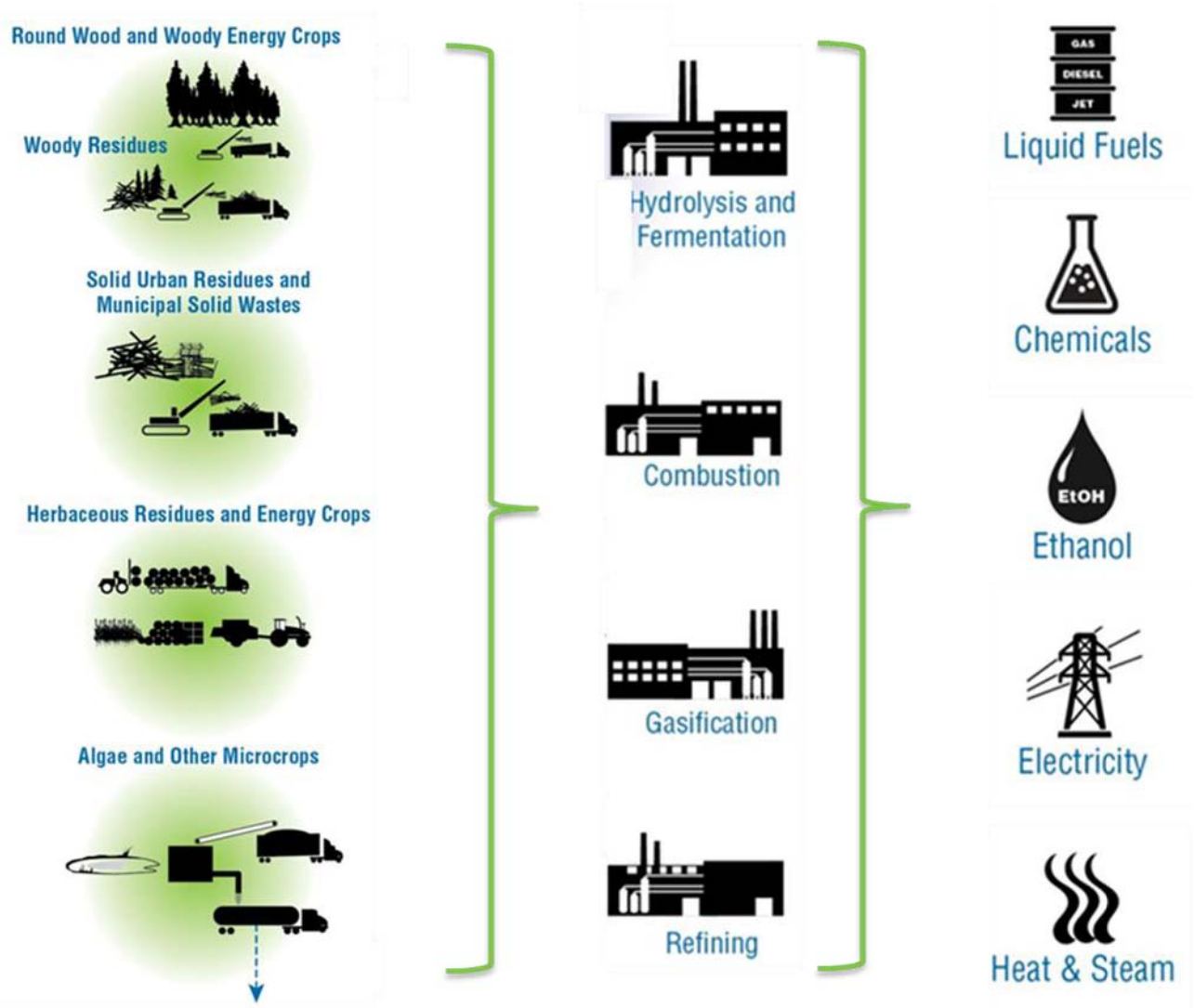
- State-of-science biomass potential supply to 2040
  - Agricultural, forestry, algal, and waste resources
  - From farm to roadside to regional delivery points

- Environmental sustainability analysis of potential supply (Vol. 2)





The Bioeconomy Concept



- **Revenue and economic growth**
- **Broad spectrum of new jobs**
- **Rural development**
- **Advanced technologies and manufacturing**
- **Reduced emissions and Environmental Sustainability**
- **Export potential of technology and products**
- **Positive societal changes**
- **Investments and new infrastructure**

Project Partners

BETO works with partners in industry , universities, and the National Labs

- THANK YOU again to all the Lead Reviewers and Steering Committee, as well as TCG and BCS staff.