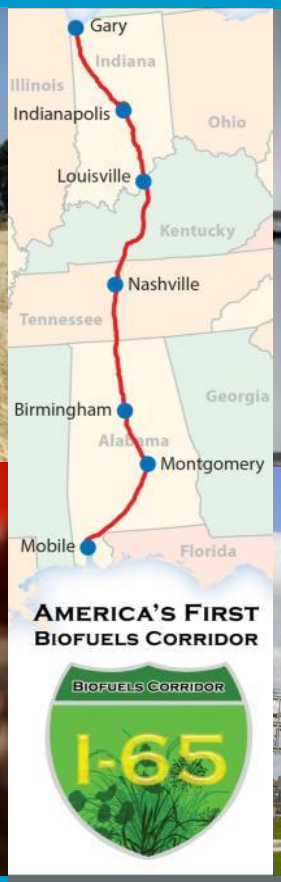
BIOENERGY TECHNOLOGIES OFFICE

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



Lessons Learned, Challenges, and Future Needs

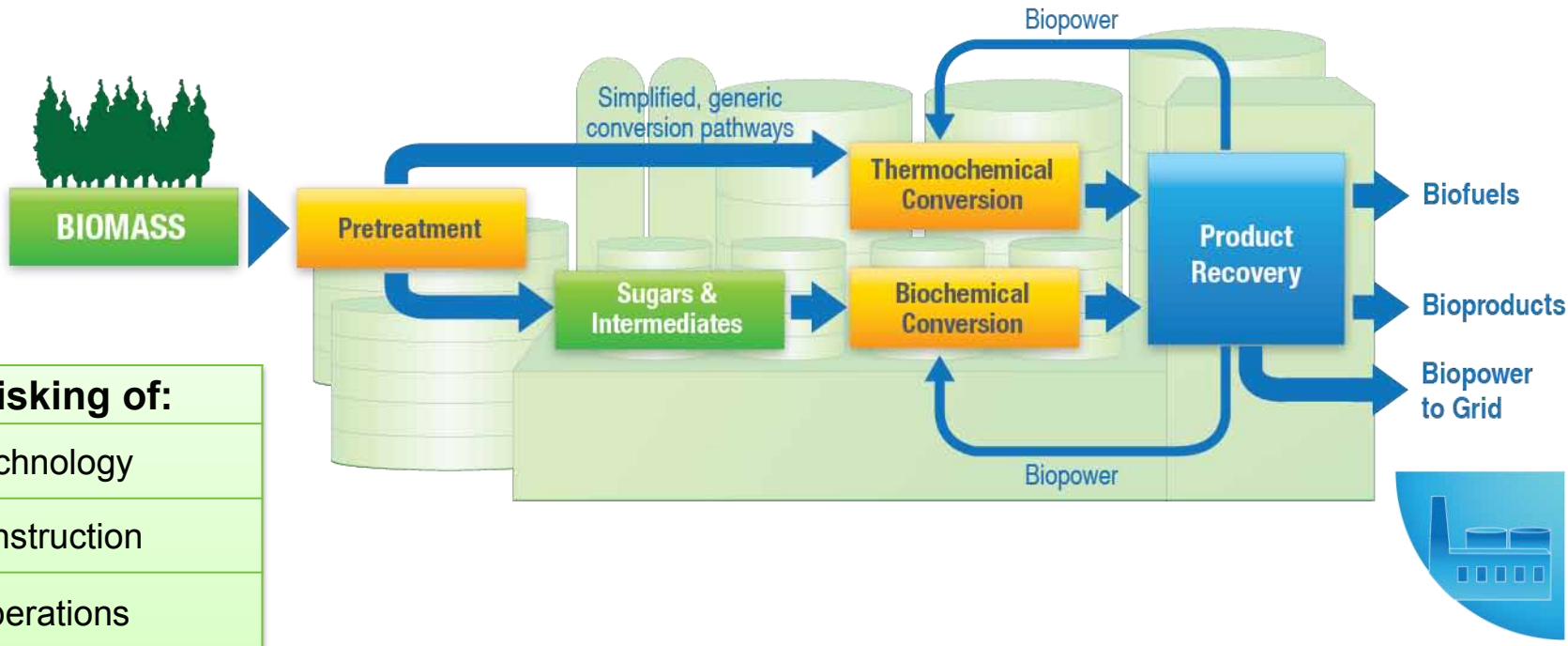
March 12, 2014

Jim Spaeth
Demonstration and Deployment Program Manager

Outline

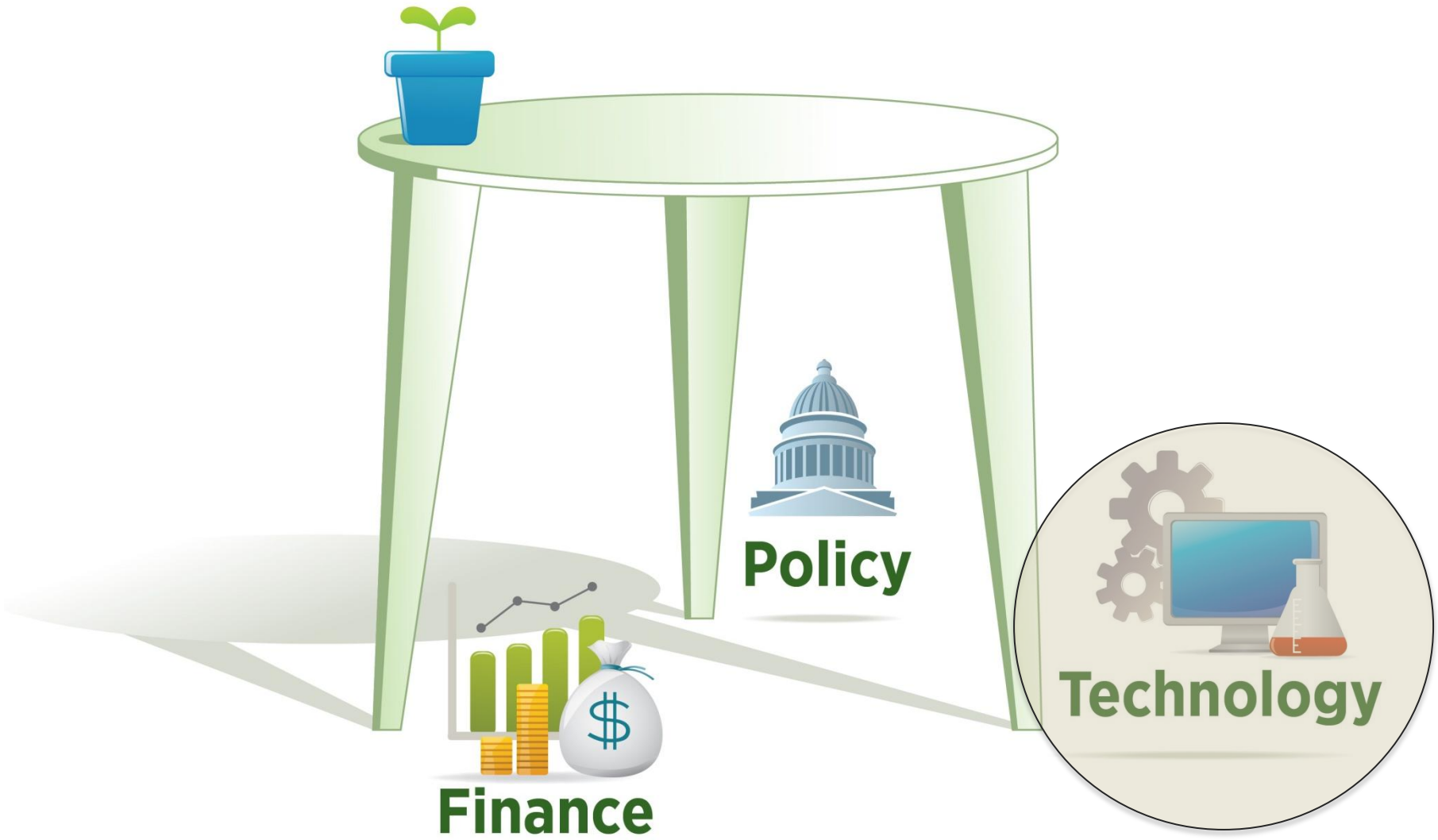
I. Introduction
II. Three Legged Stool
III. Pilot, Demonstration, and Pioneer Scales
IV. Portfolio Overview
V. Lessons Learned
VI. Challenges and Future Actions

BETO's Demonstration and Deployment Program

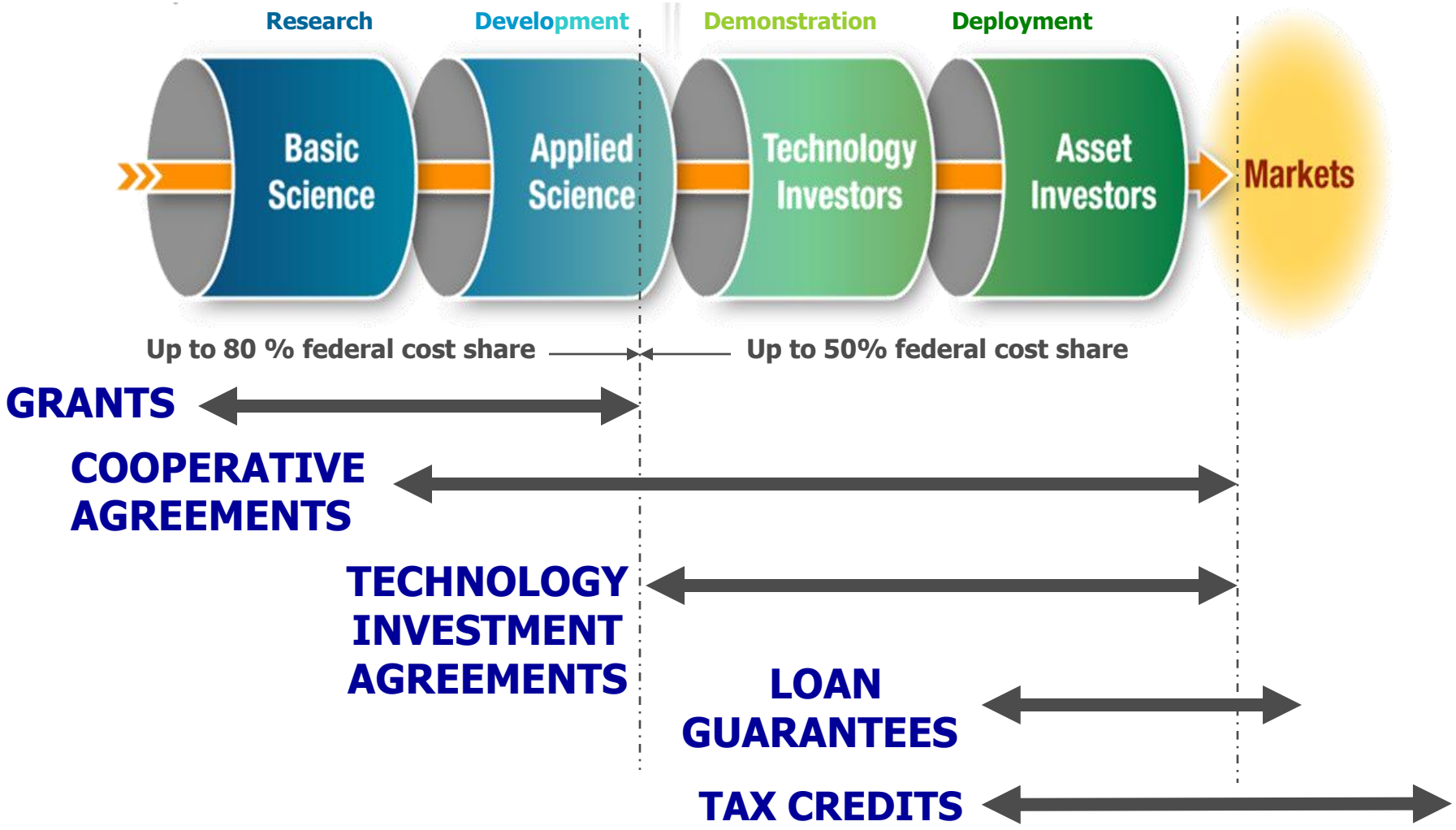


De-risking of:
Technology
Construction
Operations
Finance
Feedstock Supply
Product Off take
Markets

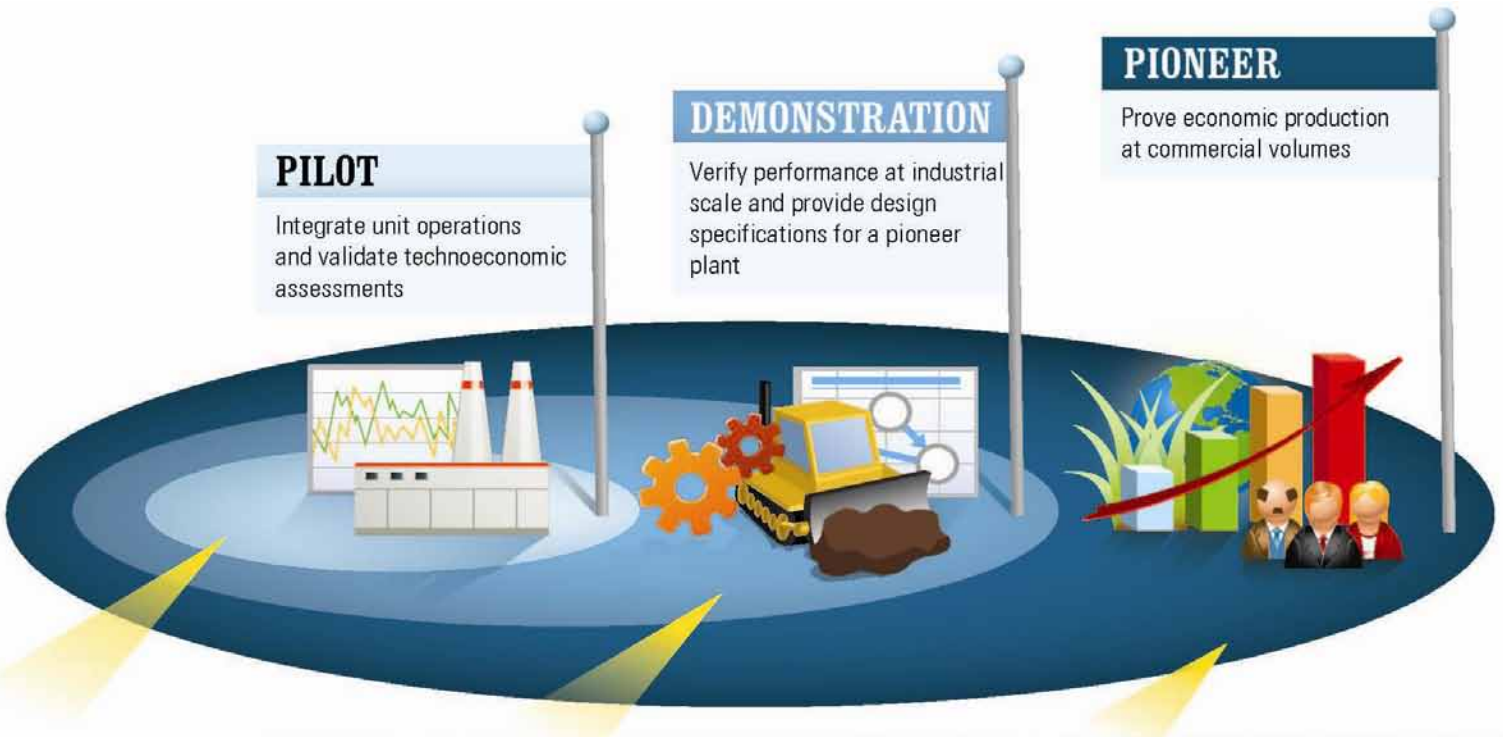
Success Depends On



DOE Financing Assistance - Technology Pipeline



Pilot, Demonstration, and Pioneer Plants



PILOT OBJECTIVES

- Technical Performance
  - Prove conversion efficiencies
  - Confirm mass and energy balance
- Operations
  - Determine feedstock and product specifications
  - Integrate technology from feedstock in through product out
  - Evaluate process sustainability metrics
- Scale-Up to Demonstration
  - Develop robust economic model

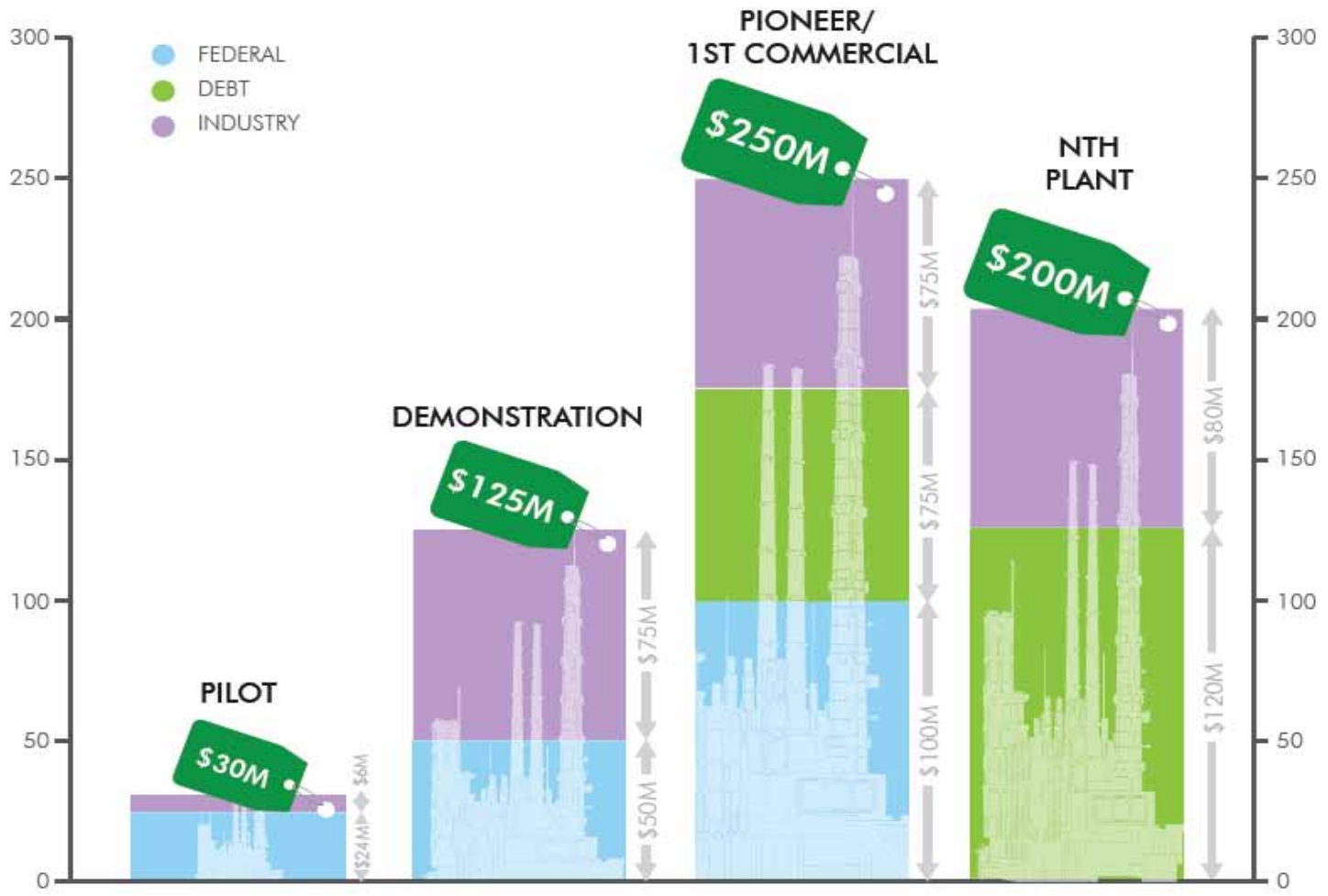
DEMONSTRATION OBJECTIVES

- Market Risk
  - Manufacture product for commercial acceptance testing
- Operations
  - Generate over 1000 hours of continuous operational data
  - Balance sustainability performance across environmental, social, and economic dimensions
- Scale-Up to Pioneer
  - Validate commercial equipment specifications and performance

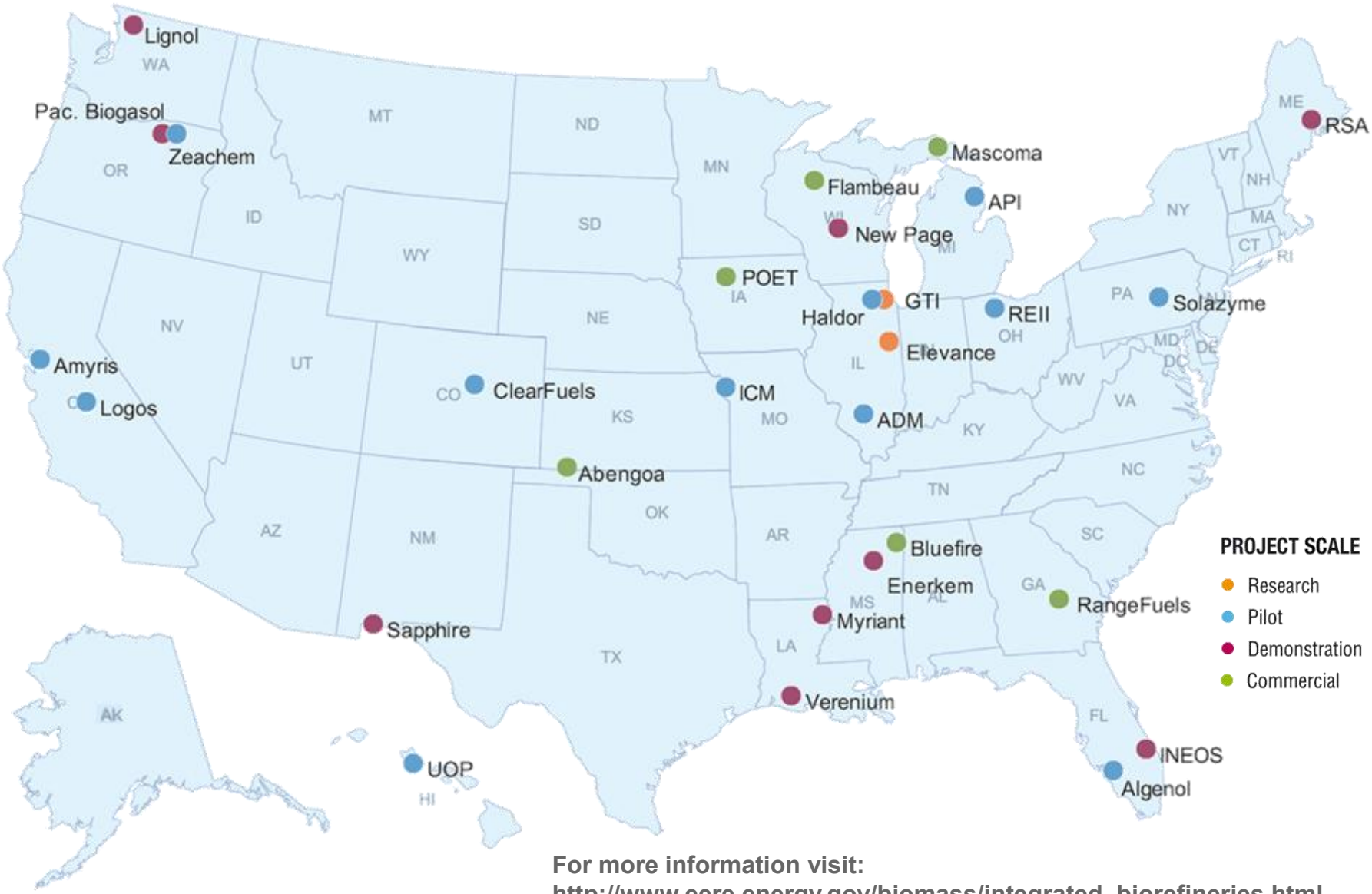
PIONEER OBJECTIVES

- Financial Risk
  - Prove technology is profitable to support robust replication of commercial facilities
- Feedstock Supply and Logistics
  - Demonstrate robust feedstock supply and offtake value chain
- Operations
  - Validate performance data and equipment design specifications
  - Verify sustainability performance across environmental, social, and economic dimensions

IBR Project Funding

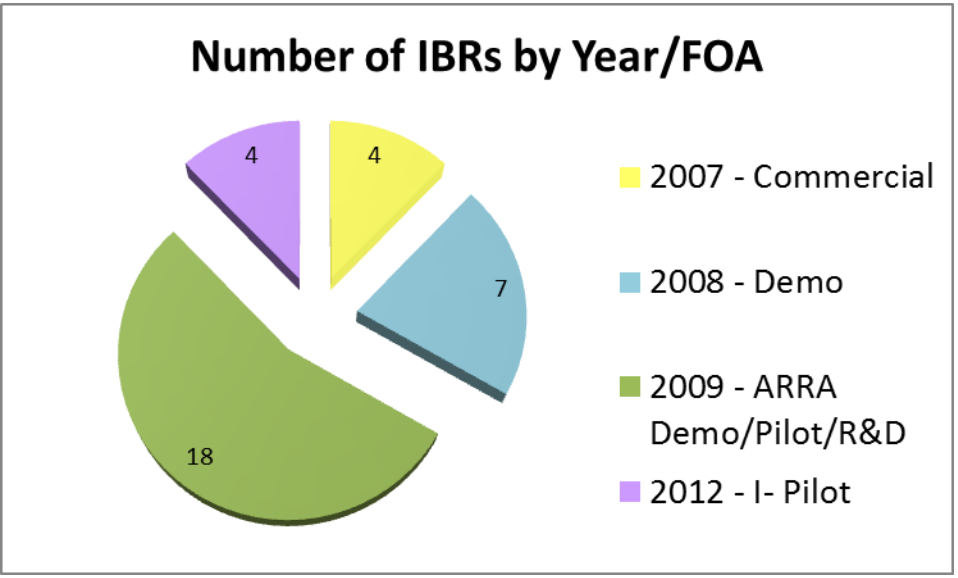


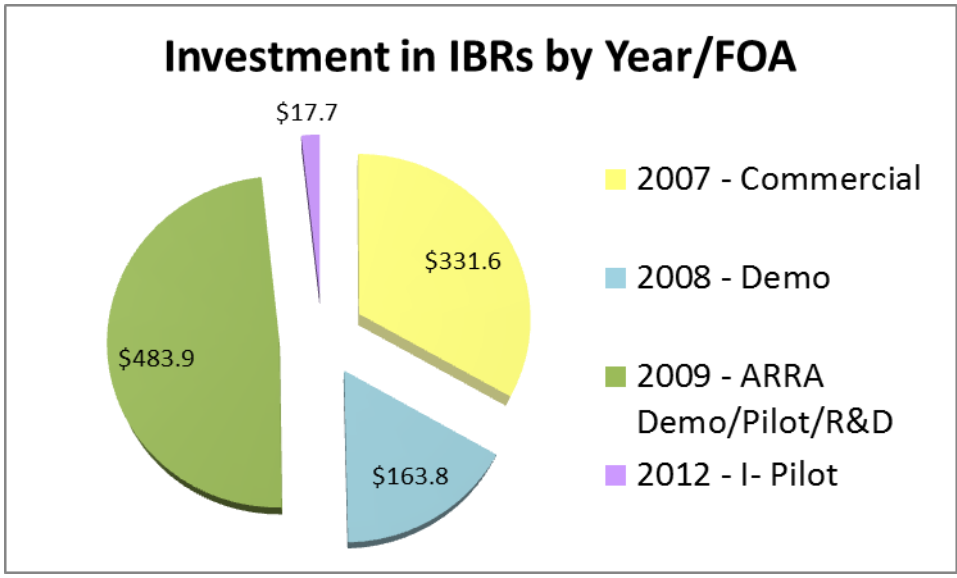
Portfolio Geographic Diversity



For more information visit:
http://www.eere.energy.gov/biomass/integrated_biorefineries.html

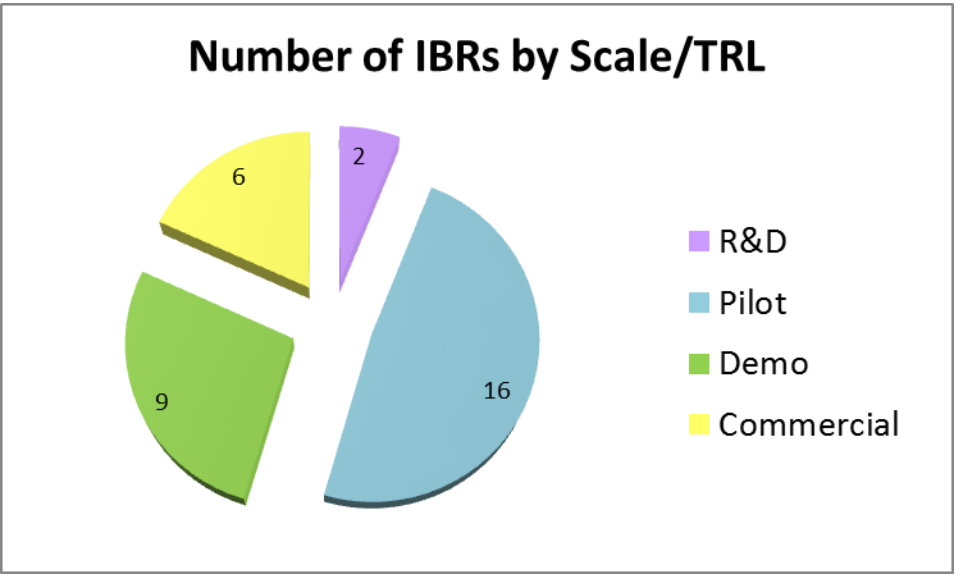
Portfolio by Funding Year

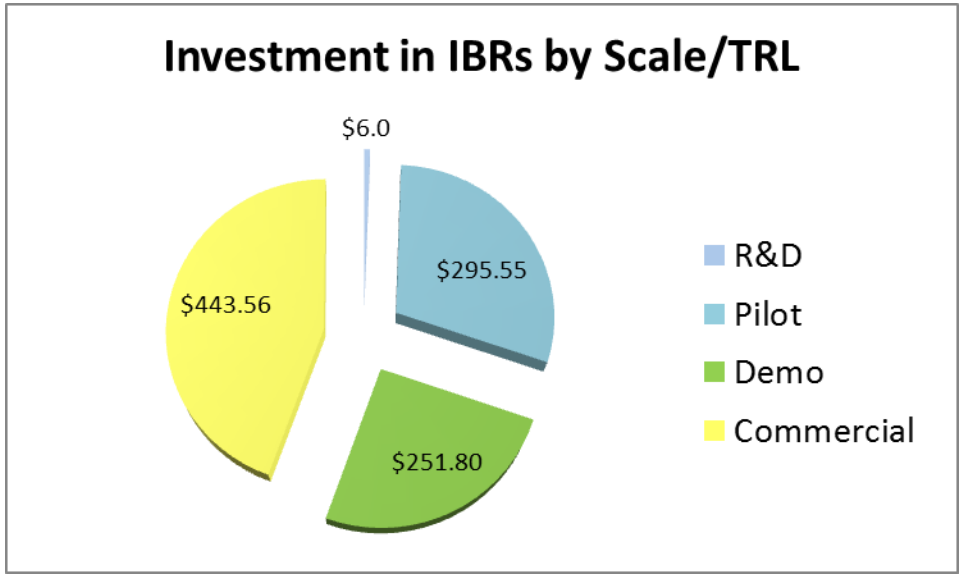




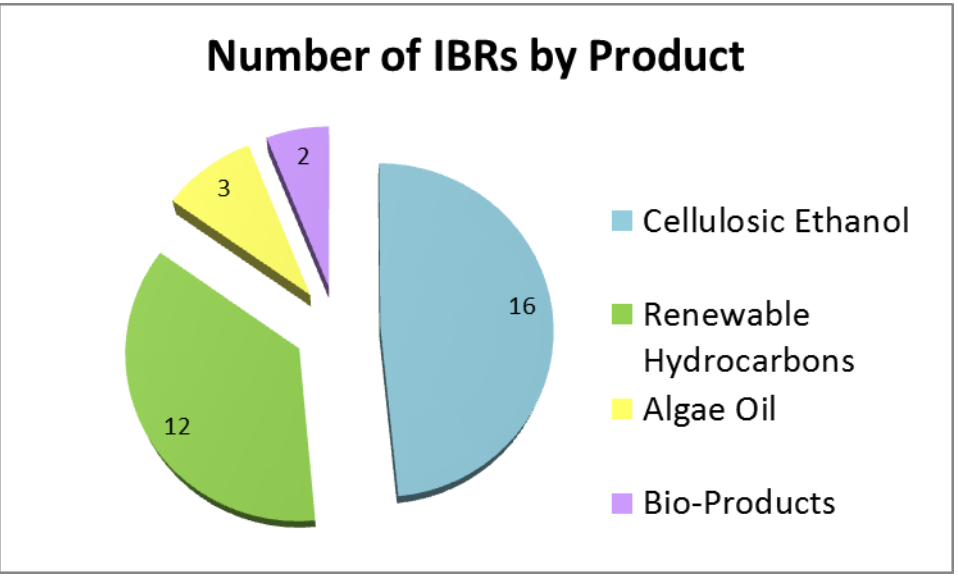
$1,000,000,000	$1,500,000,000	$2,500,000,000
DOE Share	Cost Share	Total

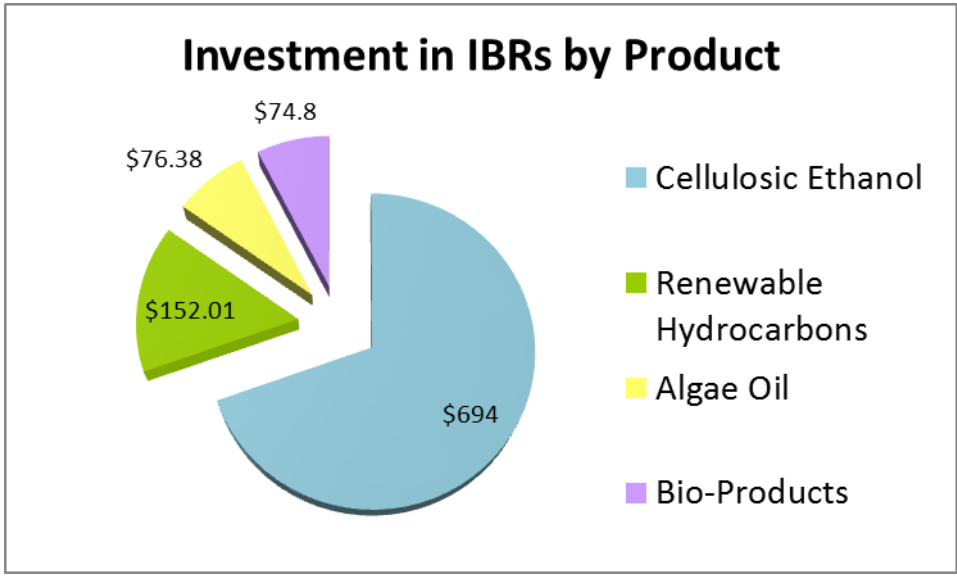
D&D Portfolio by Project Scale/TRL





D&D Portfolio by Product





Lessons to Re-Learn

- **Multiple new technology steps -** equates to higher risk [1]
- **Feeding solid biomass to reactors -** continues to be a challenge [1]
- Commercially available, '**off-the-shelf**' equipment
  - Does not necessarily integrate easily into new processes [1]
- **Integrated pilot testing -** has high value for new technologies [1]
- Energy projects have **multi-decade time horizons …[2]**

1 - Quantitative Assessment of R&D Requirements for Solids Processing Technology. E .W. Merrow (1986) R-3216-DOE/PSSP

2 – Koonin S, Gopstein A, *Accelerating the Pace of Energy Change*, Issues in Science and Technology, Dec 2010

Valley of Death for New Technologies: IPA Key Findings

- Commercializing some level of new technology - 40% of projects fail
- New technology projects – 80% don't meet performance expectations

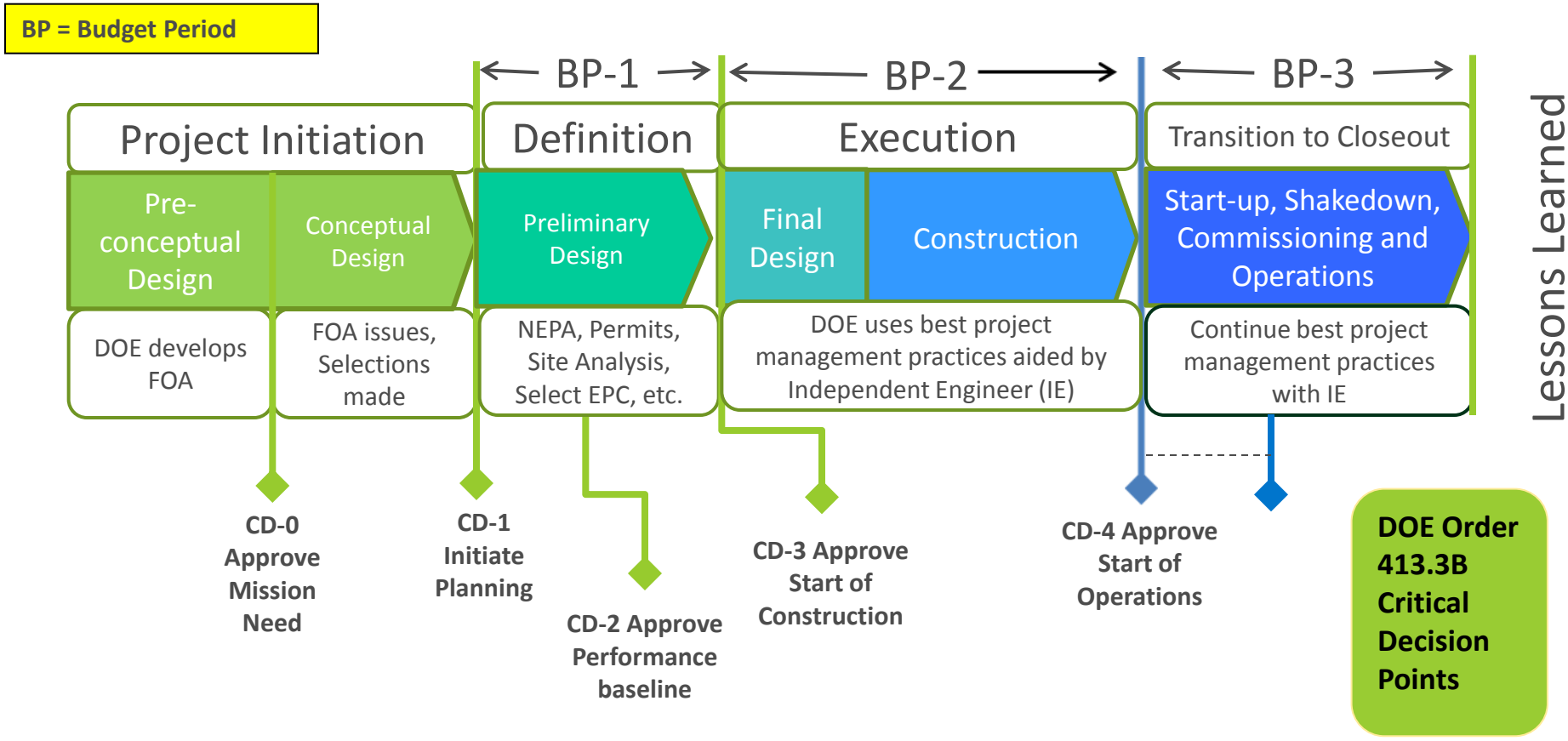
- Incorrect assessment of the level of difficulty posed by underlying process
  - Leads to overoptimistic expectations on project and process performance
    - Average cost growth = 30%
    - Average schedule growth = 65%
    - Average production shortfalls over 50% in second 6 months of operation
    - Average startup durations 50% longer than industry average

- Shortcomings often don't surface until startup and operation
  - Only remedy is costly de-bottlenecking and corrective engineering

- Core lesson:
  - Must understand and accept higher levels of project and process risk

Approach to Project Management

Figure 1 – Framework for Executing DOE Project Management for Integrated Biorefinery Projects



INEOS New Planet Biorefinery

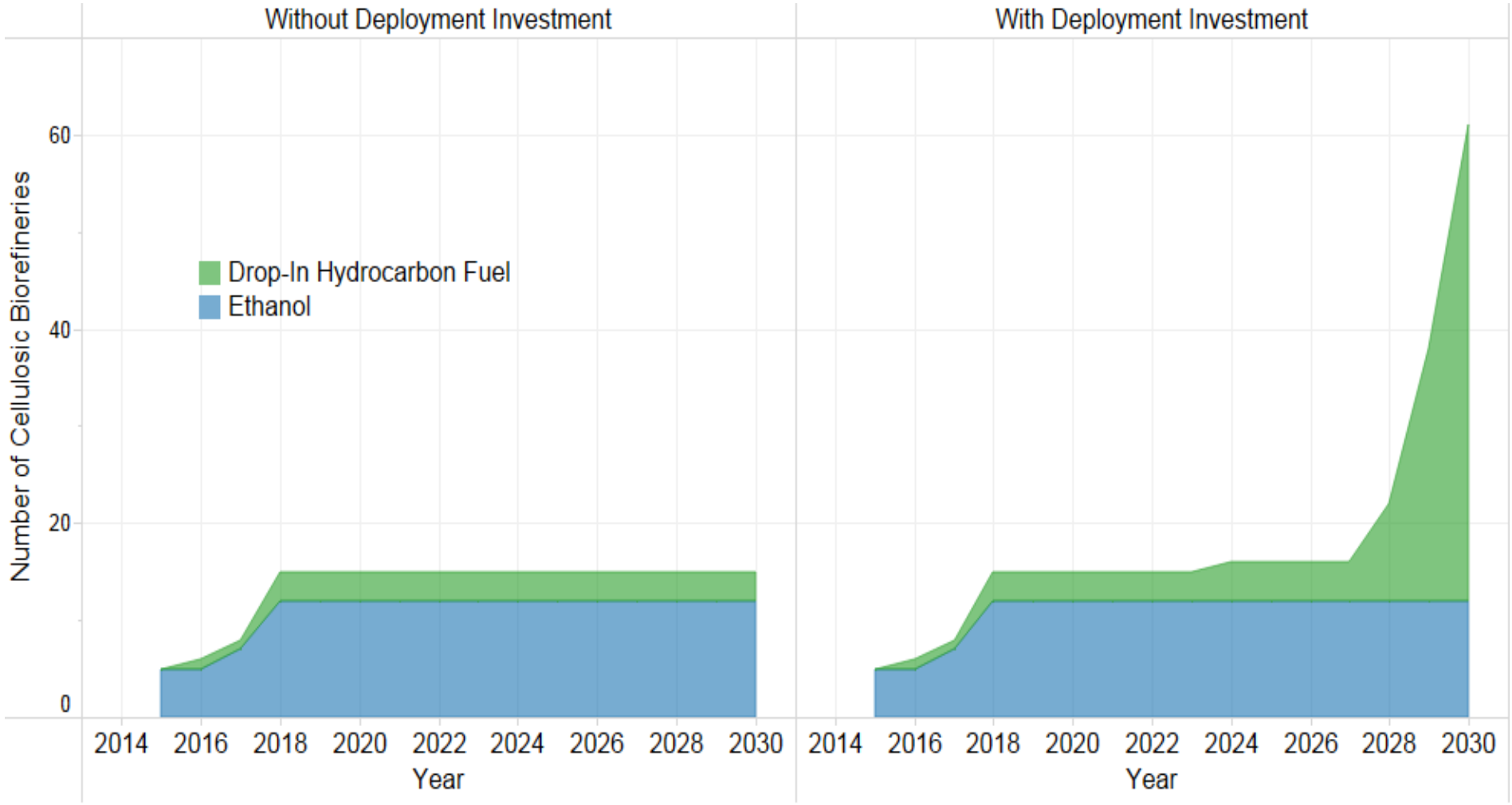
Myriant's Bio-Succinic Acid Plant

Abengoa Bioenergy

Graphic to be included in March update of BETO's MYPP.

POET: Project LIBERTY

Future



Assumes DOE continued investment and RIN Value of $0.50

Next Steps?

Challenges, Future Needs and Actions