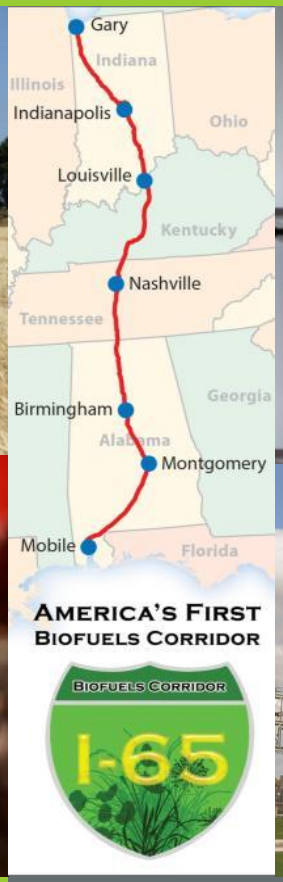
BIOENERGY TECHNOLOGIES OFFICE

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



Demonstration & Market Transformation Plenary Presentation

March 23, 2015

Jim Spaeth

Program Manager

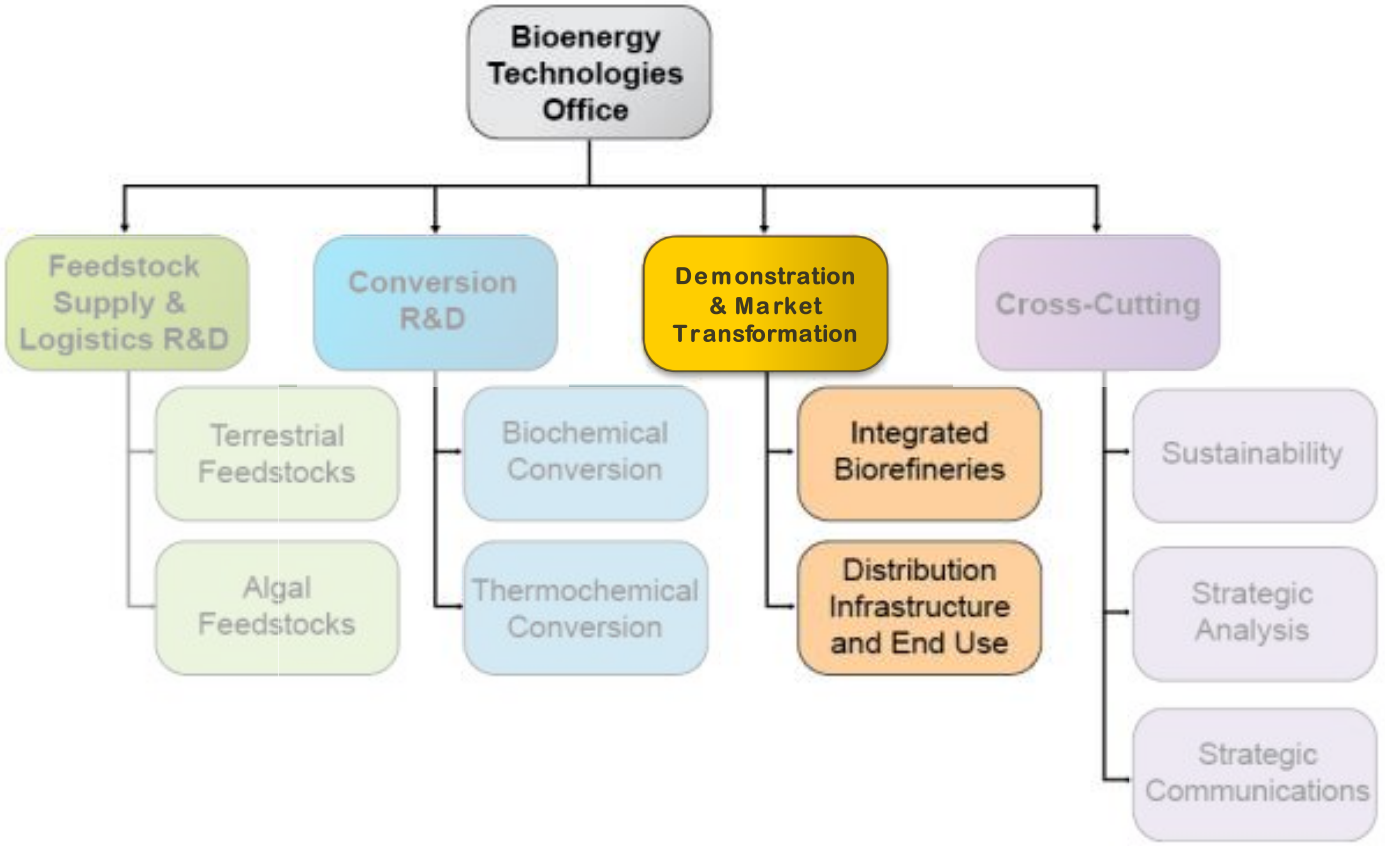
Demonstration & Market Transformation

DMT Plenary - Outline

- Goals and Objectives
- Key Barriers
- Approach to Overcoming Barriers
- Key Accomplishments
- Portfolio
- Budget History
- Funding Opportunity Announcements
- Coordination Efforts
- Future Directions
- BETO Staff
- Reviewers

Introduction to Demonstration & Market Transformation

The Demonstration and Market Transformation (DMT) subprogram (formerly Demonstration & Deployment) is focused on demonstrating and validating biomass conversion technologies through successful construction and operation of cost-shared pilot, demonstration, and pioneer scale integrated biorefineries (IBRs).

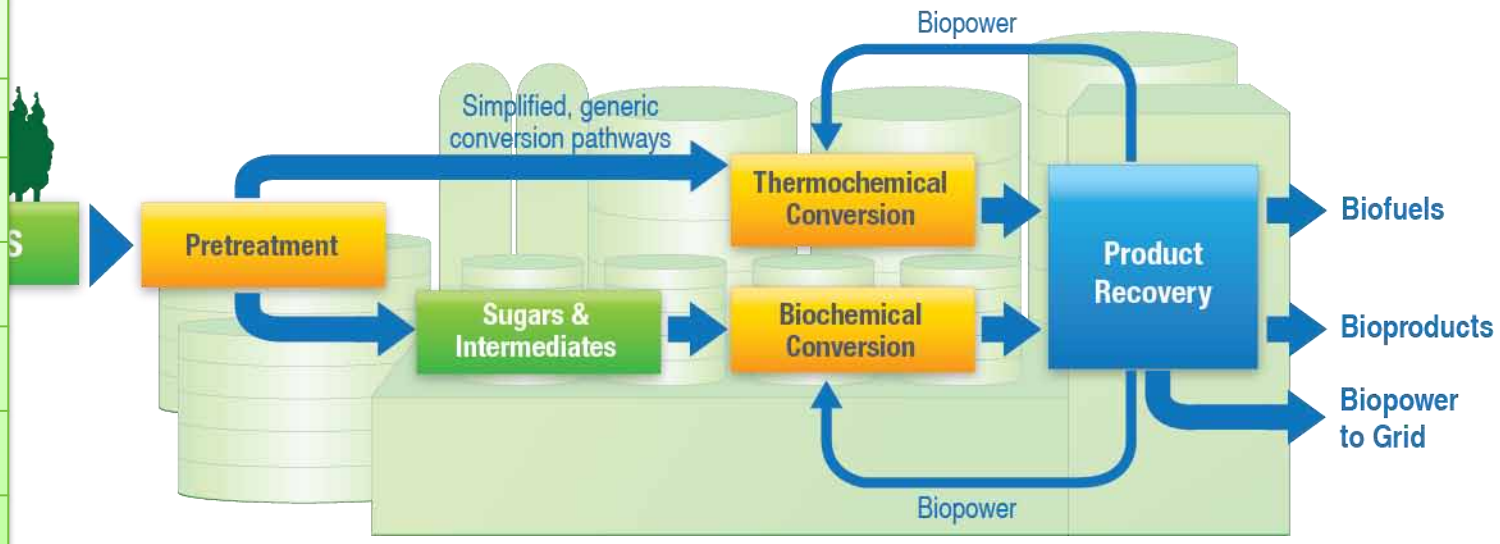


DMT Key Challenges Involve Lowering Risks

Strategic Goal

- Develop commercially viable biomass utilization technologies through public-private partnerships that build and validate pilot-, demonstration-, and pioneer-scale integrated biorefineries.
- Develop supporting infrastructure to enable a fully operational and sustainable biomass-to-bioenergy value chain in the United States.

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



DMT Support of Office Performance Goals

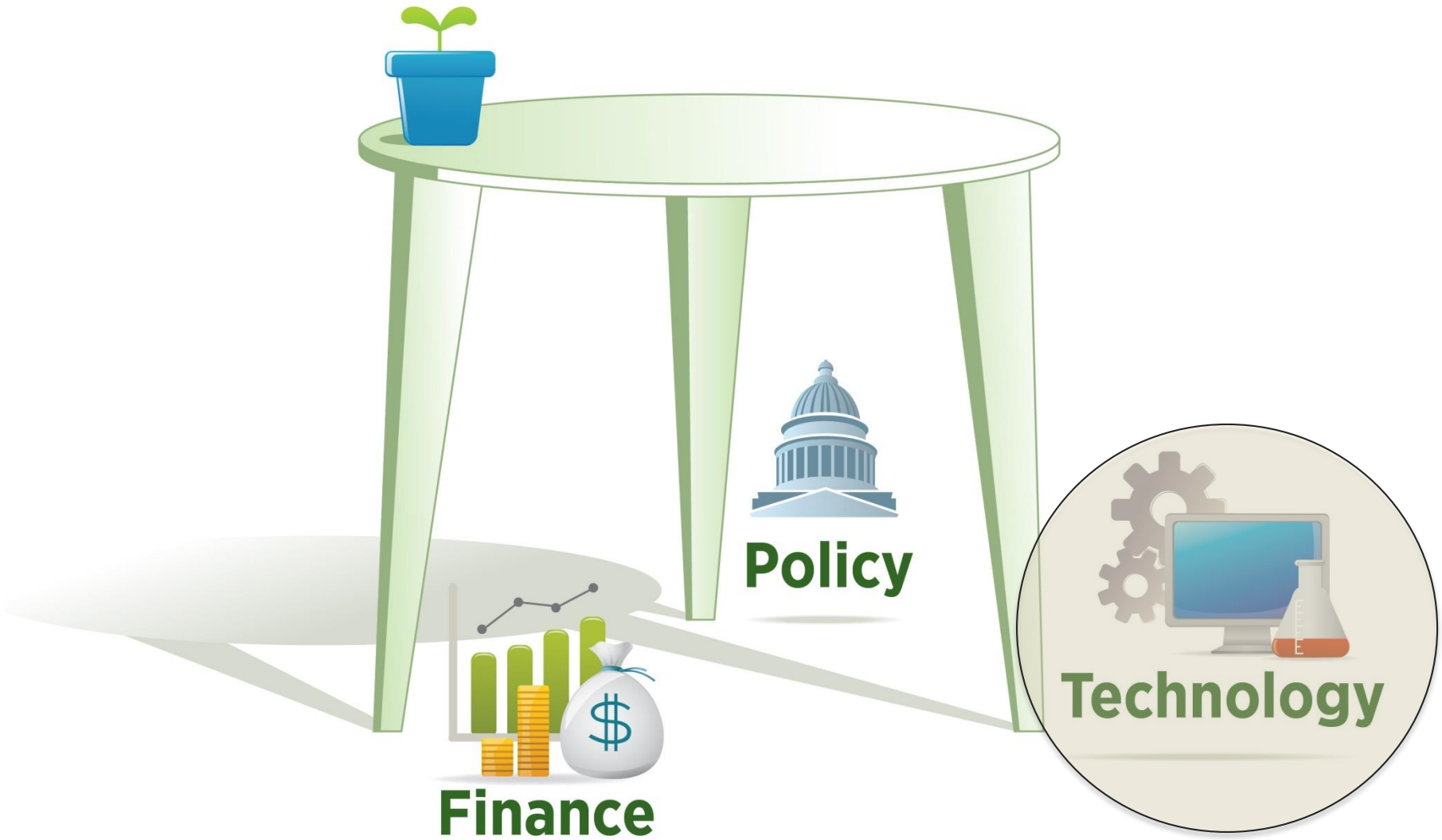
- By 2017, validate a mature technology modeled cost of cellulosic ethanol production, based on actual IBR performance data, and compare to the target of $2.15/gallon ethanol ($2007)
- By 2027, validate a mature technology modeled cost of infrastructure-compatible hydrocarbon biofuel production, based on actual IBR performance data, and compare to the target of $3/GGE ($2011).

DMT milestones toward reaching these goals include the following:

- By 2018, validate three infrastructure-compatible hydrocarbon biofuel or bioproduct manufacturing processes at pilot scale
- By 2020, validate one to two infrastructure-compatible hydrocarbon biofuel or bioproduct manufacturing processes at demonstration scale
- By 2024, validate one infrastructure-compatible hydrocarbon biofuel or bioproduct manufacturing process at appropriate scale.

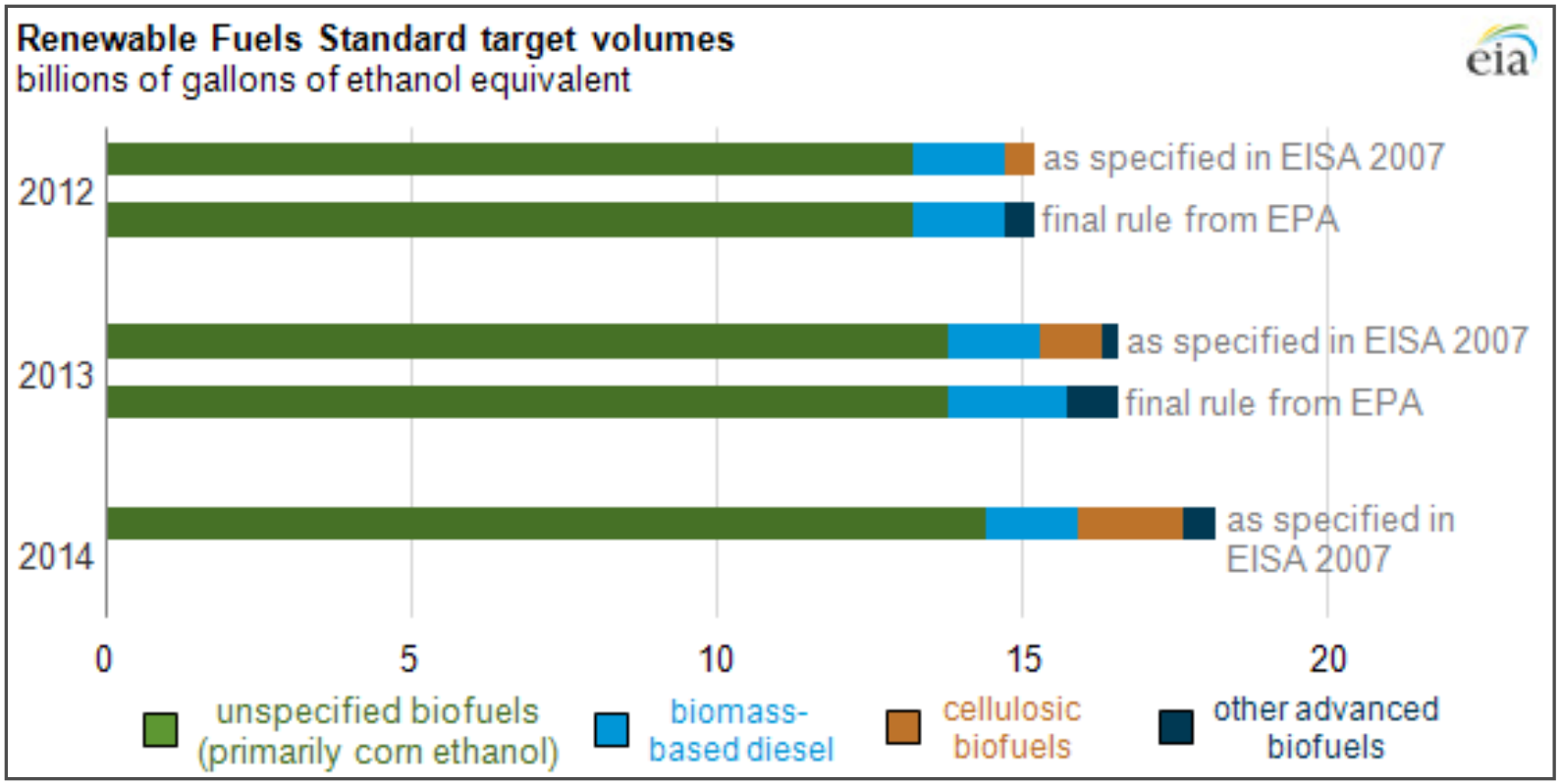
Key Barriers in Demonstration & Market Transformation

Success Depends On



Policy Challenges

- RFS Uncertainty
  - For early biorefineries, assured markets are typically tied to mandated volumetric production or greenhouse gas saving levels.
  - Uncertainty endangers the commercial viability of biorefineries

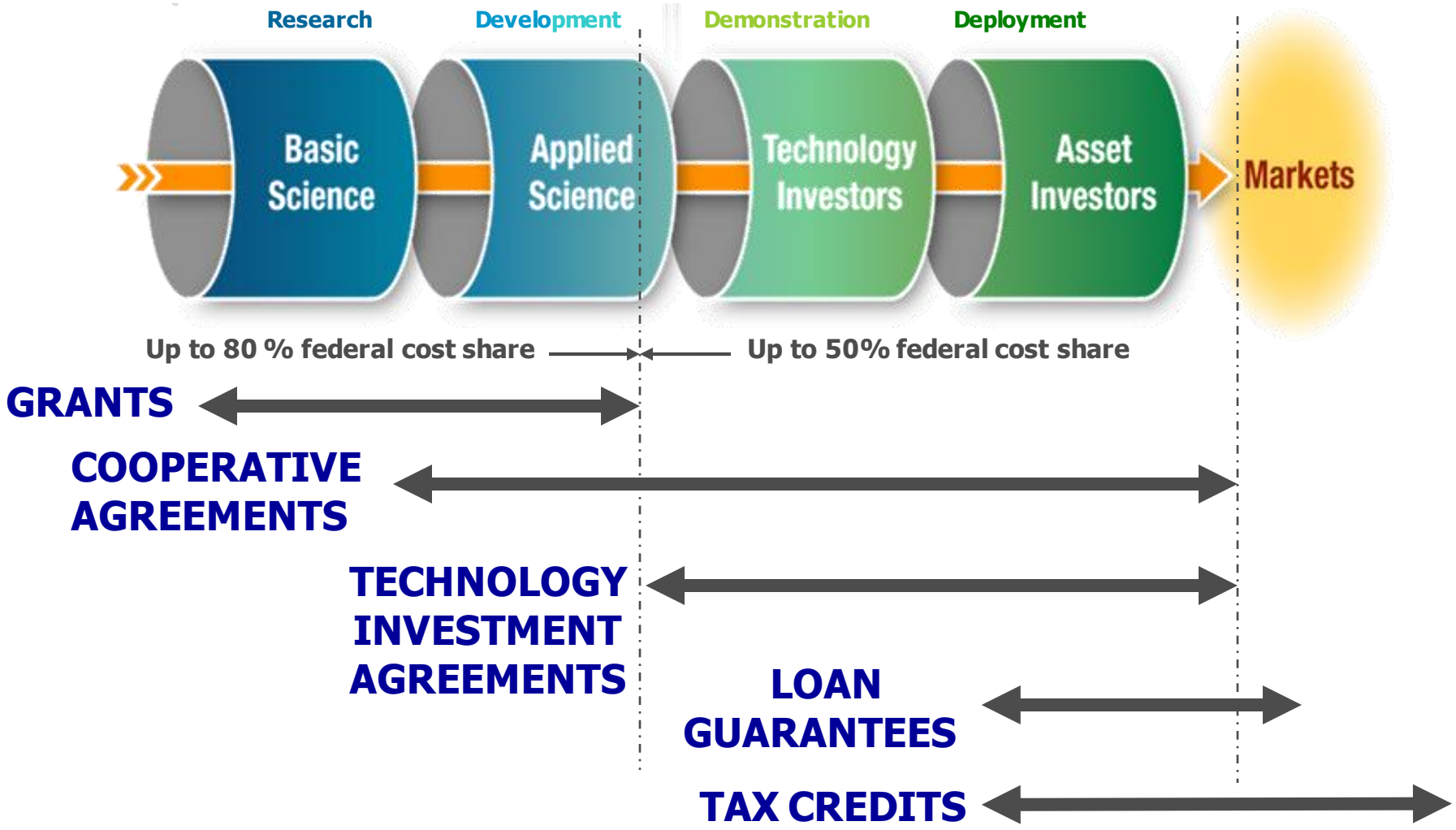


Critical Barriers and Key Challenges

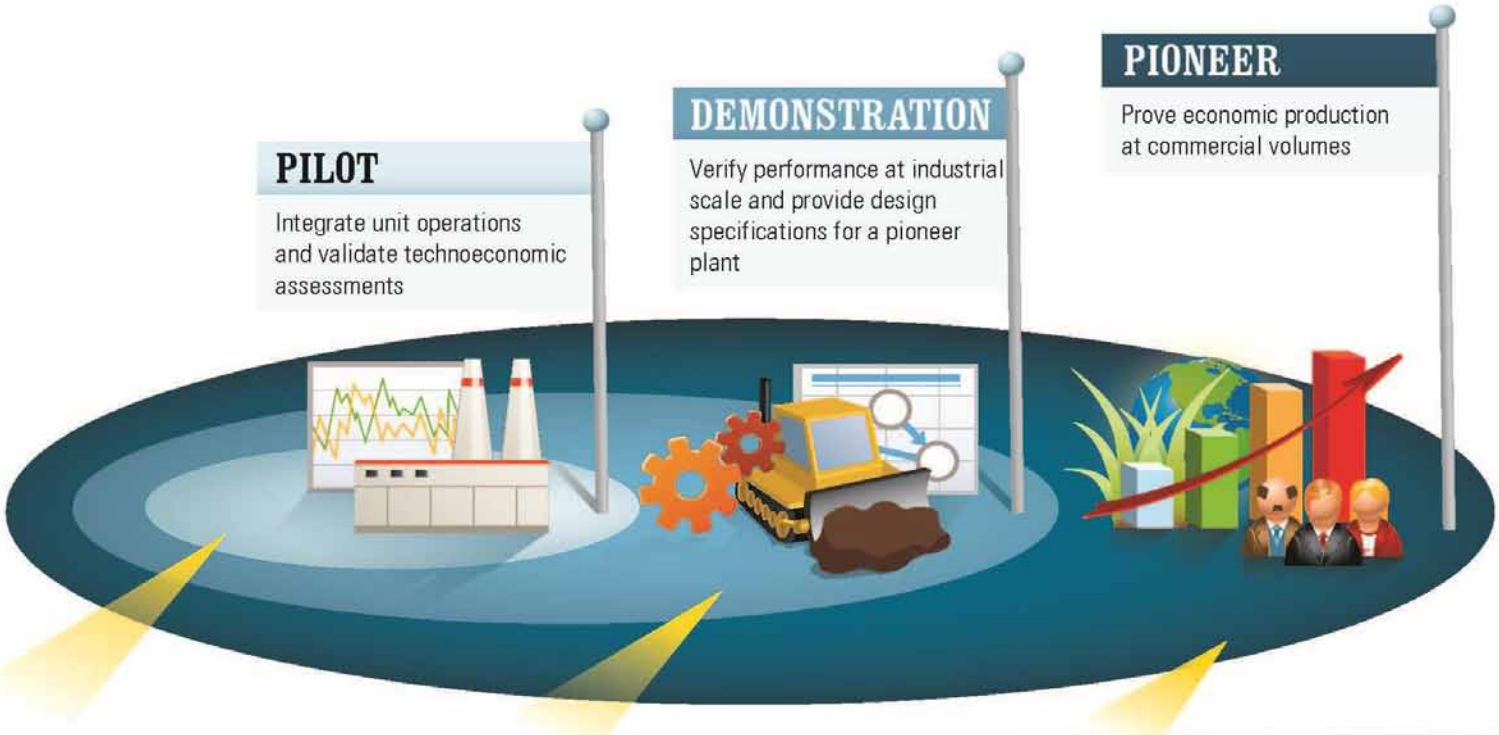
- Inadequate Supply Chain Infrastructure
- Processing, Conversion and Production Costs
- Replicability
- Scalability (sustainability)
- Financing
- Offtake Agreements
- Biofuels Distribution Infrastructure
- Codes, Standards, and Approval for Use
- Consumer Lack of Acceptance and Awareness

DMT Approach to Overcoming Barriers

Financing Assistance – US DOE Approach



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

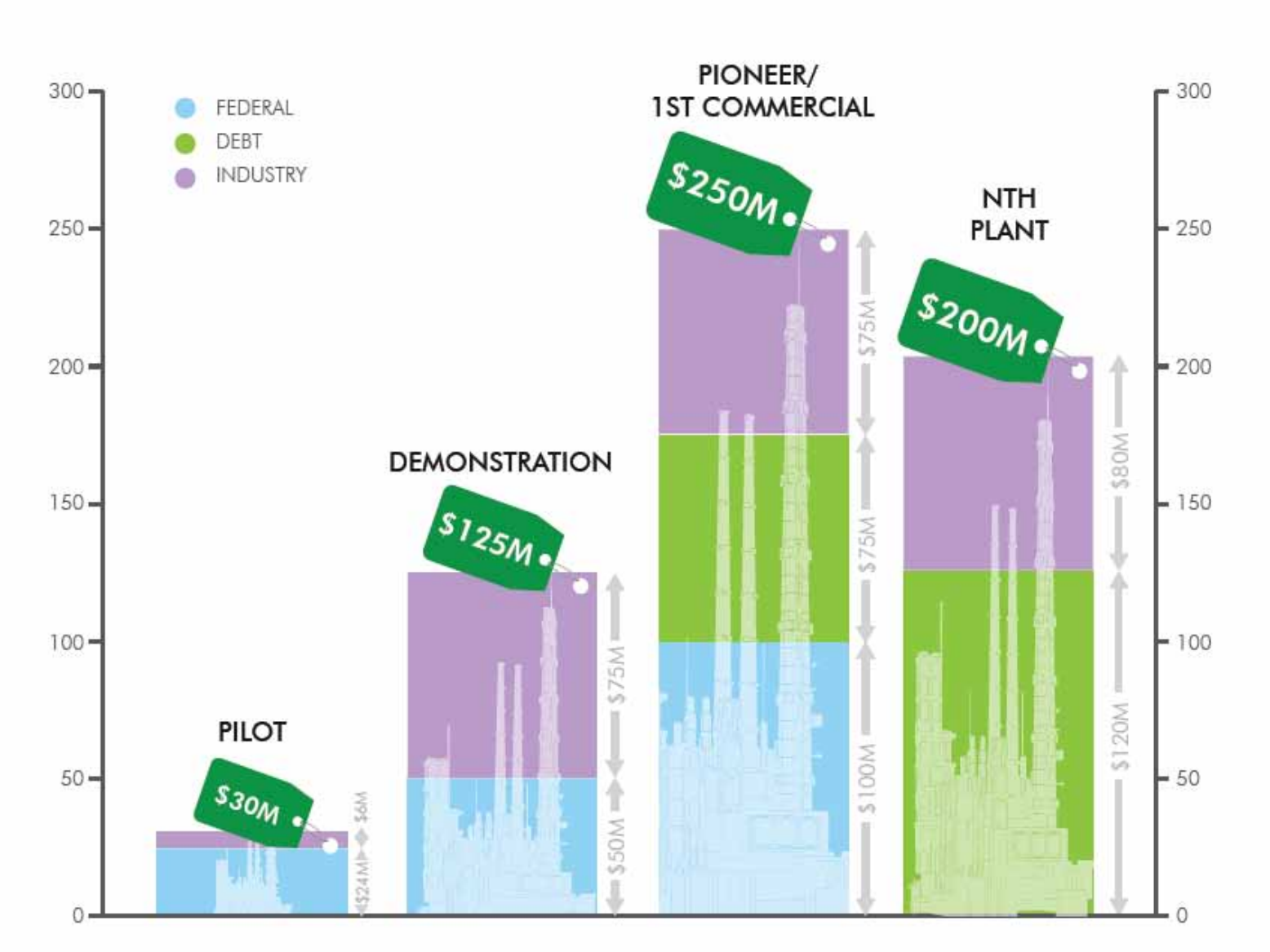
DEMONSTRATION OBJECTIVES

- 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 Profile – Investment Required



Key DMT Accomplishments Since 2013

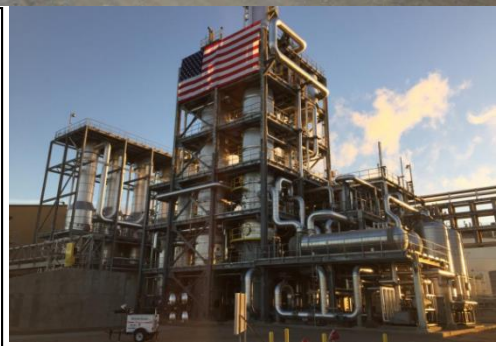
Abengoa and POET Grand Openings

POET Project Overview:

- Feedstock: Corn Stover
- Scale: 770 Dry tons/day
- Capacity: 25 Million gal/year
- Product: Ethanol
- Coproduct: Power

Abengoa Project Overview:

- Feedstock: Corn stover
- Scale: 930 Dry tons/day
- Capacity: 25 Million gallons/year
- Product: Ethanol
- Coproduct - Energy Cogen (21 MW)



Green Racing with Cellulosic Ethanol and Renewable Diesel

Green Racing

- On Friday, March 14, 2014, DOE officials participated in a green racing event at Sebring International Raceway in Florida.
- NASCAR's International Motor Sports Association uses its Green Racing series to help promote and develop renewable fuels for consumers.
- INEOS Bioenergy provided cellulosic ethanol from its DOE-supported, Vero Beach, Florida biorefinery.

Demonstration Portfolio – Selected Projects

American Process, Inc., Alpena, MI

- Feedstock: waste hydrolyzate stream from hardboard manufacturing process (mixed northern hardwood and aspen).
- Capacity: 894,200 gallons/year of cellulosic ethanol (from C6 sugars) and 696,000 gallons/year of aqueous potassium acetate (De-Icer) (from C5 sugars).
- Accomplishments to date:
  - First batch of pure cellulosic ethanol produced in early FY14.

Haldor Topsoe, Inc., Des Plaines, IL

- Thermochemical process for the conversion of wood waste and woody biomass to gasoline.
- Expected to produce approximately 345,000 gal/year.
- Accomplishments to Date:
  - Testing shows acceptable ranges for gasoline blendstock.
  - Emission level was "substantially similar" to conventional gasoline.
- Collaborative agreements with Gas Technology Institute, Andritz-Carbona, UPM-Kymmene, and Phillips 66.

Defense Production Act (DPA) Initiative

In July 2011, the Secretaries of Agriculture, Energy, and Navy signed a Memorandum of Understanding to commit $510 M ($170 M from each agency) to produce hydrocarbon jet and diesel biofuels in the near term. This initiative sought to achieve:

- Multiple, commercial-scale integrated biorefineries.
- Cost-competitive biofuel with conventional petroleum (without subsidies).
- Domestically produced fuels from non-food feedstocks.
- Drop-in, fully compatible, MILSPEC fuels (F-76, JP-5, JP8).
- Help meet the Navy's demand for 1.26 billion gallons of fuel per year.
- Contribute to the Navy's goal of launching the "Great Green Fleet" in 2016.
- Demonstration of the production and use of more than 100 million gallons per year will dramatically reduce risk for drop-in biofuels production and adoption.

On September 19th, 2014 three projects were selected for construction and commissioning:

Company	Location	Feedstock	Conversion Pathway	Capacity (MMgpy)
Emerald Biofuels	Gulf Coast	Fats, Oils, and Greases	Hydroprocessed Esters and Fatty Acids (HEFA)	82.0
Fulcrum BioEnergy	McCarran, NV	Municipal Solid Waste	Gasification – Fischer Tröpsch (FT)	10.0
Red Rock Biofuels	Lakeview, OR	Woody Biomass	Gasification – Fischer Tröpsch (FT)	12.0

DMT Portfolio

Status of DMT IBR Portfolio

- 19 Active IBR Projects – 15 Being Reviewed

Scale	Invested IBR Projects (42)[1]		Active IBR Projects (19)	
	Number of Projects	Capacity (MGPY)	Number of Projects	Capacity (MGPY)
Commercial	9	70.0	2	50.0
Demonstration	10	63.6	2	8.5
Pilot	16 [2]	15.2	11 [2]	2.1
DPA	4	192.8	3	127.0
Total	39	341.6 [3]	18	187.6 [3]

Table Notes [ ]:
•Two ARRA projects were bench-scale projects with no listed volumetric production capacity. These projects are included in the total invested project count, but do not fit the scale groupings. These projects are completed.
•One pilot-scale project was producing succinic acid and not fuel. It is excluded from the project count but has no capacity in summation.
•One pilot-scale project has its production capacity listed as “To Be Determined.” It is included in the count but has no capacity in summation.

Status of DMT IBR Portfolio – Geographic Distribution

BETO (2015), Integrated Biorefineries, http://energy.gov/eere/bioenergy/integrated-biorefineries.

- Currently Active IBRs in the United States, Funded by the U.S. Department of Energy

DMT Budget and Funding Opportunity Announcements

DMT Budget

- FY13 Budget - $43.63M
- FY14 Budget - $64.79M
  - $45M for Defense Production Act Initiative
- FY15 Budget - $79.7M
  - $45M for Defense Production Act Initiative
- FY16 Budget - $87.5M
  - $45M for Defense Production Act Initiative

FY15 Demonstration FOA

- Integrated Biorefinery Demonstration Projects FOA
  - As requested in the FY15 DOE BETO Budget Request
  - Hydrocarbon Fuels
    - Bioproducts to Enable Biofuels
  - Feedstocks
    - Cellulosic
    - Wet Waste
    - Algae
  - Project Definition Phase Only
  - Pilot or Demonstration Scale
  - $24.7 million
    - Multiple awards

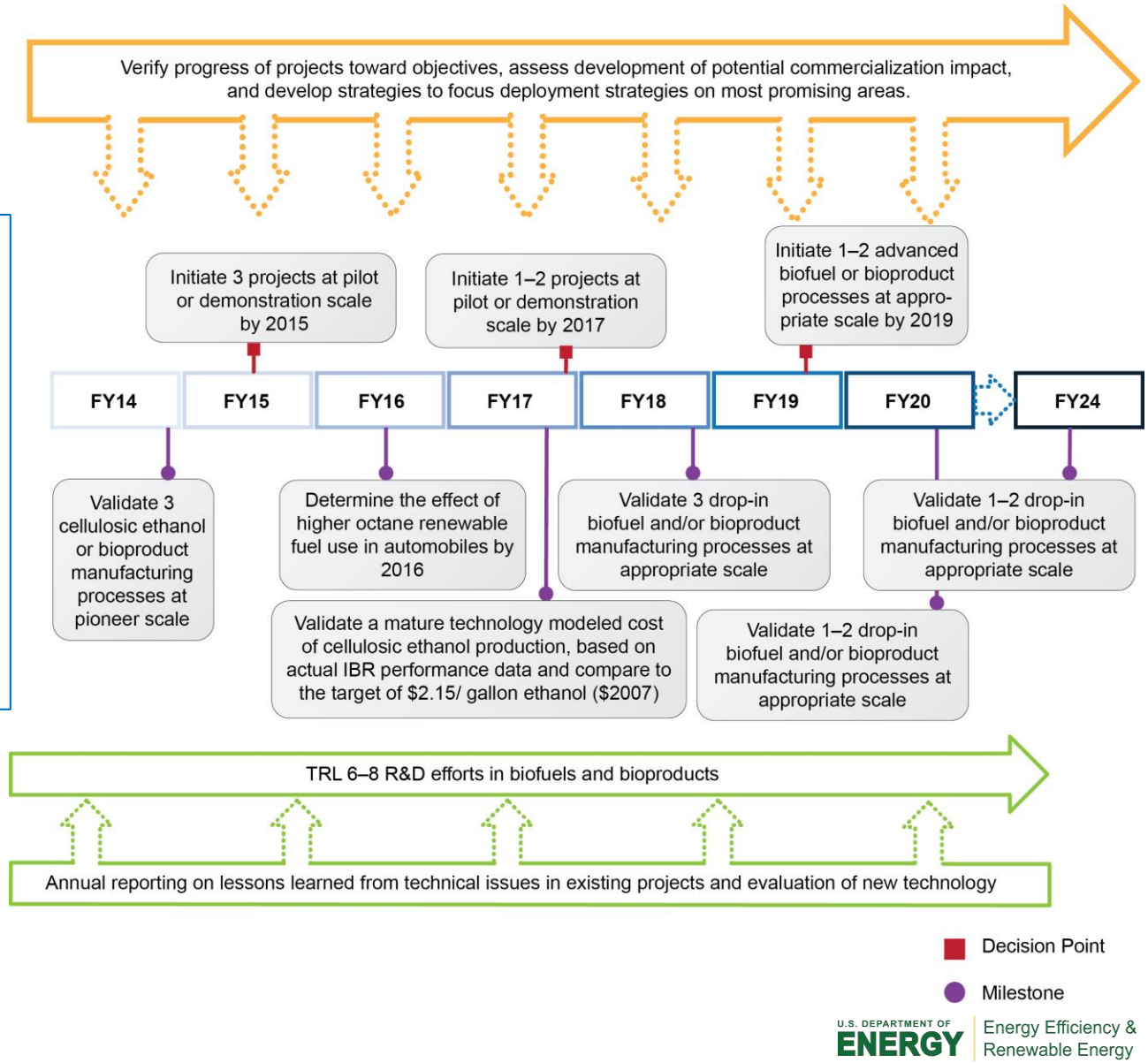
DMT Coordination Efforts and Future Directions

Coordination Efforts

- Coordination with Vehicle Technologies Office (VTO)
  - FY15 - $9M in DMT budget for Biofuels Compatibility work
    - To evaluate and enable usage of advanced biofuels at higher volumes in light duty vehicles
    - DMT will study and identify both optimization of “Renewable Super Premium” (RSP) 20–40 volume percent ethanol fuels and the optimal “drop-in” biofuels for use in fueling infrastructure and current and future vehicles.
  - FY16 – Continue Biofuels Compatibility work
    - Co-optimization of fuels and vehicle engines and technology components
    - Conduct fuel characterization of cellulosic ethanol and/or other hydrocarbon biofuel blends and
    - Biofuel blends will also be tested for compatibility with existing infrastructure systems, impacts on engine efficiency and tailpipe emissions, and for the development of various codes and standards for certification.

Future Directions: DMT Performance Goals and Targets

Aligned to support Hydrocarbon and Bioproduct Manufacturing goals, as well as Market Transformation



BETO Staff – DMT

Staff	Title
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Elliott Levine	Technology Manager
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Liz Moore	Technology Manager
Christy Sterner	Technology Manager

Special thanks to Glenn Doyle, Brian Duff, Fred Gerdeman, Paul Grabowski, Gene Petersen, John Scahill, and Travis Tempel!

DMT Peer Review Panel

Reviewer	Affiliation
Bill Crump (Lead Reviewer)	Leidos
Alan Propp	Merrick & Company
James Doss	Professional Project Services, Inc.
Brian Duff	Northrup Grumman
John Wyatt	Carmagen Engineering, Inc
Dan Strope	Refining Sciences, LLC.

Thank You

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