BIOENERGY TECHNOLOGIES OFFICE

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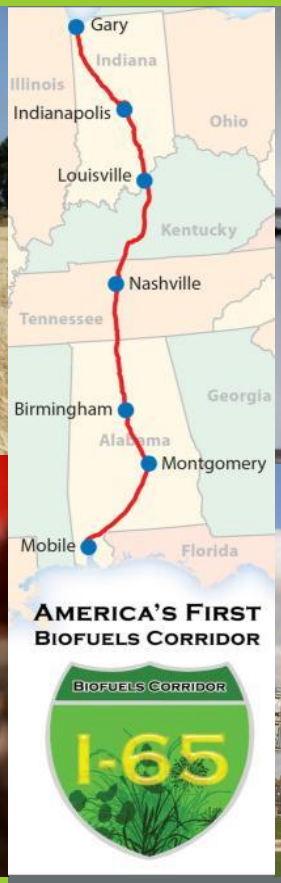


Demonstration & Market Transformation Peer Review Break-Out Presentation

March 23, 2015

Jim Spaeth

Program Manager

Demonstration & Market Transformation

DMT Portfolio Peer Review

- Introduction of the DMT Peer Review Team
- Peer Review Process
  - Ground rules for review process
- DMT Approach to Project Management
  - Budget Periods
- Changes Made in Response to the 2013 Peer Review
  - Lessons Learned / Best Practices
- Portfolio Overview
  - FOA Status and History
  - Project Portfolio Changes since 2013
  - Project Agenda
- Q&A

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.

Peer Review Process

Review Criteria

2015 Evaluation Criteria

1. **Project Overview**
   - Description of the history, context, and high level objectives of the project.
2. **Project Approach**
   - Describe overall technical approach using one slide and management approach using one slide.
   - Emphasize the structure of your approach including management approach, use of milestones for monitoring progress, and any unique aspects of your approach; de-emphasize discussion of equipment used.
   - Describe critical success factors (technical, market, business) which will define technical and commercial viability.
   - Explain the top 2-3 potential challenges (technical and non-technical) to be overcome for achieving successful project results.

Review Criteria (Continued)

3. Technical Progress and Accomplishments

- Describe progress made in meeting project objectives and following the project management plan.
- Describe the most important technical accomplishments achieved (from the last review to the present for existing projects, or progress to date for new projects).
- Benchmark the progress versus previously reported results (if applicable).
- Benchmark the accomplishments against the technical targets (if applicable).

4. Project Relevance

- Describe how project accomplishments contribute to meeting the platform goals and objectives of the Biomass Program Multi-Year Program Plan.
- Demonstrate how the project considers applications of the expected outputs.
- Your objectives should be clear regarding the relevance of your project to the Bioenergy Technologies Office, alignment with MYPP goals, and relevance for the overall bioenergy industry.

5. Future Work

- Explain what it is you plan to do through the end of the project with emphasis on the next 16 months (through September 30, 2016).
- Highlight upcoming key milestones.
- Address how you will deal with any decision points during that time and any remaining issues.

Overall Impressions (Not Scored)

– Please provide an overall assessment of the project based on the above criteria. These comments will be featured in the Final Peer Review Report.

Criteria Weighting System

The Criteria Weighting System has three categories based on the current stages of the projects.

1. Sun-Setting Projects: Projects completed by March 2015.
2. New Projects: Projects that have start dates that occur since April 1st, 2014.
3. Existing Projects: All other projects.

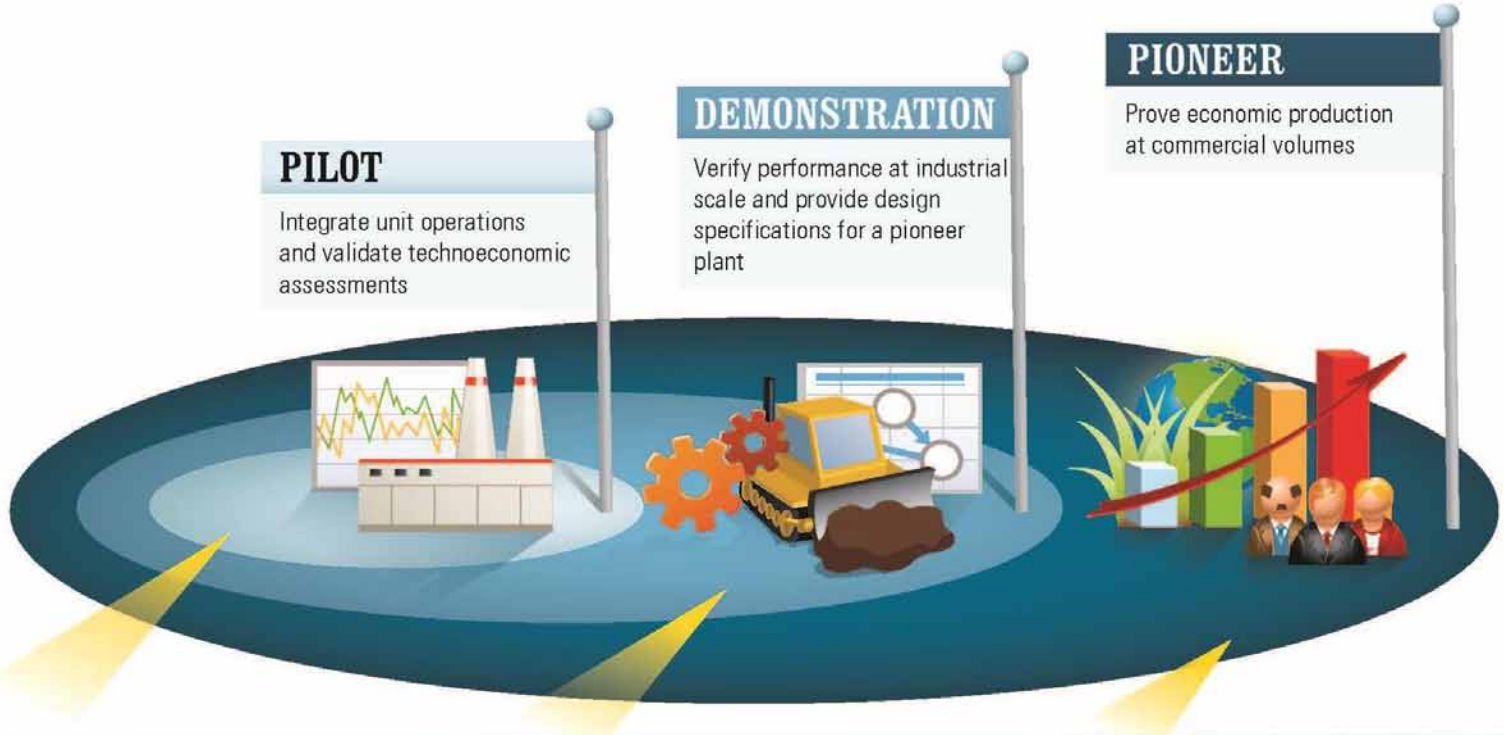
Scored Criteria	Sun-Setting Projects (completed by March 2015)	New Projects (since April 2014)	Existing Projects (everything else)
Overview	5%	5%	5%
Approach	15%	25%	20%
Accomplishments/ Progress	50%	10%	30%
Relevance	30%	25%	25%
Future Work	0% (no slide)	35% (2–3 slides)	20%

Project Scoring Criteria

Superior		Good		Satisfactory		Marginal		Unsatisfactory	
10	9	8	7	6	5	4	3	2	1
All aspects of the criterion are comprehensively addressed. There are significant strengths and no more than a few—easily correctable—weaknesses.		All aspects of the criterion are adequately addressed. There are significant strengths and some weaknesses. The significance of the strengths outweighs most aspects of the weaknesses.		Most aspects of the criterion are adequately addressed. There are strengths and weaknesses. The significance of the strengths slightly outweighs aspects of the weaknesses.		Some aspects of the criterion are not adequately addressed. There are strengths and significant weaknesses. The significance of the weaknesses outweighs most aspects of the strengths.		Most aspects of the criterion are not adequately addressed. There may be strengths, but there are significant weaknesses. The significance of the weaknesses outweighs the strengths.	

DMT Approach to Project Management

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

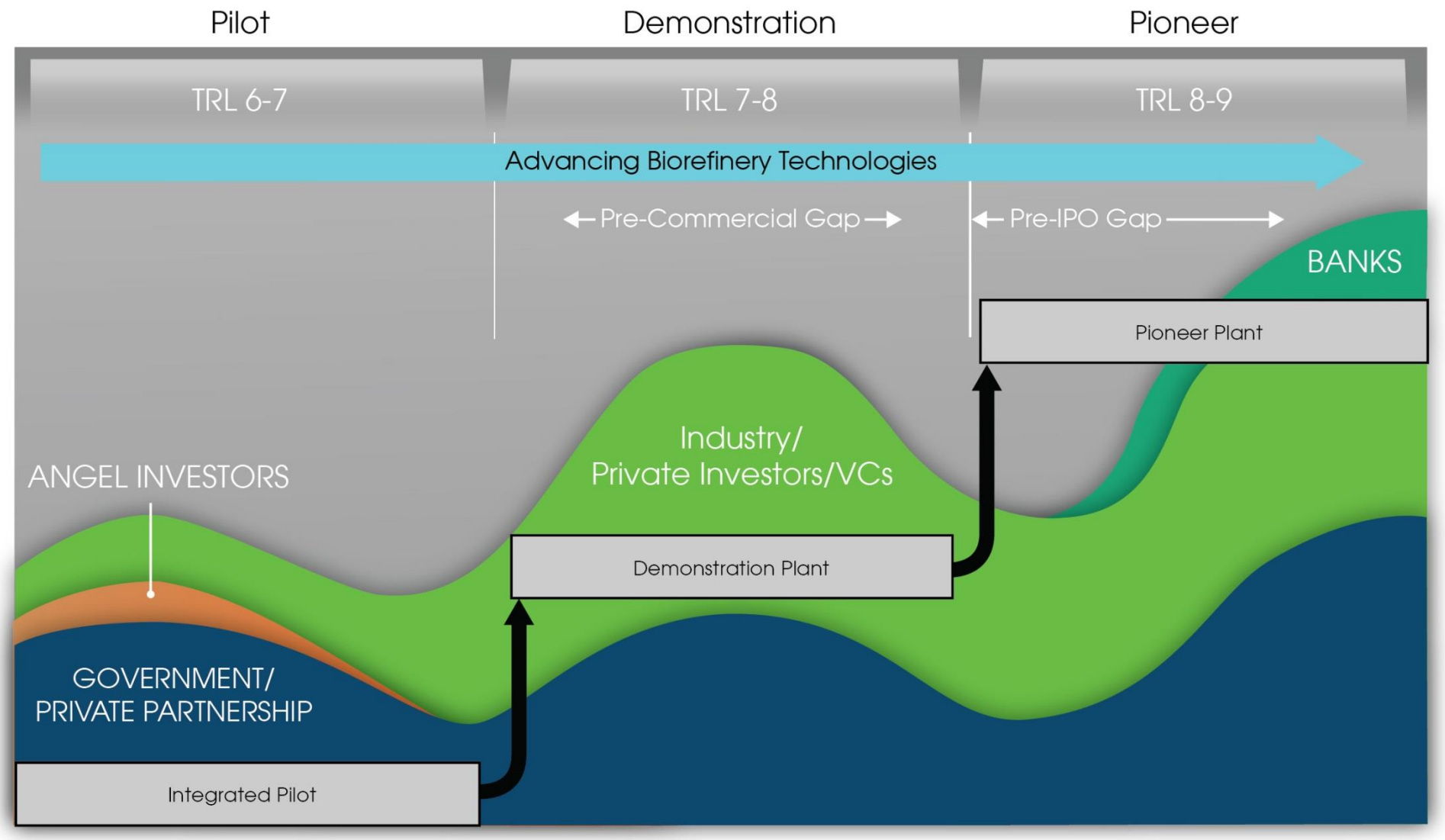
DEMONSTRATION OBJECTIVES

- 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

DMT Approach – Overcoming the "Valley of Death"



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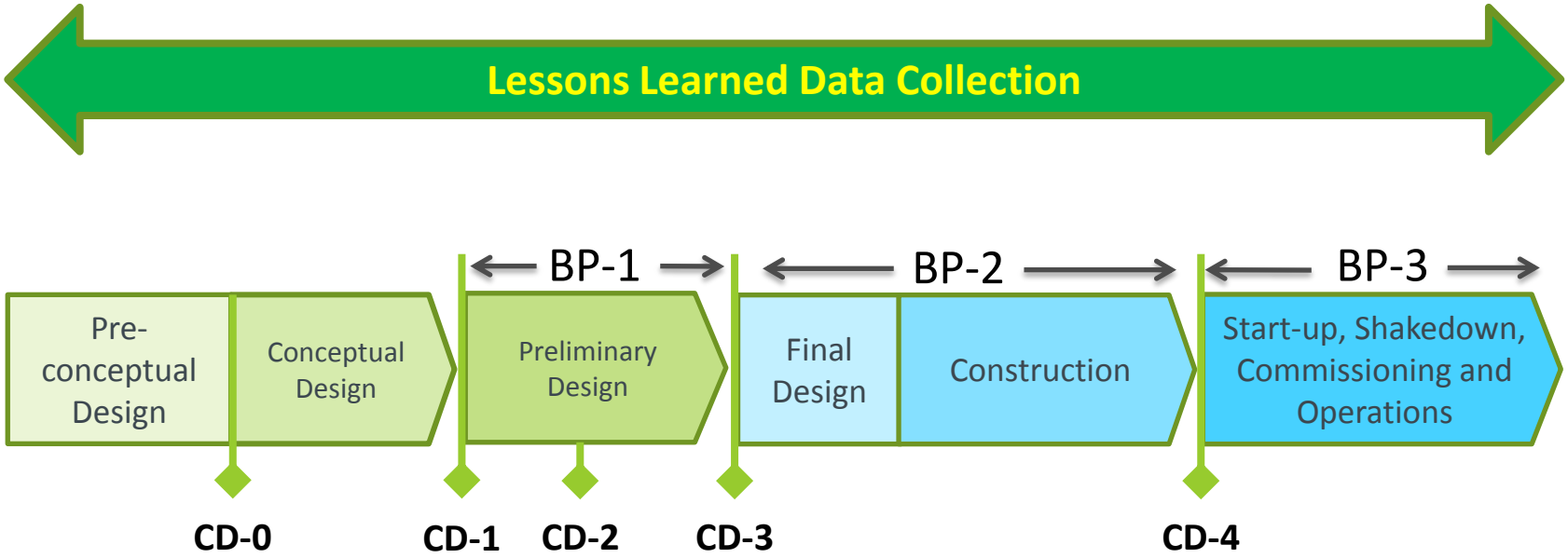
Framework for Executing DOE Project Management



BP = Budget Periods
CD = Critical Decision Points

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Changes Made in Response to the 2013 Peer Review

2013 Peer Review Report

- "The use of grants have been necessary to reduce the project capital investment; has provided project credibility which has acted as an attractant for private investment; and have provided a path for demonstrating technology proof of concept and market viability which is necessary for private industry to invest in future projects."

- "The biggest strengths of the portfolio were the actual construction of facilities which were preparing to produce significant quantities of advanced biofuels."

- "BETO should continue to fund IBR projects in the pilot, demo, and commercial stage with a larger number of pilot-scale, with fewer demonstration plants and even fewer commercial plants. All of these are important."

IBR Lessons Learned/Best Practices: Industry Interest & Value

Interest:

Recent workshops highlight the call for BETO to expand its role based on bioindustry lessons learned

- Standards Development and Market Analysis
- Facilities/Test Beds
- Feedstock Handling
- Equipment Development
- Outreach and Partnering
- Economic Value
- Funding Support

Photo courtesy of Tim Volk (SUNY-ESF)

Potential Value:

- Reduce costs of future projects (federal or otherwise)
- Informs BETO investment strategy to reduce risk
- Reduce barriers to commercialization of technologies
- Reduce barriers to private financing of future projects

Lessons Learned & Best Practices Definitions

"A lesson learned is a knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of lessons learned. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result."

- Secchi, P., Ciaschi, R., Spence, D.

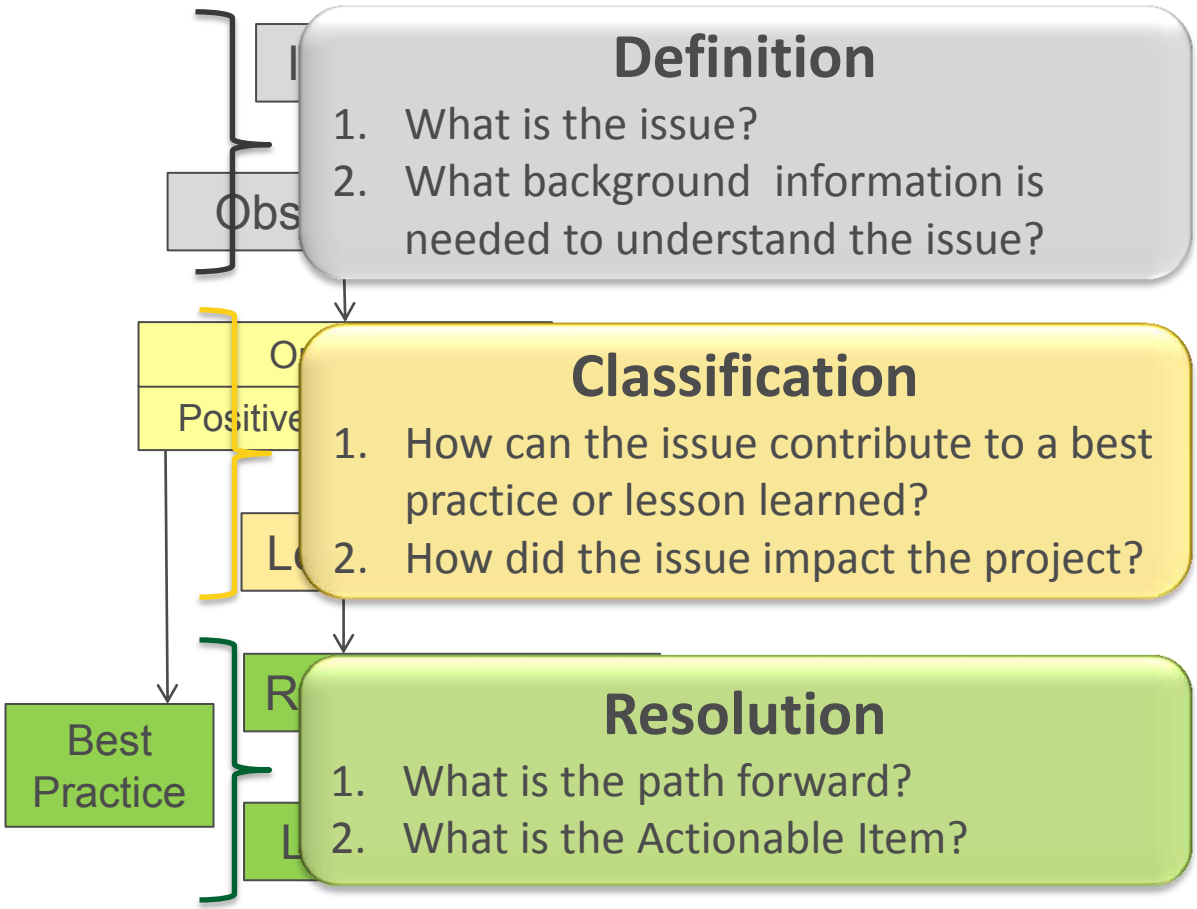
- Essentially, a lesson has not been "learned" unless an impact is realized and an action taken that increases the potential to improve outcomes
- A Lesson Learned or multiple Lessons Learned could lead to a Best Practice

"A best practice is known as a technique, method, process, activity or incentive which has proven to be most effective in providing a certain outcome."

– bestpractice.com

IBR Lessons Learned/Best Practices - System

Data Collection & Analysis Method



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IBR Initial Lessons Identified

1. Greater emphasis needs to be placed on **scale up risks** where data validation and piloting efforts should be seriously considered prior to design of an integrated facility

2. Fully **integrated pilot plant** tests are essential for
   - Refining the scale-up design
   - Testing modifications
   - De-bottlenecking

3. Projects without **fully developed designs** that were sent out for bid resulted in inaccurate cost estimates, schedule slip, and large cost overruns

Photo courtesy of NREL

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IBR Initial Lessons Identified (Continued)

4. Project location **weather and climate** should be considered in the plant design and construction:
   - How will humidity impact your process?
   - How will the plant start-up in a freeze?
   - Do heat traces need to be in place?
   - Are there related local climate related policies that will affect construction?
5. **"Commercially available" equipment** for a new function or scale needs to be treated as new technology
6. Oversight of **long lead equipment manufacturers** is important including:
   - Site visits at key manufacturing points
   - Verification of correct materials of construction
   - Interaction with the fabrication shop to ensure the finished product meets specifications
7. Appropriate risk mitigation plans should be created for even minor **heat or power disruptions**, especially during start up
8. Feeding solid biomass to reactors continues to be a challenge

IBR Initial Lessons Identified (Continued)

9. Overaggressive **schedules** mask risks and could result in YEARS of delay
10. Well balanced, **diverse project teams** are vital to the project success. The following can result in significant delays or cost overruns:
    - Misaligned expertise
    - Inexperience of key personnel
    - Over reliance on expertise of vendors
    - Legal counsel not used to review contracts (EPC/M, PPAs, vendors, etc.)
    - PMs inexperienced managing large, complex construction projects
    - Inappropriate expertise to review vendor's designs
11. Consider **additional contingency** during commissioning due to unknowns with starting up first-of-a-kind units

Photo courtesy of REII

Photo courtesy of POET

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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: Some 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

IBR Lessons Learned/Best Practices: Dissemination Opportunities

- Incorporate LL/BP into Funding Opportunities
- Non-proprietary Reports to Electronic Newsgroups (BETO email list)
- Bioenergy Knowledge Discovery Framework (KDF)
- Collaborative partnership – BETO, industry, financial community
- Technical Conferences, Workshops
- Journal Articles
- Interagency collaborations
- **Other ideas**

Photo courtesy of Myriant

Portfolio Overview

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.

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Project Status by FOA

Project (State)	Fuel Type	Scale
932 FOA		
Abengoa (KS)	Cellulosic Ethanol	Commercial
Poet (IA)	Cellulosic Ethanol	Commercial
Bluefire (MS)	Cellulosic Ethanol	Commercial
RangeFuels (GA)	Mixed alcohol	Commercial
Iogen	Cellulosic Ethanol	Commercial
Alico	Cellulosic Ethanol	Commercial
10% FOA		
Mascoma (MI)	Cellulosic Ethanol	Demo/Commercial
RSA (ME)	Cellulosic Ethanol	Demonstration
Verenium (LA)	Cellulosic Ethanol	Demonstration
Flambeau (WI)	FT diesel and waxes	Commercial
Lignol (OR)	Cellulosic Ethanol	Demonstration
NewPage (WI)	FT diesel and waxes	Demonstration
Pacific Biogasol (OR)	Cellulosic Ethanol	Demonstration
iPilots		
Bioprocess Algae (IA)	Algal oil to Jet A	iPilots
Cobalt (CO)	Diesel, jet	iPilots
Frontline (IA)	Diesel, jet	iPilots
Mercurius (WA)	Ethyl levulinate	iPilots

KEY	
	Completed
	In-Close Out
	Project Discontinued or Recipient Withdrew

Project (State)	Fuel Type	Scale
ARRA		
INEOS (FL)	Cellulosic Ethanol	Demonstration
Sapphire (NM)	Jet fuel and diesel	Demonstration
Enerkem (MS)	Cellulosic Ethanol	Demonstration
Myriant (MI)	Succinic Acid	Pilot/ Demonstration
API (MI)	Cellulosic Ethanol	Pilot
ICM (MO)	Cellulosic Ethanol	Pilot
ADM (IL)	Cellulosic Ethanol	Pilot
Zeachem (OR)	Cellulosic Ethanol	Pilot
Algenol (FL)	Cellulosic Ethanol	Pilot
REII (OH)	Diesel	Pilot
Solazyme (IL)	Biodiesel and renewable diesel	Pilot
UOP (HI)	Diesel, gas, jet fuel	Pilot
Haldor Topsoe (IL)	Green gasoline	Pilot
Amyris (CA)	Diesel	Pilot
Clearfuels (CO)	FT diesel and jet fuel	Pilot
Logos/EdenIQ (CA)	Cellulosic Ethanol	Pilot
Elevance	Metathesis Chemistry for Oil to fuels/products	R&D
Gas Tech. Institute (IL)	Pyrolysis Oils for fuels	R&D

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DMT FOAs Since 2012 – Innovative Pilot Solicitation

- DOE released the Innovative Pilot (iPilot) solicitation in 2013, which provided up to $18 million for pilot-scale biorefineries.
- Goal of the solicitation was to increase the amount of available alternative transportation fuel options meeting military specifications for jet fuel and shipboard diesel for cars, trucks, and planes.
- Projects were required to provide a minimum of 50% cost share and utilize non-food biomass feedstocks, waste materials, or algae.

Project	Location	Feedstock Type	Conversion Technology	Status
BioProcess Algae	Shenandoah, Iowa	Algae	Biochemical	Active
Frontline Bioenergy, LLC	Ames, Iowa	Woody Biomass, MSW, and Refuse-Derived Fuel	Thermochemical—Gasification	Active
Mercurius Biorefining, Inc.	Ferndale, Washington	Cellulosic Biomass	Thermochemical	Active
Cobalt Technologies	Mountain View, California	-	-	Withdrawn

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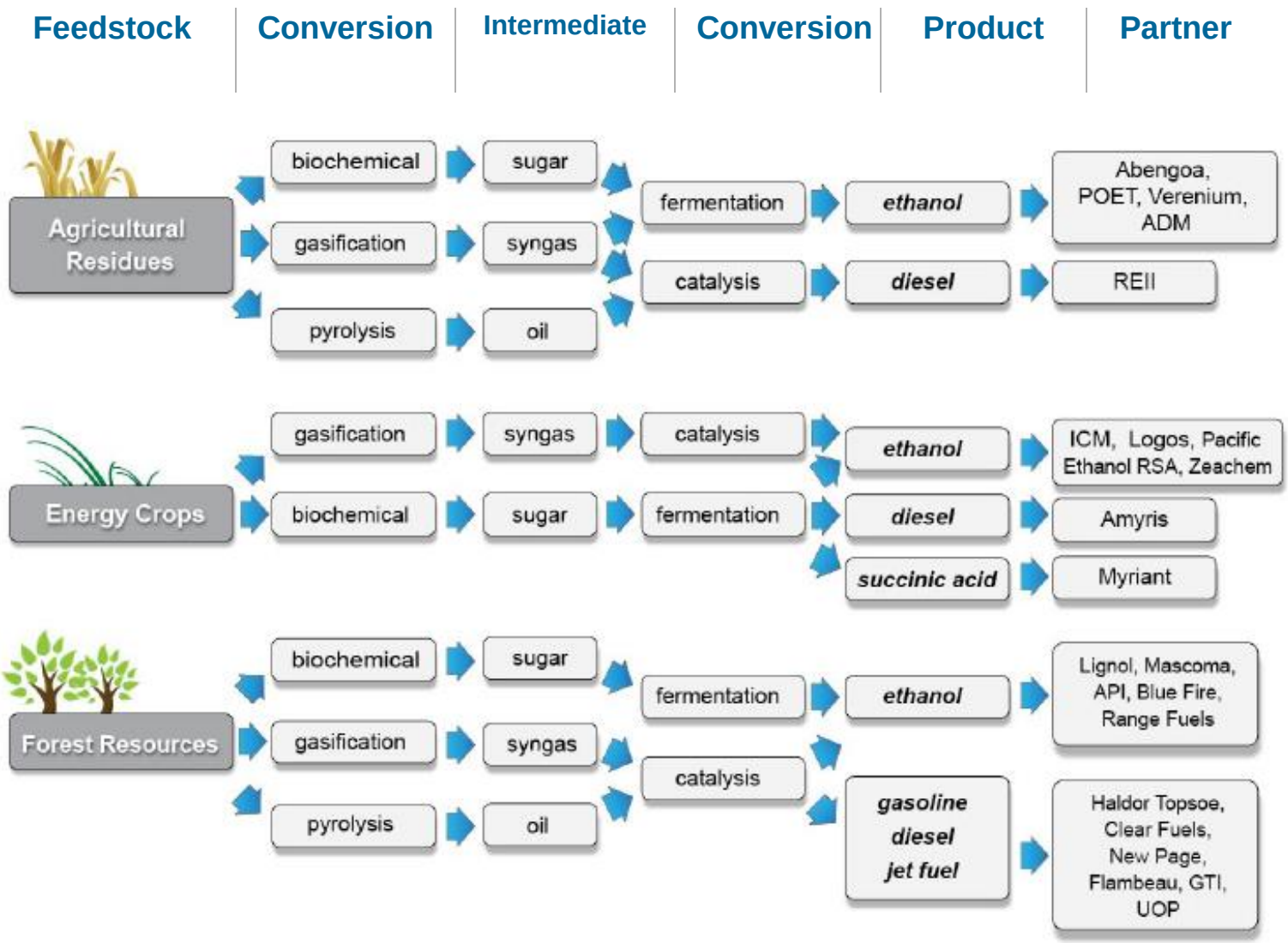
Status of DMT IBR Portfolio – Geographic Distribution

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 Integrated Biorefineries– Pathway Diversity



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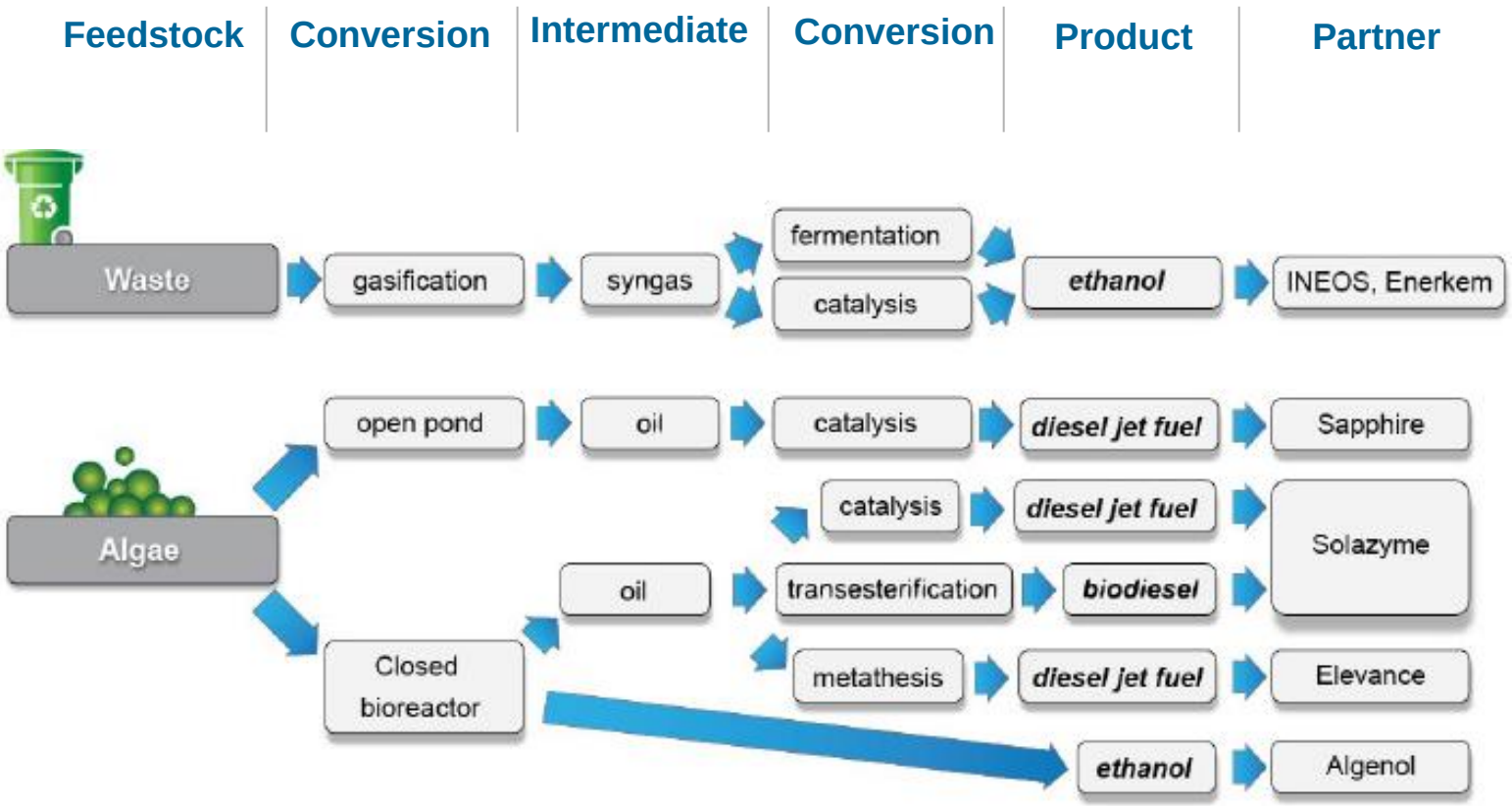
DMT Integrated Biorefineries– Pathway Diversity



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DMT FY15 National Laboratory Projects

- Increasing biofuel deployment and utilization through development of renewable super premium
  - ANL, NREL, and ORNL
- Sustainable Transport Fuels from Biomass and Algal Residue via Integrated Pyrolysis and Catalytic Hydroconversion ; and Renewable Jet Fuel
  - PNNL
- Fire Standards Codes and Prevention in IBR's
  - ORNL
- Systems Integration - Data mining of IBR's
  - NREL

DMT Peer Review Portfolio

Recipient	Project Title	Product	Scale	FOA
Oak Ridge National Laboratory	Fire Standards Codes and Prevention in IBR's	N/A	Market Transformation	AOP
Brookhaven National Laboratory	BNL Bio-Oil Deployment in the Home Heating Market	N/A	Market Transformation	AOP
Humboldt State University (CA)	Waste to Wisdom: Utilizing forest residues for the production of bioenergy and biobased products	In field conversion	Demonstration	BRDI
Argonne National Laboratory	Increasing biofuel deployment and utilization through development of renewable super premium	N/A	Market Transformation	AOP
National Renewable Energy Laboratory	Increasing biofuel deployment and utilization through development of renewable super premium	N/A	Market Transformation	AOP
Oak Ridge National Laboratory	Increasing biofuel deployment and utilization through development of renewable super premium	N/A	Market Transformation	AOP
Frontline BioEnergy, LLC (IA)	Innovative Gasification to Produce Fischer-Tropsch Jet and Diesel Fuel	Diesel, jet	iPilots	iPilots
Mercurius (WA)	Renewable Acid-hydrolysis Condensation Hydrotreating (REACH) Pilot Plant	Ethyl levulinate	iPilots	iPilots
Bioprocess Algae (IA)	Pilot-Scale Mixotrophic Algae Integrated Biorefinery (IBT)	Algal oil to Jet A	iPilots	iPilots

DMT Peer Review Portfolio (Continued)

Recipient	Project Title	Product	Scale	FOA
Algenol (FL)	Integrated Pilot-Scale Biorefinery for Producing Ethanol from Hybrid Algae	Cellulosic Ethanol	Pilot	ARRA
Sapphire (NM)	Sapphire Integrated Algal Biofinery (IABR)	Jet fuel and diesel	Demonstration	ARRA
UOP (HI)	Pilot Scale Biorefinery: Sustainable Transport Fuels from Biomass and Algal Residue via Integrated Pyrolysis and Catalytic Hydroconversion	Diesel, gas, jet fuel	Pilot	ARRA
Haldor Topsoe (IL)	Green Gasoline from Wood Using Carbona Gasification and Topsoe TIGAS Processes	Green gasoline	Pilot	ARRA
INEOS (FL)	INP BioEnergy Indian River County Facility	Cellulosic Ethanol	Demonstration	ARRA
Zeachem (OR)	High-Yield Hybrid Cellulosic Ethanol Process Using High-Impact Feedstock for Commercialization by 2013	Cellulosic Ethanol	Pilot	ARRA
ICM, Inc. (MO)	Pilot Integrated Cellulosic Biorefinery Operations to Fuel Ethanol	Cellulosic Ethanol	Pilot	ARRA
Myriant (MS)	BEI - Myriant Succinic Acid Biorefinery (MySAB)	Succinic Acid	Pilot/ Demonstration	ARRA
Archer Daniels Midland (IL)	Conversion of Lignocellulosic Biomass to Ethanol and Ethyl Acrylate	Cellulosic Ethanol	Pilot	ARRA
American Process, Inc. (MI)	Alpena Prototype Biorefinery	Cellulosic Ethanol	Pilot	ARRA
Abengoa (KS)	Integrated Biorefinery for Conversion of Biomass to Ethanol, Synthesis Gas, and Heat	Cellulosic Ethanol	Commercial	932
Poet (IA)	LIBERTY - Launch of an Integrated Bio-refinery with Eco-sustainable and Renewable Technologies in Y2009 - TIA	Cellulosic Ethanol	Commercial	932

Critical Dates and Activities

March 23-27, 2015

Project Peer Review

Hilton Mark Center,

Alexandria, Virginia

(arrival Sunday March 22, 2015)

June 25, 2015

Program Management Review

Washington Convention Center

Washington DC Metropolitan Area

June 23-24, 2015

Bioenergy 2015 Conference

Washington Convention Center

2015 PROJECT PEER REVIEW

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BIOENERGY TECHNOLOGIES OFFICE

2015 Peer Review Website

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2015

Questions and Discussion

Thank You

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