

U.S. Department of Energy (DOE)
Bioenergy Technologies Office (BETO)
2017 Project Peer Review

POET-DSM Project LIBERTY

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Demonstration and Market Transformation
Session Area Review

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Project LIBERTY



Goal Statement

- Project Objectives
 - Process 700 metric tonnes of biomass for the purpose of manufacturing cellulosic ethanol in a co-located IBR model
 - Implement a sustainable stover collection, storage and delivery system
 - Demonstrate shared DOE/POET-DSM foresight for biomass investments and technology for rapid deployment of commercial scale biorefineries
 - Maximize alternative energy production and minimize traditional energy usage (MYPP goal)
- As with BETO, POET-DSM goal is to develop commercially viable bioenergy
 - To enable sustainable, nationwide production of biofuels
 - Displace a share of petroleum-derived fuels to reduce U.S. dependence on foreign oil
 - Encourage the creation of a new domestic bioenergy and bioproduct industry. (MYPP goal)
- Project LIBERTY is one of the first commercial scale cellulosic biorefineries operating in the U.S.
 - DOE grant accelerated DMT construction and operations
 - Successful DMT will help launch replication

Quad Chart Overview

Timeline

- Project start dates (construction):
 - Biomass stackyard - 2010
 - Biorefinery - 2012
- Project end date:
 - Commercial biomass handling operations began: July 2014
 - Mechanically Complete: Dec. 2014
 - **Final Acceptance: Dec 2017**
- Percent complete:
 - EPC & cost share funding 100%

Budget

	Total Costs FY 12 –FY 14	FY 15 Costs	FY 16 Costs	Total Planned Funding (FY 17- Project End Date)
DOE Funded	\$97,521,074	\$100,000,000	\$0	\$0
Project Cost Share (Comp.) *	>\$174,999,998	>\$175,000,000	>\$	>\$

Barriers

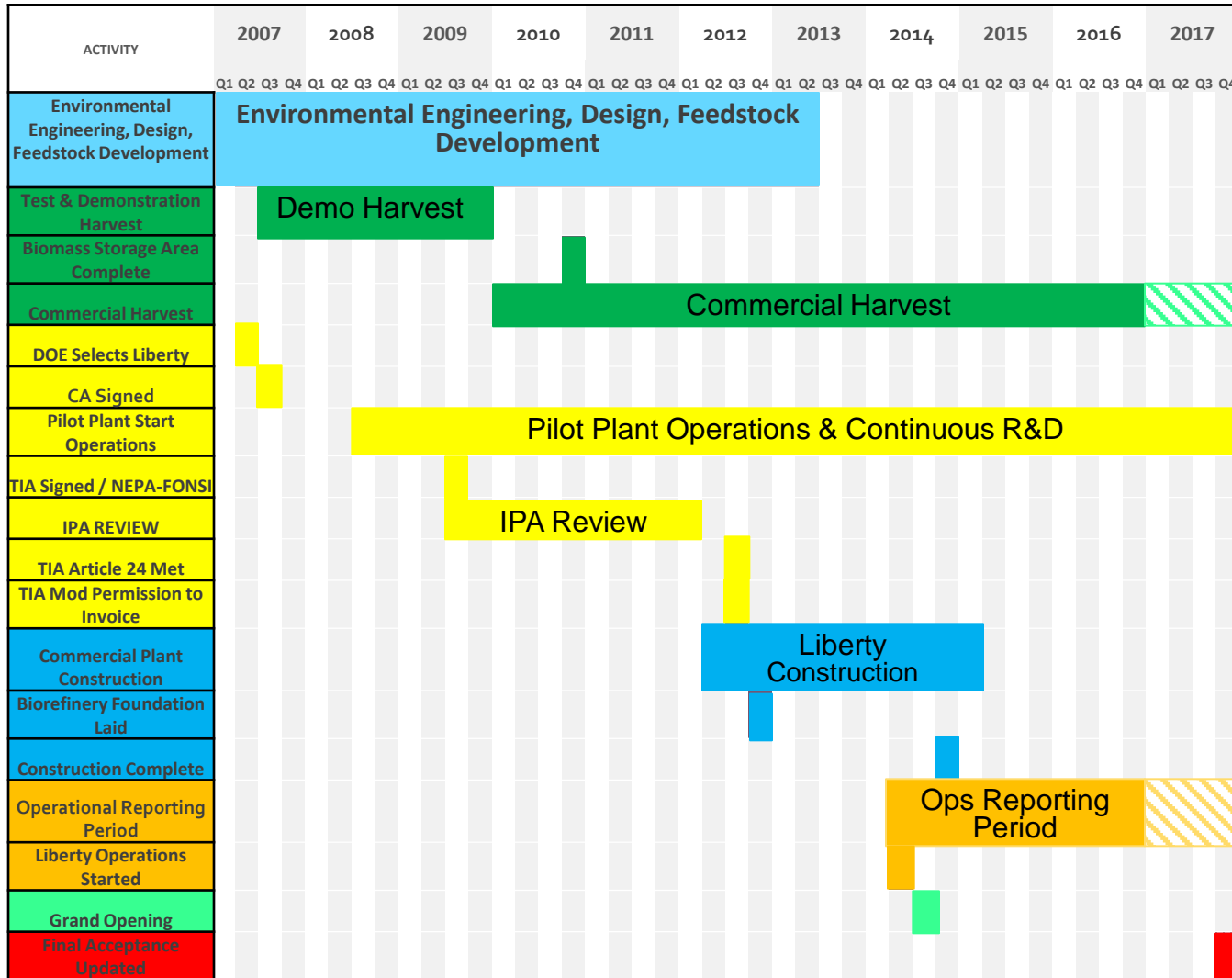
Barriers Addressed:

- .Start up & operations are underway
- System improvements are being executed.
- Preparing for Performance Testing and Final Acceptance

Partners

- DOE & State of Iowa for grant funding
- Business is joint venture between POET (50%) and DSM (50%).
- Collaborating with Novozymes and NREL.
- Intellectual property licenses are held by POET and DSM.
- Project/construction management and commissioning contracted to POET Design and Construction.
- Start-up and Operations contracted to POET Plant Management.

Key Milestones



Key Milestones

- Project schedule status
 - Major construction was complete August 2014
 - Front end processing construction was complete June 2014
 - » Baseline was May 2014
 - Back end processing construction was complete August 2014
 - » Baseline was May 2014
 - Front end operational start was July 07, 2014
 - Major commissioning was complete September 2014
 - 28 months of operation
 - Achieved Mechanical Completion December 2014
 - Operational capacity goal of 770 BDT/day to achieve Final Acceptance by end of 2017

Detailed Project Budget Table

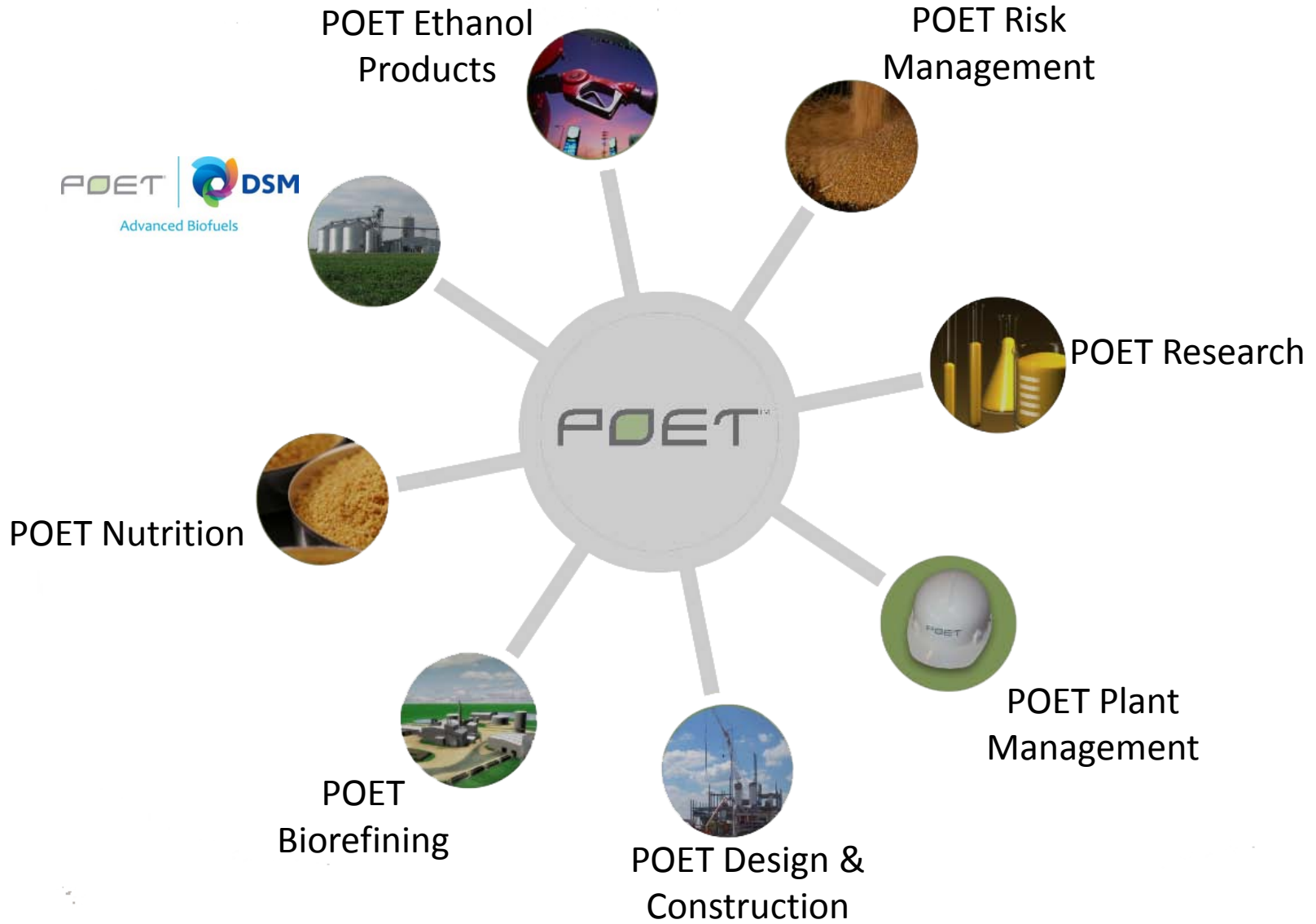
Budget Periods and Phasing	Original Project Cost (Estimated)			Project Spending and Balance		Final Project Costs
	DOE Funding	Project Team Cost Shared Funding	Contingency	Spend to Date	Remaining Balance	What funding is needed to complete the project.
2008-2012 Design & Engineering	\$13.7M	\$25M		\$38.7M	\$244.3M	\$0
2013 IBR Construction	\$54M	\$97M		\$151M	\$93.3M	\$0
2014 IBR Construction & Startup	\$29.7M	>\$51M		\$80.7M	\$12.6M	\$0
2015 Operations Start Up	\$100M	>\$175M		>\$~	\$	JV Equity
2016 Operations Start Up	\$0	>\$~		>\$~	\$	JV Equity

Detailed Project Scope Change Detail

Scope Changes	Date	Logic / Reasoning	Approval / Rejection Date
Added SFB	2012/07	Solid Fuel Boiler Added to Project Could not break down lignin thermophyically.	2012/07
ADBG Technology	2012/11	Change order to support engineering adjustments to scope design. JV formed. Switched vendor technology for ADBG	2012/11
Scope / Schedule	2013/11	Scope increases to complete project on time.	2013/11
Scope / Schedule	2014/04	Scope increases to complete project on time.	2014/04

1 - Project Overview

- Location of project and company headquarters: Project LIBERTY is located in Emmetsburg, IA, co-located with POET Biorefining – Emmetsburg. POET-DSM company headquarters is in Sioux Falls, SD.
- High Level overview of:
 - Feedstock handling: Manual handling from trailer to milling equipment by rolling stock. Net wrap removal will be automated by POET designed equipment.
 - Conversion technology: Acid pretreatment with enzymatic conversion
 - Product purification: Standard fuel ethanol distillation and molecular sieves
- Scale of the project under development with DOE assistance:
 - Feedstock(s) tons per day at this facility: Minimum of 700 metric tonnes per day
 - product(s) gallons (or pounds) per year of this facility: 20 million gallons of cellulosic biofuel per year, ramping up to 25 million gallons per year



Company Structure and Project Management

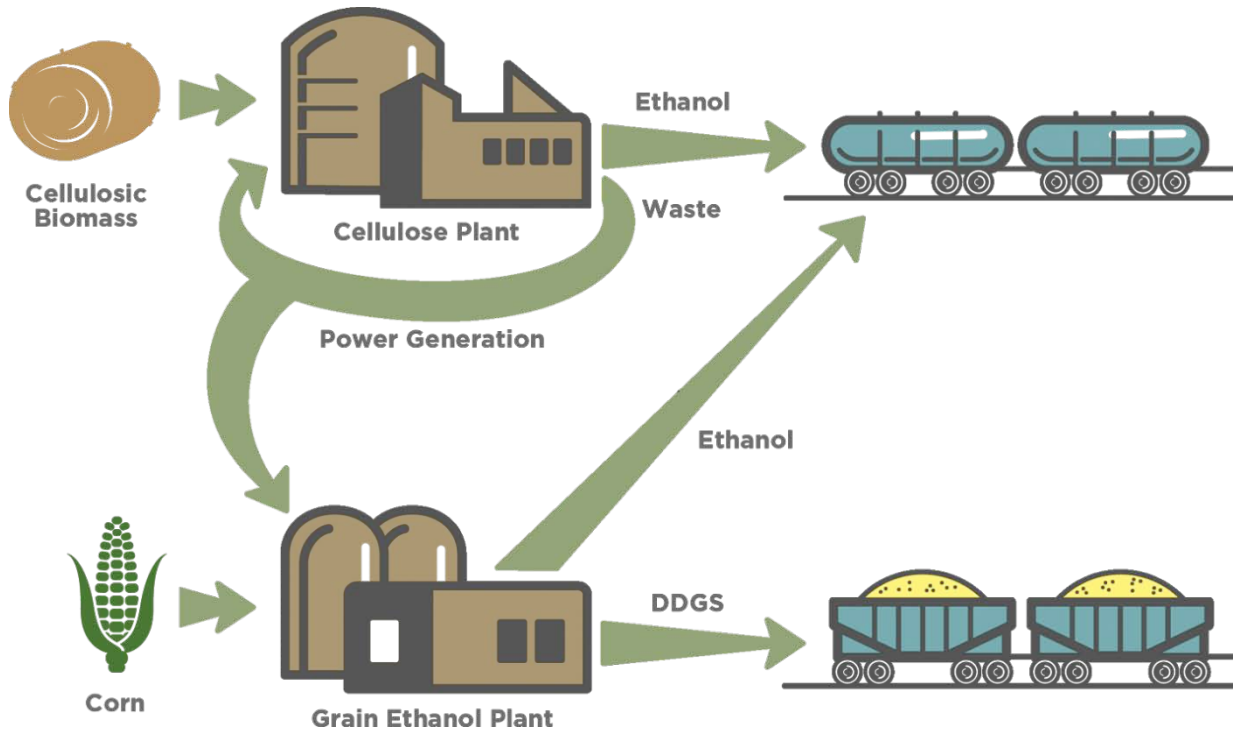
Key Partnership Objectives

- Global footprint – ability to enhance POET's US footprint with global assets
- Leadership in licensing model – licensing opportunity for cellulosic key value proposition
- Ability to match POETs strong history of technological advancement – mitigate technology risk
- Matching culture – critical to success

2 - Approach Management

- POET-DSM Advanced Biofuels uses its combined expertise to address open technical issues.
- The POET pilot plant in Scotland, SD has been operating since 2008. The technologies used in the LIBERTY project have been either piloted in Scotland or at vendor locations.
- Commercial, pilot plant, and lab results are reviewed on a continuous basis.
- All of the critical go/no go decisions have been cleared for the project. The technical teams continue to review results and seek continuous improvements.
- All process development activities are evaluated through an economic model. The economic model evaluates key indicators such as operational cost/gallon, total capex/gallon, etc.

2- Overall Technical Approach



Goal: Commercial-scale cellulosic plant

Objectives

- Integrated model
- Sustainable biomass supply
- Replication model

2 - Overall Technical Approach

- Manual corn stover bale handling from trailer to milling equipment by rolling stock.
- Sized biomass is processed with acid pretreatment and enzymatic conversion
- Sugars created in acid pretreatment and enzymatic conversion are fermented with a propagated GMO yeast.
- Standard fuel ethanol distillation and molecular sieves are used to purify the fermentation beer
- Beer solids and evaporator solids are converted to steam in a solid fuel boiler. The steam is used at LIBERTY and co-located grain ethanol plant.
- Waste water is anaerobically treated to produce methane gas which is used at Liberty and the co-located plant.

2 - Critical Management Success Factors

1. Feedstock supply & management
2. Commercial scale technology demonstration
3. Replication

2 - Management Potential Challenges

1. Feedstock supply & management
2. Commercial scale technology demonstration
3. RFS / Market access / Financing for replication

2 - Technical Accomplishments/Progress/Results

- The technical objectives continue to be tested both at lab and pilot scale. The basis for the LIBERTY design specifications and current operations are created based on this data.
- Commercial biomass handling operations began in July 2014.
- Technical Accomplishments include:
 - Completion of detailed design engineering including anaerobic digestion and biogas scrubbing technology based on pilot plant results.
 - Mechanical Completion issued by Design Builder.
 - Commissioning is complete and start-up efforts continue.
 - Design Builder turnover of entire facility completed.
 - Facility operations have commenced
 - Optimization to meet design rate improving

2- Technical Accomplishments/Progress/Results

Progress Benchmarks

- Recent Key Milestones Include:
 - Operations turned over to POET Plant Management July 2014
 - Mechanical Completion certification July 2015
 - Begin operations of anaerobic digestion/biogas scrubbing unit operation Q2 2015
- Future Key Milestones Include:
 - D/B Guaranteed Performance Test Q3 2017 - Behind Schedule
 - D/B Final Acceptance Certification Q4 2017 - Behind Schedule

2 - Technical Accomplishments/Progress/Results

Progress Benchmarks

- Mechanical Completion, commissioning and start-up were achieved slightly behind the planned schedule.
 - Progress was slowed by winter construction and finalization of the anaerobic digestion and biogas scrubbing detailed design.
- Operational turn-over to POET Plant Management was partially completed on schedule.
 - The majority of the facility was turned over as planned. The anaerobic digestion and biogas scrubbing systems were turned over later than the other areas of the facility.
- Currently working toward continuous cellulosic ethanol production
 - Biomass conveyance
 - Pretreatment

3- Relevance

- Project LIBERTY is one of the first commercial scale cellulosic biorefineries designed to 770BDT/day (MYPP goal)
- DOE grant accelerated commercial demonstration scale construction and operations of Project LIBERTY.
- Successful demonstration at commercial scale will encourage replication at other biorefineries. (MYPP goal)
- POET plans to have a hand in producing billions gallons of cellulosic ethanol by 2022. (MYPP goal)
- Within 3 years of continuous production, POET anticipates a 15% reduction in the cost per gallon
- Over 25 years of POET corn-to-ethanol technology improvements are strong evidence that cellulose-to-ethanol technology improvements will be significant
 - Corn based ethanol yields have improved by 20%
 - POET plants are using 33% less energy/gallon than 12 years ago
 - POET plants' water usage/gallon is down 80%

3 - Relevance

The POET Plan

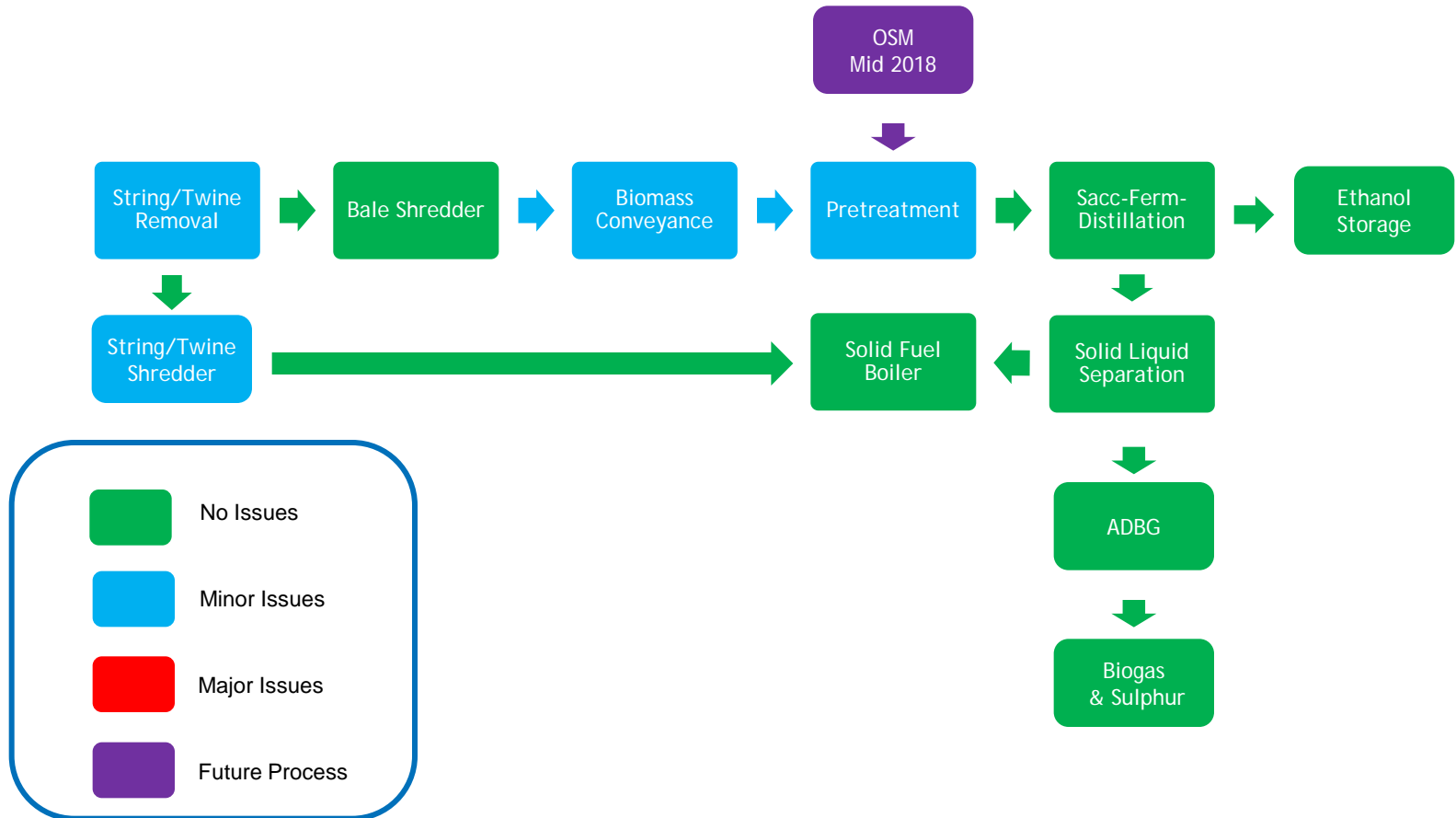
- Our vision is to enable all consumers in every state to choose domestic, renewable fuels
- Our objective is to ensure sufficient supply to meet the consumer demand
- We will start with a goal...
- **3.5 billion gallons of cellulosic ethanol by 2022**
 - 1 billion from adding cellulosic technology to POET plants
 - 1.4 billion from licensing technology to other corn-based ethanol producers
 - 1.1 billion from other forms of biomass produced by POET through joint ventures and opportunities

Risk Registry Table

Tracking Number	Project Area	Project Risk	Risk Mitigation Plan	Risk Probability	Potential Impact	Mitigation Location / Strategy	Status
PROJECT MANAGEMENT & ENGINEERING							
41	Management	Turnover in project management or engineering staff during the course of the project	Project oversight by multiple managers will create virtual redundancy.	Medium	Medium	POET	Open
TECHNOLOGY							
4	Biomass Feedstock	Bale age and how it relates to dry matter loss/carbohydrate content/ferment ability/ethanol yield and fines creation during milling.	Continued research by PRI and PBM with LIB stack yard material.	Medium	Medium	Gather yield data at LIBERTY and take corrective action as data indicates.	Open
9.1	Pretreatment	Solids /Liquid Ratio control	Install new POET technology	High	High	Technology installed and being optimized	Open
FEEDSTOCK							
12	Biomass Feedstock	Feedstock oversupply due to less than design rate steady state operations.	Currently working to increase feed rates to the solid fuel boiler. Increase steady feed from biomass handling to pretreatment	High	High	This is a concern and we are establishing contracting management strategies to have flexibility. Getting to design rate will mitigate this issue.	Open
13	Biomass Feedstock	Alternative option to disposing of older material.	Working on strategies to enable the product to be fed into the plant. It will require more resources to do so.	High	High	Working on possible alternative outlets for aged material. Evaluation continues on handling viability for conversion of older biomass	Open
14	Biomass Feedstock	Ability to contract an unknown amount of volume.	Based on lack of run-time experience, the quantity necessary for full production in unknown.	Medium	High	Continue to keep producers informed of forecasted needs while maintaining realistic expectations.	Open
OPERATIONS							
7	Pretreatment	Continuous Operations challenge due to solids/liquid ratio	Evaluate alternative systems	Medium	High	Technology for solids management installed and showing success, optimization continues	Open
9	Solid Fuel Boiler	Syrup to SFB could cause slagging issue in combustor.	Disposal of syrup to other uses.	Medium	Medium	Sending syrup off to digester company.	Open

Technical Performance

Project LIBERTY- Process Operations Block Diagram



4 - Future Plans

- Continue to Optimize Project LIBERTY to meet 770bdt/day (MYPP Goal)
- Begin replication planning for next project in POET network as we approach commercial rates at Project LIBERTY (MYPP Goal)
- Rollout POET-DSM licensing plan starting with US based biorefineries

Summary

- POET/DSM Project LIBERTY construction is complete.
- Operations have started; commercial reality is here now.
 - System performance is being improved daily; advancements made
 - Driving towards Guaranteed Performance Tests
- Project LIBERTY is a significant contributor to the goals of the DOE Bioenergy Technology Office.
- The approach to integrate with corn-based ethanol plants allows for rapid deployment across the Corn Belt.
- Commercial-scale feedstock supply chain and biomass storage area is in place.
- Maintaining RFS is critical to drive further investment to meet volume goals.

Additional Slides

Responses to Previous Reviewers' Comments

2015 Peer Review Report Comments

"Well done POET-DSM!"

"This is an excellent project for the DOE portfolio. There is high potential for this project to have a significant impact on the development of advanced biofuels. The start-up challenges are not unusual and generally around materials handling, separations, and biological performance".

"The POET project is an outstanding success and demonstrates exactly what BETO's DMT platform should be doing to advance the state of the industry. The performance of the principal investigator and the sub-awardees on the project were exemplary and demonstrates superior project planning, project management, and project implementation. BETO should be commended for supporting the POET project. This project is an excellent example of sound project management and implementation on the part of both the performer and the BETO project officers".

"As in 2013, the project continues to demonstrate the value of having an experienced operator/developer, with other sources of cash flow, and managing the project".

"This is an excellent example of a well-planned and executed project. The feed supply chain work is particularly impressive. I would like to see more reporting of safety indexes during construction".

Response- Safety is the primary focus for Project LIBERTY. The operations team and contractors on site demonstrate sound behavior-based safety culture. Unsafe condition and Near-miss reporting have improved year-over-year since commissioning.

POET-DSM appreciates the support and guidance DOE-BETO has provided our world-changing project

Patents, Awards, Publications, and Presentations

Patents

- DOE Funded Intellectual Property
 - None
- POET-owned Liberty Related Process Technology IP
 - 7 PCT (filed nationally)
 - 9 US patent applications pending
 - 2 US issued patents
- POET-owned Biomass Collection, Storage and Logistics IP
 - 1 PCT (filed nationally)
 - 2 US patent applications pending
 - 2 US issued patents
- IP-related Agreements
 - C5 Ethanologen: use in pilot plant (secured); commercial license (secured); tolling agreement (secured)
 - Process Technology & Enzyme Use: enzyme supply (field exclusive/time advantage; secured)
 - Pretreatment Equipment Technology: commercial use
 - Many nondisclosure and material transfer agreements

Awards

- None

Publications

- None

Presentations

- None, other than those related to Department of Energy Reviews