

2015 DOE Bioenergy Technologies Office(BETO) IBR Project Peer Review

POET-DSM Project LIBERTY

2015
DOE Biomass Platform Peer Review (BPR)

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POET



Goal Statement

- Project Objectives
 - Process 700 metric tonnes of biomass for the purpose of manufacturing cellulosic ethanol in a co-located model to optimize relational benefits
 - Implement a sustainable stover collection, storage and delivery system
 - Utilize the foresight of previous DOE biomass investments and technology from Joint Venture for rapid deployment of commercial scale biorefineries
 - Maximize alternative energy production and minimize traditional energy usage
- Project LIBERTY is one of the first commercial scale cellulosic biorefineries operating in the U.S.
- DOE grant accelerated commercial demonstration scale construction and operations of Project LIBERTY.
- Successful demonstration at commercial scale will help launch replication and build-out of new cellulosic biorefineries.

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
- Percent complete:
 - EPC & cost share funding 100%

Budget				
	Total Costs FY 08-12	FY 13 Costs	FY 14 Costs	Funding (FY 15 - Project End Date)
DOE Funded	\$ 13,730,470	\$ 54,000,219	\$ 29,790,385	\$ 100,000,000
Project Cost Share	\$25,605,329.33	\$97,525,933.71	> \$51,868,736	> \$175,000,000

Barriers

Barriers Addressed:

- The EPC project design, construction, commissioning is complete.
- Start up & operations are underway
- System improvements are being executed.
- Preparing for Performance Testing and Final Acceptance

Partners

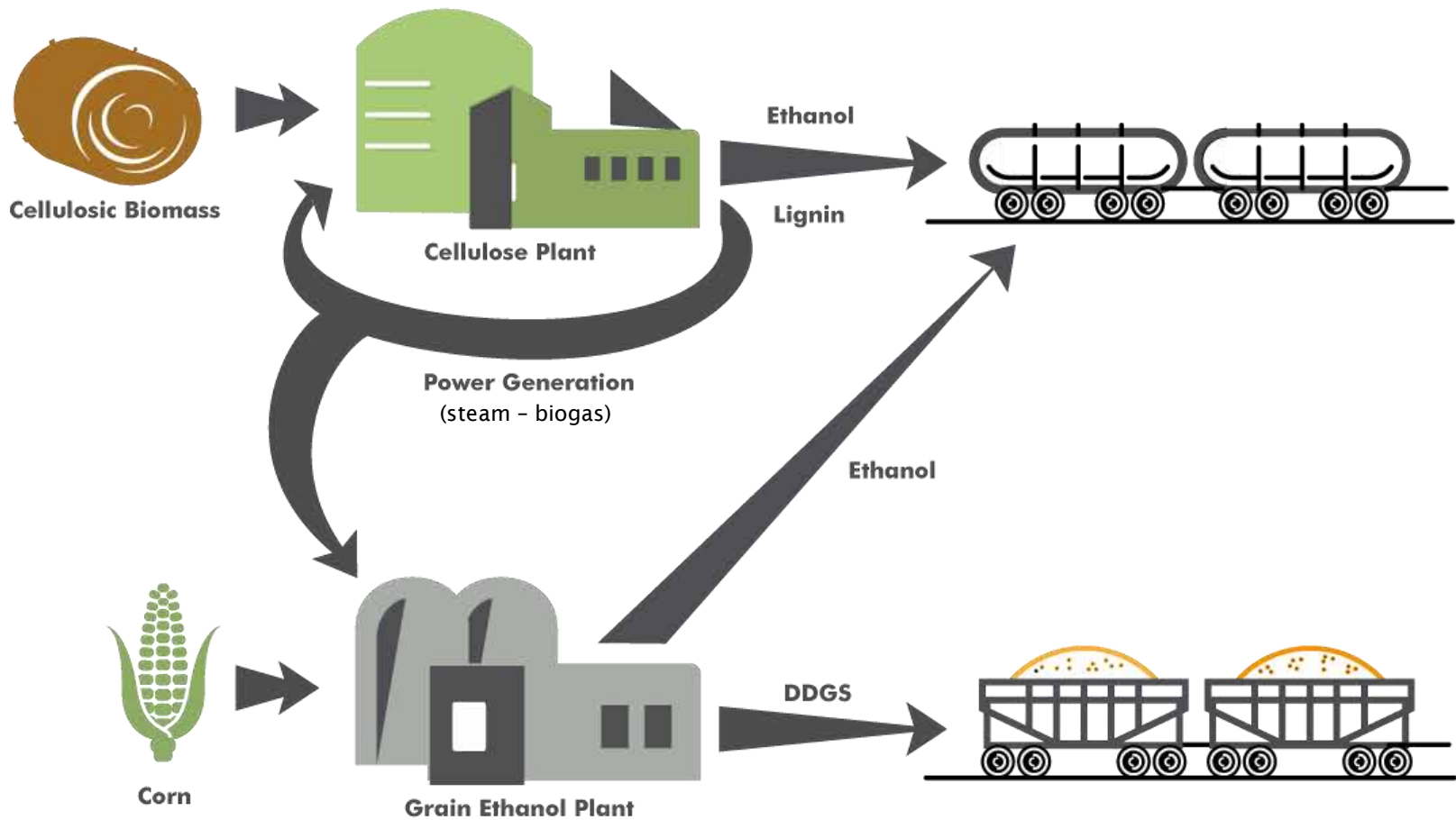
- DOE & State of Iowa for grant funding
- Business is joint venture between POET (50%) and DSM (50%).
- Collaborating with Novozymes and NREL.
- Intellectual property licenses are held by POET and DSM.
- Project/construction management and commissioning contracted to POET Design and Construction.
- Start-up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

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 are 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

Project Overview

POET's Integrated Model

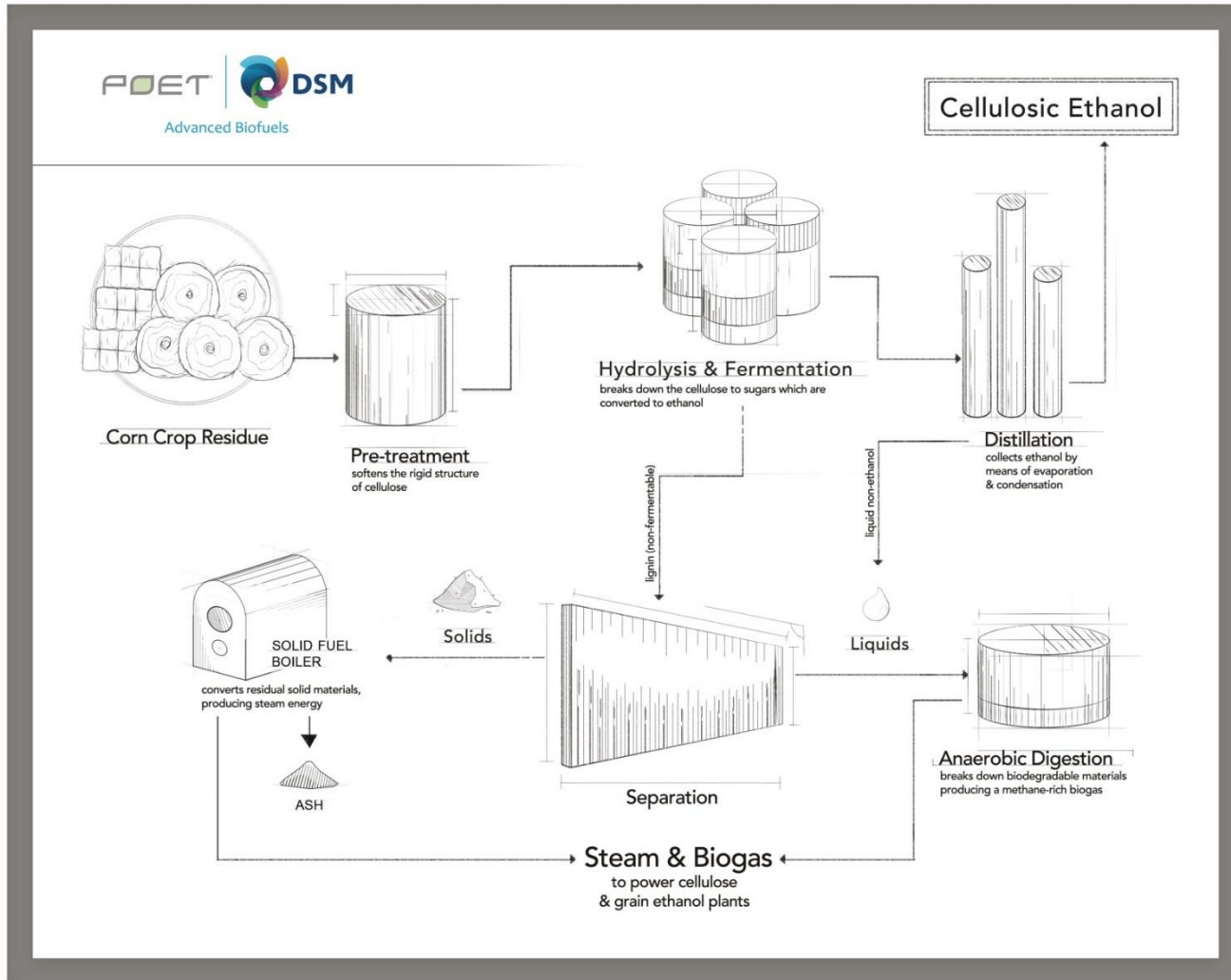


2 - Overall Technical Approach

- 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.

Project Overview

Overall Technical Approach



2 - Critical Technical Success Factors

- Describe critical success factors (technical, market, business) that will define technical and commercial viability of your project.
 - Solids handling throughout the conversion processes
 - Enzyme and yeast technology progression for conversion, yield, and cost
 - Waste water conversion effectiveness
 - Anaerobic digestion conversion of bi-products to methane gas

2 - Technical Potential Challenges

- Explain the top 2-3 potential challenges (technical and non technical) to be overcome for achieving successful project results
 - Material handling of changing biomass feedstock
 - Age and seasonal changes to the feedstock
 - Enzyme and yeast technology progression for conversion, yield, and cost
 - Waste water technology risk - anaerobic digestion and biogas scrubbing of waste water

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 - Critical Management Success Factors

- Describe critical success factors (technical, market, business) that will define technical and commercial viability of your project.
1. Feedstock supply & management
 2. Commercial scale technology demonstration
 3. Replication

2 - Management Potential Challenges

- Explain the top 2-3 potential challenges (technical and non technical) to be overcome for achieving successful project results
 1. Feedstock supply & management
 2. Commercial scale technology demonstration
 3. RFS / market access / financing for replication

2 - Project Management Feedstock



Collection

Logistics

Storage

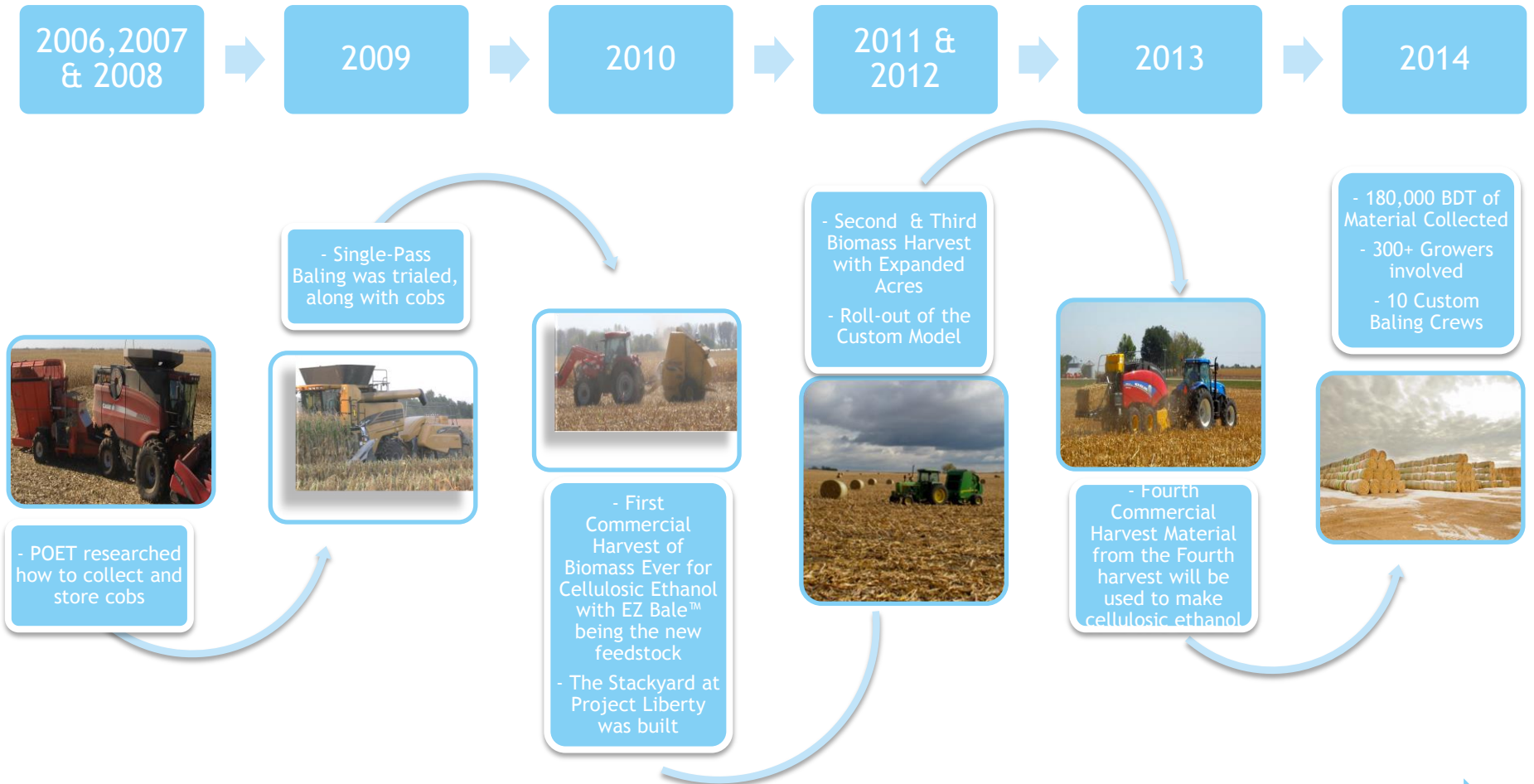
At-Plant Activities



Feedstock From Field to Facility



2 - Project Management Feedstock



ISU - UDSA: Biomass Removal Soil Research (8 Years)

2 - Project Management Feedstock



- EZ Bales™ - Corn cobs and high cut material
- Requirement:
 - 770 bone dry ton (BDT) per day
 - 300,000 acres (1/3 of corn acres in 35 mi. radius)
- 25% of above-ground corn plant removal is environmentally sustainable



2 - Project Management Feedstock

- 300+ Growers Under Contract
- 180,000 BDT baled in 2014
- Greater than 90% retention for 2015



2 - Project Management Feedstock

Collection Best Practices

- SOPs for combine and baler
- Minimize dirt and stalk
- Ensure bale integrity

This



Not This



2nd Pass Cob Baling – Standard Operating Procedure

Combine Setup

1. Corn Head
 - Stalk Stompers Required (See Figure 1 & 2)
 - Four stompers required for the middle four rows. (See Figure 2)
 - The entire head can be outfitted with stompers without concern.
 - Chopping Head Optional



Figure 2

2nd Pass Cob Baling – Standard Operating Procedure

- The baler pickup should be set so that the tines leave 1½-2" of ground clearance (Figure 5).
 - This setup is to minimize the pickup of rocks and dirt.
 - If the ground is soft, the pickup height may need to be adjusted.
 - To set, place baler on level ground. Using a 2x4, set the tooth height to the point of it just touching the 2x4.

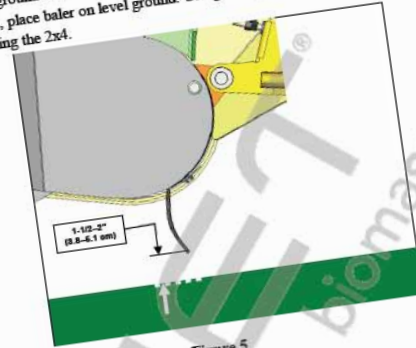


Figure 5

4. Speed
 - Proper ground speed is usually 6-8 mph.

Do Not's

1. Do not rake stover to form windrows.
2. Make sure the baler pickup is not running in the dirt and the bales are not filled with dirt.
3. Do not use twine, all bales must be wrapped at minimum of three times with net wrap.

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2 - Project Management Feedstock



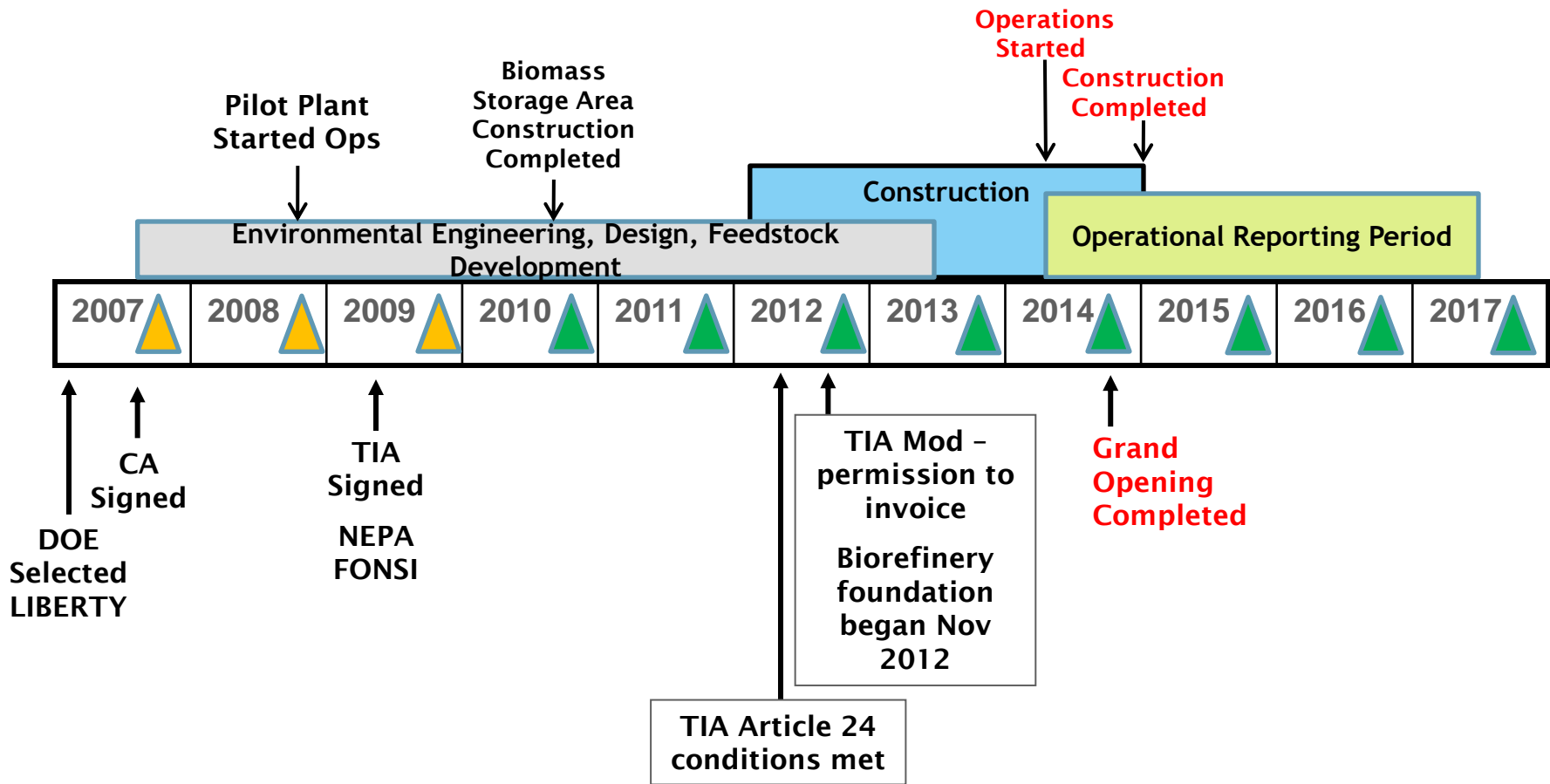
In Field Support



- POET staff answer grower calls, provide field visits, and collect samples throughout the harvest period.
 - Provide in-field support and advisement
- 2014 Harvest
 - 15,000 miles of field visit travel
 - 1,632 FTE hours spent consulting
 - 745 field samples collected from grower fields





3 - Technical Accomplishments/Progress/Results



-  Test & Demonstration Harvests
-  Commercial Harvests

3 - 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.
 - Inspection planning underway
 - Commissioning is complete and start-up efforts continue.
 - System improvements are being executed.
 - Design Builder turnover of entire facility completed.
 - Facility operations have commenced
 - Improving mechanical systems to improve operational reliability

3 - Technical Accomplishments/Progress/Results

- Recent Key Milestones Include:

- Completing the anaerobic digestion and biogas scrubbing detailed design in late 2013
- Final construction packages released and issued in 2014
- Commissioning and Start-up completed in 2014
- Design Builder (D/B) issuing Mechanical Completion in 2014
- Operations turned over to POET Plant Management July 2014

- Future Key Milestones Include:

- Mechanical Completion certification Q1 2015 - Status on track
- Begin operations of anaerobic digestion/biogas scrubbing unit operation Q2 2015 - Status on track
- D/B Guaranteed Performance Test Q2 2015 - Status on track
- D/B Final Acceptance Certification Q3 2015 - Status on track

3 - 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

4 - Relevance

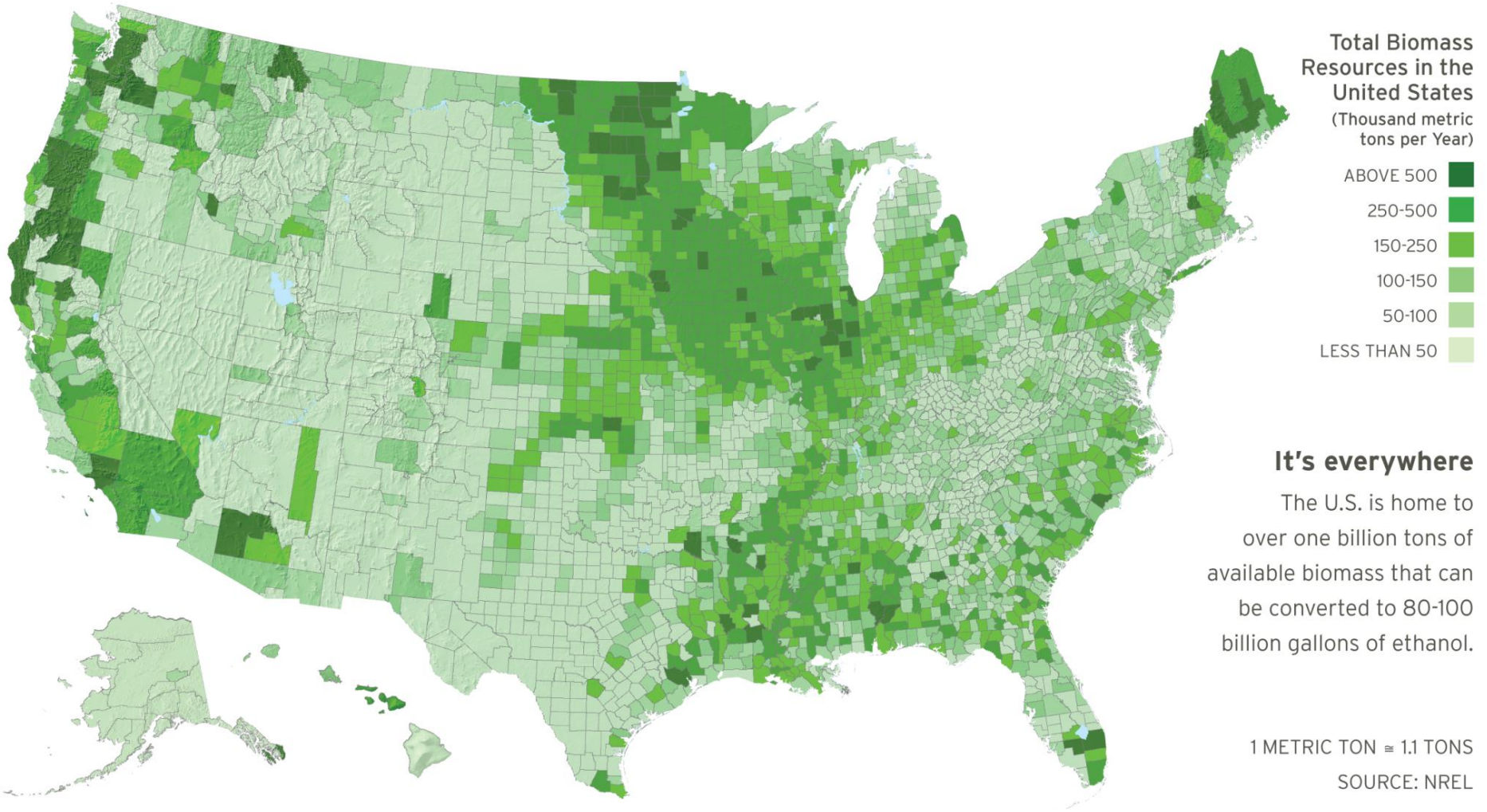
- Project LIBERTY is one of the first commercial scale cellulosic biorefineries operating in the U.S.
- DOE grant accelerated commercial demonstration scale construction and operations of Project LIBERTY.
- Successful demonstration at commercial scale will help launch replication and build-out of new cellulosic biorefineries.
- POET plans to have a hand in producing billions gallons of cellulosic ethanol by 2022.
- 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%

4 - 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

The '50-State' Solution



4 - Relevance

Demonstrate that the successful project will advance the state of technology and positively impact the commercial viability of biomass and/or biofuels.

- Vision is for cellulosic ethanol production to be economically viable and cost competitive with gasoline and starch based ethanol.
- Technical advancements are anticipated in all major unit operations and conversion technologies are driven by achievements and learnings from commercial scale operations.
- Within 3 years of continuous production, POET anticipates a 15% reduction in the cost per gallon.
- Project LIBERTY is co-located with POET Biorefining - Emmetsburg. Thermal energy produced from LIBERTY is consumed at LIBERTY and excess energy is sold to the starch plant displacing natural gas.
- 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%

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).
 - Begin anaerobic digestion and biogas scrubbing unit operations
 - Certify Mechanical, Substantial, and Final Acceptance criteria with the Design Builder including Guaranteed Performance Tests.
 - Optimize enzymatic and yeast conversion technologies
 - Seek alternatives for co-products (ash, sulfur cake)
- Highlight upcoming key milestones.
 - Mechanical Completion certification Q1 2015
 - Start anaerobic digestion/biogas scrubbing operations Q2 2015
 - D/B Guaranteed Performance Test Q2 2015
 - D/B Final Acceptance Certification Q3 2015

5 - Future Work

- Address how you will deal with any decision points during that time and any remaining issues with proposed abatement actions.
 - Any technical decision points required during this time will be coordinated by POET Design and Construction and communicated to the Owner and DOE.
 - Changes in scope, schedule, and budget will follow the Change Order Process outlined in the EPC Agreement.
 - Operational decision points will be coordinated by POET Plant Management.

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 ready to be 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 are in place.
- RFS is critical to drive further investment to meet volume goals.



Advanced Biofuels

Additional Slides

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

Responses to Previous Reviewers' Comments

Several reviewers remarked on the ability to replicate & finance the technology due to a strong dependency on the RFS.

POET-DSM shares the same concern and has expressed this to US & state policy makers and regulators.

Action by the US EPA in 2014 weakened the RVO in the RFS resulting in erosion of economic values, uncertainty of policy consistency and severe reduction in investment interest for second generation biofuel assets in the US.

A couple of comments touched on completing construction, commissioning & start-up.

- The EPC project design, construction, commissioning is complete.
- Start up & operations are underway
- System improvements are being executed.
- Preparing for Performance Testing and Final Acceptance