

**U.S. Department of Energy (DOE)  
Bioenergy Technologies Office (BETO)  
2019 Project Peer Review**

**POET-DSM Project LIBERTY**

March 4<sup>th</sup>, 2019  
Advanced Development and Optimization  
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
  - Final Acceptance: ~Dec 2019
- Percent complete:
  - EPC & cost share funding 100%

## Barriers Addressed

- ADO-A. Process Integration
- ADO-B. Feedstock Supply Chain Infrastructure

## Objective

- Commercialize an IBR producing cellulosic biofuel and replicating the technology for rapid deployment.

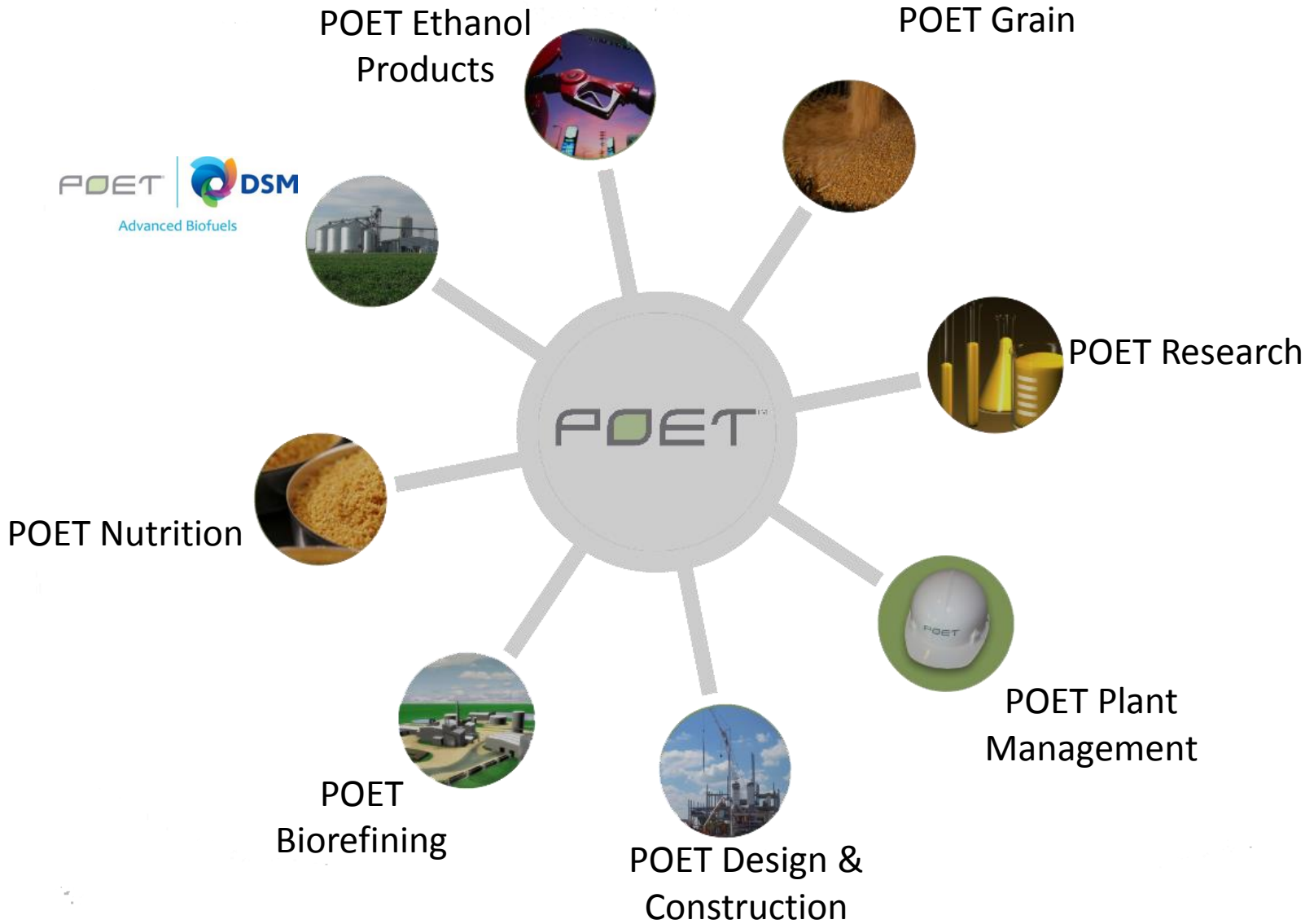
## End of Project Goal

- Complete approved Final Acceptance Test of 700 metric tonnes per day

	Total Costs Pre FY 17	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 19-Project End Date)
DOE Funded	\$100,000,000 Expended	\$0	\$0	\$0
Project Cost Share (Comp.) *	>\$175,000,000	>\$	>\$	>\$

# 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 POET's strong history of technological advancement – mitigate technology risk
- Matching culture – critical to success

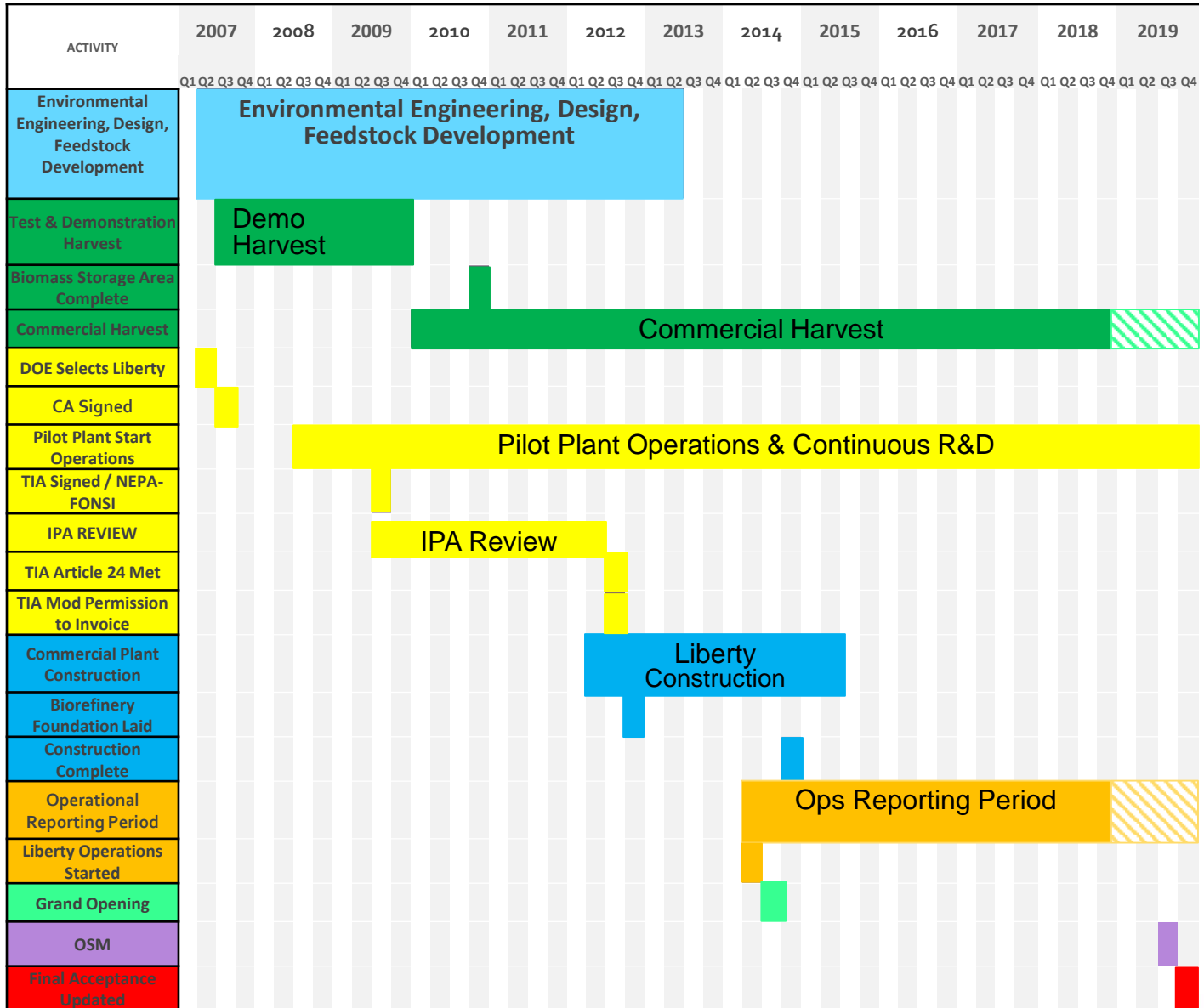


## 2 - Approach Management

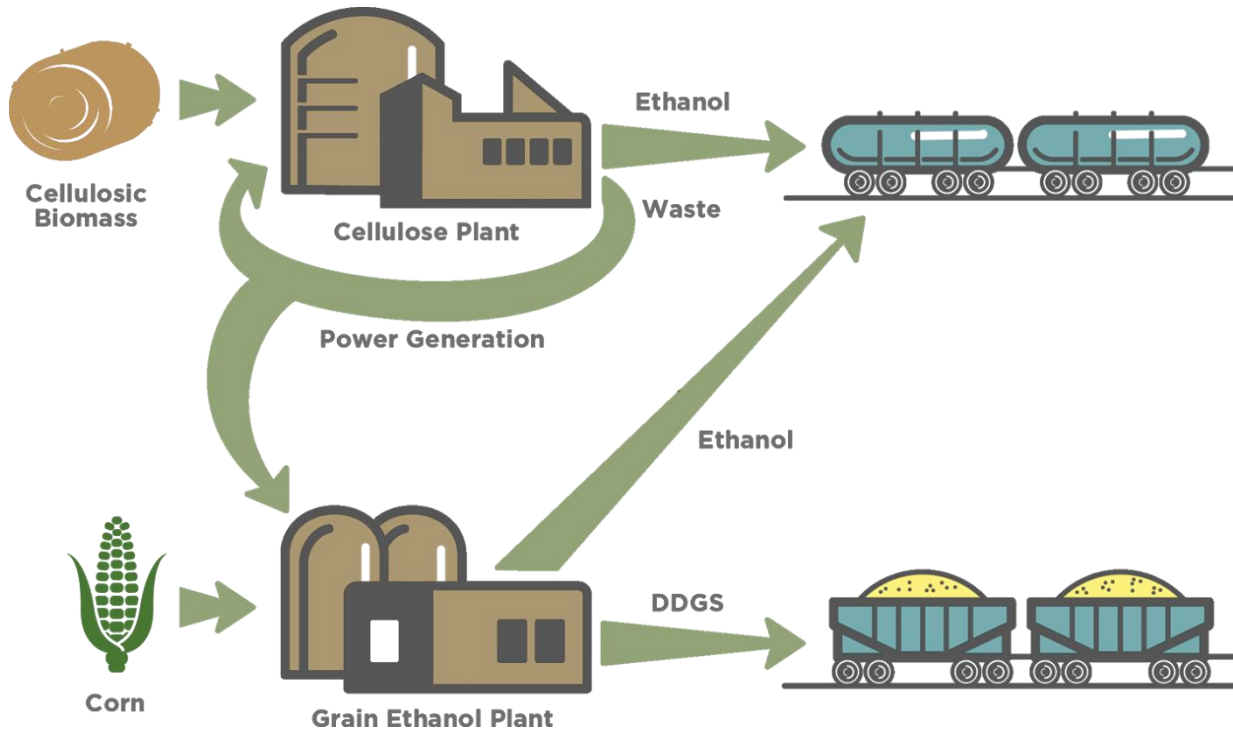
- POET-DSM Advanced Biofuels uses its combined expertise to address open technical issues.
- The POET pilot plant in Scotland, SD has been operating since 2008. The technologies used in the LIBERTY project have been either piloted in Scotland or at vendor locations.
- Commercial, pilot plant, and lab 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.



# Key Milestones



## 2- Overall Technical Approach



Goal: Commercial-scale cellulosic plant

Objectives

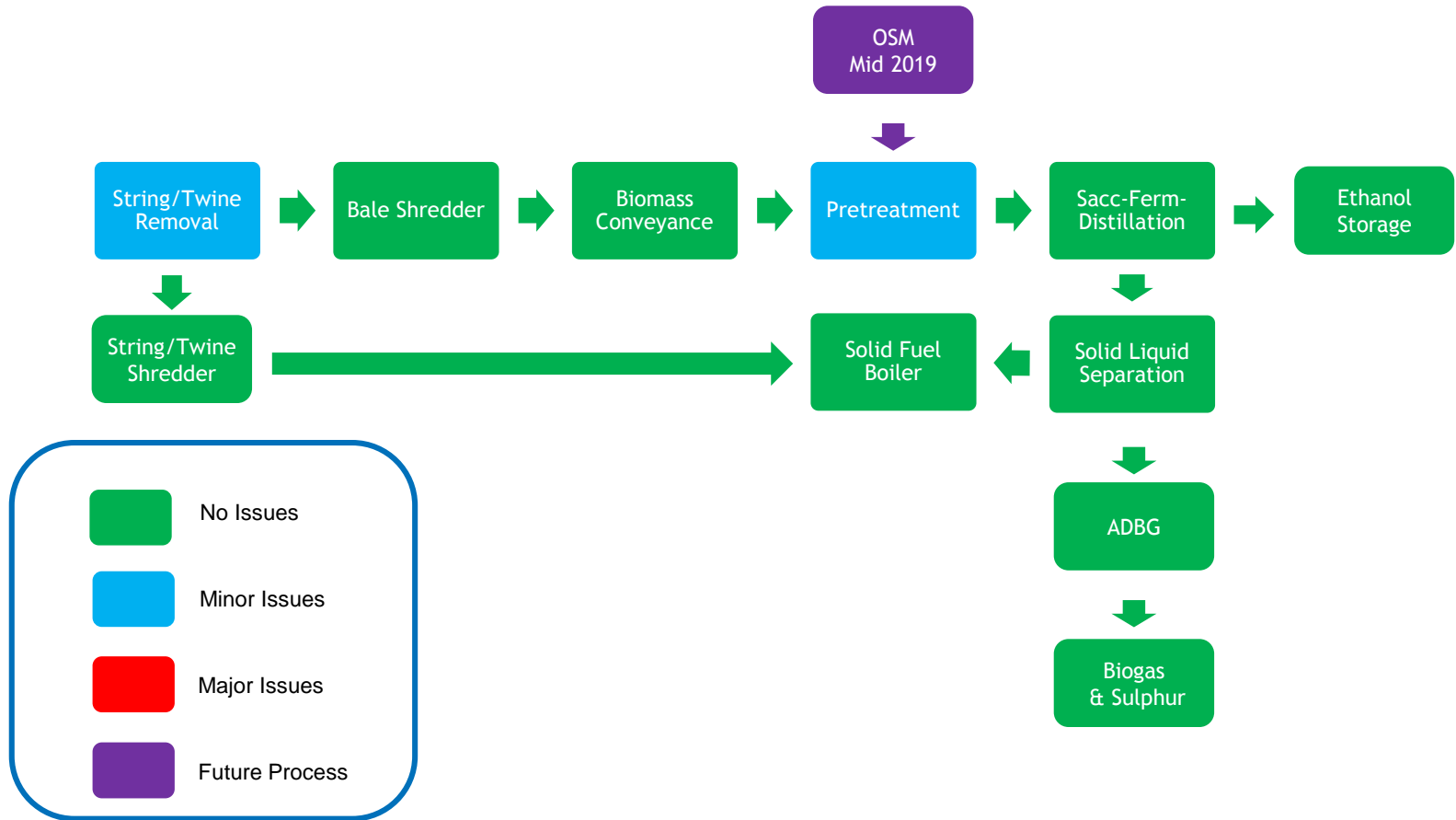
- Integrated model
- Sustainable biomass supply
- Replication model

## 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.

# 3 - Technical Accomplishments/Progress/Results

## Project LIBERTY- Process Operations Block Diagram



# 3 - Technical Accomplishments/Progress/Results

- Since 2017 Peer Review
  - Pretreatment Uptime (Key Metric)
    - Overall Two-Year Improvement - **434%**
      - » Redesigned or replaced original design equipment
      - » Simplified design with more robustness
  - Decreased \$/gal direct cost
    - Overall Two-Year Improvement - **143%**
      - » Improved operations
      - » Optimized input ingredients
  - Increased Production
    - Overall Two-Year Improvement - **250%**
      - » Increased uptime
      - » Improved throughput
      - » Improved mechanical reliability

# 3- 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
- Revamp of pre-treatment equipment Q3-2017.
- 2017-2018 Increased uptime and mechanical reliability
- 2018 Increased throughput

- Future Key Milestones Include:

- D/B Guaranteed Performance Test - TBD
- D/B Final Acceptance Certification - TBD

## 4- 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%

# 4 - Relevance

## The POET-DSM 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



## 5 - Future Plans

- Continue to Optimize Project LIBERTY to meet 770bdt/day (**MYPP Goal**)
  - Improve uptime
  - Improve yield
  - Continue value engineering for LIBERTY 2.0
- 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;
  - Optimizing commercial production levels
  - 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

## 2017 Peer Review Report Comments

“Even at their goal of \$10/annual gallon, the future economics hinge on Renewable Identification Numbers. That seems like a shaky economic proposition at this point. Overall, though, the project has attained most of its goals and has been well-run. I hope they can soon solve their remaining technical challenges and reach sustained design output, and then get on with a second plant (and a third).”

“POET-DSM’s Project LIBERTY has successfully built a cellulosic ethanol facility using their technology. They have proven that their technology can produce ethanol from corn stover. However, they have not yet proven the availability of the system or the commercial viability of the technology. These are two key drivers of any future plant.”

“Once POET-DSM achieves commercial operations, it will be a star project for DOE and BETO to point to in order to display the impact that they can have on pushing new technologies to commercial viability. The POET project would not have been successful if it were not for DOE’s support”

**Response-** POET-DSM believes our advances in the challenges to the cellulosic biofuel industry will propel the industry forward. We know our process works and believe the United States and the world will become invested as we continue to prove cellulosic biofuels are no longer a fantasy fuel.

**POET-DSM is gaining momentum on commercializing cellulosic biofuels. DOE-BETO is the engine. Together we will succeed.**

# Publications, Patents, Presentations, Awards, and Commercialization

## 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

- Society for Industrial Microbiology and Biotechnology - 2018 Bioeconomy Leadership Award
- Biorenewable Deployment Consortium - Spring 2018 Achievement Award

## Publications

- None

## Presentations

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