

# **DOE Bioenergy Technologies Office (BETO) 2019 Project Peer Review**

## **Improved Feeding and Residual Solids Recovery System for IBR DOE Award EE0008249**

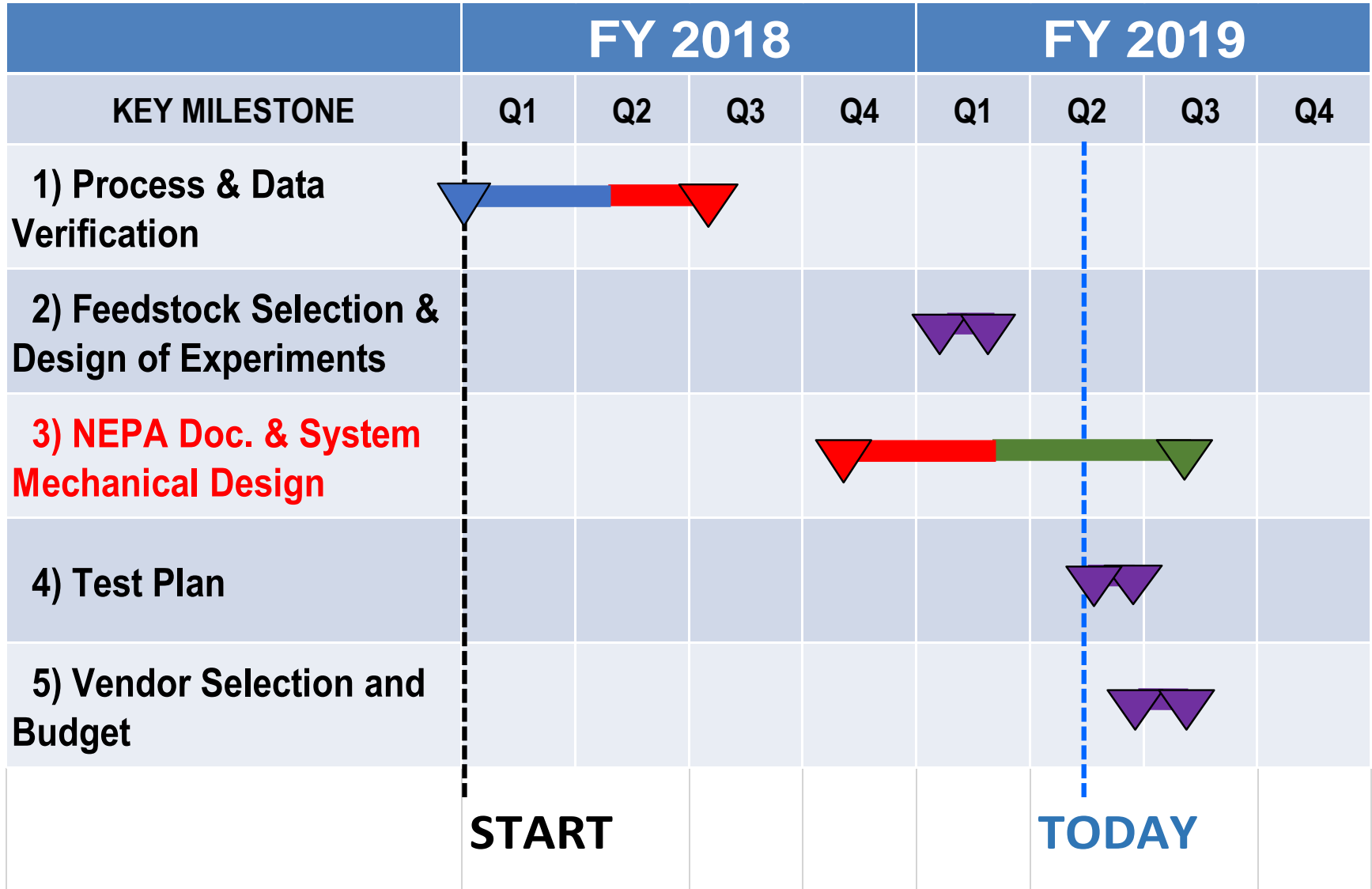
March 4, 2019  
Technology Session Area Review

Ravi Chandran  
TRI

# Goal Statement

- Enhance IBR Engineering and Economic Viability  
*Design and develop 2<sup>nd</sup> generation feed system and advanced residuals handling system to accommodate feedstock variability and improve robustness, reliability, energy efficiency and cost, and accelerate IBR deployment*
- Meet DOE/EERE/BETO objectives:
  - *Dramatically reduce dependence on imported oil*
  - *Spur the creation of the domestic bio-industry*
- CapEx, OpEx and GHG reduction

# Key Milestones



# Project Budget Table

Budget Periods / Tasks	Original Project Cost (Estimated)			Project Spending and Balance		Final Project Costs
	DOE Funding	Project Team Cost Shared Funding		Spending to Date	Remaining Balance	What funding is needed to complete the task / project
<b>BP-1A</b>						
Process and Data Validation	10,000	10,000		25,341	--	Done
<b>BP-1B</b>						
NEPA Documentation	5,000	5,000		1,200	8,800	
Mechanical Design of Systems	87,175	90,000		49,963	127,212	
Vendor Quotations for Equip. Fab. & Installation	10,000	10,000		--	20,000	
Prepare Test Plan	5,000	5,000		--	10,000	
Generate Budget	2,000	2,000		--	4,000	
<b>TOTALS (as of 12.31.18)</b>				<b>76,504</b>	<b>170,012</b>	

# Quad Chart Overview

## Timeline

- Project start date – 10/1/2017
- Original project end date 12/31/2018  
Revised project end date 07/31/19  
(longer validation period)
- 65% complete

## Budget

	Total Costs Pre FY 17	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 19- Project End Date)
DOE Funded				123,258
Project Cost Share (Comp.)*			58,309	64,949

## Barriers

- Barriers addressed
  - Ft-E. Feedstock Quality
  - Ft-J. Operational Reliability
  - ADO-D Technology Uncertainty of Integration & Scaling
  - ADO-A. Process Integration
  - At-E. Quantification of Economic, Environmental & other Benefits & Costs

## Partners

- Other interactions/collaborations
  - Cunningham Machine Design
  - Airline Hydraulics
  - Singularis Solutions

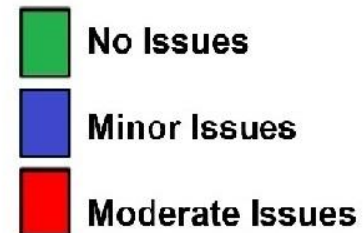
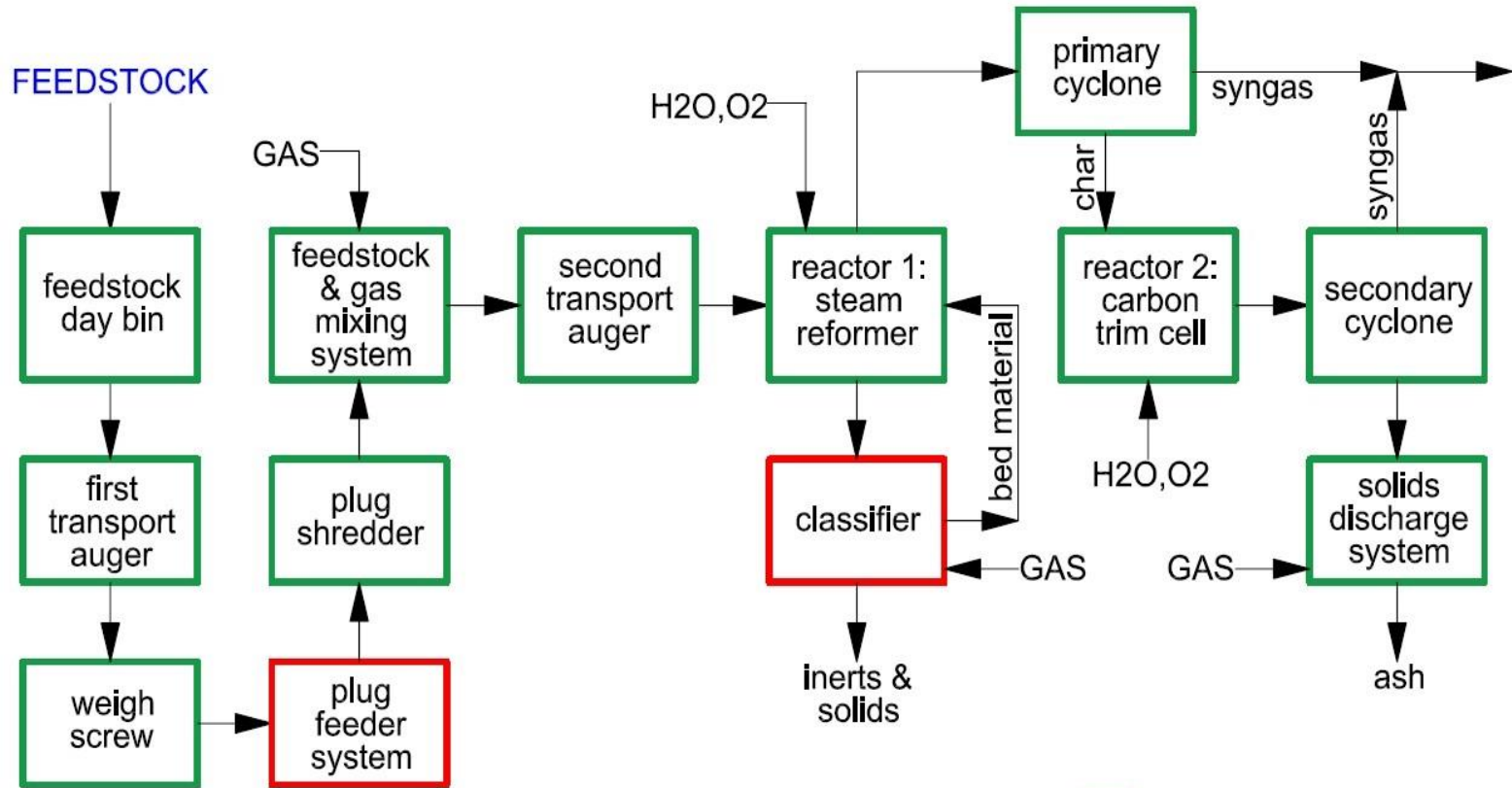
# 1 - Project Overview

- History, context & high-level objectives of the project
  - FOA No. DE-FOA-0001689 Demonstration and Market Transformation - Integrated Biorefinery Optimization
  - Project team TRI – no changes
  - Planned: Initial Process & Data Validation; Component Design and PDU Integration Achieved: Successful Validation; Component Design and PDU Integration on schedule
  - Delay due to longer validation
  - On track to meet Phase 1 objectives
  - No showstoppers apparent; no directional changes required
  - Project schedule takes into account the availability of resources to complete the remaining project

# 2 – Approach (Technical)

- *Overall technical approach: Design, test and validate improvements to feed and solids removal systems to optimize IBR*
  - *Experimental validation of feeder, selective removal of inert solids and ash*
  - *Design, fabricate, install and commission components and test the integrated Process Demonstration Unit (PDU) to demonstrate improvements*
- *Critical success factors:*
  - *Demonstrate improved robustness, feedstock flexibility, energy savings, operability, availability, safety and life with the PDU modifications; continuous, robust operation for a minimum 4 weeks 24/7 operation*
  - *For a commercial 500 dtpd biomass to biofuel conversion system:*
    - *> 30% increase in feedstock throughput per feeder*
    - *> 3,500 MWh per year energy savings*
    - *> 2.5 CO<sub>2</sub>e g/MJ diesel reduction in GHG emissions or > 3,000 tons CO<sub>2</sub>e/year*
- *Challenges:*
  - *Brownfield installation with tight space and limited access*
  - *Premature blinding of the filter in the ash discharge system*
  - *Biomass preparation for PDU testing*
  - *Infrastructure or balance of plant may not operate as reliably as commercial system*

# Process Operations Block Diagram





## 2 – Approach (Management)

### *Management approach:*

- *Stage Gate method with a Steering Committee review at the first level and the DOE (and the Independent Engineers) review at the second level for Go/No Go decision*
- *Critical success criteria or key technical achievements formulated for each stage so that the project meets or exceeds a minimum hurdle rate to proceed forward*
- *Task based milestones to monitor progress*

### *Project structure:*

*TRI*

*TRI technical & Admin POCs for the DOE, Steering Committee, subcontractor leads*

#### *Task Areas:*

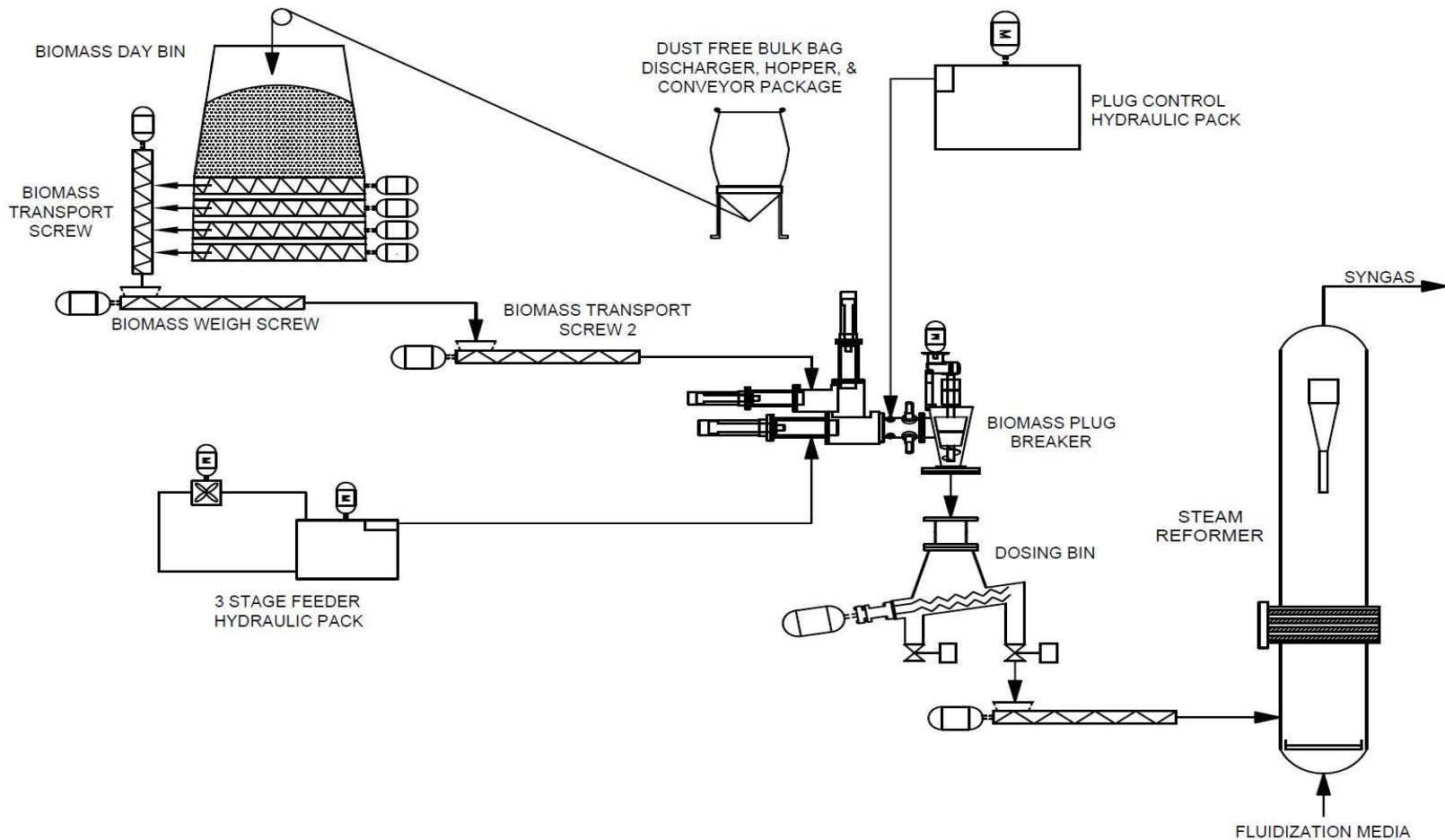
*Validation, component design, fabrication, PDU Integration, testing, scaleup, TEA, LCA*

# 3 – Technical Accomplishments/ Progress/Results

- *Successful validation of relevant unit ops in BP-1A:*
  - *A total of 3 unit operations*
  - *TR1 piston feeder system baseline performance benchmarked including demonstration of feed rate stability, operability, reliability, safety and gasifier output stability*
  - *Selective removal of inert solids from the fluidized bed drain and recycle of bed material with > 99% bed material retention*
  - *Stable performance of the filter element of the ash discharge system without blinding*

# 3 – Technical Accomplishments/ Progress/Results (cont'd)

## Validation: TRI Feed System



# 3 – Technical Accomplishments/ Progress/Results (cont'd)

Validation: *TRI Feed System*

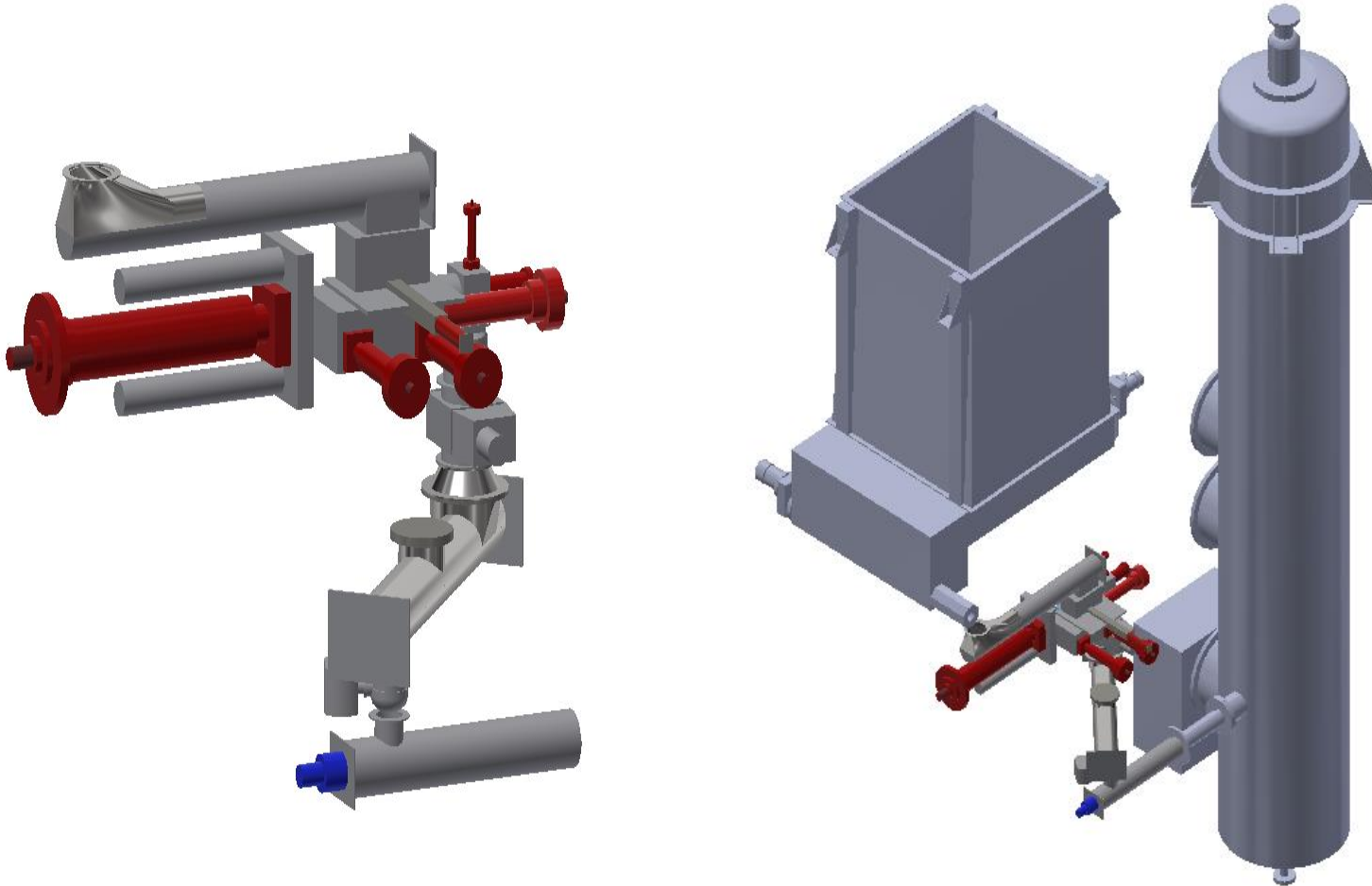


# 3 – Technical Accomplishments/ Progress/Results (cont'd)

- *Status of BP-1B:*
  - *Feedstocks selected and statistical design of experiments completed*
  - *Environmental audit and NEPA form completed*
  - *Design of the modified feeder ongoing*
  - *Design of the selective inerts removal system ongoing*
  - *Design of the ash discharge system ongoing*
  - *3D model of the existing equipment is being updated with the modified components to check for interference, access and installation*
  - *Vendor quotes for fabrication, installation & integration, test plan, budget for BP-2 and BP-3 all pending - Go/No Go decision point*

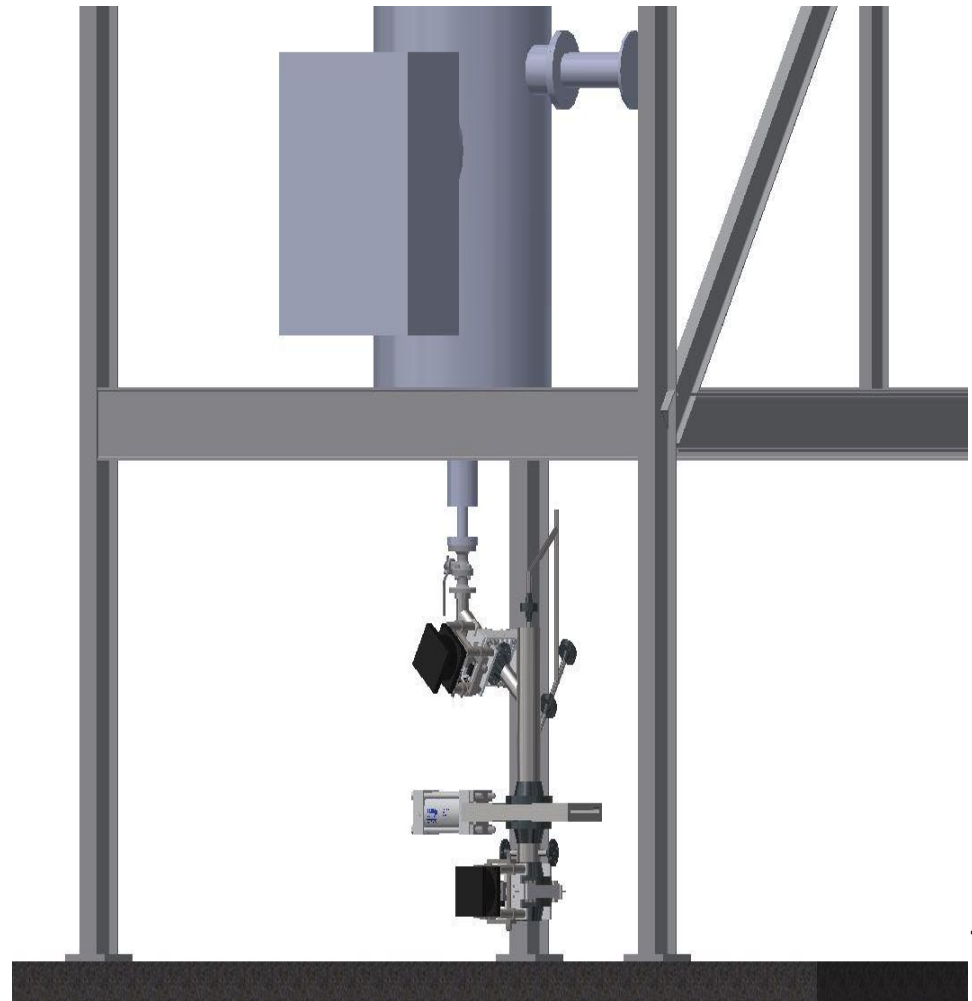
# 3 – Technical Accomplishments/ Progress/Results (cont'd)

## *Modified TRI Feed System*



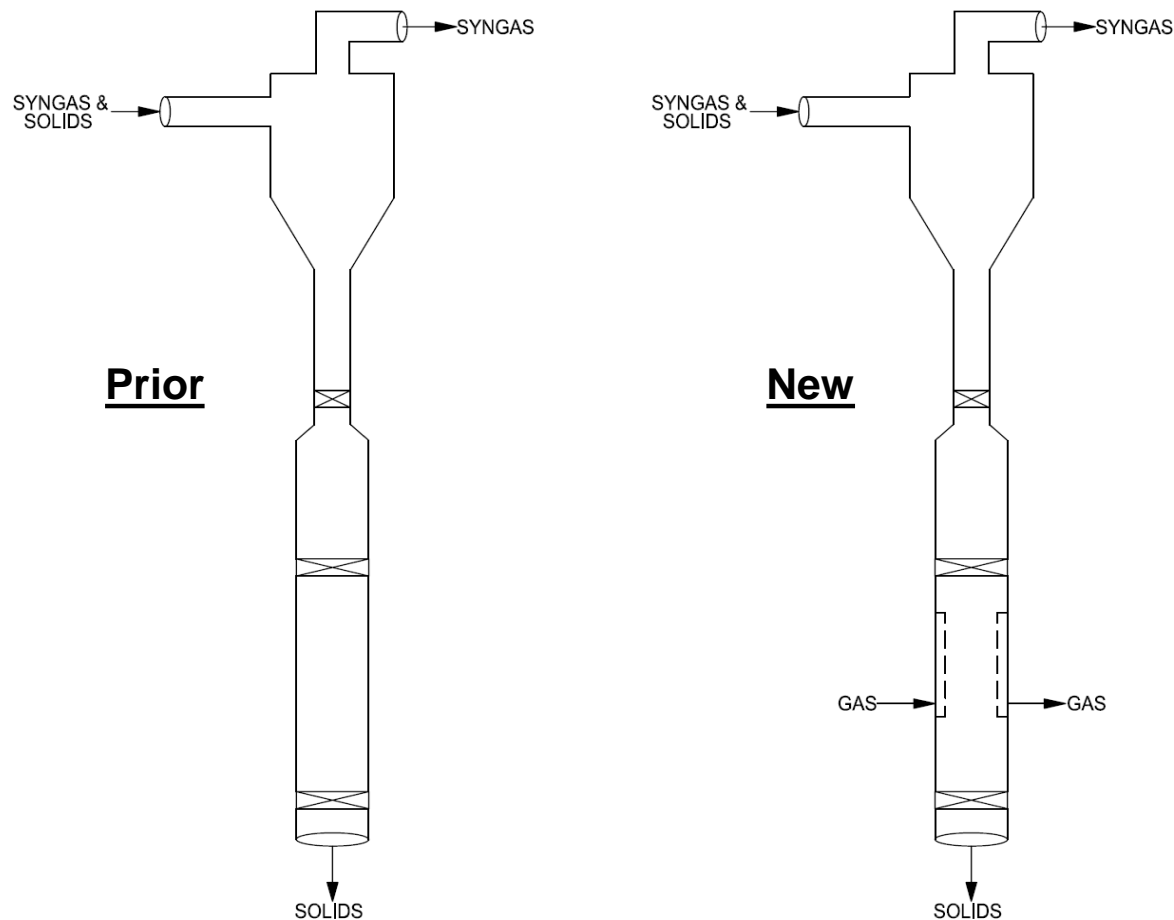
# 3 – Technical Accomplishments/ Progress/Results (cont'd)

Selective Solids Removal System: *Feedstock Inerts/Clinkers Removal*



# 3 – Technical Accomplishments/ Progress/Results (cont'd)

Selective Solids Removal System: *Residual Fine Solids Discharge*





# 4 – Relevance

- *Improved feeding and residuals removal system for IBR decreases biomass conversion costs and directly supports BETO MYPP goals:*
  - *Enable sustainable, nationwide production of biofuels that are compatible with today's transportation infrastructure, can reduce greenhouse gas emissions relative to petroleum-derived fuels, and can 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*
- *Addresses BETO's 2017 target of <\$2/GGE biofuel cost*
- *Targets BETO's goal to validate biofuel production at pilot scale (>1 ton/day) by 2022*
- *Expected outputs – energy savings; robustness, availability and operability of the improved feeding and residuals removal system, reduction in GHG emissions*
- *Project metrics, technical targets and marketing driven by TEA and LCA*
- *TRI will market feed system for sale to any IBR; residual solids system will be integrated with TRI gasifier for licensing*

# 5 – Future Work

- *Fabrication, Construction, PDU Integration, Commissioning, Trials, Scaleup and Engineering Assessment*
- *Upcoming key milestones:*
  - *Design, test plan, vendor quote & budget – Go/No Go decision (7/31/2019)*
  - *Equipment delivery to site*
  - *Installation of new equipment*
  - *Complete Commissioning – Go/No Go decision (Q1, FY2021)*
  - *Feedstock procurement*
  - *Complete trial and shutdown*
  - *Compare system performance against targets*
  - *Perform scaleup, TEA, LCA*
  - *Issue Final Project Report (Q2, FY2022)*
- *Remaining budget (\$170 K) is sufficient to complete the remaining work in BP-1B*

# Summary

1. Overview: *Improved feed and residuals removal system for IBR to enhance robustness and economics and accelerate IBR deployment*
2. Approach: *Design, test, integrate with the TRI IBR PDU and validate the improvements to the operability and energy savings;*  
*Critical success factors: PDU*
  - *> 10% increase in feedstock throughput and feedstock flexibility*
  - *Continuous, robust minimum 4 weeks 24/7 operation**Commercial 500 dtpd biomass to biofuel conversion system*
  - *> 30% increase in feedstock throughput per feeder*
  - *> 3,500 MWh per year energy savings*
  - *> 2.5 CO<sub>2</sub>e g/MJ diesel reduction in GHG emissions or > 3,000 tons CO<sub>2</sub>e/year*
3. Technical Accomplishments/Progress/Results: *Successful validation of 3 unit ops in BP-1A; Progress on design and PDU integration assessment in BP-1B*
4. Relevance: *Directly supports BETO's MYPP, 2017 & 2022 goals*
5. Future Work: *Construction, PDU Integration and demonstration*

# Additional Slides

# Responses to Previous Reviewers' Comments

- New project
- Successful initial process and data validation in BP-1A resulted in a Go decision and approval to proceed into BP-1B

# **Publications, Patents, Presentations, Awards, and Commercialization**

- No publications, patents, awards, and presentations that have resulted from work on this project
- Biomass conversion market has shown interest in the TRI robust feeder technology

# Project Scope Change Table

Scope Changes	Date	Logic / Reasoning	Approval / Rejection Date
BP1 – A			
- Scope Change		N/A	

# Risk Registry Table

		Risk Identified		Mitigation Strategy		Status
Risk ID	Process Step	Risk Description	Severity (High/Med/Low)	Mitigation Response	Planned Action Date	Active/Closed
<b>Feed System</b>						
1	Biomass feeding	Brownfield installation	Medium	3D Modeling	02/2019	Successful; Closed
<b>Selective Residual Solids Removal</b>						
1	Inerts removal	Brownfield installation	Medium	3D Modeling	02/2019	Successful; Closed
2	Bed material recycle	Dilution of syngas with inert gas used for recycle	Medium	Fluid dynamic modeling to reduce gas use	02/2019	Successful; Closed
3	Bed drain	Oversize solids may block the drain port	Medium	Cage arrangement above drain port	02/2019	Successful; Closed
<b>Ash Discharge System</b>						
1	Ash discharge	Premature filter blinding	High	Validation trial and additional tests	Ongoing	Active