DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review

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

- March 25, 2021
- Systems Development and Integration

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- TRI

Project Overview

- *DE-FOA-0001689 – 2017 Demonstration and Market Transformation - Integrated Biorefinery Optimization*
- *Project Goals:*
  - *Design and develop 2nd generation feed system and advanced residuals handling system to*
    - *Accommodate feedstock variability and provide feedstock flexibility*
    - *Improve throughput, robustness, reliability, availability and energy efficiency of the IBR*
    - *Lower Capex and Opex, and*
    - *Accelerate IBR deployment*
  - *Meet DOE/EERE/BETO objectives*
    - *Dramatically reduce dependence on imported oil*
    - *Spur the creation of domestic bio-industry*
  - *Target drop-in cellulosic biofuel cost < $2/GGE*
- *Risk:*
  - *Brownfield installation – integration of new components with existing TRI Process Demo. Unit*

TRI Integrated Biorefinery
Process Demonstration Unit
Durham, NC

1 – 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, TRI PDU Integration, testing, scaleup, TEA, LCA

- *Risk Mitigation:*
  - *Risk Registry table included in the additional slides which identifies risk and indicates the mitigation strategy and the status*

2 – Approach

- *Overall technical approach: Design, test and validate improvements to feed and residual solids removal systems to optimize IBR*
  - *Experimental validation of feeder and selective removal subsystems for inert solids and ash*
  - *Design, fabricate, install and commission components and test the integrated Process Demonstration Unit (PDU) to demonstrate improvements*

- *Challenges:*
  - *Brownfield installation with tight space and limited access*
  - *Infrastructure or balance of plant may not operate as reliably as commercial system*
  - *Biomass preparation for PDU testing*

- *Go/No Go Decision points:*
  - *Initial Process and Data Validation for proof of performance – successfully completed*
  - *BP1 review - pending*

2 – Approach (continued)

- *Metrics used to measure progress:*
  - *Baseline performance benchmarking of TRI 1st generation piston feeder system – TRI testing*
  - *Effectiveness of inert solids removal from the fluidized bed drain and recycle of bed material (Classifier) – TRI testing*
  - *Performance, reliability and availability of filter element of the ash discharge system – TRI testing*
  - *Selection of feedstock and design of experiments*
  - *Cost-effective mechanical design of the 2nd generation feeder, classifier and ash discharge system*
  - *Readiness for brownfield installation of new process components at the TRI Process Demonstration Unit – component design and 3D modeling*

3 – Impact

- *Improved feeding and residuals removal system for IBR decreases biomass conversion costs and directly supports BETO MYPP goals:*
  - *Enable sustainable, nationwide production of biofuels compatible with today's transportation infrastructure, reduce greenhouse gas emissions relative to petroleum-derived fuels, and 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*
- *TRI will market feed system for sale to any IBR; residual solids system will be integrated with TRI gasifier for licensing*

4 – Progress and Outcomes

- *Status of project:*
  - *TRI 1st gen piston feeder system – validation, benchmarking – completed*
  - *TRI 2nd gen feeder system – design and 3D modeling for TRI PDU integration - completed*
  - *Classifier - validation, design and 3D modeling for TRI PDU integration – completed*
  - *Ash discharge system - validation, design and 3D modeling for TRI PDU integration – completed*
  - *Feedstock selection and design of experiments - completed*
  - *NEPA documentation and permitting - completed*
  - *Test plan – completed*
  - *Budget for BP2* and BP3* – pending*
  - *Project review and approval to proceed to BP2* - pending*
  - *4 milestones and the validation metric go/no go criterion have been met*
  - *Budget milestone and BP2 go/no go decision are pending*

** Proposed combining this project and the Small Scale biorefinery project (WBS 3.5.2.204) for Phase 2*

4 – Progress and Outcomes (continued)

- *Accomplishments:*
  - *TRI 1st gen piston feeder system baseline performance benchmarked including demonstration of feed rate stability, 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 with no apparent blinding*
  - *Selection of feedstocks and design of experiments*
  - *Mechanical design of TRI 2nd gen feeder, classifier and ash discharge system*
  - *3D modeling for brownfield installation of new process components at the TRI Process Demonstration Unit*
  - *Prepared test plan*

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 throughput, 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_{2e} g/(MJ diesel) reduction in GHG emissions or > 3,000 tons CO_{2e}/year reduction*
3. Technical Accomplishments/Progress/Results: *Successful validation of 3 unit ops in BP-1A; completed component design and 3D modeling for TRI PDU integration in BP-1B*
4. Relevance: *Directly supports BETO's MYPP, 2017 & 2022 goals*
5. Future work: *Construction, PDU Integration and demonstration*

TRI Integrated BioRefinery
Process Demonstration Unit
Durham, NC

Quad Chart Overview

Timeline

- *Project start date 10/01/2017*
- *Project end date 12/15/2023*

	FY20 Costed	Total Award
DOE Funding	(10/01/2019 – 9/30/2020) *$0*	(negotiated total federal share) *$1,805,533*
Project Cost Share	$55,181	$1,878,501

Project Partners

Project Goal

Design and develop 2nd generation feed system and advanced residuals handling system to enhance IBR engineering and economic viability and accelerate IBR deployment

End of Project Milestone

PDU (4 tpd)

- *> 10% increase in feedstock throughput and feedstock flexibility*
- *Continuous, robust 4+ weeks 24/7 operation*

Commercial 500 dtpd IBR

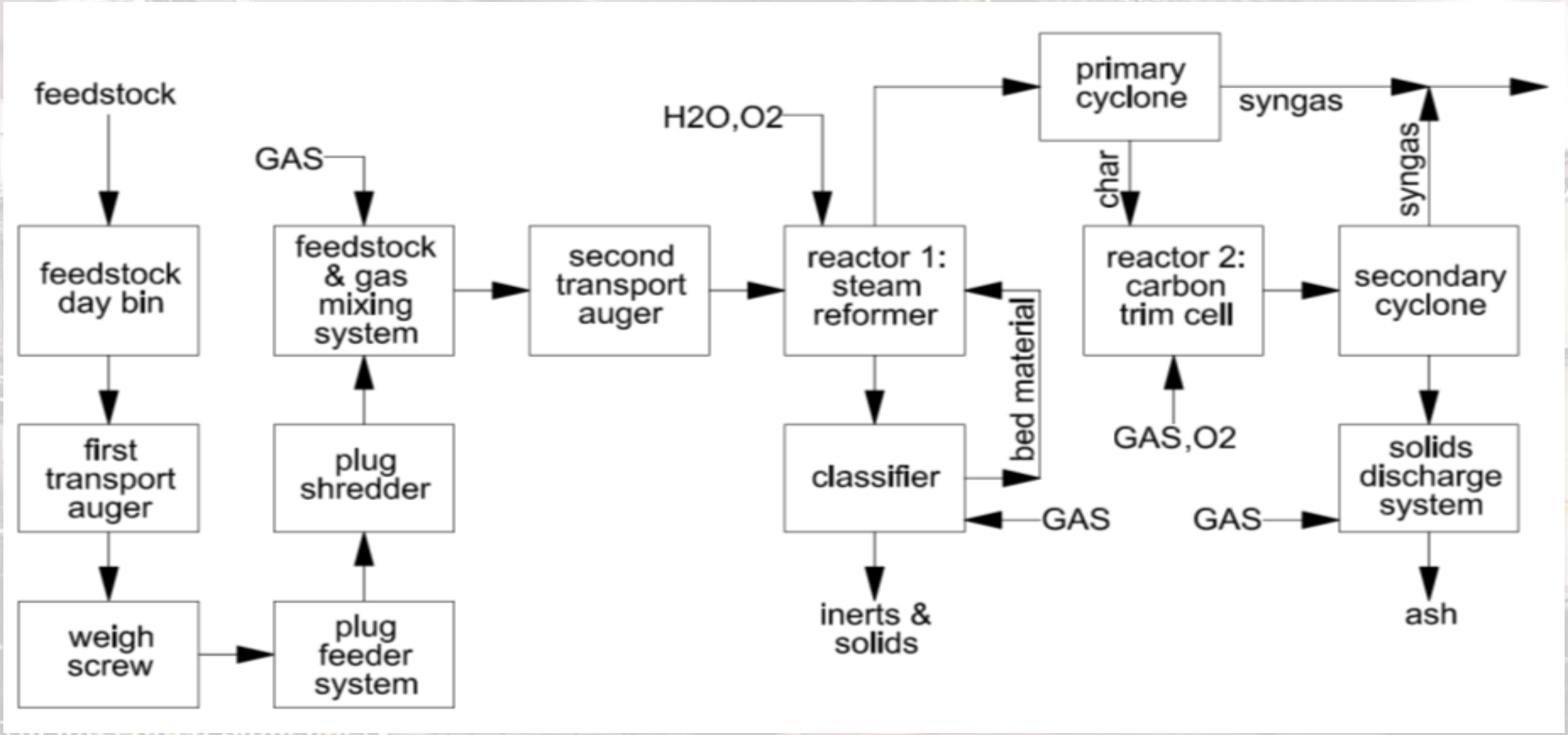
- *> 30% increase in feedstock throughput*
- *> 3,500 MWh per year energy savings*
- *> 2.5 CO_{2e} g/(MJ diesel) reduction in GHG emissions or > 3,000 tons CO_{2e}/year reduction*

Funding Mechanism

FOA No. DE-FOA-0001689 Demonstration and Market Transformation – Integrated Biorefinery Optimization - 2017

Additional Slides

Process Operations Block Diagram



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**
Feed System						
1	Biomass feeding	Brownfield installation	Medium	3D Modeling	02/2019	Successful; Closed
Selective Residual Solids Removal						
1	Inerts removal	Brownfield installation	Medium	3D Modeling	02/2019	Successful; Closed
2	Bed material recycle	Dilution of syngas with inert gas used for bed material 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
Ash Discharge System						
1	Ash discharge	Premature filter blinding	High	Validation trial and additional tests	07/2019	Successful; Closed

Responses to Previous Reviewers' Comments

- This project was peer reviewed in 2019 and the reviewers' comments were positive and complimentary
- One question: *The project needs a better definition on scope and how it is integrated with other TRI projects was not clearly defined*

  Response: *The overall scope of this project is to design, fabricate, test, and validate improvements to feed and solids removal systems to optimize IBR. While this project is focused on solids feeding and handling, the other project has a different target directed toward the process intensification of biomass conversion and syngas cleanup to decrease the IBR Capex and Opex.*

Publications, Patents, Presentations, Awards, and Commercialization

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