

Mehdi Namazian, Kenneth Lux  
Altex Technologies Corporation

## ABSTRACT

Under DOE Cooperative Agreement Number: DE-FE0023663 Altex and its team members are developing the Green-House-Gas-Reduced Coal-and-Biomass-to-Liquid-Based Jet Fuel (GHGR-CBTL) Process at TRL 5 (1BPD). The goal of the project is to produce a cost competitive drop-in synthetic jet fuel (JP-8) with a lower greenhouse-gas footprint than petroleum-based JP-8. This project builds upon the Altex previous work that has demonstrated the base of this technology at lower TRLs.

## Summary and Conclusions

The GHGR-CBTL project was started on 10/1/2014 and is planned to be completed on 1/30/2017. The project builds upon previous and existing TRL-3 and TRL-4 systems to develop a TRL-5 coal-and-biomass-to-JP-8 conversion system. The test data from this system will feed into LCA and TEA. So far all the planned milestones have been completed and the project is on track to complete the test-system design by 12/16/2015. The LCA modeling is under way. The data from the completed HMB for the full-scale plant, from the coal-supply partner, from the biomass-supply partner, and from other sources are being used to develop a GHGR-CBTL module for the GREET LCA model. The full HMB data is also being used to develop the costing data for TEA.

The project is on track, and work so far supports the previous conclusions that GHGR-CBTL is capable of producing cost-competitive JP-8 from coal and biomass with less GHG emissions than that of petroleum based Jet fuel.

## CONTACT

Mehdi Namazian  
Altex Technologies Corporation  
Email: mehdi@altextech.com  
Phone: 408-328-8303  
Website: www.altextech.com

## Project Objective and Plan

The objective of the project is to develop a TRL 5 Green-House-Gas-Reduced Coal-and-Biomass-to-Liquid (GHGR-CBTL) jet fuel process by building and testing a 1-BPD system and using the data to update the Technical and Economic Assessment (TEA) of the process.

Task No.	Task Name	Task Objective
1	Project Management	Manage the project execution and deliverables
2	Feedstock Acquisition	Identify and acquire coal and biomass feedstock
3	Life Cycle Analysis (LCA) and Logistics modeling	Update heat and mass balance, Develop and update GREET module, Prepare LCA of GHG footprint
4	GHGR-CBTL System Design	Design the CBTL-GHGR system and prepare P&ID
5	TRL 5 GHGR-CBTL Equipment Buildup	Fabricate components and integrate into a TRL 5 system
6	Production of Catalyst for Testing	Upgrade the catalysts and produce
7	GHGR-CBTL Testing	Test: components, subsystems and end-to-end system, Evaluate fuel properties
8	GHGR-CBTL TEA	Assess technical & economic performance, TEA report

## Project Success Criteria

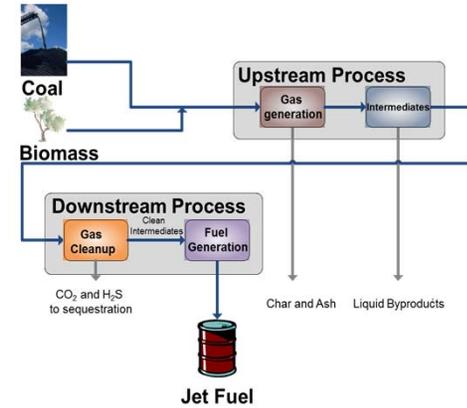
Criteria	Metrics and Success Criteria
Plant Design	cost < \$2/gallon
Operational Unit complete	Test unit (1 BPD Coal/Biomass to JP-8)
Test System Throughput	>1 BPD of product
Fuel Spec	Meet JP-8 Spec
GHG Footprint	<Less than petroleum GHG
Economics (TEA)	cost < \$2/gallon, competitive

## Project Major Milestones

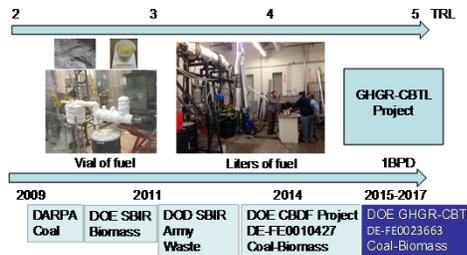
Budget Period	Major Milestone	Date
1	Kickoff Meeting	11/6/14
1	Update PFD	2/25/15
1	Coal and Biomass Supply Agreement	9/1/15
1	Upstream Design Report Complete	9/24/15
1	Downstream Design Report Complete	11/5/15
1	Engineering Drawings Complete	11/24/15
1	GREET Module Developed	12/2/15
1	System Designed	12/16/15
1	Budget Period 1 complete	1/30/2016
2	COTS Equipment Received	2/9/16
2	Custom Equipment Received	3/15/16
2	Catalyst Prepared	7/14/16
2	Test System Complete	7/19/16
2	End-to-End-System Test Complete	1/12/17
2	Economic Assessment Complete	1/25/17
2	TEA Report Complete	1/25/17
2	LCA of GHG Footprint Complete	1/26/17
2	Fuel-Property Report Completed	1/26/17
2	Technical Assessment Complete	1/26/17
2	Final Report Submitted	1/30/17

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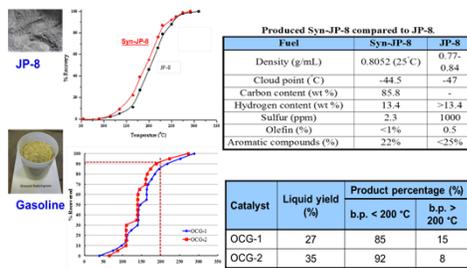
## GHGR-CBTL Block Diagram



## Project Background



GHGR-CBTL builds upon the experience gained in developing TRL 3 and TRL 4 systems shown above. Below the syn-fuel properties are shown. The JP-8 meets most of the JP-8 specs and gasoline properties can be tailored by the selection of catalyst. The experience to-date shows that the GHGR-CBTL is feed and product flexible.

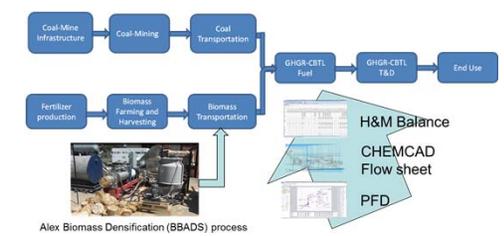


## Progress and Discussions

### Milestones completed

- Kick off meeting held
- PFD updated
- COTS equipment specified
- Heat and Mass Balance (HMB) completed with CHEMCAD
- Coal and biomass supplies are secured

## Life-Cycle Analysis of GHG Emissions



- A Well-to-wake (WTWa) Life-Cycle Analysis (LCA) utilizing ANL's GREET model is in progress. The GREET model will be updated to include the GHGR-CBTL HMB data and the Altex Biomass Densification (BBADS) process that minimizes the biomass transportation GHG and cost.
- GREET will be used to update the preliminary LCA that showed inclusion of 11.2 wt% biomass in GHGR-CBTL will lead to JP-8 with WTWa GHG emissions equivalent to petroleum-based JP-8 and inclusion of 49 wt% biomass will lead to 31% less WTWa GHG emissions.

## Economic Analysis

- A Class-4 costing of a full-scale plant will be developed utilizing equipment designs based upon the HMB.
- The DOE Power Systems Financial Model (PSFM) will use this cost to evaluate the economics of the process.
- The results will be used to update the preliminary economic analysis shown below with a comparison to traditional gasification-FT fuel production.

Gasification and FT	Date	Year	Plant Size	Feedstock(s)	Delivered Coal Price	Delivered Biomass Price	Total A-Spent Capital (TASC)	D/E Ratio	Loan Term	Loan Rate	Fuel Price*
GHGR-CBTL	Mar-14	2007	50,000 BPSD	10% switchgrass 10% lignite	\$43.16/ton	\$94/ton	\$5.74 B	60%/40%	30 y	4.56%	\$2.82
				10% switchgrass	\$16.79/ton	\$40/ton	\$1.97 B	40%/60%	15 y	3.00%	\$1.64

## Technical and Economic Assessment

The results of the economic analysis will be combined with the test results from a 1-BPD test system and the LCA to evaluate the commercial viability of the GHGR-CBTL process.