Bioenergy Technologies Office

U.S. DEPARTMENT OF ENERGY

Natural Gas-Biomass to Liquids Workshop

Biomass Research and Development Technical Advisory Committee

February 27, 2014

Zia Haq

Department of Energy

Workshop Objective

- Motivated by current cost/availability of natural gas
- Exploratory workshop September 3, 2013 to better understand how natural gas and biomass may be optimized and integrated into a conversion process to produce liquid fuels and chemicals
- Objective: obtain input from industry, academia, research establishments, and other experts to identify the pre-competitive R&D and scale-up challenges to commercializing gas-biomass-to-liquids (GBTL) technologies
- Opportunity for attendees to network and discuss possible ideas for collaboration.
- Feedback generated from the workshop will be made available in a white paper.

Discussion Topics

- GHG Emissions and resource potential track
  - GHG Emissions, baseline assumptions, geo-spatial availability
  - Price sensitivity, gas processing, natural gas benefits
  - Techno-economic analysis, plant size, other technologies

- Technical barriers track
  - Feeding systems, methane activation, catalyst development
  - Product/scale choices and optimization, novel technologies, capital cost
  - Deployment challenges, techno-economic analysis

Workshop Attendees

ABENGOA

Argonne NATIONAL LABORATORY

arpa·e

Bio Biotechnology Industry Organization

bp

BROOKHAVEN NATIONAL LABORATORY

CAAFI® COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE

CALYSTA Energy™

Corinne Young LLC

coskata

gti®

IOWA STATE UNIVERSITY

INL Idaho National Laboratory

LanzaTech

NatureWorks LLC ingeo: ingenious materials from plants not oil

BERKELEY LAB

MIT

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Pacific Northwest NATIONAL LABORATORY

PRINCETON UNIVERSITY

OAK RIDGE National Laboratory

Sandia National Laboratories

RTI INTERNATIONAL

siluria TECHNOLOGIES

SMUD™

SOUTHERN RESEARCH INSTITUTE

SRI International®

SundropFuels™

THE UNIVERSITY OF CALIFORNIA BERKELEY 1868

VIRENT

VTT

Verdigris Capital

WestVirginiaUniversity

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Life Cycle Analysis

- GREET model (Argonne National Laboratory) used to account for GHG emissions along entire supply chain
- Process: biomass gasification, blending of synthesis gas and natural gas, followed by Fischer-Tropsch conversion of synthesis gas to diesel
- Biomass feedstock: corn stover, conversion efficiency 60 gallons/ton
- Methane leakage: 1.19% (recovery 0.44%, processing 0.16%, transmission 0.36%, distribution 0.23%) – Source: EPA 2013 GHG Inventory
- Cases: with and without electricity co-production (from medium grade steam), with and without carbon capture and sequestration (90% capture from conversion facility)
- Similar analysis done by DOE-NETL, Iowa State University, and Princeton University

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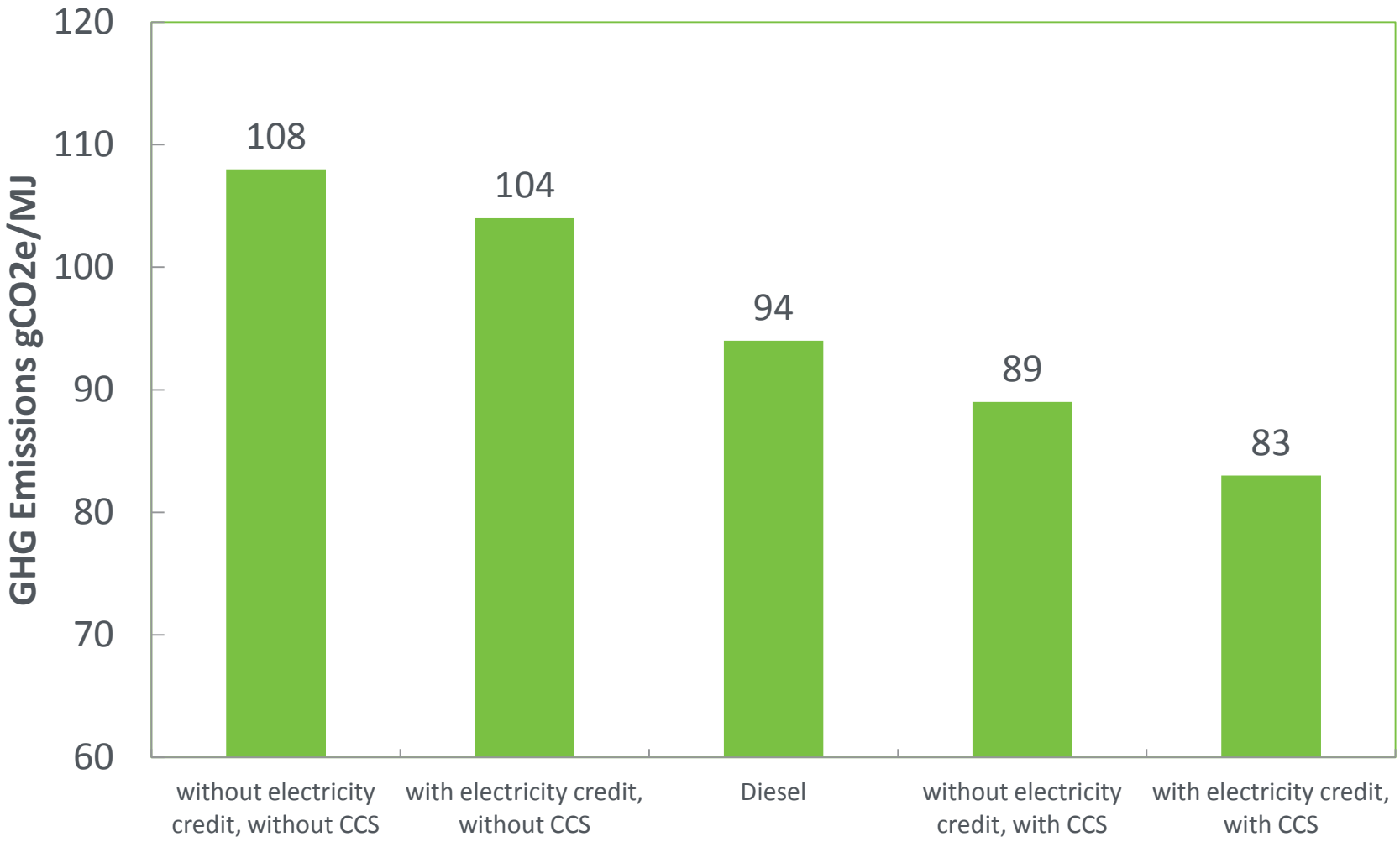
Preliminary LCA Results – GTL GHG Emissions – No Biomass



- If CCS is not utilized then GTL GHG emissions can be higher than diesel with no biomass
- The use of CCS (90% carbon removal) results in marginal GHG reductions
- Source: GREET Model, Argonne National Laboratory

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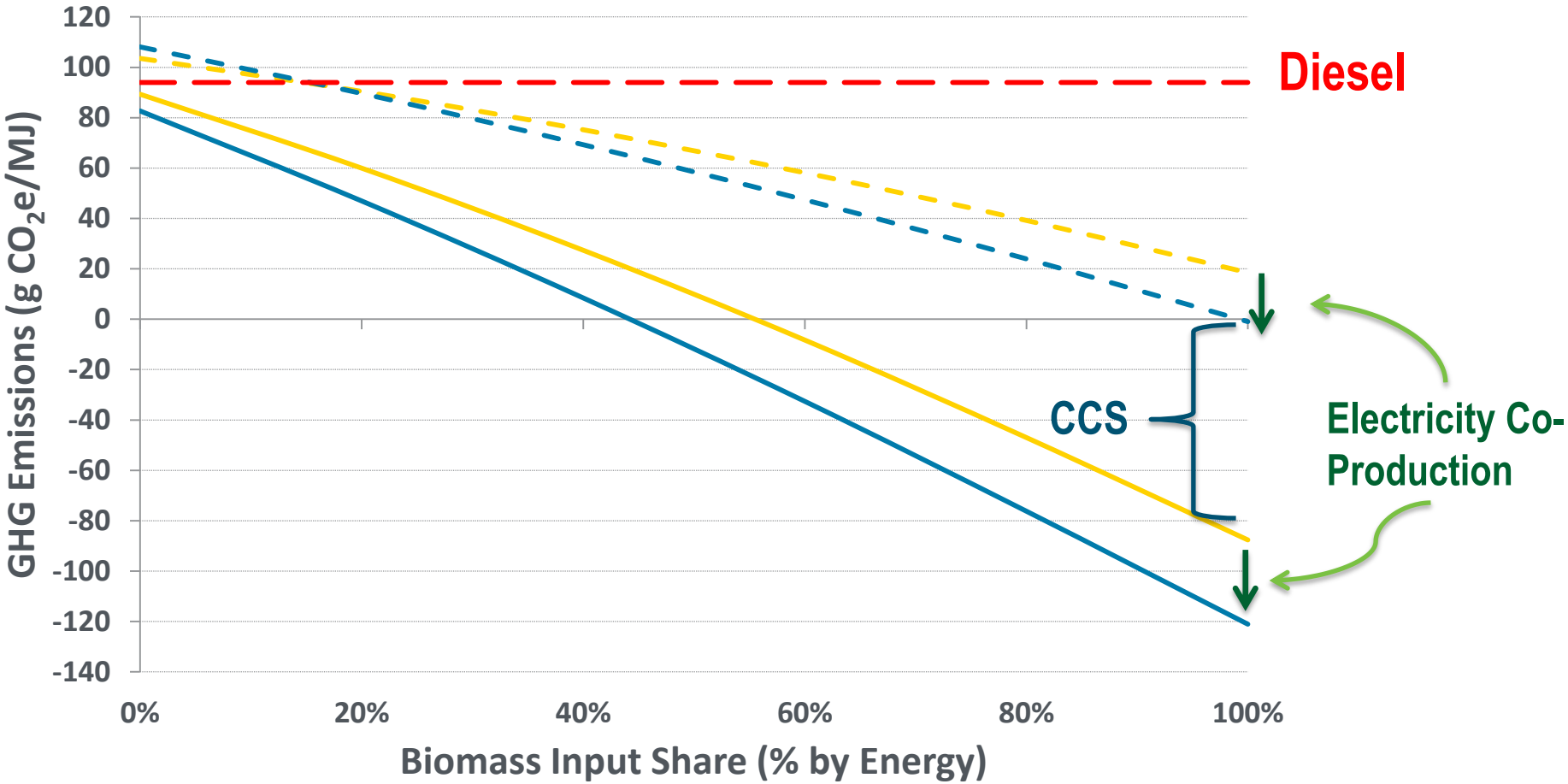
Preliminary Results – GHG as a Function of Biomass Shares



- If CCS is not used, a GHG reduction of 50% below diesel baseline can be achieved with about 65% biomass input (by energy)
- If CCS is used then a GHG reduction of 50% below diesel baseline can be achieved with about 30% biomass input (by energy)
- Source: GREET Model, Argonne National Laboratory

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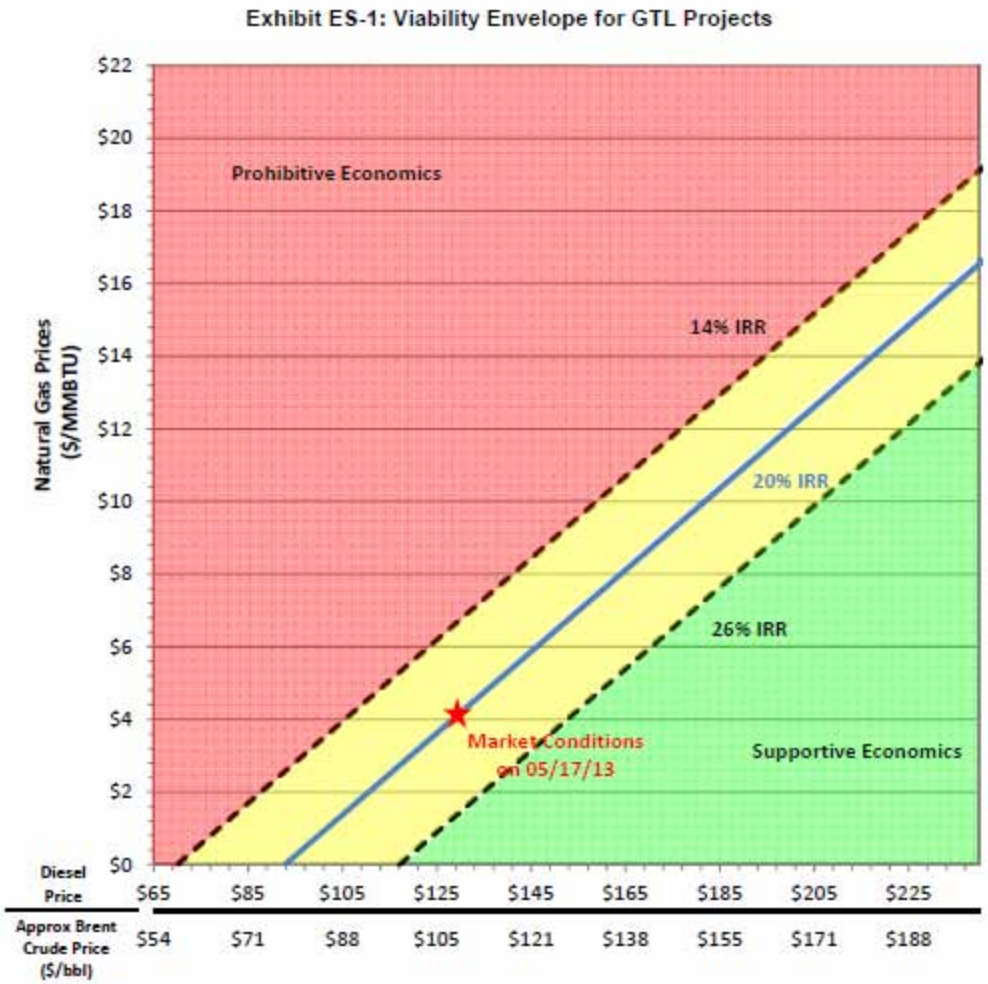
Gas-to-Liquids Cost of Production



Source: NETL, "Analysis of Natural Gas-to Liquid Transportation Fuels via Fischer Tropsch", DOE/NETL-2013/1597, September, 2013.

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Workshop Results and Next Steps

- Key takeaways from workshop:
  - Rationale for integrating biomass and natural gas resources to produce liquid transportation fuels is: need for smaller scale distributed processes, greenhouse gas reduction and the need for a specific C/H ratio in the fuel
  - GBTL processes can produce transportation fuels with 50% lower GHG emissions if substantial amounts of lignocellulosic biomass is co-processed with natural gas
  - GBTL processes have significantly higher yields than processes converting only biomass
  - Stranded biomass and stranded natural gas offer near-term opportunities to utilize currently unutilized feedstocks
  - Research challenges: down-scaling GTL systems, improved catalysts, biochemical conversion processes, feeding biomass into pressurized systems, production of co-products, and many more.

- Next steps
  - Integrating and organizing the feedback into a workshop summary report (to be posted on website)

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BETO's February Webinar

- *"The Potential for Natural Gas to Enhance Biomass Technologies"*
- Overview of Natural Gas-Biomass to Liquids technology, advantages of using natural gas, and key themes that were established at the September Natural Gas-Biomass to Liquids Workshop
- February 6, 2014
- 1:00 p.m .– 2:00 p.m.
- Presented by:
  - Zia Haq, BETO
  - Prasad Gupte, BETO
  - Chad Haynes, ARPA-E
  - TJ Augustine, ARPA-E
  - Tim Skone, FE/NETL

Webinar Details & Results	
Scheduled Duration	60 minutes
Total Registrants	595
Total Attendees	401
Average Attendance Duration	54.2 minutes
International Attendees	37
Q&A Questions Asked	99

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GBTL Next Steps

- Natural gas to liquids processes are highly capital intensive
  - One facility by Sasol in Louisiana is projected to cost between $11 to $14 billion. Final capital cost could be factor of 2 to 3 higher.
  - Facilities have to be large in order to realize economies of scale. Louisiana facility will produce 96,000 barrels/day of products (1.5 billion gallons/year).
  - The paradigm has to change to smaller-scale distributed production of GBTL so that more natural gas (stranded resources such as flared natural gas) and biomass can be accessed.

- NETL study shows that production cost is currently competitive with diesel but sensitive to natural gas price, oil price, capital cost.

- In FY14:
  - NETL techno-economic analysis and life-cycle GHG analysis has been published
  - Continuing analysis and publications focusing on TEA, LCA, resource assessment are planned
  - ARPA-E has announced 15 projects on innovative GTL process technologies
  - Formulate DOE strategy on GBTL including natural gas-biomass to methanol and chemicals
  - Cross-cutting interest by EERE (VTO, FCTO, AMO), FE, ARPA-E

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