Life Cycle Assessment of Logistics Supply Systems

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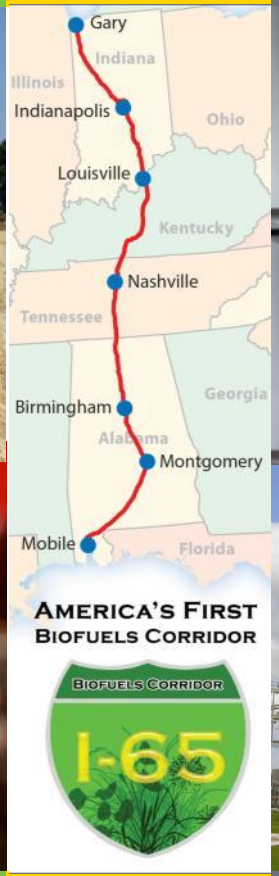

Project 11.2.4.2
Analysis and Sustainability

May 22, 2013

Kara Cafferty, PI

Idaho National Laboratory

Goal Statement

Support the Bioenergy Technology Office sustainability efforts

BETO Sustainability Activity Areas
Water Quantity and Quality
Soil Health and Agronomics
Climate Change and Air Quality
Land Use
Biodiversity

Quad Chart Overview

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Timeline
Project Start Date: Oct. 1, 2011
Project End Date: Sept. 30, 2013
Completion: 75%

Barriers
St-D Indicators and Methodology
St-B Sustainability Data Across Supply Chain

Budget
DOE Share: 100%
Funding for FY13: $90K
Funding for FY12: $90K
Years Funded: 2 years
Average Annual Funding: $90K

Partners
National Renewable Energy Lab
Argonne National Laboratory
Drexel University

INL

Project Overview

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Focus: Determine sustainability performance for feedstock supply systems

Objectives:

- Develop methodology for assessing sustainability performance for feedstock logistics
- Assess sustainability performance for the conventional and advanced feedstock logistics supply systems
- Identify high impact operations through statistical analysis to help direct further research

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Approach

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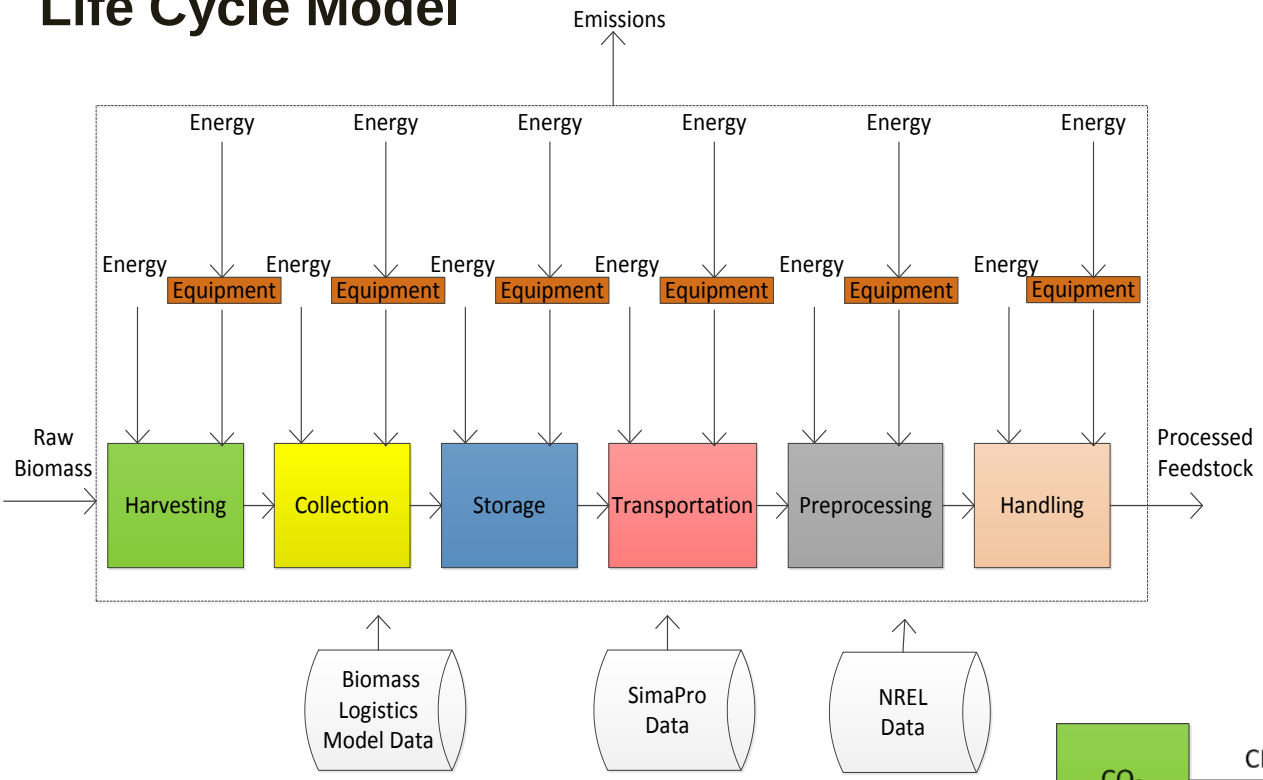
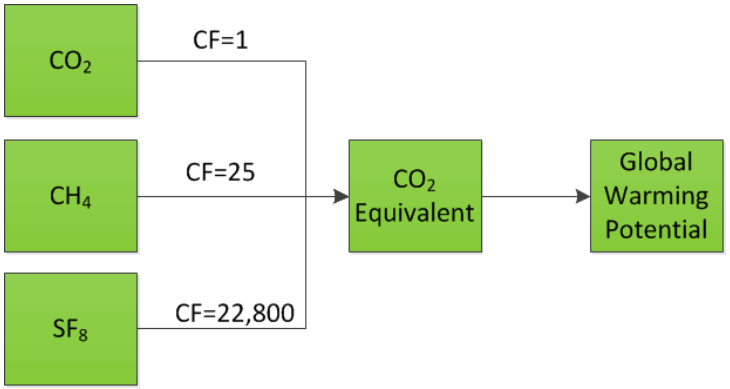
Cradle-to-Cradle Life Cycle Model



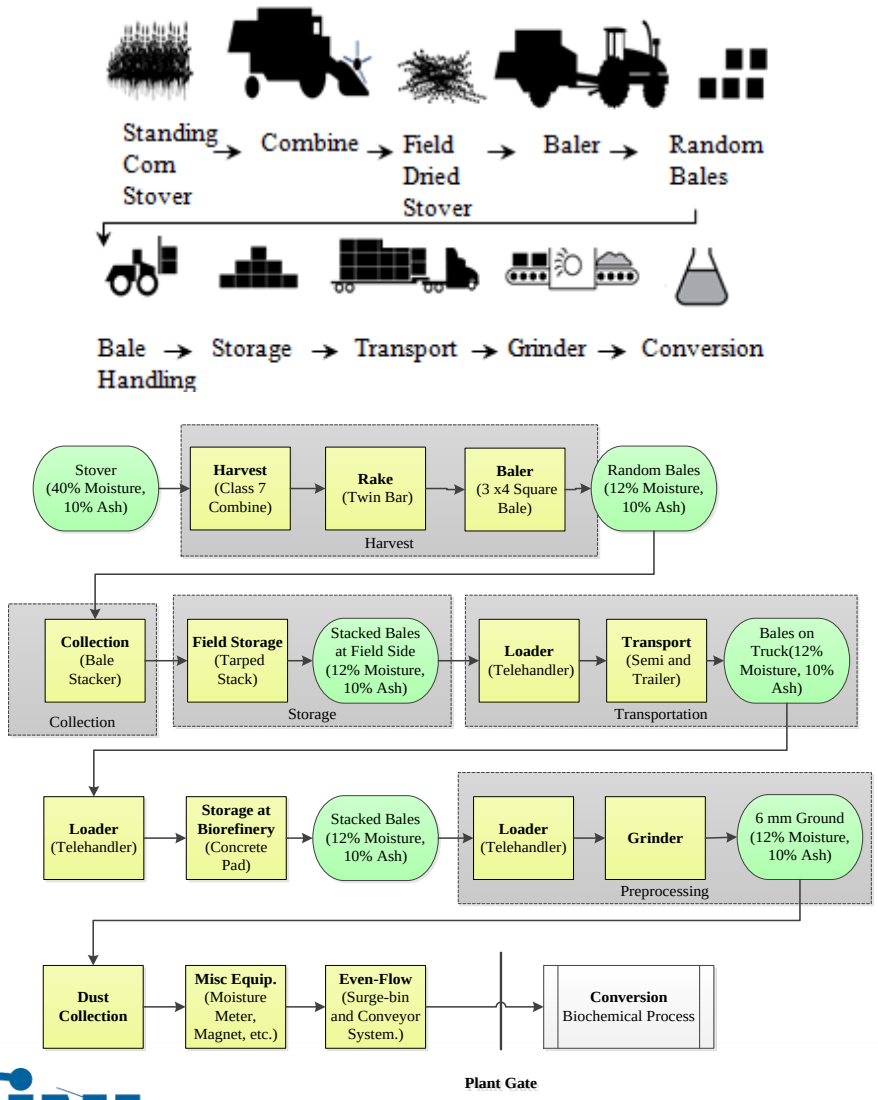
Life Cycle Inventory

Substance	Compartment	Unit	Total
1-Butanol	Air	ng	12.5
1-Butanol	Water	mg	1.27
1-Pentanol	Air	pg	0.0772
1-Pentanol	Water	pg	0.185
1-Pentene	Air	pg	0.0583
1-Pentene	Water	pg	0.14
1-Propanol	Air	ng	247
1,4-Butanediol	Air	µg	4.02
1,4-Butanediol	Water	µg	1.61
2-Aminopropanol	Air	pg	0.093
2-Aminopropanol	Water	pg	0.234
2-Butene, 2-methyl-	Air	pg	1.29E-5
2-Methyl-1-propanol	Air	pg	0.244
2-Methyl-1-propanol	Water	pg	0.586
2-Methyl-2-butene	Water	pg	3.11E-5
2-Nitrobenzoic acid	Air	pg	0.168
2-Propanol	Air	mg	75.4
2-Propanol	Water	pg	0.677

Aggregated Inventory/ Impact Assessment



Technical Accomplishments (cont)



2012 State of Technology Supply System Design

	GWP Kg CO_2-Eq/Mg
Harvesting	7.52
Bailing	8.45
Collection	1.19
Transportation	4.07
Preprocessing	150.01
Storage	2.52
Handling	3.38
Total	**177.14**

Technical Accomplishments

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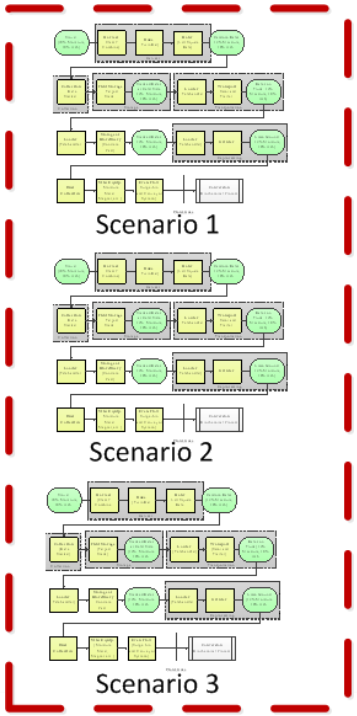
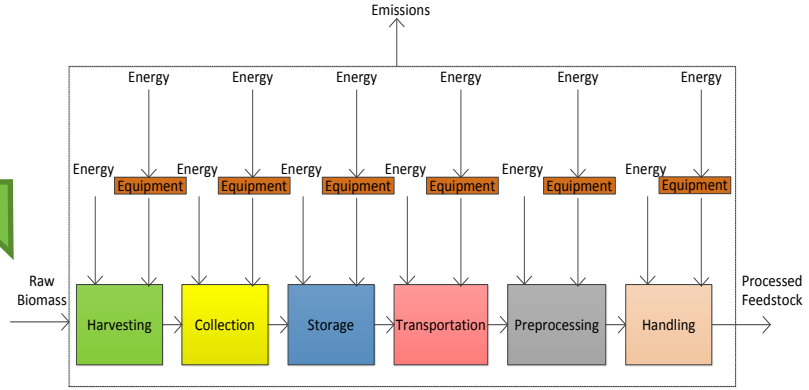
Connected Logistics Model and Life Cycle Model to stream-line assessments

Supply Systems

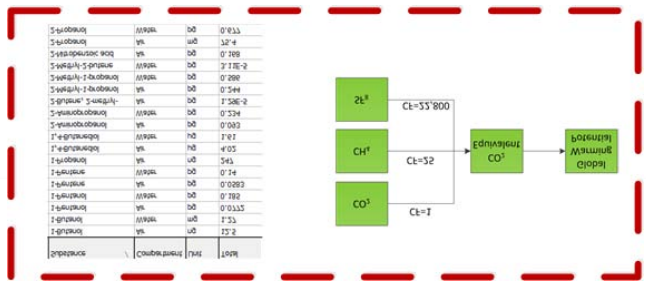


Logistics Model Calculations

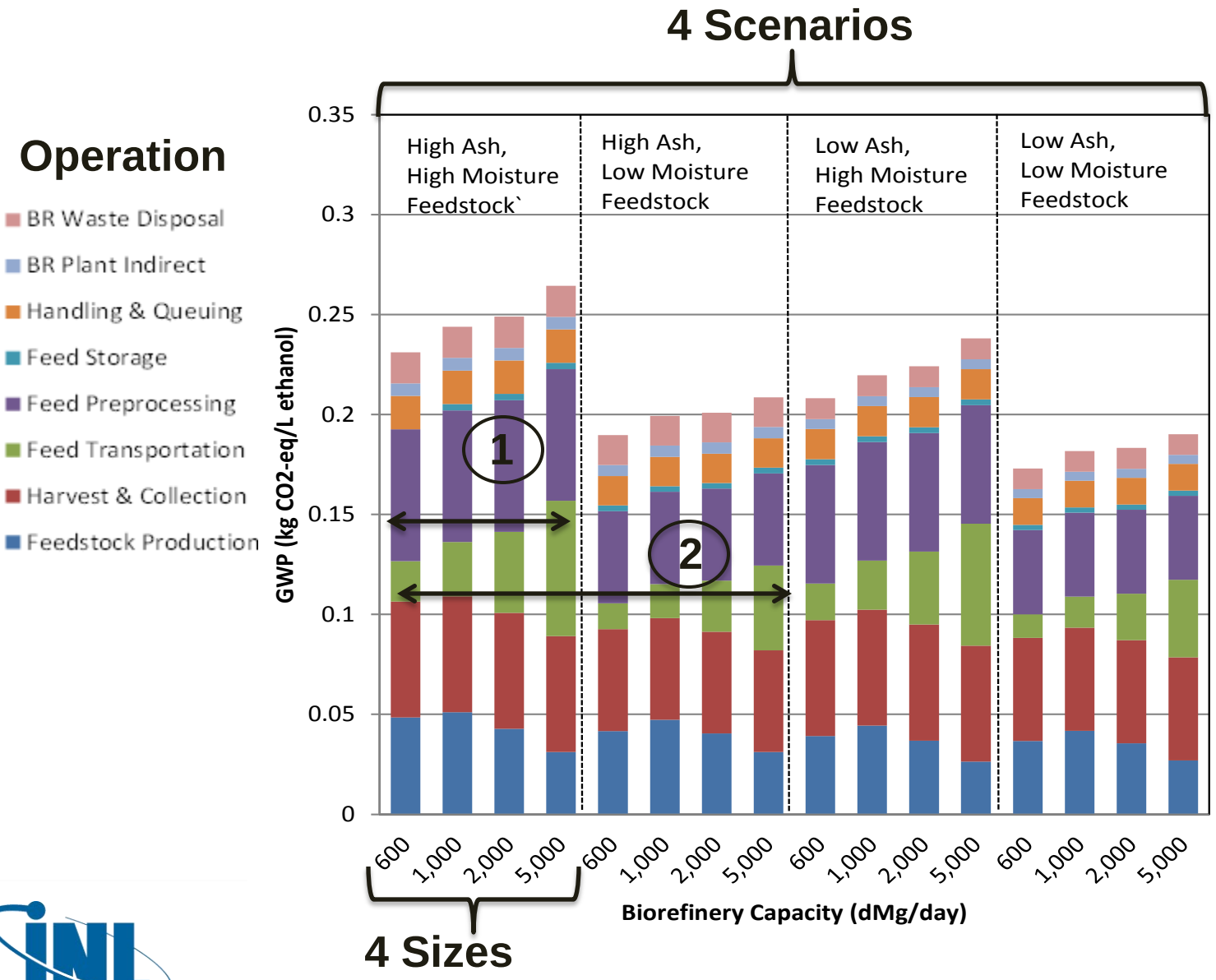
Life Cycle Model



Results



Technical Accomplishments (cont)



1

BR Waste Disposal
BR Plant Indirect
Handling & Queuing
Feed Storage
Feed Preprocessing
Feed Transportation
Harvest & Collection
Feedstock Production

2

Increased transport distance due to capacity

Transport of excess moisture

Technical Accomplishments (cont)

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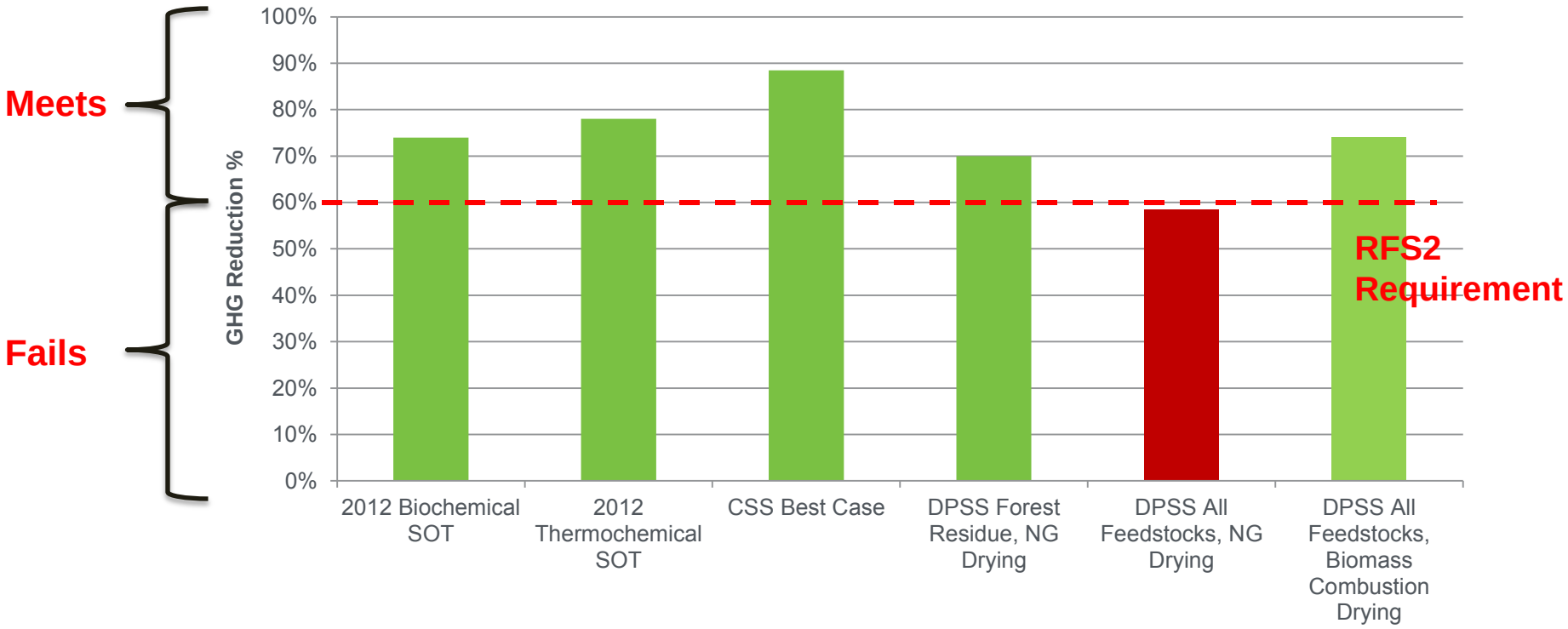
Comparison of GHG Reduction



RFS2 Requirement to Qualify as Cellulosic Ethanol:

60% reduction of GHG from 2005 levels

Relevance

BETO Relevance:

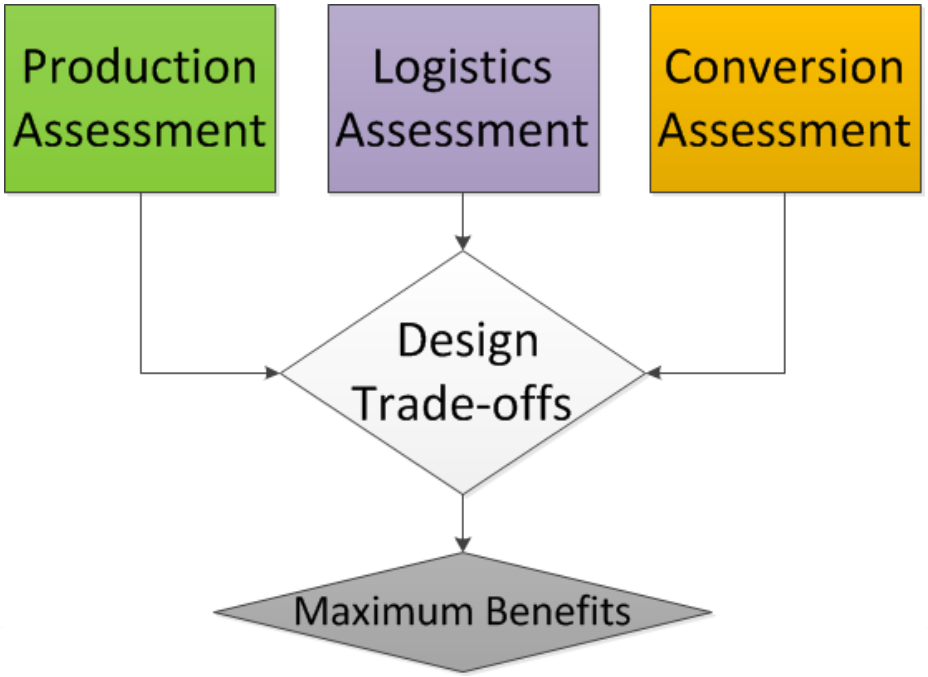
- Assesses environmental performances for feedstock supply chains
- Provides information to guide program decisions
- Allows for investigation of system-trade offs for maximum benefits

Industry Relevance:

- Evaluates RFS2 compliance for cellulosic ethanol

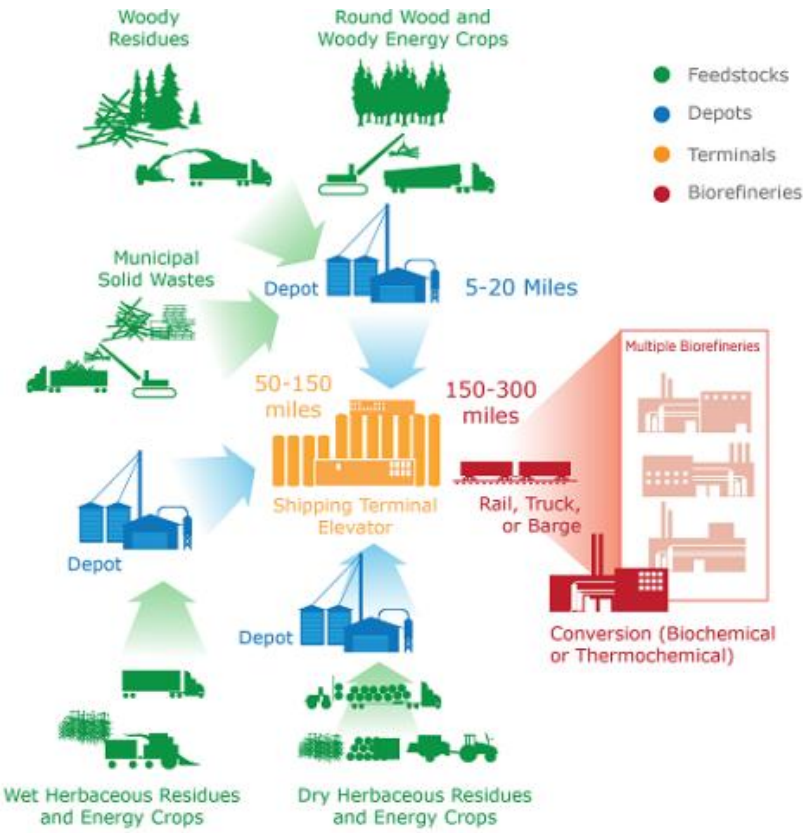
Critical Success Factors

This project enables the investigation of environmental performance and the trade-offs of system designs in order to achieve maximum benefits



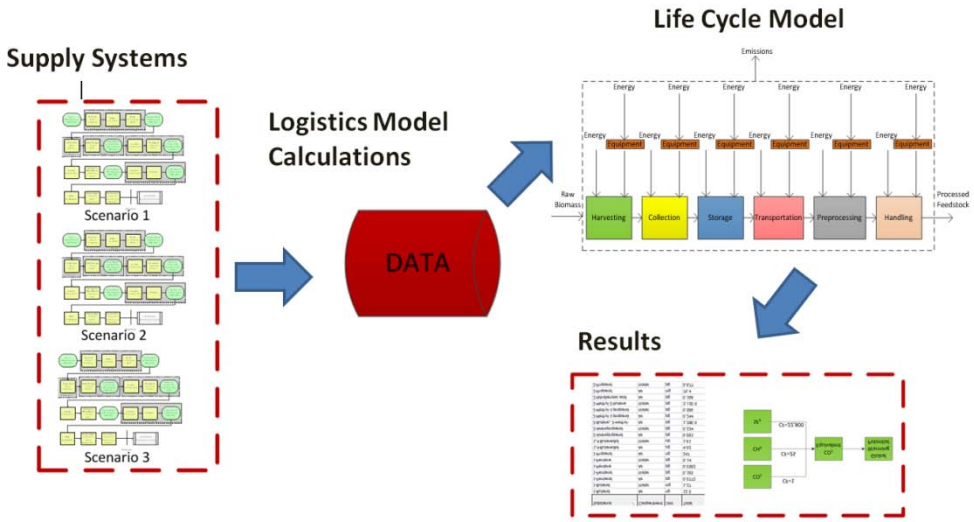
Future Work

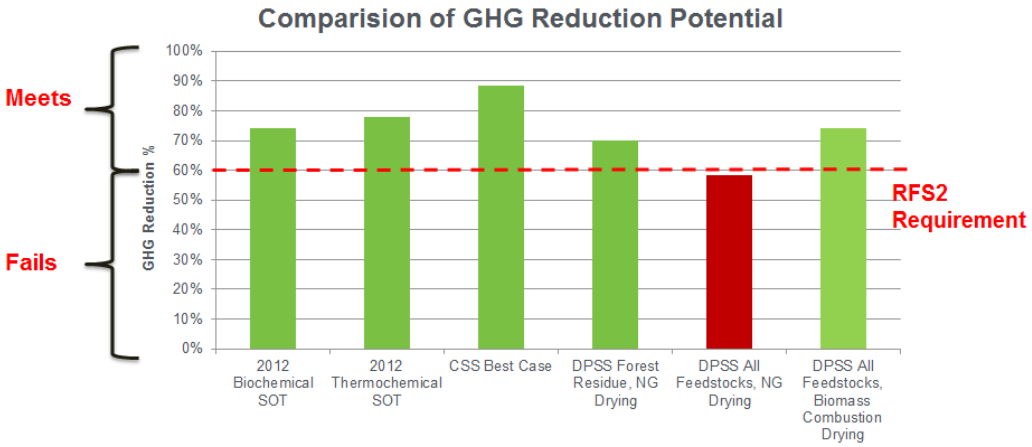
- Assesses environmental performances for feedstock supply chains
- Final Report September 2013
- Expand environmental performance to include other factors (water and air quality)

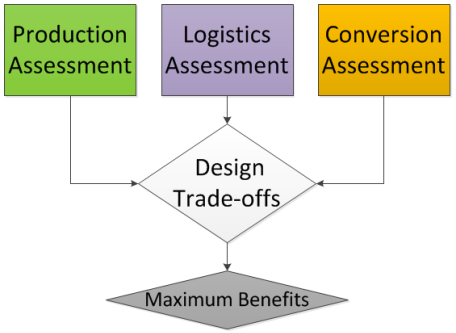


Summary

- Developed framework for assessing sustainability performance for feedstock logistics
- Stream-lined process
- Demonstrated capability
  - 2012 SOT
- Evaluate trade-offs







Questions

Additional Slides

Publications

- *Investigation of Biochemical Biorefinery Sizing and Environmental Sustainability Impacts for Conventional Bale System and Advanced Uniform Biomass Logistics Designs,* R. Graham, M. Langholtz, L. Eaton, J. Jacobson, C. Wright, D. Muth, D. Inman, E. Tan, M. Wu, Y.-W. Chiu, S. Jones, L. Snowden-Swan, A. Argo. BioFPR, April 2013

- *Investigation of Thermochemical Biorefinery Sizing and Environmental Sustainability Impacts for Conventional Supply System and Distributed Preprocessing Supply System Designs*, David Muth, Matt H. Hangholtz, Andrew Argo, Eric Tan, Abhijit Dutta, Laurence Eaton, Crang C. Brandt, Jacob J. Jacobson, Erin M. Searcy, Kara Cafferty, May Wu, Yi-Wen Chiu, in development.