Feedstock Supply & Logistics
Feedstock Supply System Integration

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy





Project 1.6.1.9
Technology Area Review

May 21, 2013

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Idaho National Laboratory

1.6.1.9 Goals: Supply System Integration

Determine the regional performance of biomass feedstock logistic supply chains driven by conversion facility in-feed specifications, by…

Improving the capability of research toolsets to:

- Collect and relay relevant biomass characteristics at multiple points in the supply chain
- Translate these characteristics into measures of value and performance
- Determine how logistics pathways change these characteristics
- Suggest the most promising supply chain configurations
- Couple best-available predictive models spatially and temporally
- Facilitate research integration

1.6.1.9 Quad Chart Overview

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Timeline
Project Start Date: Oct. 1, 2009
Project End Date: Sept. 30, 2022

Barriers
Ft-M: Overall Integration
St-F: Systems Approach

Budget	
Average funding per year:	$380k
Years funded to date:	5 years
Funding for FY13:	$750k
Funding for FY12:	$250k
Funding for FY11:	$285k

Partners
National Renewable Energy Lab
Oak Ridge National Laboratory
Biomass R&D Library Consortium
Iowa State University

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1.6.1.9 Project Overview

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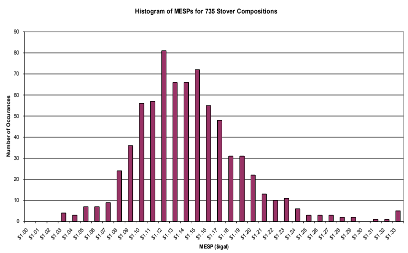
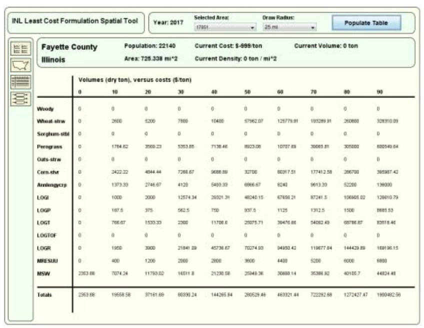
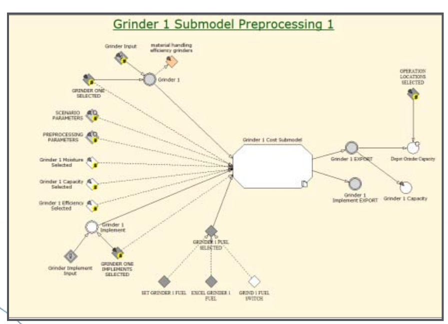


Biomass characteristics library

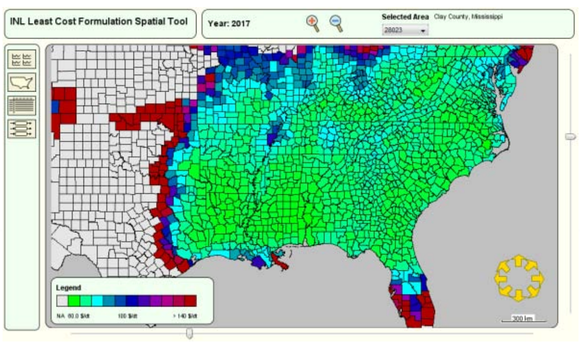


County-level volume vs. cost

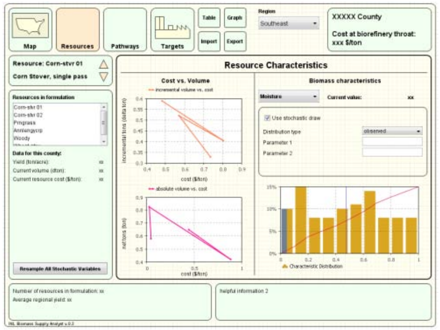
1. Develops and manages the Biomass Resource Library as a centralized collection of characteristic information
2. Incorporates the Billion Ton Update cost vs. volume data to inform least-cost formulations by county
3. Integrates modularized Biomass Logistic Model components to assess feedstock logistics pathways
4. Spatially and temporally couples biomass resources through pathways with conversion facilities
5. Creates a usable interface to these integrated models, providing analytical capability to multiple researchers



Modular logistics components



Spatial and temporal analysis engine



Intuitive user interface

Overview: Biomass Library

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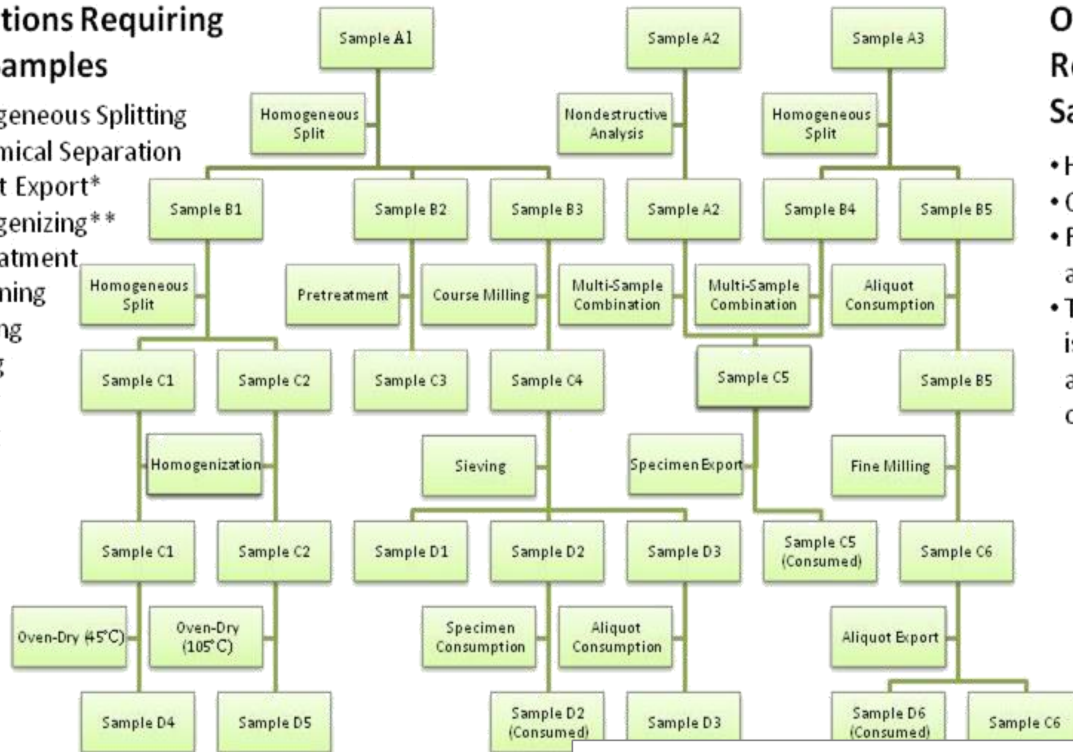
Biomass Library:

- Biomass Type
- Location
- Date of Harvest
- Moisture
- Sugars
- Lignin…

This information will be used to formulate a feedstock based on a conversion facility specification.

Operations Requiring New Samples

- Homogeneous Splitting
- Anatomical Separation
- Aliquot Export*
- Homogenizing**
- Pretreatment
- Combining
- Grinding
- Sieving
- Drying
- Milling



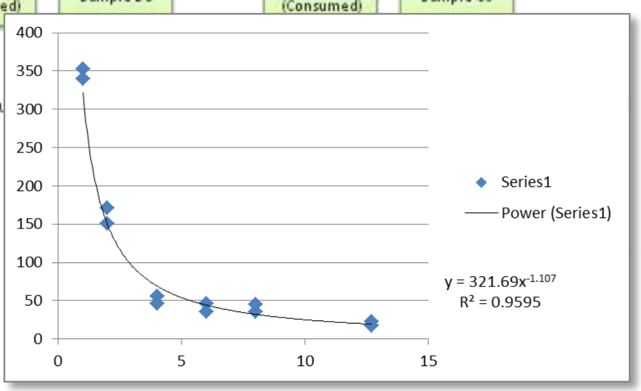
Operations NOT Requiring New Samples

- Homogenizing***
- Consumption
- Removal of an aliquot for analysis
- Typical child sample is direct result of analysis and is consumed

*Aliquot Export results in the creation of only one child sample with a uniq

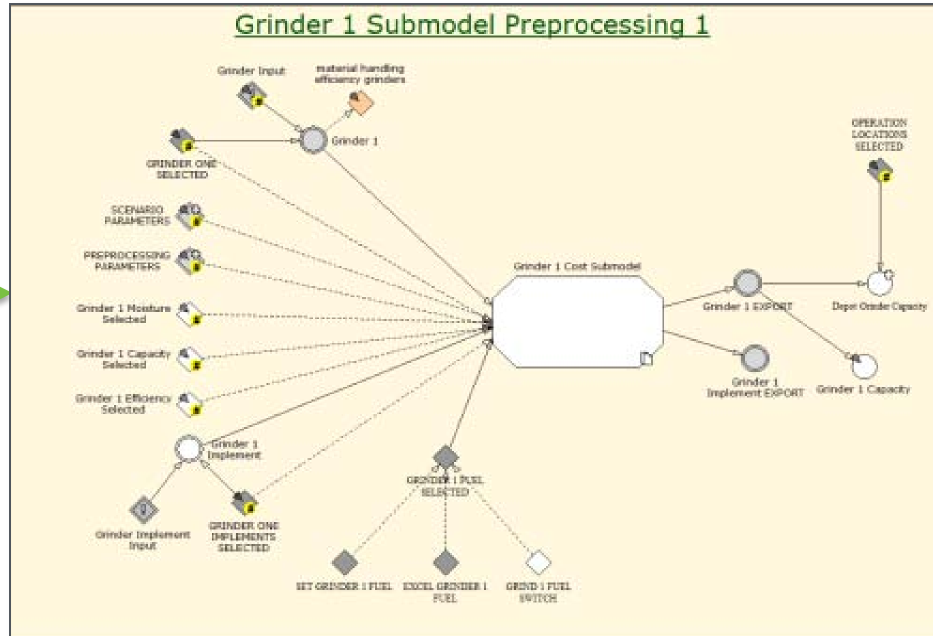
** Homogenizing through centrifugal milling

*** Homogenizing by mixing a single sample



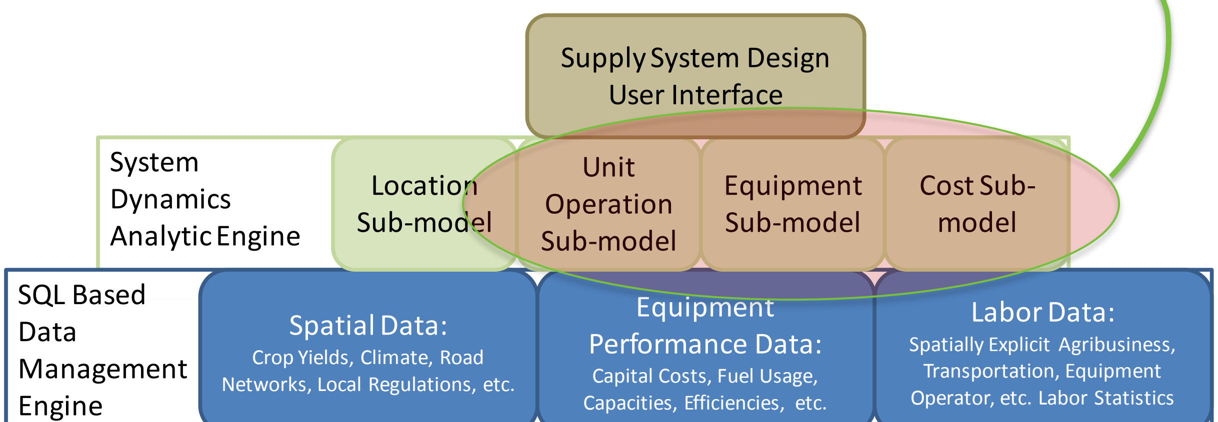
Overview:
Biomass Logistics Model Framework

Inputs:
Volume
Characteristics
Desired output specs

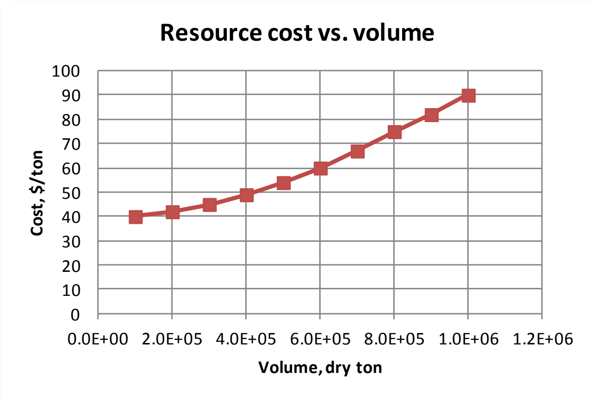


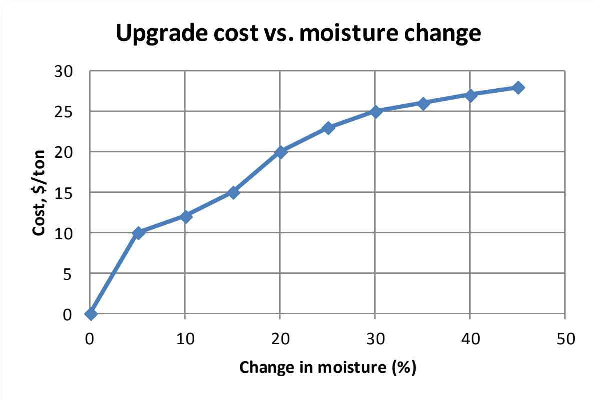
Modular logistics components

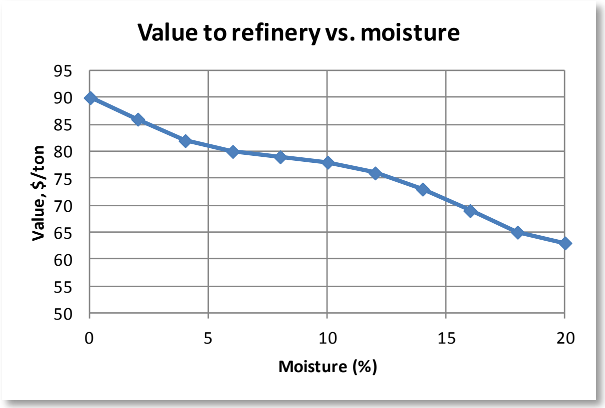
Outputs:
Volume
Characteristics
Cost

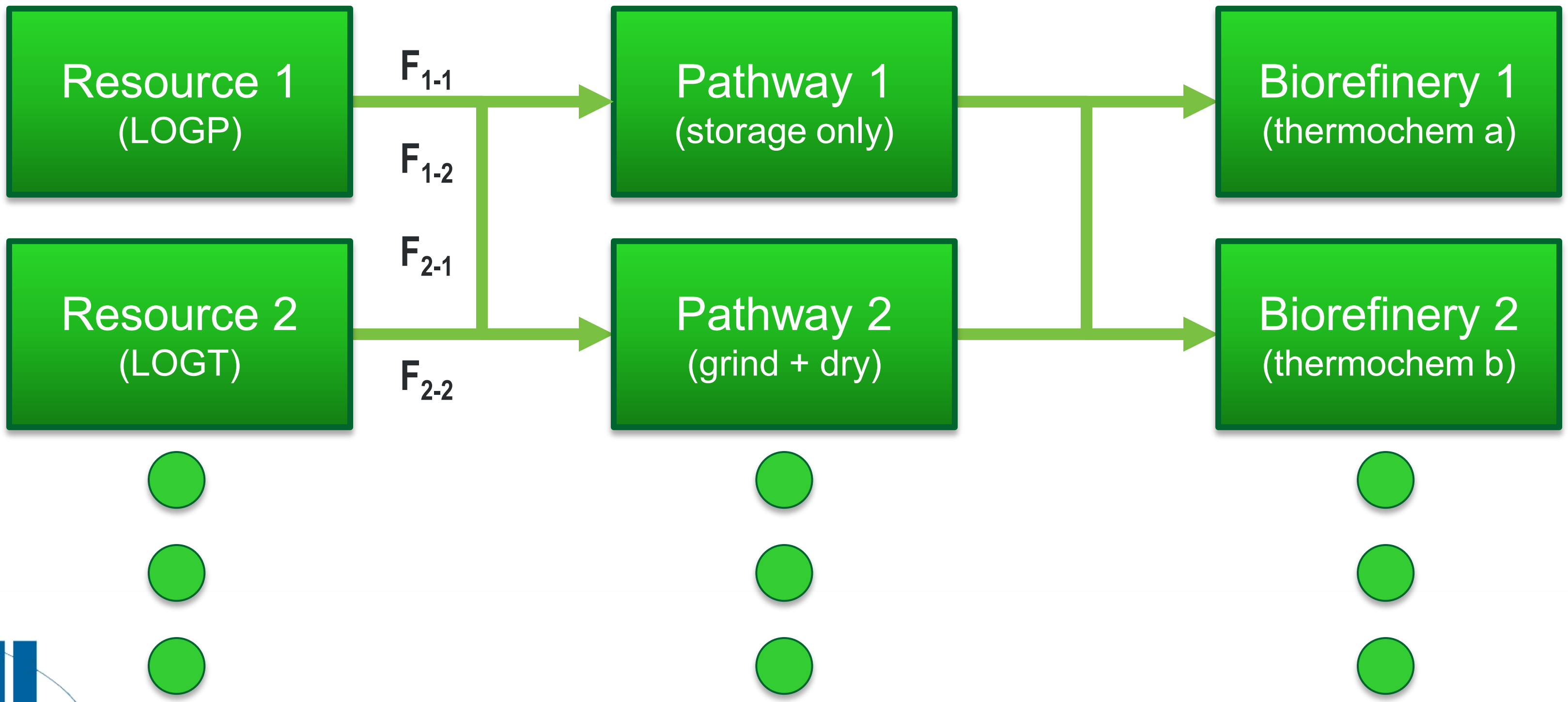


Overview:
System-level Simulation Engine





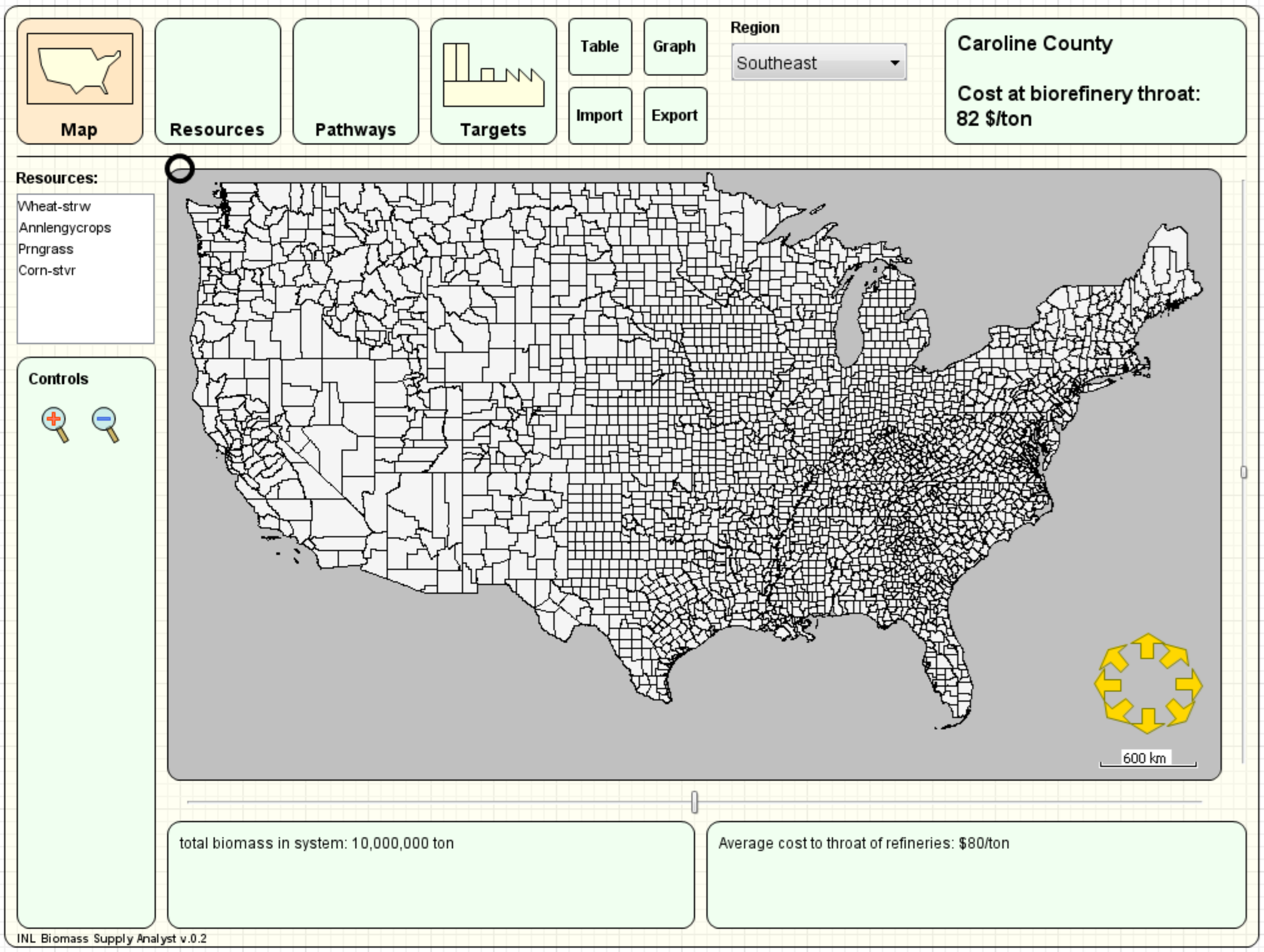




Overview: Visualization and Interface

User access to:

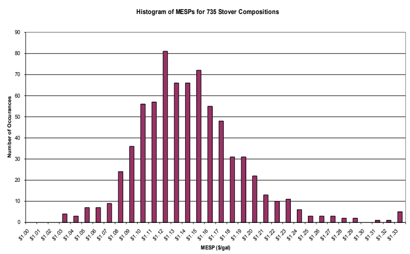
- BTU data
- Characteristics
- Logistics designs
- Biomass blends
- Regional info



Visual web-based interface for testing pathway performance over space and time

1.6.1.9 Approach

Develop integrative tools and methodologies that support large-scale technical, economic, and policy decisions regarding the feedstock supply system



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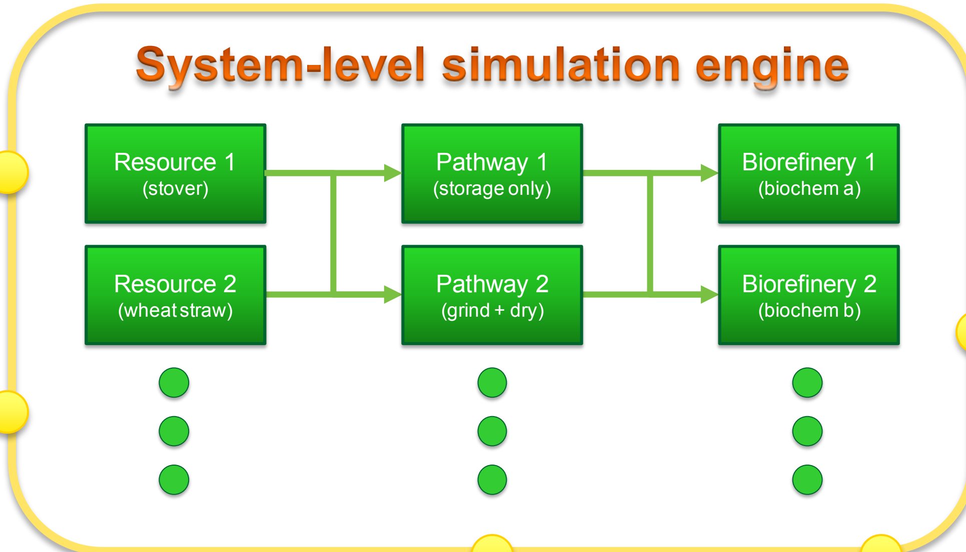
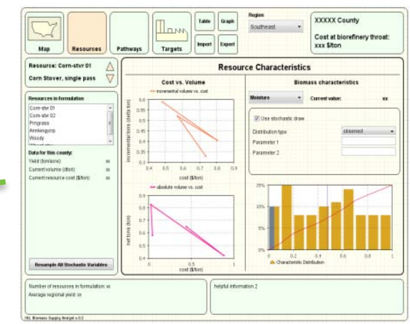
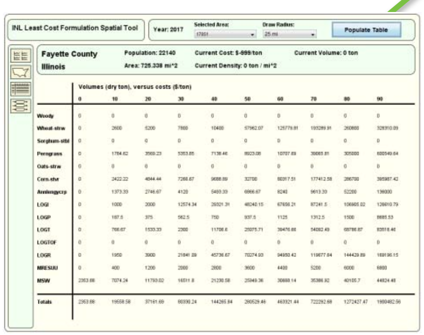
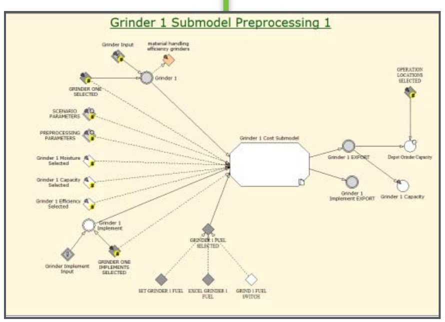




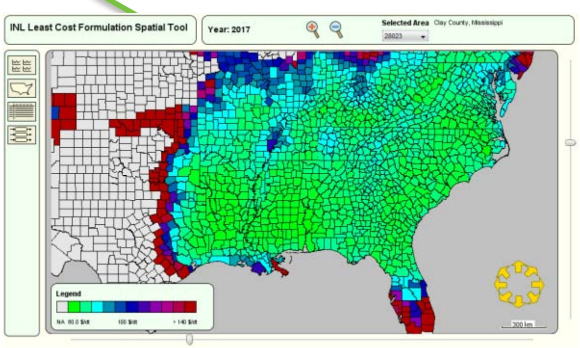
Intuitive user interface



County-level volume vs. cost



Modular logistics components



Spatial and temporal analysis engine

Supported the Joule Milestone of achieving an $80/dt target delivered feedstock

- Helped to develop supply chains that can deliver high quality, low cost biomass to the biofuel conversion reactor throat.
- Suggested biomass supply chain pathways by region that utilize blending to achieve the $80/DMT target.

Internally demonstrated that these tools can be published via the web.

- A web-based logistics analysis tool will be deployed in June through the KDF

Results: Least-cost formulation

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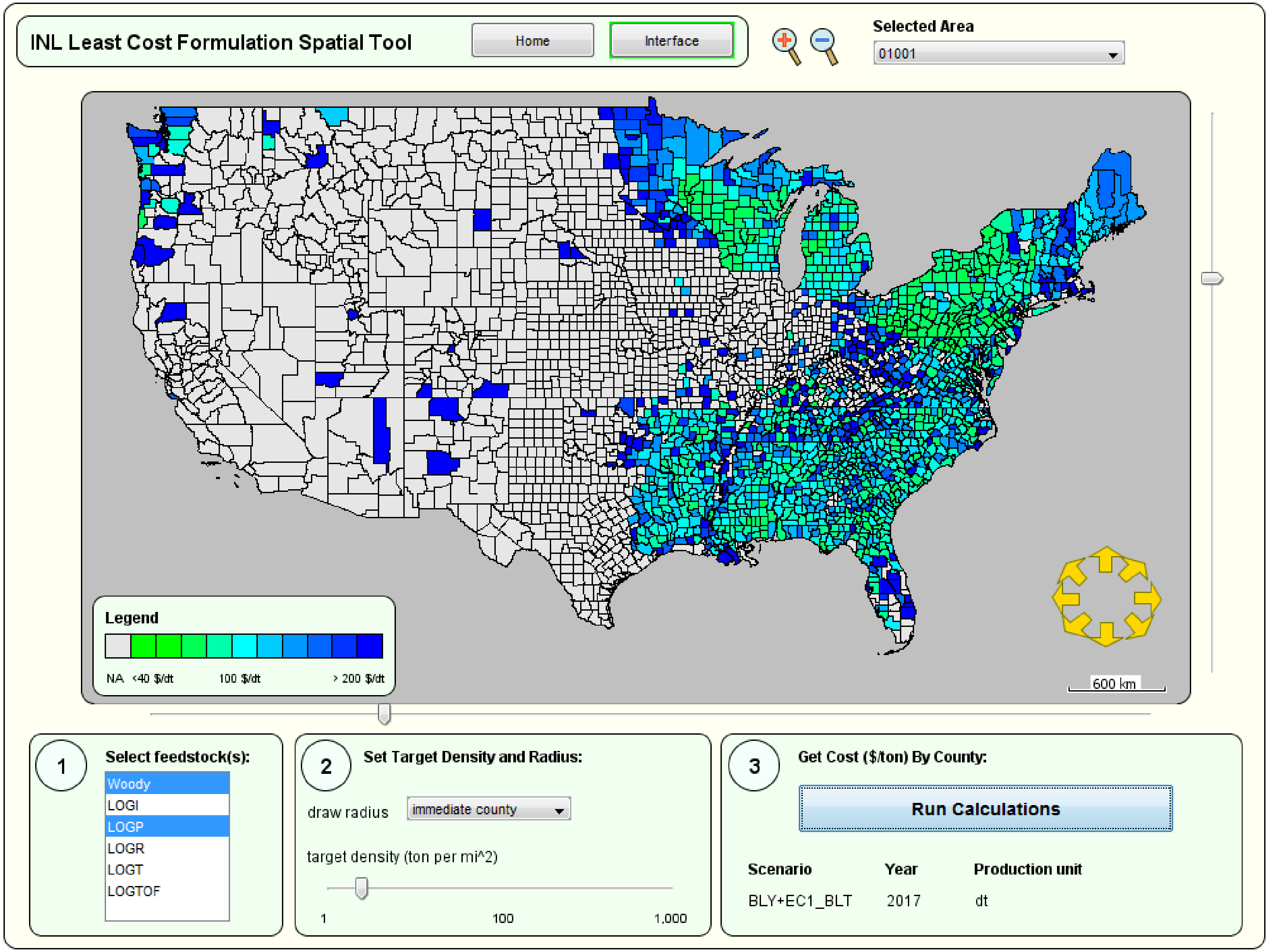
Clean Wood Chip Cost and Quantity: Landing Price



Primary Resources

- Conventional Wood
- Pulp Wood
- Short Rotation Woody

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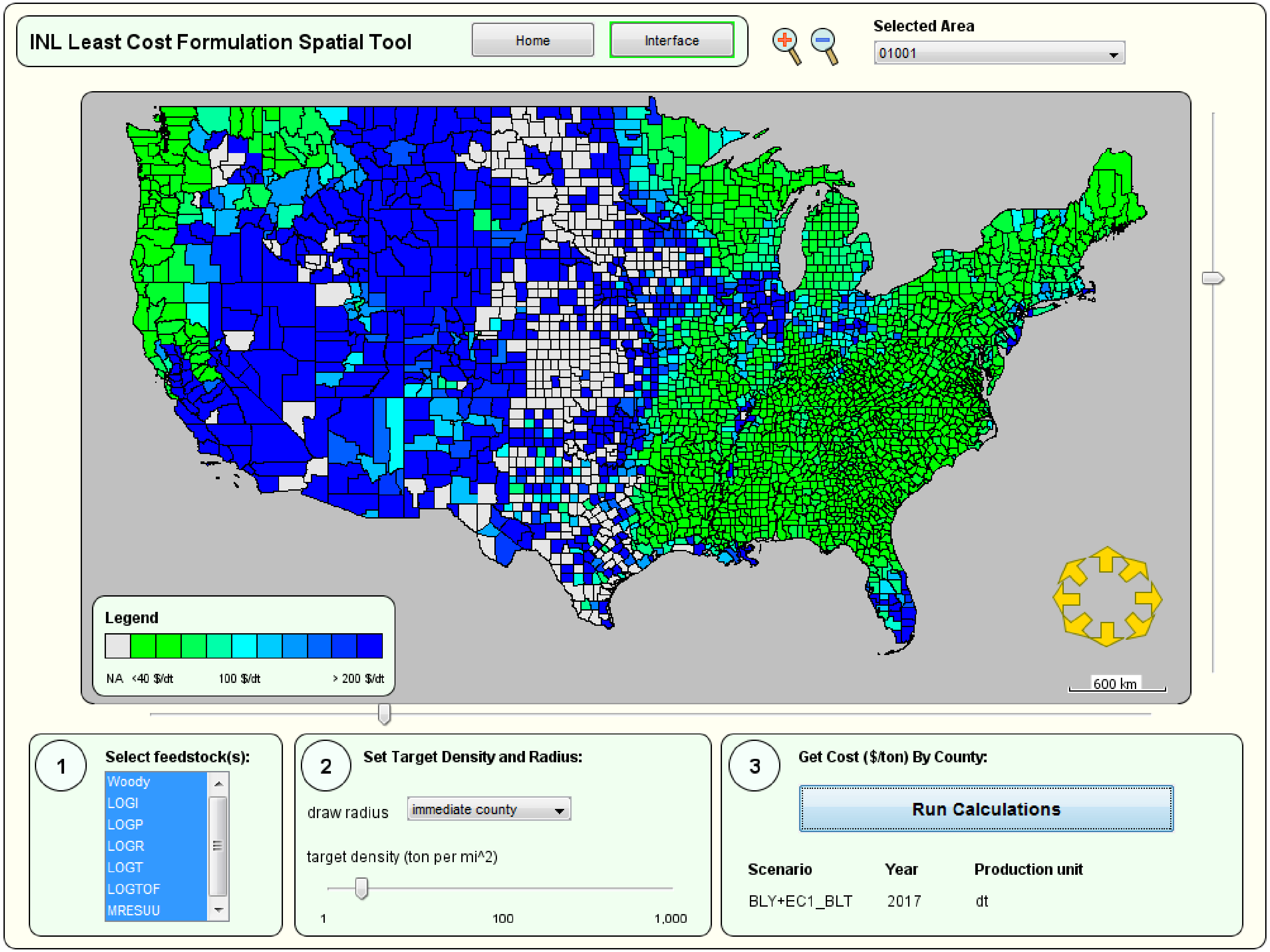
Results: Least-cost formulation

Formulated Woody Feedstock Cost and Quantity: Landing Price



Primary Resources

- Conventional Wood
- Pulp Wood
- Short Rotation Woody
- Thinnings
- Logging Residues
- Unused Mill Residues

Results: Least-cost formulation

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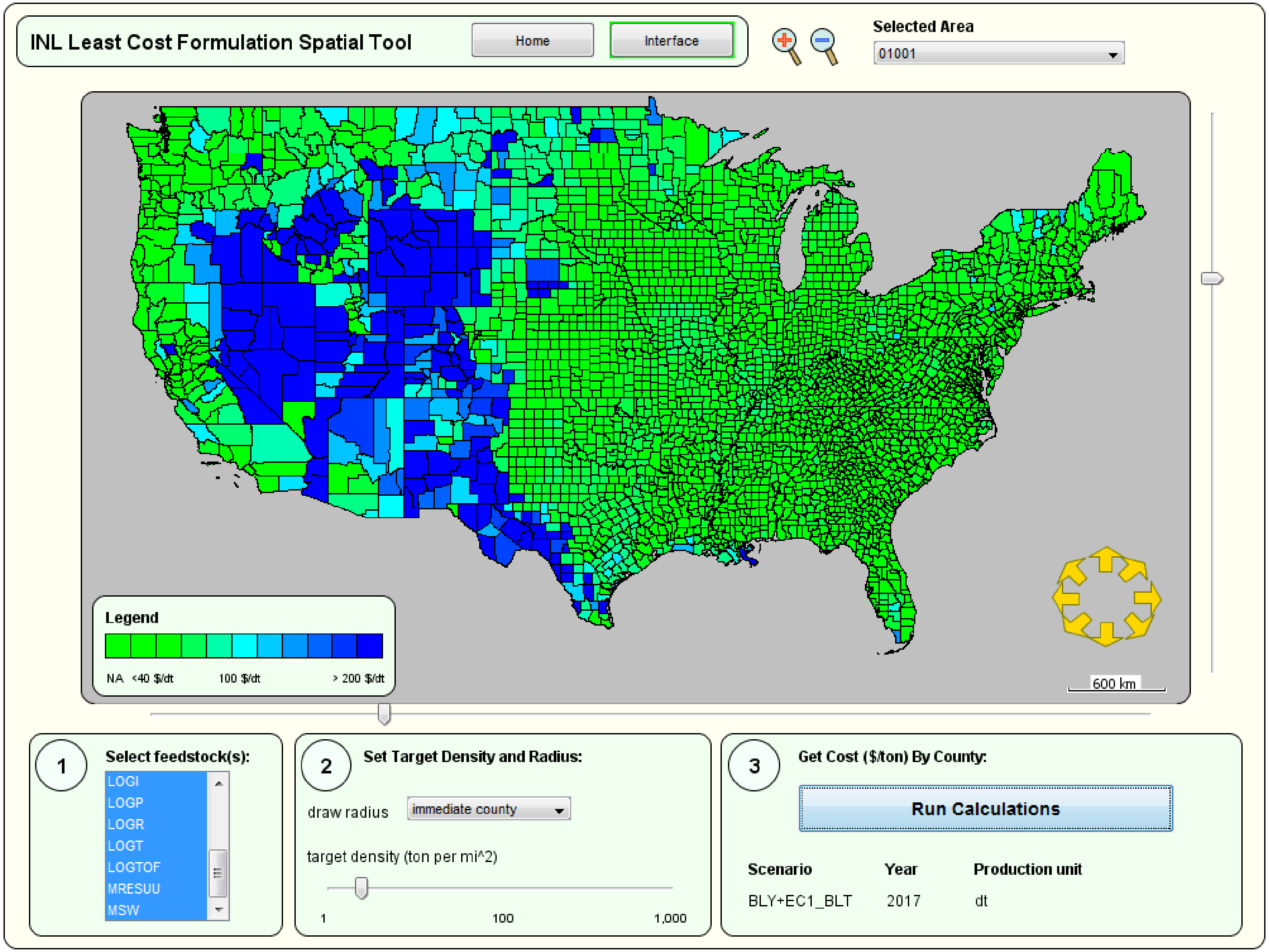
Formulated Woody/Herbaceous/MSW Blend Feedstock Cost and Quantity: Landing/Farmgate Price



<u>Primary Resources</u>

- Conventional Wood
- Pulp Wood
- Short Rotation Woody
- Thinnings
- Logging Residues
- Unused Mill Residues
- Ag Residues
- Perennial Grasses
- Energy Sorghum
- Potentially Usable Fraction of MSW

Results: Least-cost formulation

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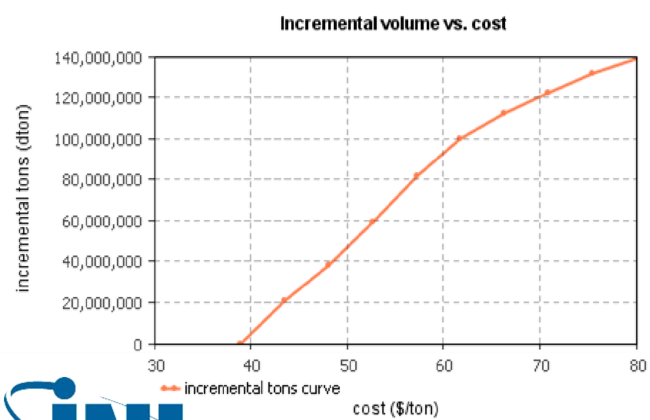
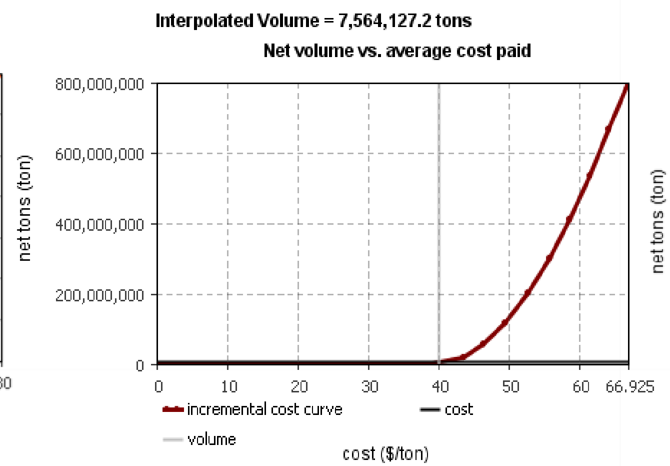
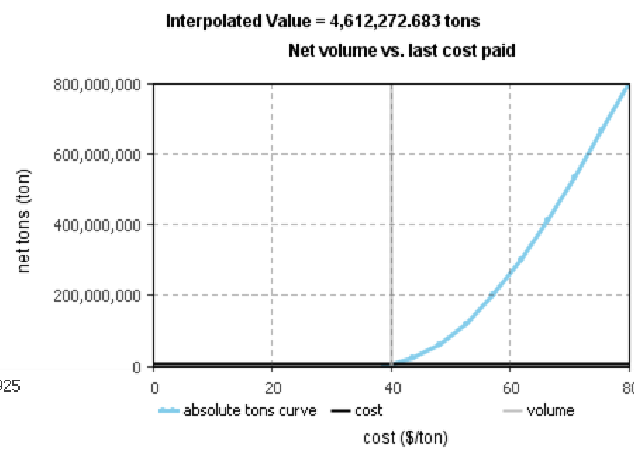
Two types of blending:

- Selection of multiple resources with complementary characteristics
- Selection of one resource type over multiple periods or locations

National feedstock supply for 2017 at $40/ton			Supply (Mton/yr)	Supply (Mton/yr)
Resource		BTU code(s)	No Blending	Intra feedstock blending
Agricultural Residues	Corn Stover	Corn-stvr	13.87	22.74
	Cereal Straw	Wheat-strw, Oats-strw	3.21	5.27
Energy Crops	Herbaceous energy crops	Perngrass, Annlengycrp	4.61	7.56
	Woody energy crops	Woody	0.01	0.01
Forest Resources	Pulpwood	LOGP	0.02	0.06
	Logging residues and fuel treatments	LOGR	101.17	164.02
	Other forestland removals	LOGT, LOGTOF	36.95	60.22
	Urban and mill wood wastes	MRESUU	4.56	7.79
Potential feedstock supply (Totals)			**164.4**	**267.67**







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Results: Library informs pathways

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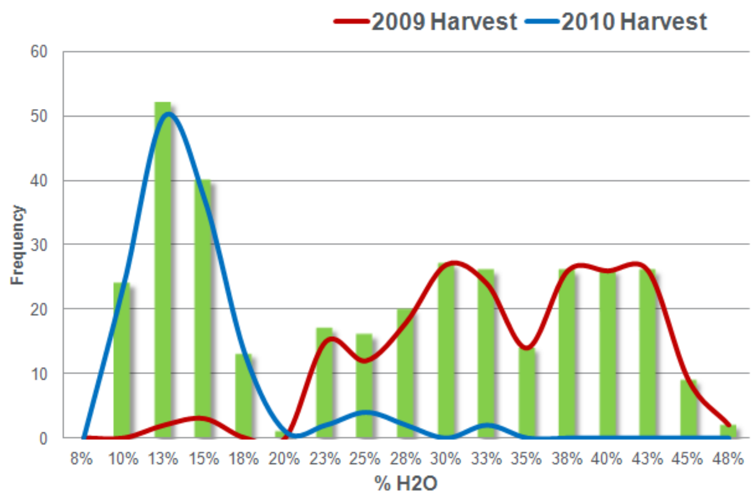
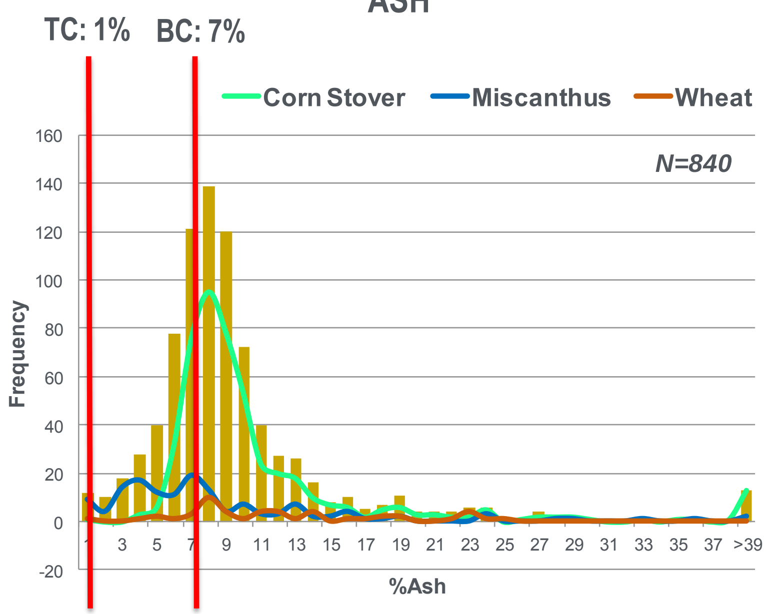
Variability over time



Distributed blending to spec



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Relevance

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Relevant to industry

- Can show return on investment in logistics systems
- Shows the most promising logistics designs by location and year

Relevant to BETO

- Publishing online gives a clear indication of "vision"
- Informs the most promising areas of technical research

Relevant to researchers

- Easy and fast access to spatial and temporal cost and characteristic information
- Feedback & discussion: quickly implement design ideas

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Success Factors

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Library:

Encourage collaborators to further populate the Biomass Library
Increase the pedigree of the data in the library
Minimize data "gaps" – defined by areas of analytic difficulty

Logistics model:

Modularize the Logistic Submodels to allow dynamic coupling
Develop a web-based logistics analysis tool – deploy in KDF
Incorporate predictive algorithms based on Library data

Overall toolset:

Integrate with and inform industry partners
Show return on investment in depot systems
Become predictive about the most promising feedstock pathways

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Future Work

Data:

Updated BTU database

example: questionable information from “woody, perngrass”

Continuously evolving Biomass Resource Library

work “BRL data upload” into projects’ milestones

Biorefinery behavior vs. feedstock characteristics

example: how much does it cost to accept biomass above ash targets? Below? What determines the value of the feedstock?

Analytics:

Determine preprocessing/logistics cost dynamics

example: in anomaly years, how do depots buffer characteristics, lowering the overall long-term cost of operation?

Publish tools online and get feedback from researchers and BTOE

Continue to discuss ideal “blends” for different regions

Publishing:

Extend beyond our “normal” publishing avenues

examples: Biomass & Bioenergy (elsevier), Energy & Fuels (ACS), System Dynamics Society, others?

Summary

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- **Approach…**

  From biomass to feedstock: Biomass with variable characteristics over time and space, to commoditized bioenergy feedstocks with reliable characteristics.

  From descriptive to predictive: Developing tools that inform feedstock supply chain pathways instead of simply analyzing them.

  Full integration:

- **Outcomes…**

  To date: Over 50,000 data points in the Biomass Library, modularization of grinding and drying unit operations for the Biomass Logistics Model, incorporation of Billion Ton Update data in the Least Cost Formulation Model

  To come: Automated analysis of multiple feedstock pathways by incorporating cost-predictive models based on biomass characteristics at multiple points in the supply chain.

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Questions

Publications/Presentations

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Least Cost Formulation of Biomass to Reduce the Cost of Renewable Hydrocarbon Fuels, Dave Muth, Robert Jeffers, Jake Jacobson, Kara Cafferty, Kenneth Bryden, Accepted to 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit and 11th International Energy Conversion Engineering Conference. July, 2013.

Robert F. Jeffers, Jacob J. Jacobson, Erin M. Searcy. (INL) *Dynamic Analysis of Policy Drivers for Bioenergy Commodity Markets*, Energy Policy (January 2013). The publication is a summation of the results of a dynamic analysis of the competition for biomass for three competing entities, biofuel, biopower and international exports.
Link: http://www.sciencedirect.com/science/article/pii/S0301421512007549

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