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

DOE Bioenergy Technologies Office (BETO) 2015 Project Peer Review

4.1.2.20

Economic Analysis of Policy Effects Analysis Platform

March 24, 2015

This presentation does not contain any proprietary, confidential, or otherwise restricted information

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Goal Statement

- The **goal of this project** is to 1) identify risk factors in the biofuel supply system, 2) translate risk factors to implications, and 3) identify strategies and polices to **minimize risks**.
- The current supply system, the conventional design, procures biomass locally, stores it field-side then delivers it to the biorefinery. This work **analyzes the risks** in this system.
- The supply system is sensitive to market forces, such as RIN prices and the RFS(2), and supply chain disruptions. "**De-risking**" the biorefinery industry means knowing what points in the supply system can be leveraged to mitigate market and other risks.
- **Reducing risk** in this industry **is critical** to the success of the Billion Ton Economy, thus reducing America's dependence on foreign energy.

Quad Chart Overview

Timeline

- Project start date: Oct. 1, 2013
- Project end date: Sept. 30, 2017
- Percent complete: 25%

Budget

	Total Costs FY 10–FY 12	FY 13 Costs	FY 14 Costs	Total Planned Funding (FY 15-Project End Date
DOE Funded (x1000)			$240	$450
Project Cost Share (Comp.)*				

*No cost share in this project

Barriers

- Barriers addressed
  - At-A. Comparable, Transparent and Reproducible Analyses
  - At-B. Analytic tools and capabilities
  - At-C. Data availability across the supply chain
  - Mm-B. Inconsistent, competing Policies

Partners

- Collaborators
  - ORNL
  - NREL
- Other Groups
  - US EPA

1 – Project Overview

History

Policy and technology are vitally important to the growth of the biofuel industry. Understanding the role of each, and how to direct research to minimize risks while building on positive impacts is key to promoting the industry.

Context

Analysis to date has centered on **minimizing costs** to supply biofuels, but **little focus on market conditions** and supply chain **risk**.

- RIN market, price volatility
- Bioenergy byproduct markets
- Supply disruptions

Objectives

This work **analyzes** the **market risk** implications of price volatility and co-product competition on the success of the biofuels industry and on **supply chain risks**, focusing in on policy and strategies to minimize risks.

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Dynamic analysis of policy drivers for bioenergy commodity markets

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HIGHLIGHTS

- We model a United States bioenergy feedstock commodity market.
- Three buyers compete for biomass: biopower, biofuels, and foreign exports.
- The presented methodology improves on dynamic economic equilibrium theory.
- With current policy incentives and ignoring exports, biofuels dominates the market.
- Overseas biomass demand could dominate unless a CO_2-limiting policy is enacted.

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ABSTRACT

Biomass is increasingly being considered as a feedstock to provide a clean and renewable source of energy in the form of both liquid fuels and electric power. In the United States, the biofuels and biopower industries are regulated by different policies and have different drivers, which impact the maximum price the industries are willing to pay for biomass. This article describes a dynamic computer simulation model that analyzes future behavior of bioenergy feedstock markets given policy and technical options. The model simulates the long-term dynamics of these markets by treating advanced biomass feedstocks as a commodity and projecting the total demand of each industry, as well as the market price over time. The model is used for an analysis of the United States bioenergy feedstock market that projects supply, demand, and market price given three independent buyers: domestic biopower, domestic biofuels, and foreign exports. With base-case assumptions, the biofuels industry is able to dominate the market and meet the federal Renewable Fuel Standard (RFS) targets for advanced biofuels. Further analyses suggest that United States bioenergy studies should include estimates of export demand in their projections, and that GHG-limiting policy would partially shield both industries from export dominance.

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1. Introduction

The use of biomass as a feedstock for energy production is one option to provide a clean, renewable, and domestic source of energy. Although biomass is a renewable resource, the amount that can be grown sustainably and accessed economically is limited (US Department of Energy (DOE), 2011a). In the United States (US), growth in the use of biomass feedstocks for energy production is increasingly being driven by governmental policies such as Renewable Fuels Standard (RFS) for biofuels production and Renewable Portfolio Standards (RPS) for biopower production (Sorda et al., 2010; US Department of Energy (DOE), 2010). However, the future size and strength of the bioenergy industry in the US is uncertain in the face of high values for biomass overseas that may drive up domestic prices for processed bioenergy feedstocks. Additionally, the potential for greenhouse gas (GHG)-limiting legislation creates uncertainty for investors in bioenergy and could disproportionately change the value of biomass for biopower compared to biofuel. The US Department of Energy (DOE) is investigating the utility of a commoditized uniform format for bioenergy feedstocks, which would expand access to many biomass industries and biomass resources, help minimize market volatility, and reduce risk to both biorefineries

Abbreviations: DOE, United States Department of Energy; EERE, DOE Office of Energy Efficiency and Renewable Energy; EISA, Energy Independence and Security Act of 2007; EPA, Environmental Protection Agency; EU, European Union; IEA, International Energy Agency; Gas, Petroleum-based gasoline; GHG, Greenhouse Gas; MYPP, OBP Multi-Year Program Plan; OBP, Office of Biomass Program within DOE, EERE; REC, Renewable Energy Certificate; RFS, Renewable Fuel Standard; RIN, Renewable Identification Number; RPS, Renewable Portfolio Standard; US, United States of America

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2 – Approach (Technical)

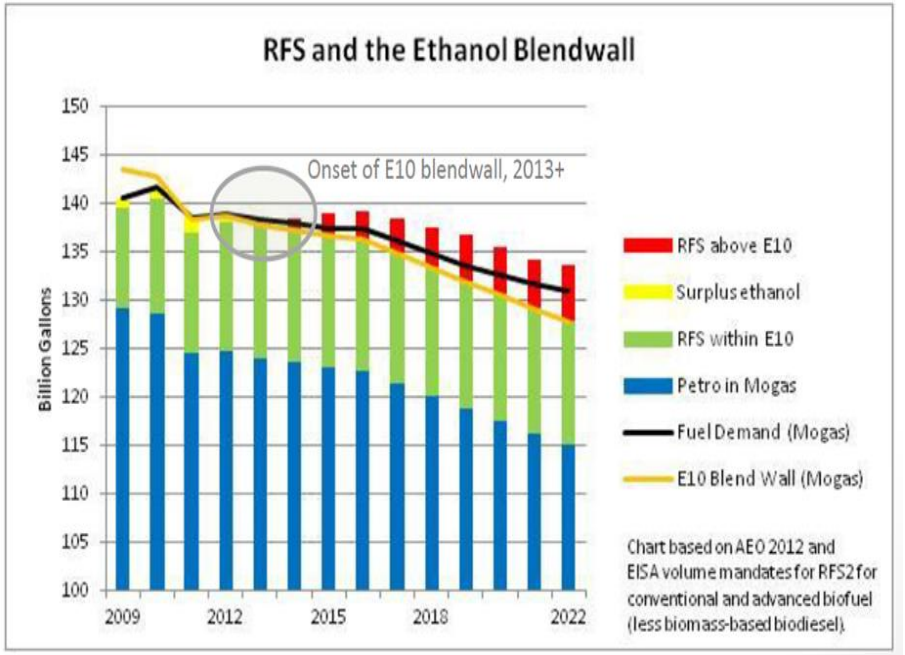
- In FY14 the project surveyed the biofuel industry to identify the set of risk factors and analyzed the RIN market under RFS2.
  - **De-risking** the biofuel industry means securing a consistent biomass supply in volume, price, and quality. Transitioning from conventional to advanced minimizes risks.
  - The **RIN market** functioned as it was designed. The RIN price increased according to pressure to meet the EPA mandates.
- In FY15 this work will use developed tools and methodologies to examine market development in bioenergy co-products and their impacts on biofuel costs and market competition.
  - **Co-products** provide firm owners the ability to leverage sales in alternative markets against the high cost of biofuel production, making biofuel more competitive.
  - **Success** in de-risking the biofuels industry correlates to growth in the number of biorefineries and ancillary support services.

2-Approach (Management)

- ❑ **SUCCESS FACTORS**
- ✓ Translating risk to cost
- ✓ Developing innovative strategies that reduce risk and are implementable
- ✓ Policy implications on markets
- ❑ **CHALLENGES**
- ✓ Dissecting complex interactions between policies and behavior
- ✓ Engaging regulators, policy makers and industry
- ❑ **TRACKING**
- ✓ On-going engagement, communication and reporting, to BETO
- ✓ Viability of co-products as a secondary income stream and market impacts (9/30/15)
- ✓ Analyze various subsidy options in terms of sustainable increased biofuel production and impacts to US economy (9/30/16)

3 – Technical Accomplishments/Progress/Results

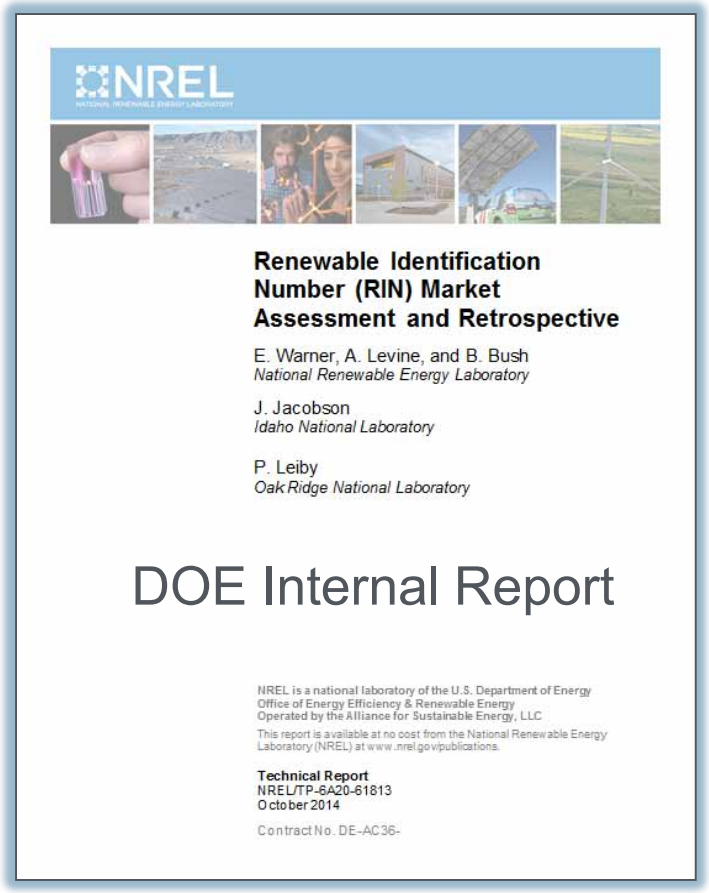
The "Blend Wall"



- **Synthesize** the historical data and literature on RFS2/RIN into a coherent analysis of observations, key drivers and issues
- Asses **legal** and statutory **context** of the RIN market
- Conceptualize key qualitative and quantitative **factors affecting RFS2/RIN** and impact on bioenergy industry

3 – Technical Accomplishments/Progress/Results

- Price Drivers
  - Biofuel (and many secondary) markets
  - Biofuel volumetric requirements
  - Nested structure of RIN categories
  - Expectations
- Impacts
  - Limited influence on commercial ethanol
  - Crop price support
  - Transfer from petroleum producers to biofuel producers
  - Negligible impact at gas pump


NREL

Renewable Identification Number (RIN) Market Assessment and Retrospective

E. Warner, A. Levine, and B. Bush
National Renewable Energy Laboratory

J. Jacobson
Idaho National Laboratory

P. Leiby
Oak Ridge National Laboratory

DOE Internal Report

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
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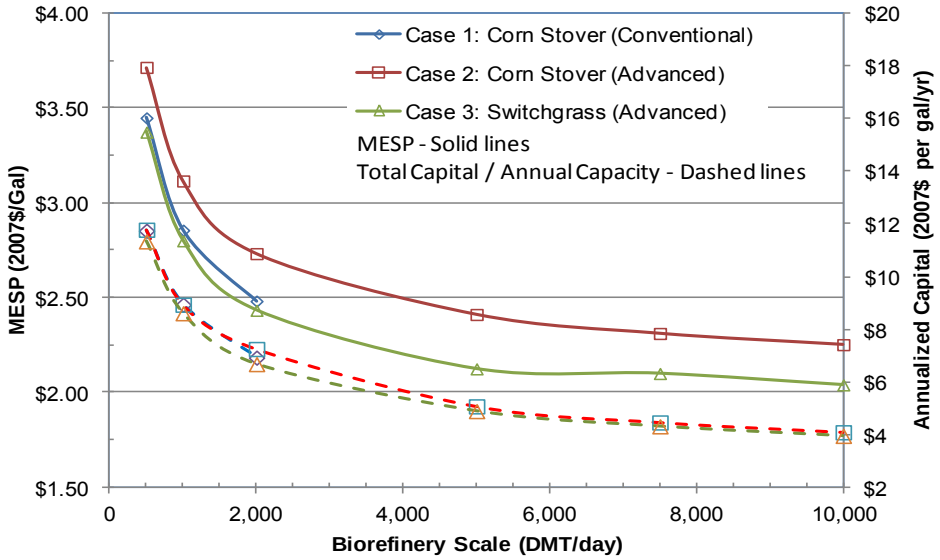
Technical Report
NREL/TP-6A20-61813
October 2014

Contract No. DE-AC36-

3 –Technical Accomplishments/Progress/Results

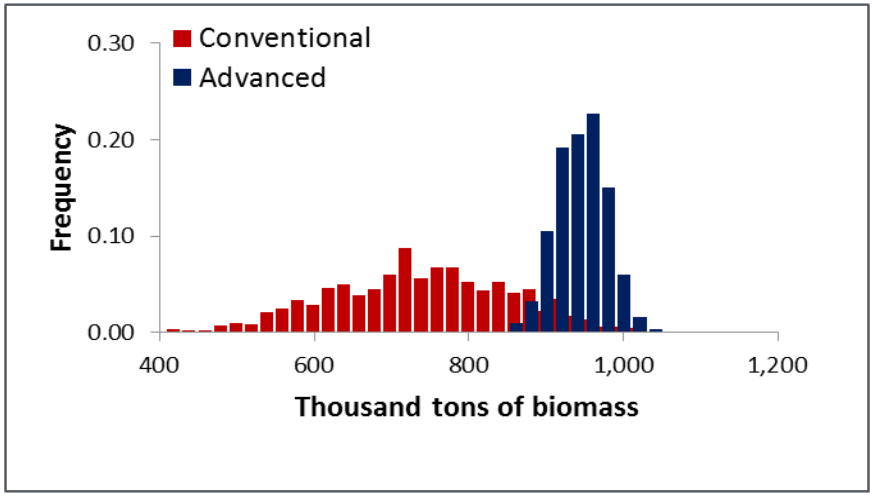
Economies of Scale in Biorefinery Size



- Increase efficiency of capital resources
- Reduce unit costs by increasing biorefinery size

Muth et al. (2014). *Biofpr* 8(4), 545-567.
Argo et al. (2013). *Biofpr* 7(3), 282-302.

Quantity Uncertainty for Corn Stover



$/GGE	Min	Average	Max
Conventional	$3.00	$3.21	$3.71
Advanced	$3.00	$3.13	$3.19

- Mitigate risk with advanced supply
- Diversify supply portfolio, reduce exposure to drought, flood, extreme events, etc.
- Reduce cost uncertainty

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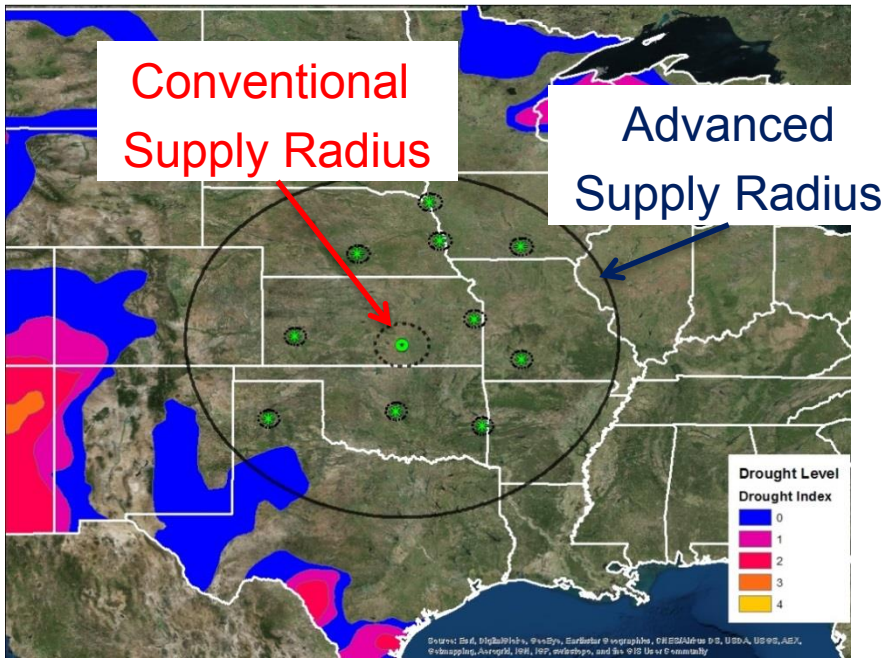
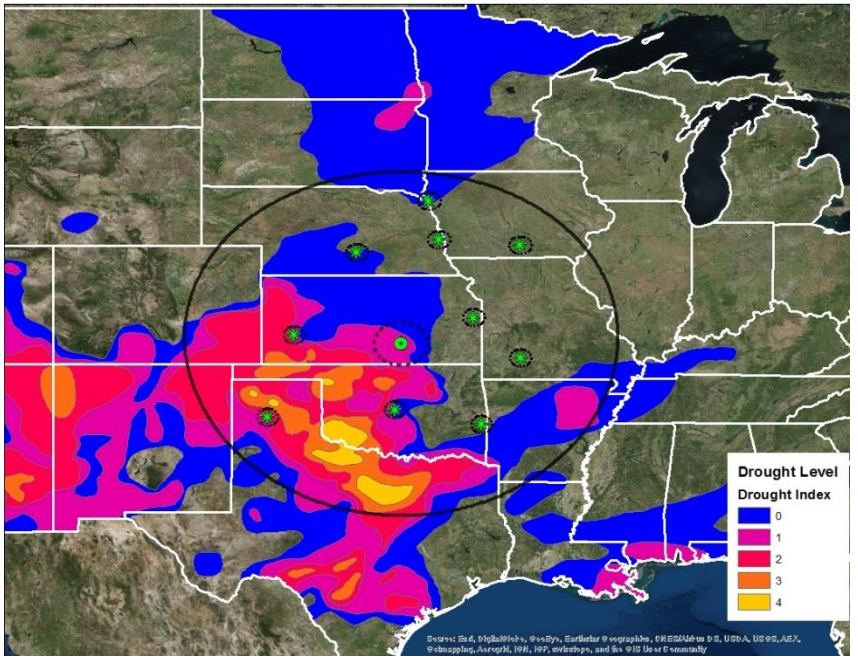
3 –Technical Accomplishments/Progress/Results





Year A

Year B

Diversification Mitigates Risk

- Conventional supply region in Year A not disrupted
- In Year B conventional supply region all in drought
- Advanced supply region in Year B partially in drought

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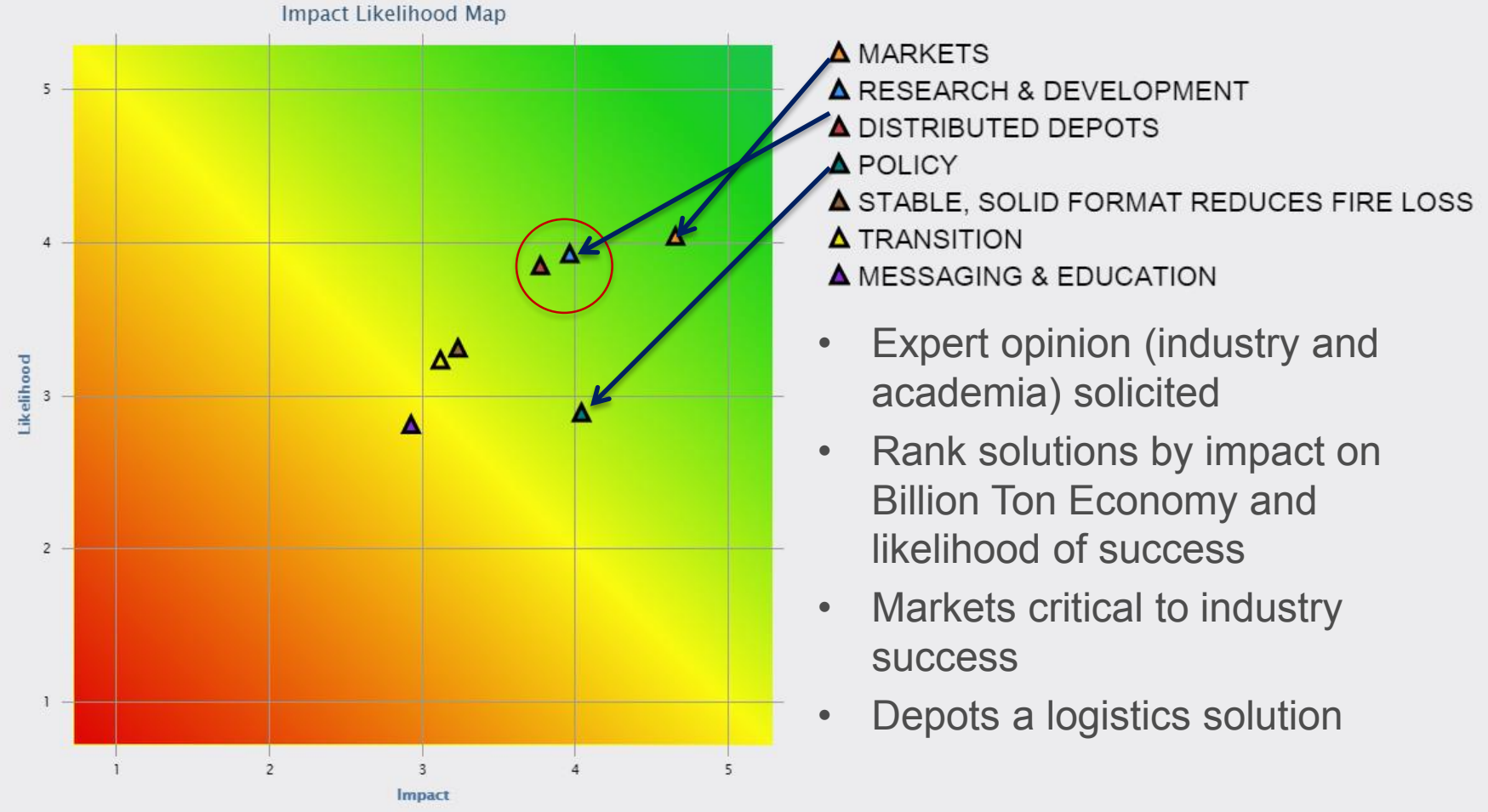
3 –Technical Accomplishments/Progress/Results

	Biochemical (2011$/GGE)	Thermochemical (2011$/GGE)	AFEX pretreatment (2011$/GGE)
Depot costs	*+$0.06 to +$0.14*	*Up to +$0.11*	*Up to +$0.32*
Biorefinery benefits			
Supply risk (interest rate) reduction by -2% to -5%	-$0.05 to -$0.18	-$0.05 to -$0.18	-$0.05 to -$0.18
Economies of scale (for biorefinery capital equipment)	-$0.07 to -$0.23	-$0.06 to -$0.60	-$0.07 to -$0.23
Conversion efficiency improvements	*(lack of data)*	-$0.14 to -$0.51	*(lack of data)*
Reduced storage and handling equipment	Up to -$0.20	Up to -$0.20	Up to -$0.20
Reduced preprocessing equipment	Up to -$0.48	Up to -$0.29	Up to -$0.48
Reduced pretreatment equipment	*(not applicable)*	*(not applicable)*	Up to -$0.45
TOTAL	**-$0.75 to -$0.96**	**-$0.63 to -$1.67**	**-$0.94 to -$1.22**

4 – Relevance

Heat Map of Solutions from Advance Supply System Validation Workshop



- Expert opinion (industry and academia) solicited
- Rank solutions by impact on Billion Ton Economy and likelihood of success
- Markets critical to industry success
- Depots a logistics solution

5 –Future Work

- Develop a new **capability** for BETO to analyze policy and regulation (state and federal) impacts ("fire drills") with **quick turn around** such that implications of decisions are understood in the context of various decision criteria in a timely manner
  - ✓ In the framework of systems dynamic analysis apply analytic methods to provide fast insights (i.e. within two weeks) that inform policy decisions and directions for future research
  - ✓ Understanding the consequences of decisions (intended and unintended) provides policy makers with better information in making choices about how to grow and promote the bioenergy industry
- Annual Milestone (9/30/15): Identify economic benefits of **co-products** on biorefinery profitability
- Annual Milestone (9/30/16): **Benefit Cost Analysis** of industry promoting **policy** (i.e. subsidy and tax policy), estimating payback time, foreign oil offset and domestic multiplier effects

Summary

- Early research informed about the **gaps in understanding policy and risk implications**, building on that this project characterizes risks in the marketplace and in the supply chain.
- The research surveyed the industry to **identify risk factors, market drivers and policy impacts**, catalogued them for further research.
- Project **identified** market and technology **drivers**, statues and policies, then **analyzed impacts in terms of risk** to the industry.
- **Experts** from industry and academia **validated** the importance of market and policy analysis, and relevance of risk analysis on success of the bioenergy industry.
- Building on the types of models used in this project we will **develop a policy analysis capability** that BETO can use to ascertain **quick insights** and understanding for various policy, market or program decisions.

Questions

Responses to Previous Reviewers' Comments

- New Project – First time being reviewed
- No "Go/No Go" decisions in this project

Publications, Presentations, Outreach

Presentations:

- Jacobson J., *Commoditization of Biomass for International Trade*, International Energy Agency-Task 40 workshop, Miami, Florida, October 28, 2013.
- Carnohan S., Jacobson J., *Strategies to Reduce Risk for Lignocellulosic Biorefineries: Exploring Densification with System Dynamics*, International System Dynamics Conference, Delft, Netherlands, July 2015.
- Jeffers, R. Jacobson, J., *Bioenergy Market Competition for Biomass: A System Dynamics review of current policies*, International System Dynamics Conference, July 2013, Washington DC.

Publications:

- Jeffers, R. F.; Jacobson, J. J.; Searcy, E. M., *Dynamic analysis of policy drivers for bioenergy commodity markets*. Energy Policy 2013, 52, 249-263.
- Hansen, J. K.; Jacobson, J. J.; Lamers, P.; Roni, M. S.; Cafferty, *Quantifying operational risk in a cellulosic biorefinery.* Manuscript in preparation.
- Lamers, P.; Jacobson, J. J.; Cafferty, K.; Roni, M. S.; Hansen, J. K.; Searcy, E.; Kenney, K.; Scarlata, C.; Tan, E. *How feedstock supply system design influences the biorefinery's operational risk and production costs.* Manuscript in preparation.