Expert Elicitation on the Integrated Production of 2nd Gen (Cellulosic) Biofuels & Biochemicals

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Introduction

Population growth and attendant demand for energy and environmentally-friendly products are straining conventional non-renewable resources. The world's dependency on fossil fuels, much of which are imported from unstable sources, is under scrutiny. Biofuels address both supply and demand issues, and offers the promise of various benefits related to energy security, economics and greenhouse gas (GHG) emissions reduction (Hoekman, 2009). In the United States, corn-grain ethanol and biodiesel have served as the major alternatives to petroleum-based gasoline and diesel over the past few decades and now account for over 90% of the total renewable biofuels (EPA, 2015). However, two fundamental challenges are constraining the U.S. first generation biofuels industry: the "food-vs.-fuel" debate and the ethanol "blend wall" issue.

Growing research interests, therefore, have been focused on the conversion of lignocellulosic feedstocks into renewable transportation fuels. The scale-up of the U.S. cellulosic biofuels industry faces great uncertainties, such as untested technologies, high production costs and uncertain policy (Coyle, 2010; Pacini et al., 2014). A 2014 USDA report projected that the added value of bio-based chemicals will increase from $775 million by 2017 to $3 billion by 2022 (Nexant, 2014). Given the growth of the biochemicals industry, the integrated production of cellulosic biofuels and biochemicals is a potential strategy that can provide financial incentives to and mitigate risks for cellulosic biofuel biorefineries (BRs).

Objectives

The objectives of this research are to:

1) Examine factors affecting the scale-up (commercialization) of the U.S. 2nd Gen (cellulosic) biofuels industry;
2) Identify drivers and potential barriers to the integrated production of cellulosic biofuels and biochemicals; and
3) Estimate the future growth of the U.S. cellulosic biofuels and biochemicals industries.

Methodology

Expert elicitation, deployed in a wide range of areas, is used in this research. The use of expert opinions has become increasingly commonplace to elicit hidden information and to provide useful insights regarding many important uncertainties (Baker & Keisler, 2011; Fiorese et al., 2013). We selected 45 academic and industrial experts. Each expert was carefully vetted by considering tangible evidence such as conference presentations and publications related to cellulosic biofuels and bio-based chemicals.

Primary data collection used an online-based survey containing 12 questions. Data collection procedures included the following steps (Fig. 1).

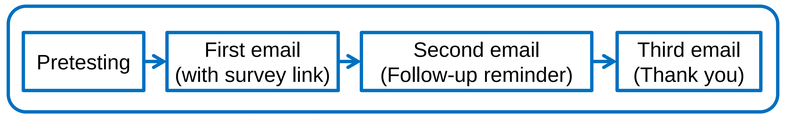

Fig. 1. E-survey administration

Results

1. Profile Information

The semi-structured survey was administered to 45 experts within U.S. and EU in July, 2015, resulting in 18 responses (40% response rate), profiled in Fig. 2.

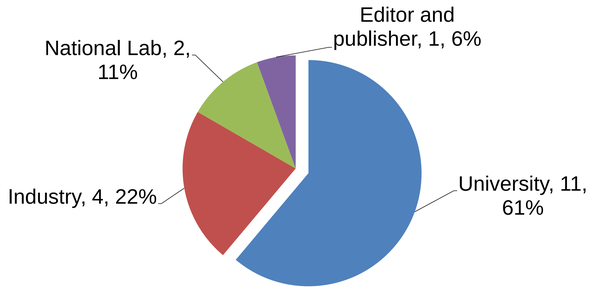

Fig. 2. Profile information (Sector, Number, Percentage)

2. Drivers & Barriers to the Scale-up of the U.S. Cellulosic Biofuels Industry

Participants were provided 6 drivers and asked to rank them in terms of "…***the successful commercialization of the U.S. cellulosic biofuels industry***. Please rank them in order of importance from 1=the most important to 6=the least important". Next, participants were instructed to use a pull-down menu of 9 barriers, and asked to "…***indicate the 3 largest barriers to the successful commercialization of the U.S. cellulosic biofuels industry***". The results are shown in Fig. 3 & Fig. 4.

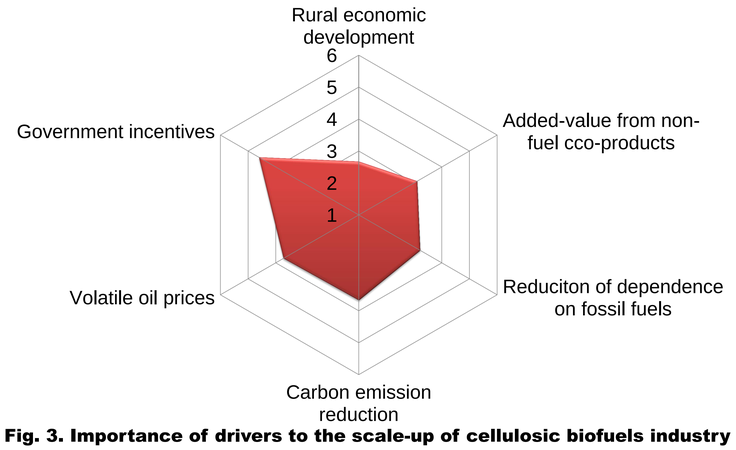

Fig. 3. Importance of drivers to the scale-up of cellulosic biofuels industry

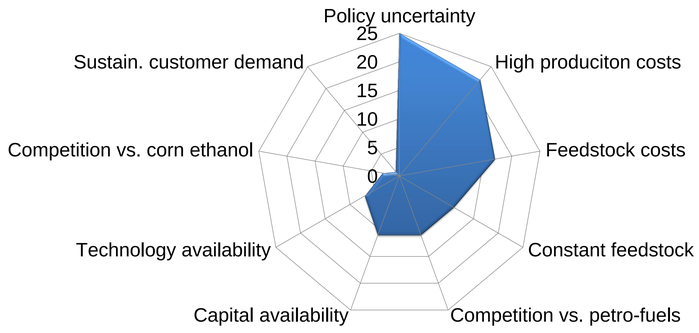

Fig. 4. Top 3 barriers to the scale-up of cellulosic biofuels industry

3. Drivers & Barriers to Integrating Biochemicals to Cellulosic Biofuels BRs

Participants were asked (open-ended question): "… ***what are the most important drivers for the integrated production of cellulosic biofuels and biochemicals***?" & "…***what are the top 3 barriers to the integrated production***?" (Fig. 5)

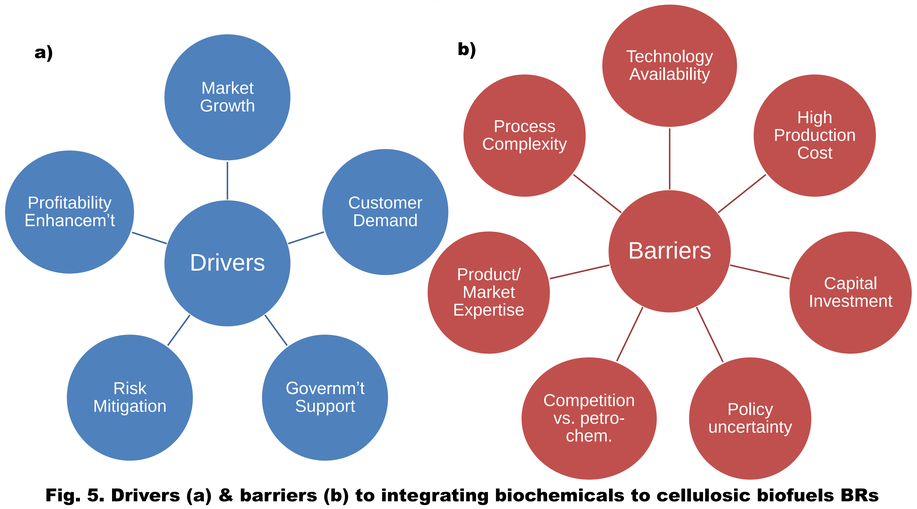

Fig. 5. Drivers (a) & barriers (b) to integrating biochemicals to cellulosic biofuels BRs

4. Future Penetration of Cellulosic Biofuels and Biochemicals

Participants were also asked: "*What is your best estimate of the percent of cellulosic biofuels accounting for the U.S. total renewable liquid fuels in the year 2020*." & "*the percent of bio-based chemicals constituting the entire U.S. chemical market in 2020*."

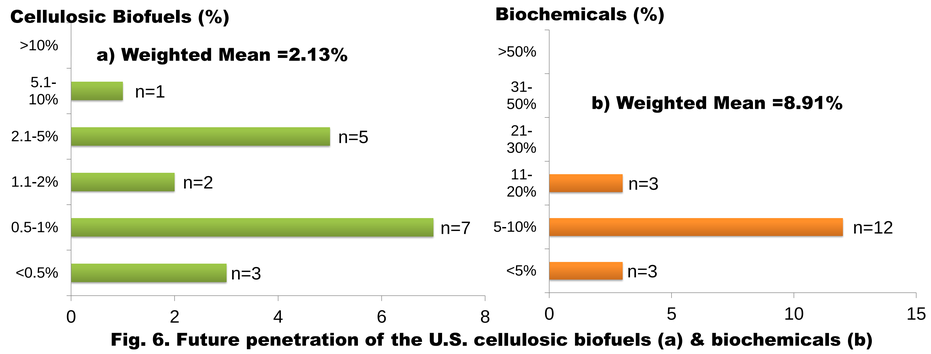

Fig. 6. Future penetration of the U.S. cellulosic biofuels (a) & biochemicals (b)

Conclusions

- Contributes to our understanding of the factors affecting the scale-up of the U.S. cellulosic biofuels industry
- Elicit factors affecting the successful integration of biochemicals into cellulosic biofuels biorefineries. These factors will serve as important constructs for the next step of our quantitative paper-survey with an expanded population.
- In 2020 participants estimated cellulosic biofuels to be ~2% of renewable liquid biofuels & biochemicals to be ~9% of all U.S. chemicals.

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