



Qualitative insights into buyer–supplier relationship attributes in the U.S. biofuels industry

Min Chen^a, Paul M. Smith^{a,*} and Evelyn Thomchick^b

^a Department of Agricultural and Biological Engineering, The Pennsylvania State University, University Park, PA 16802, USA

^b Department of Supply Chain & Information Systems, The Pennsylvania State University, University Park, PA 16802, USA

Abstract

The United States biofuels industry has experienced significant growth since its inception in the early 1990s due to concerns regarding climate change, energy security, and oil price volatility. Corn (maize) ethanol has served as an alternative to petroleum-based gasoline over the past few decades and currently accounts for nearly 90% of total U.S. renewable biofuels. In recent years, research interests have transitioned to biofuels recovered from lignocellulosic biomass due, in part, to the food-fuel controversy and the “ethanol blend” wall issue. However, the sustainable development of the U.S. lignocellulosic biofuels industry faces a variety of challenges, including feedstock costs and availability, high production and capital costs, and policy and market fluctuations. Literature suggests that buyer–supplier relationship management has the potential to solidify the supply chain and bring stability to commercialization plans. This study conducted semi-structured interviews with three lignocellulosic biofuel producers to explore relationships with their ethanol biofuel customers. Results show that refiners and blenders of gasoline were the primary customers of corn ethanol with fuel marketing companies as secondary intermediaries. Meanwhile, communication, trust, commitment, and power between participating parties were identified as important relationship attributes. To strengthen biofuel buyer–supplier relationships, this study identified manufacturing of consistent and regulated products and communication regarding logistics and environmental benefits of biofuels as key relationship management activities. This research provides business-to-business marketers of biofuels with a better understanding of relationship management and offers insights into the biofuel refinery-to-market value stream for researchers, practitioners, and policymakers.

1. Introduction

New carbon emission legislation, environmental concerns resulting from the combustion of fossil fuels (such as climate change, air and water pollution, and acid rain), and supply and demand issues have collectively spurred the development of commercially viable alternatives to traditional fossil-based liquid fuels for the U.S.

transportation sector [1–3]. The U.S. biofuels industry is dominated by first generation biofuel–corn or maize [*Zea mays* subsp. *mays*] ethanol, which accounted for 80.1% of the total U.S. renewable biofuels in 2016 [4]. In the U.S., corn ethanol is mandated to blend with gasoline, primarily as E10 (typically, up to 10%) [5]. Also, corn ethanol represents a mature biofuel due in part to stable and supportive policies, established conversion technologies, and synergy with existing U.S. food production systems [5]. In 2015, 208 corn ethanol production plants produced 14.8 billion gallons of transportation fuels [5]. As a result, the U.S. corn ethanol

*Corresponding author at: 210 Forest Resources Building, University Park, PA 16802, USA. Chen, M. (muc283@alumni.psu.edu), Smith, P.M. (pms6@psu.edu), Thomchick, E. (ethomchick@psu.edu)

industry has reshaped corn farming by reducing government support for cropping subsidies while raising farmers' incomes [6]. Meanwhile, ethanol blends in gasoline improve the octane number and add oxygen content to meet the U.S. Clean Air Act (CAA) [7].

Despite the benefits of first generation corn ethanol, the “food-versus-fuel” and ethanol “blend wall” arguments continue to constrain the industry. The “food-versus-fuel” debate has lasted for more than a decade and includes controversy over food security [8–10] and food price inflation [11–14]. The ethanol “blend wall” also constrains the growth of the U.S. corn ethanol industry due to the E10 (10%) blend limit, the infrastructure requirements for higher blend (e.g. E15 and E85) options, and consumer acceptance for higher biofuel blends [15]. Therefore, industrial, governmental, and academic research interests are shifting to second generation biofuels produced from lignocellulosic biomass to avoid the negative impacts associated with first generation biofuels.

A wide variety of agricultural biomass can be used as raw materials to produce second generation biofuels including short rotation forestry crops (e.g. poplar or aspens [*Populus*] and willow [*Salix*]), perennial grasses (e.g. silvergrass [*Miscanthus*] and switchgrass [*Panicum*]), agricultural, forest, and mill residues, and municipal solid waste (MSW) [16,17]. Compared to first generation biofuels, second generation lignocellulosic biofuels avoid the food-fuel controversy by using non-edible feedstocks to ease the economic and geopolitical concerns while benefiting from lower lifecycle GHG emissions [17–21]. Similar to first generation biofuels, the renewable fuel standard (RFS) plays an important role in stimulating second generation biorefinery investment. The production volume requirement of second generation (lignocellulosic) biofuels was proposed by environmental protection agency (EPA) under the RFS program to increase from 33 million gallons (MG) in 2014 to 312 MG in 2017, accounting for 0.20% in 2014 vs. 1.66% in 2017 of the total U.S. renewable biofuels [4]. Thus, the growing volume requirement indicates that some progress has been achieved over the past five years with respect to lignocellulosic biofuel scale-up improvements. Chen et al. [5] identified twenty-five companies focusing on the production of lignocellulosic ethanol, of which, five had launched commercial scale production by fall 2015 (Table 1).

The other twenty second generation biofuel start-ups, however, remain “under development” due to a variety of underlying issues [18,19]. For instance, lignocellulosic ethanol faces the same ethanol “blend wall” issue, plus strong price competition from existing corn ethanol players due to the same end use applications (Figure 1) [5]. The ethanol “blend wall” may be eased by the introduction of additional blends; however, many independent

owners of the 150,000+ U.S. branded retail gas stations are skeptical of the demand for higher blends and unwilling to make the investment in infrastructure upgrades necessary to add E15 or E85 [25,26]. Despite the approval of E15 for use in model year 2001 and newer vehicles and the 17.4 million E85 Flex-Fuel Vehicles (FFVs) on U.S. roads today, consumers typically lack the knowledge and awareness necessary to drive demand for additional blends. To address these impediments, the USDA has launched the Biofuels Infrastructure Partnership (BIP) program to provide \$100 million toward blender pump installation in 21 states [26,27].

The impact of policy mechanisms on the industrial commercialization of second generation biofuels industry is debatable, although several government policies (e.g. cellulosic waiver credits, loan guarantees, and grants) have been designed to support this industry [20,28,29]. Additional barriers to the commercialization of the lignocellulosic biofuel industry are documented throughout the supply chain from field/forest to wheel/wing (Figure 1). These barriers include feedstock costs and availability, high production and capital costs, and various technical, environmental, social, and market issues [5,18,20,30–36].

Relationship management has been emphasized as a crucial strategy to address potential risks and improve value between suppliers and their customers [40,41]. Scholars have linked relationship benefits to sustained competitive advantage through mutual strategy development [42]. Wilson indicated that strengthened relationships with suppliers can provide buyers with increased quality, reduced inventory, and decreased time to market [43]. Information sharing can speed up flows of information and materials and decrease tied-up capital [41]. Within the U.S. biofuels industry, relationship management has been suggested as a means to solidify the supply chain and bring stability to commercialization plans [40]. Companies, like AltAir Fuels, are leveraging purchase agreements with United Airlines and the U.S. Navy to obtain better debt financing terms [40]. Russell et al. [44] suggests that future research may benefit from a focus on the relationship management between ethanol producers and their customers. Also, with technology advancement and increasing sustainability concerns, the relationship management of advanced (lignocellulosic) ethanol is of key interest to current researchers [44].

1.1. Variables characterizing buyer–supplier relationships

Variables characterizing buyer–supplier relationships are well documented in the literature and include commitment, trust, cooperation, dependence/power, communication, functional conflict, relationship-specific investment/nonretrievable investments, shared values/mutual goals, relationship termination costs, and opportunistic behavior [43,45–49] (Table 2).

TABLE 1

Five commercial-scale lignocellulosic ethanol companies in fall 2015. Source: [22–24].

Companies	Location	Feedstock	Capacity	Launch date
Abengoa Bioenergy	Hugoton, KS	Mixture of agriculture waste, energy crops and wood waste	25 MGY	Oct. 19, 2014
DuPont	Nevada, IA	Corn stover	30 MGY	Oct. 30, 2015
INEOS Bio	Vero Beach, FL	Vegetative and wood waste	8 MGY	July 31, 2013
POET-DSM “Project Liberty”	Emmetsburg, IA	Crop residue	25 MGY	Sept. 3, 2014
Quad County Corn Processors	Galva, IA	Corn kernel fiber	2 MGY	July 1, 2014

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