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Implications of U.S. biofuels policy for sustainable transportation energy in Maine and the Northeast

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ABSTRACT

Drop-in biofuels that are compatible with the existing vehicle and retail infrastructure continue to receive great attention due to their promise in addressing climate change and energy security concerns stemming from use of petroleum-based fuels. In this paper we discuss current drop-in biofuel production technologies and assess relevant biofuel policies in the U.S., particularly those impacting forest biomass in Maine and the Northeast. In this context, we examine the Renewable Fuel Standard (RFS) policy and its definition of biomass which favors biomass from plantations regardless of actual ecological impacts on biodiversity, soil and water quality. We argue that the Environmental Protection Agency (EPA) should consider revising the definition of biomass eligible for renewable fuel credits to include sustainably managed natural forests.

1. Introduction

The Energy Independence and Security Act of 2007 (EISA, P.L. 110–140) addresses multiple policy goals including moving the US towards greater energy independence, increasing the production of low-carbon renewable fuels, increasing the efficiency of products, buildings and vehicles and promoting research on carbon capture and storage. EISA expanded the scope of the Renewable Fuel Program (RFS) authorized by the Energy Policy Act of 2005 (Energy Policy Act of 2005, P.L. 109-58) to the new Renewable Fuel Standard (RFS2) program. RFS2 is aimed at the challenging goal of expanding the production and use of liquid fuels that can replace petroleum fuels used in transport. First generation biofuel such as corn-grain ethanol production has been successful, reaching approximately 15 billion gallons by 2015 due to stable and consistent policies [15]. Second generation biofuels such as cellulosic ethanol, however, face challenges due to policy uncertainty. This uncertainty is mostly reflected in volumetric requirement obligations set by the EPA [16,19]. As of early 2016, about a dozen companies are producing or proposing to produce cellulosic biofuels. In addition to policy uncertainty, cellulosic ethanol production also faces challenges from feedstock availability, cost, and various environmental and societal constraints (Chen et al., 2016). Among other cellulosic biofuels, particularly interesting are drop-in biofuels that are compatible with the existing vehicle, distribution and retail infrastructure and are ready to use in vehicles without upgrading or blending with other fuels. This technological breakthrough can develop cost-effective conversion pathways and lead to a commercial production of next-generation biofuels from woody biomass [31,51].

As highlighted by previous assessments [15,20,55] cellulosic biofuels including drop-in fuel are not commercially produced due in part to the inadequate supply of cellulosic feedstock such as woody biomass. The US Northeast region[1] and particularly the State of Maine has great potential to produce cellulosic biofuels. Northeast states including Maine can produce significant amounts of advanced biofuels due to their high forestland coverage [19]. Furthermore, potential sustainable production in the Northeast alone can account for a large share of the goal for nation-wide cellulosic ethanol production mandated by the U.S. Congress.

One of the overarching goals of drop-in biofuel is to reduce greenhouse gas emissions and high dependence on imported petroleum by developing renewable energy from domestic feedstock. But an important question arises to this end – i.e., can forest-based drop-in biofuel meet these expected goals while maintaining the socio-economic and environmental integrity? If this fuel is to be produced as part of a transition toward a sustainable energy pathway, then what is the current status of policies that guide biofuel production, and what are the consequences of commercial drop-in biofuel production for the economy, society and environment? The answers to these questions largely hinge on the policies formulated to regulate and evaluate biofuel production. While the U.S. Department of Energy (USDOE) and

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[1] The Northeast includes the following states: NY, ME, PA, WV, OH, NH, VT, MA, MD, NJ, CT, DE and RI.

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Department of Agriculture (USDA) continuously investigate possibilities to make biofuels economically, socially and environmentally sustainable, these organizations regularly formulate and update policies to guide biofuel production [17,61,62].

A fundamental requirement to achieving sustainable production of forest-based drop-in biofuel is to evaluate current drop-in biofuel production processes and associated policies and improve them as needed. It is essential to design policies that overcome technological barriers and address social, economic and environmental challenges in parallel [28]. These challenges include constraints imposed by production costs, feedstock availability, and economic benefits including subsidies, social values, and ecosystem and biodiversity impacts. Responding to these challenges effectively requires analyzing policies that directly or indirectly affect biofuels production. Biofuels produced from forest biomass face conflicting definitions of renewable biomass that adversely impact the viability of biofuel production in Maine's and other northeastern forests despite a long history of using those same forests for pulp and paper production. Previous studies have provided overview of RFS [20,53,57] and assessed the challenges linked with implementation of RFS [15,20,49,66]. To our knowledge no previous study has looked into the definitions and terminology within this policy which has long-term impact on development of biofuels industry.

In this study, we review the current status of RFS policy and its environmental and economic implications, with focus on drop-in biofuels produced from woody biomass in Maine and the Northeast. We provide an evidence-based provision to be included in revised RFS regulations. Our proposal in revising the definition of 'biomass' in current RFS policy provides a consistent and sustainability driven approach that will allow the biofuels industry to overcome the biomass availability challenge while maintaining the forest diversity, soil and water quality. We pose the following research questions:

1. What is the current status of RFS policy and what are potential challenges in implementing this policy?
2. What is the potential of drop-in biofuel from forest biomass in the state of Maine and the Northeast?
3. What are the broader environmental, economic and social implications of drop-in biofuel production, in particular looking at RFS policy and forest biomass availability, in Maine and the Northeast?

The analysis begins by reviewing the current status of RFS policy, then the paper provides a review of drop-in biofuel production technologies with focus on how these technologies can be relevant to ongoing renewable bioenergy production. The paper then discusses an important flaw in the definition of renewable biomass in RFS. This discussion provides evidence based metrics in the context of Maine that support our argument for potential revision of the current biomass definition in RFS.

2. Renewable fuel standard

The Renewable Fuel Standard (RFS) is a program developed by the Environmental Protection Agency (EPA) to comply with the Clean Air Act and the Energy Policy Act of 2005. The RFS mandated the production of 7.5 billion gallons of biofuels by 2012, with an incremental production over subsequent years [22,53]. In 2007, under the EISA, the RFS was updated, which increased mandated biofuel volumes and extended targets to the year 2022. These revised mandates – referred to as RFS2 – required the annual use of 36 billion gallons of biofuel by 2022, with at least 16 billion gallons coming from cellulosic feedstocks [23].

RFS2 recognizes four types of biofuels, each with its own per-year production requirement (Table 1). The categories include: (1) advanced biofuels; (2) biomass-based diesel; (3) cellulosic biofuels; and (4) total renewable fuels. Further, biofuels qualifying under each category must achieve a certain minimum threshold of life cycle greenhouse gas (GHG) emissions reductions compared to the petroleum baseline (Table 1). These biofuels should be produced from feedstocks that meet the EPA's definitions of renewable biomass.

The total renewable fuel is the combination of the first three biofuel types and corn-starch based biofuel. As is seen in Table 1, most biofuel produced in the U.S. is still ethanol derived from corn (i.e., total renewable minus other fuel categories). The contribution of cellulosic ethanol in the total volume of biofuels is still quite limited (about 700,000 gallons out of 14.3 billion gallons produced in 2014 [23]. The production of corn-starch based biofuel is capped at 15 billion gallons/year after 2015, and focus thereafter is directed toward cellulose-based biofuels.

Pursuant to RFS2, the EPA is required to set cellulosic biofuels standards for every year that it estimates commercially available quantities will be less than the targets set in the statute. Due to a lack of US production, the EPA lowered the cellulosic, biomass-based diesel and advanced biofuel standards from 2010 through 2017 below statutory targets (see Table 1) [10,25]. The most recent targets, 2015–2016 (and 2017 for biodiesel) represent progress over historic levels given the lowered actual target levels. The standard for advanced biofuel mandated volume at 3.61 billion gallons is nearly 1 billion gallons greater than the 2014 standard of 2.67 billion gallons. The 2016 cellulosic biofuel requirement rises from 123 million gallons in 2015 to 230 million gallons in 2016. By statute, however, the 2016 standard for advanced biofuels and cellulosic biofuels was set at 7.25 and 4.25 billion gallons. The difference between statutorily set volumes and final yearly required volumes have been met with EPA created waiver credits whose prices are set based on statute but vary with the price of gasoline [27].

The ramp-up in the required cellulosic fuel volumes by the EPA has been limited by a number of factors including technical costs and challenges of producing cellulosic biofuels, access to financing, uncertainty in the way that EPA sets future volume standards, and the uncertainty in approved feedstocks. The relatively low cellulosic waiver price and the low prices of petro-gasoline and petro-diesel fuels also are major barriers to expanding the cellulosic fuel industry.

Under RFS2, the EPA assigns petroleum importers and refiners called "obligated parties" a Renewable Identification Number (RIN) for every gallon of biofuel produced. These RINs can be separated from the renewable fuel and bought and sold by the parties. The RINs are used by obligated parties as a means of demonstrating compliance with their renewable volume obligations.[2] Importantly, RIN credits provide an additional source of market value to producers of renewable fuels beyond the value of the fuels themselves used for combustion.

RIN market values are determined by their supply and the need of petroleum fuel suppliers and importers to have RIN credits to demonstrate compliance with RFS2. RIN prices can vary greatly depending on complex market interactions that involve petroleum fuel markets, tax incentives for biofuels, expectations of RIN availability, and EPA's actions to set future advanced biofuel volume targets [52]. The price of corn ethanol RIN credits ranged between $0.01 per gallon to $0.05 per gallon, whereas biodiesel RIN prices ranged between $1.00 and $1.50 in 2013 [21]. RIN prices of cellulosic biofuel RIN were between $0.38 and $0.46 in September of 2015 [48].

3. Drop-In Fuels

The 2016 volume of traditional corn (starch)-based ethanol was lowered in 2016 to 14.5 billion gallons from its statutory level of 15 billion gallons. This reduction reflects recognition of the declining sales

[2] The law allows for some exemptions. Producers of less than 10,000 gallons per year are not required to participate. Similarly, new producers who make less than 125,000 gallons per year and are in their first three years of operation are also exempt from RIN compliance. The intention of this exemption is to allow pilot or demonstration plants to focus on developing the technology [22,54].

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