



Research paper

Social acceptability of establishing forest-based biorefineries in Maine, United States



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ABSTRACT

Forest-based biomass has a significant role to play in the development of a renewable U.S. energy portfolio, especially in the context of mandated cellulosic biofuel production requirements. Biorefinery development has the potential to create economic, environmental, and social benefits. In Maine, co-location opportunities for biorefineries and existing pulp and paper manufacturing facilities could strengthen industry and mill communities. Understanding general public and local perceptions of bioenergy industries and products may play a key role in their establishment, success, and sustainability. Our aim was to compare the general Maine public and mill towns in their support for forest-based biorefineries, and we surveyed: (1) Statewide residents, and (2) Mill Town residents from 10 communities with major pulp and paper facilities. We found differences between local and state support for biorefineries across all response categories. Mill Town respondents were significantly more supportive of biorefinery projects in their communities, and overall the potential positive impacts of biorefineries were rated higher than the potential negative impacts. Both groups preferred facility siting at pulp mills no longer in operation, and Mill Town respondents expressed less concern about potential negative impacts than Statewide respondents. Our findings provide important insight into forest-based biorefinery issues important to communities. We encourage policy makers, industry leaders, and researchers to use our results as a foundation to actively engage statewide and local communities future biorefinery policies and siting proposals.

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1. Introduction

In the mid-2000s, rising United States energy costs coupled with concerns over fossil fuel use, energy independence, and climate change spurred policies and technologies to increase the commercialization of alternative, low-carbon, domestic, and renewable energy sources. In 2007, the Energy Independence and Security Act (EISA) mandated an increase in biofuel production over 15 years with 16 of the total 36 billion gallons of renewable fuel/year to be derived from cellulosic or non-corn feedstocks [1]. Due to these cellulosic fuels requirements, forest-based biomass will play a significant role in the development of a U.S. renewable energy portfolio [2–5], especially in northern New England [6–8]. Biomass resource assessments estimate considerable feedstock availability, and the potential for increased supply over the next 20 years [2–5].

Economic viability of the biofuel sector will require significant

research investment, as will feedstock production and delivery systems, and product marketing and distribution. In biofuels research, there has been a considerable focus on the development of production-scale processing and conversion technologies [9–11]. In addition to this necessary technological research, there is growing evidence that an understanding of public perceptions and social acceptability of biomass and bioenergy-related industries and products will play a key role in their establishment, success, and sustainability [12–17]. Public support will be especially important to ensure establishment of new production at the industrial scale envisioned under EISA.

Social acceptability is a concept originally defined in the context of ecosystem management practices [18]. It is now a cross-disciplinary term used in forestry, rural sociology, economics, and other fields to understand public perceptions of practices or technologies. *Acceptability* at its most basic is an individual's judgment about something, where acceptance is influenced by an individual's physical and social environment [18–20].

While not expressly using the term social acceptability, Firey [21] proposed that there are three qualities that influence the

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adoption and successful implementation of resource activities—physically possible, economically justifiable, and culturally adoptable. Brunson et al. [18] updated the three limiting qualities (ecologically sustainable, economically feasible, and socially acceptable), and their checks and balances remain salient. A project may be deemed objectively ecologically sustainable and economically feasible, but project activities could be derailed if they are not socially acceptable. There are numerous examples of negative public perceptions leading to project resistance or failures even under favorable environmental and economic circumstances [17,19,22–25]. Broad public support does not guarantee local acceptance for specific facility sites [23,26–29]. Project proposal and implementation under inconsistent or unknown social acceptability has led to commercialization challenges for technologies and products (e.g., genetic modification, wind power, and the so-called “food versus fuel” debate over corn-based ethanol) [15]. Negative public perceptions of corn-based ethanol include food security impacts, environmental degradation, biodiversity loss, and greenhouse gas release from land conversion, increased water consumption, and other ecological, economic, and social impacts [24,25]. These perceptions have had an important effect on the bioenergy sector [24,25], and are reflected in EISA’s mandate to increase U.S. *cellulosic* ethanol production capacity [1].

Given Maine’s extensive forests and diverse forest products sector, cellulosic ethanol derived from woody biomass could be of great interest to the state. Maine is the most heavily forested state in the U.S., with 17 million acres of forest and a large and well-diversified forest products sector [30,31]. For centuries, Maine’s vast forests have served as the foundation of its cultural identity and social and economic institutions. These forests have provided wood for forest products, fuel for heat in the winter, habitat for game, land for agriculture, and the backdrop for the state’s tourism and recreation sectors. Of these forest products, Maine’s pulp and paper sector has been the most significant for generations, and has produced high-quality paper from the region’s mixed hardwood and softwood forests. Forest biomass is increasingly viewed as a potential raw material for industrial and consumer “bioproducts,” including transportation and heating fuels, wood-based chemicals, product “fillers” and more [6,32,33]. These new products have the potential to strengthen timber markets, increase processing-related value-added and revenue streams, improve forest management, revitalize rural communities, and reduce fossil fuel consumption and greenhouse gas emissions [1,6,25,30–32].

The prospect of new technologies and markets for the state’s forest products sector creates both opportunities and challenges. While the forest-based bioproducts industry is in its infancy, gaining commercial viability faces a host of barriers, including technological, economic, and social. State and local residents’ views of the desirability of forest-based biorefineries may impact the sector’s development, and lack of social acceptability could be a significant barrier to the development of the industry. This is especially true in mill towns where long-established pulp and paper manufacturing is undergoing rapid change [6,15,34]. There is opportunity for Maine to contribute to EISA’s biofuels mandate, and successful implementation of new biorefineries will require public and local support. In Maine, the co-location potential of forest-based biorefineries and existing pulp and paper manufacturing facilities presents an opportunity to strengthen the economic viability of this industry and revitalize mill communities. Our aim was to understand the differences between the general Maine public and mill towns in their support for and concerns about various costs, benefits, and other aspects of biorefineries. To evaluate the social acceptability of the potential costs and benefits associated with biorefinery construction and the manufacture of new products, we surveyed: (1) Maine residents statewide; and (2)

Maine residents of communities with major pulp and paper manufacturing facilities, or mill towns.

2. Theory

2.1. Social acceptability in renewable energy contexts

The application of social acceptability as an important component of renewable energy research has grown in recent years [12,14,16,17,26,27,35–38]. Social acceptability is a critical component of moving toward global sustainable energy [39]. Across disciplines and countries, researchers have argued for incorporation of social acceptability research for better energy policy and innovation [13,14,16,17,26,35–37,39]. Renewable energy is often articulated as a single energy category, but all forms are not perceived to be equally acceptable. In studies across various regions, wind power has the strongest general support, followed by solar energy, and hydropower is seen as slightly less favorable [26–28]. Despite public support, there are many examples of specific energy projects meeting significant local resistance [23,26–29]. Biomass-based energy is a large category, and many factors contribute to broad and local public support [12,23–25,40,41]. These differences between broad and local support are important to understand in any renewable energy research with commercialization, development, and policy implications.

There is increased attention to the factors influencing these differences between widespread social and site-specific support. Renewable energy literature has moved away from a focus on not in my backyard (NIMBY) behaviors as drivers of project opposition, a label that implies selfishness of community members and does not address root causes of local opposition [28,29,42–44]. Researchers, rather, have evaluated the role that nuanced place-based contexts and values play in local support for renewable energy development [26–28,42–44]. Researchers have suggested that an area’s industrial heritage informs local place-based values, and may decrease facility development opposition [19,22,45,46]. This is especially relevant for Maine and other regions with long histories of forest products industry-dependence. With evidence that a community’s industrial heritage plays a role in support or opposition to facility siting, understanding a local community’s views before a facility is proposed may be more critical to facility success than understanding broad social acceptance.

2.2. Social acceptability judgment formation framework

We use a five-factor social acceptability judgment framework developed by Stankey and Shindler [20] to understand public views about forest-based biorefineries in Maine. An individual’s judgments are influenced by internal and external factors. Social acceptability is dynamic, as new information and experiences potentially impact and change judgments [20]. This framework process explains how people make decisions to accept or reject a practice at a particular point in time. Stankey and Shindler [20] describe five factors that influence social acceptability: technical and personal knowledge; spatial, temporal, and social context; risk and uncertainty; aesthetics; and institutional and personal trust.

Knowledge derived from personal experience is highly influential to public acceptance of new initiatives or technologies. The manner in which scientific experts and trusted knowledge sources present information also impacts public support [20,47,48], and despite the evidence to the contrary, scientists’ longstanding assumption that public ignorance is at the core of public opposition remains a prevalent narrative [47,48]. Methods that are more likely to be successful integrate personal knowledge in a respectful, engaged exchange of information between experts and the public

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