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Research paper

What are the prospects for deploying advanced biofuels in Canada?

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ABSTRACT

This article addresses the prospects for advanced biofuels in Canada by examining whether recommendations of two literatures for overcoming the unfavourable market conditions and policy uncertainty facing advanced biofuels are met in Canada. Our empirical analyses demonstrate the presence of conditions posited by the innovation policy literature. That is, Canadian governments provide financial support for biofuels research infrastructure and private R&D, invest in training highly qualified personnel, and support knowledge creation and mobilization across industry, academia and government. However, our analyses indicate deficiencies in the conditions posited by the policy network and governance literature for policy innovation. The Canadian state's policy analytical capacity, autonomy from industry, and coordination capabilities are low, as is the organizational development of industry actors. Consistent with the recommendations of the policy network and governance literature, we conclude that improving the prospects for the Canadian advanced biofuels sector requires the Canadian government augment its personnel, expertise and budgetary resources for advanced biofuels policymaking, and strengthen its interdepartmental and intergovernmental coordination mechanisms. Greater cooperation between the two organizations representing Canada's advanced biofuels sector is also recommended.

1. Introduction

Pursuant to signing the 2015 Paris Climate Conference (COP21) agreement, the Government of Canada has committed to an ambitious agenda to cut greenhouse gas (GHG) emissions [1]. Since 2016, it has engaged in discussions with provincial and territorial governments, as well as with Indigenous Peoples and groups representing economic interests and civil society, to develop a Clean Fuel Standard and set of regulations to achieve its climate change objectives.

The expressed intention of Canadian federal and provincial governments to provide incentives for lower carbon renewable fuels provides an opportunity for greater deployment of advanced biofuels than has hitherto existed in Canada. Advanced biofuels are usually distinguished from conventional biofuels by two criteria. First, their manufacturing requires innovation, through the use of new conversion technology, production methods, or feedstocks (e.g. biofuels based on lignocellulosic biomass, hydrotreated vegetable oil (HVO), or algae-based biofuels) [2], p. 8. Second, they minimize impacts on land and water use and have greater potential to reduce GHG emissions compared to fossil fuels. The International Energy Agency has stated that biofuels consumption in the transport sector must triple by 2030 in order to meet the Paris commitment to keep global warming below 2° Centigrade, and that two-thirds of that increase in biofuels should come from advanced biofuels [3]. California [4] and British Columbia [5], leading jurisdictions in North America on climate policy, are demonstrating how carbon emissions reduction objectives in the transport sector can be met by the increasing use of low-carbon biofuels.

Given the stated objectives of Canadian governments to provide incentives for low carbon renewable fuels, what are the prospects that advanced biofuels will be deployed as part of Canada's climate change policy? We assess these prospects here by examining whether the recommendations of two literature on how to overcome structural impediments to innovative technologies are currently being met in Canada. On the basis of our empirical findings, we identify changes consistent with these literature that are needed to overcome existing impediments to advanced biofuels deployment in Canada.

We proceed as follows. In Section 2, we examine the current state of advanced biofuels in Canada, and the opportunities as well as constraints to their further development. In Section 3 we turn to two literature that theorize how the two roadblocks to advanced biofuels'

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deployment of unfavourable market conditions and policy uncertainty can be overcome. The first literature, the policy innovation literature, focuses on the state's role in supplying innovation. The second literature, drawn from the policy network and governance literature, highlights institutional and policy capabilities of both public and private actors, as well as mechanisms to coordinate their interactions, that are needed not only to support but also to stabilize public policies. In Section 4, we explain our methods: the indicators we use to operationalize these theories and the sources of information we use to determine the presence or absence of these indicators.

Section 5 presents and discusses the results of our inquiry. We examine whether the components of a policy context that is conducive to innovation, as theorized by the two relevant literature, currently exist for advanced biofuels in Canada. The information obtained through interviews and qualitative textual analysis of government documents demonstrates that the recommendations from the innovation policy literature have been largely applied in Canada. Canadian governments have invested in private and public research and development (R&D) and educational infrastructure. They have also provided targeted initiatives to promote knowledge mobilization across business, government, and academia. In contrast, the recommendations from the policy network and governance literature have not yet been met. Neither the advanced biofuels business sector nor the Government of Canada appears to possess the organizational and institutional attributes they require to develop and stabilize advanced biofuels as part of Canada's climate change policy.

We conclude in Section 6 with recommendations on how to overcome the current institutional and organizational impediments to advanced biofuels making a greater contribution to Canada's climate change strategy in the transport sector.

2. The state of advanced biofuels in Canada

The prospects for advanced biofuels contributing to Canada's goal of reducing its GHG emissions look good if one begins with Canada's extensive agricultural and forestry resources. These resources are abundant enough to enable Canada to become a global leader in the production of advanced biofuels [6]. There is also reason to be optimistic when we consider whether Canadian governments should be able to count on broad public support to deploy advanced biofuel technologies to address the climate change challenge [7,8]. Canada has been largely exempt from the negative public opinion that has plagued US efforts and made European governments wary of policy support for biofuels [9,10].

Notwithstanding these incentives and political opportunities, Canada's political economy has historically presented structural constraints to the deployment of innovative biofuels. The fossil fuel sector accounts for about 10% of Canada's GDP and about 20% of its merchandise exports [11], p. 5–8. Its economic importance grew from the late 1990s through to late 2014 when there were massive investments in the exploitation of oil sands resources of Alberta, and later in crude oil resources of Saskatchewan and Newfoundland [11], p. 9. Even when oil prices turned downward in 2015, the energy sector still accounted for 20% and 18% respectively of the GDP of Alberta and Saskatchewan [11], p. 6.

Given the economic importance of the fossil fuel industry, Canadian federal governments, at least until recently, have had few incentives to promote a renewable fuels sector that would undermine the fossil fuel sector's profitability. The Conservative Harper governments (2006–2015) were based in western Canada and owed their parliamentary support to rural communities and the oil sector. When the Conservative Government introduced modest ethanol (E5) and biodiesel (B2) mandates in 2010 and 2011, respectively, its motivation was to raise the prices of corn, wheat, and canola feedstocks. These mandates benefitted its farm and rural constituency without hurting the oil sector. Subsequent political will to push renewable alternatives further in the transport sector quickly evaporated under the Harper government. Although some provincial governments introduced higher ethanol and biodiesel mandates, there are no specific mandates for advanced biofuels in Canada, at either the federal or provincial levels [5,11] p. 91. However, the province of British Columbia's Clean Fuel Standard, by setting a maximum carbon content in fuel, provides incentives for advanced biofuels' use.

Table 1
Number of advanced biofuel production facilities in Canada, by technological readiness level.[a]
Source: Figures compiled by authors from the Bioenergy2020 + database [13] and Biofuels Digest [64]. See supplementary material for more detail on individual facilities.

Technological readiness level	Number of facilities	Percentage of total
Pilot	8	36%
Demonstration	10	46%
First-of-a-kind commercial demo	4	18%
Total	22	100%

[a] Because of limitations in the availability and reliability of data on production capacity, we report here the number of facilities as opposed to potential production volumes. One Canadian project in the database was excluded from the compilation because of insufficient information on its classification.

Canadian renewable fuel obligations in the transport sector have to date been filled virtually entirely by conventional biofuels: that is, ethanol made from corn and wheat, and biodiesel made from canola, palm or soy oil. Only a small fraction of the renewable fuel used to meet biodiesel mandates is made from waste sources such as tallow and yellow grease. Over the 2010–2014 period, tallow comprised 7.0% of renewable diesel; yellow grease, 14.9% of biodiesel [12]. As Table 1 shows, most advanced biofuels projects in Canada are still in the pilot or demonstration stage. Furthermore, among the three commercial-scale projects, only one facility is currently operational. Enerkem's Edmonton-based waste-to-biofuels plant began commercial production of cellulosic ethanol in 2017. The two other facilities are still under construction.

The slow progress in deploying advanced biofuel technologies to date in Canada reflects the structural challenge facing advanced biofuels everywhere. Given current oil prices, advanced biofuels are not competitive with fossil fuels. Advanced biofuels' higher costs (relative to fossil fuels) result in an uncertain supply of venture capital throughout the life cycle of their development. This disadvantage worsened in the wake of the 2008 financial crisis [13–18]. Half of the $25 billion invested by venture capital firms in clean energy (which includes biofuel investments) between 2006 and 2011 was lost as the “combination of high risk and low returns dried up” investment in the sector [14]. Although the capacity to raise capital for advanced fuels projects has subsequently improved, even today announcements of new investments in advanced biofuel plants are accompanied by news of closures of plants [19].

Even under conditions of rising oil prices, advanced biofuels come up against what experts describe as the technological lock-in effects of our fossil-fuel based economy [20,21]. Past policies, established infrastructure, and consumer habits reproduce the dominance of fossil-fuel based transportation. In fact, the transport sector epitomizes the issue of ‘carbon lock-in’: that is, the increasing returns to the use of fossil fuels owing to industrial economies' infrastructural, technological, institutional, and behavioural dependence on fossil-fuel based technological systems [22].

Not surprisingly, then, government support is deemed critical to mitigating the uncertainty of future economic incentives that deters investment in advanced fuels [19,23–25]. Indeed, experts along the cellulosic biofuel supply chain, for example, view government policies as the most important driver for commercialization [23]. The International Energy Agency, for example, recommends financial de-risking