

# Assessing Stakeholders' Interest in Biofuels

By

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## **Abstract**

The global biofuels industry is growing fast, involving many different actors, such as producers, forestry companies, biofuel producers and others. This development forces industry actors and policy makers to take biofuels into consideration as a source of energy and to also consider arising and shifting stakeholder interests. Experience has shown that the role of stakeholders can be critical to commercial success especially where environmentally sensitive activities are involved or when strong lobby groups exist.

The purpose of the first part of this study is to identify the interests of different stakeholder groups involved in the biofuel industry in Canada. This study is based on primary data collected from representatives of each stakeholder group. It follows a framework developed by Turcksin et al. (2011), who use a similar stakeholder analysis as input to a Multi-Actor Multi-Criteria Analysis (MAMCA) to assess different biofuel alternatives and opportunities. This study draws on the definition of stakeholders and their interests, and uses pairwise comparisons of the interests for each stakeholder group. The responses are analyzed using a methodology commonly used in the Analytic Hierarchy Process (AHP, Saaty, 1990) to derive a ranking of stakeholder interests for each group. The key results of this study are the weighted rankings of interests for each stakeholder group. These results also allow for a comparison between Canada and Belgium, based on the earlier work of Turcksin et al. (2011), which shows noticeable differences between the priorities of stakeholders in Canada and Belgium.

The second part of this study explores first the potential impact of public research on stakeholders and then the opinions of all stakeholders on public policies and programs of

relevance to the development of the biofuels industry. The results suggest that researchers generally expect positive impacts of their work on all stakeholder groups. They anticipate that the greatest impact of their work will be on end-users, in terms of allowing them to project a green image. The second highest impact is anticipated on increasing the production capacity for biofuels producers. In terms of the importance of public policies and programs on biofuels commercialization, respondents generally anticipate tax measures and research and development support to facilitate the commercialization of biofuels. Agricultural and trade policies are considered less important. However, there are differences between the stakeholder groups. For example, government respondents are least optimistic about the effectiveness of research and development measures, yet most optimistic about biofuel mandates. Biofuel producers show the greatest appreciation for agricultural and trade measures, and consider tax measures as less important than all other stakeholders.

Comparing the results from all three parts of the study, the results document considerable differences between the stakeholder groups, and they suggest that the main contributions of researchers to the different stakeholder groups are not necessarily aligned with the priorities stakeholders have for their interests in biofuels.

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# 1 Chapter I: Introduction

## 1.1 Thesis Motivation

Biofuels are fuels that are produced by a conversion of biomass<sup>1</sup>. Biofuels are distinguished from fossil fuels in that they are based on geologically recent carbon fixation<sup>2</sup>, that is, they are made from “recently dead” organisms that are decomposed as sources of energy whereas fossil fuels are composed of “long dead” organic matter. In order to be considered a biofuel, the fuel must contain over 80% renewable materials (Mbuya, 2012; Speight & Singh, 2014).

Biofuels are a low carbon product that have many advantages over the use of fossil fuels as an energy source. Depending on feedstock and production details, the greenhouse gas (GHG) footprint and subsequent climate change impacts are lower for biofuels than fossil

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1. Biomass refers to recently living organisms, most often referring to plants or plant-derived materials (Speight & Singh, 2014).

2. Carbon fixation or carbon assimilation refers to the conversion process of inorganic carbon (carbon dioxide) to organic compounds by living organisms (EO).

fuels (Hill, Nelson, Tilman, Polasky, & Tiffany, 2006). Due to the reliance on locally grown feedstock, they can contribute to increased energy security in many jurisdictions.

Today, biofuels cover about 10% of the world's primary energy demand. Against a backdrop of rising crude oil prices during the recent past, depletion of resources, political instability in oil-producing countries and environmental challenges, biomass has the potential to provide alternative sources of supply for an energy hungry civilization. With the growing awareness of the world's environmental problems and critical political instabilities, biofuels have become the centre of attention among world governments. Biofuels have been, and are expected to continue to be, an important part of our ever-developing society (Specht, 2011).

The importance of biofuels can also be expected to increase with the further development of feedstock and processing technologies. Biofuel development to date has gone through different generations (e.g., first generation, second generation, or third generation) and, with every generation, this product and source of energy becomes more progressive and industrially advantageous (Sims, Mabee, Saddler, & Taylor, 2010). First generation biofuels faced considerable criticism due to their use of food (e.g. corn, sugar cane) as feedstock. Second generation biofuels are being developed specifically to ensure the types of feedstock are sustainable and do not affect food prices or acreage available for food crops negatively (Naik, Goud, Rout, & Dalai, 2010).

The broad interest in biofuels, as well as the resistance specifically towards first generation biofuels highlights that the important role of stakeholders (as explained in section 2.2) has become increasingly vital. It has forced policy makers to take biofuels

into consideration as a realistic alternative source of energy, and it has been suggested that the participation of stakeholders is an essential factor in the success of the biofuels industry (Hall, Bachor, & Matos, 2014).

To adequately assess the potential roles of stakeholders, it is important to empirically analyze stakeholder interests. Such analysis it meant to help shine light on the distinctive views of each stakeholder and assist in the identification of the interests stakeholder pursue when they drive or respond to developments in the biofuels industry.

This thesis focuses on establishing stakeholders' interests with regard to biofuels in Canada. In addition, it provides preliminary analyses with regard to the link between these interests, academic research and government policy. I hope this study sparks an interest in other researchers in the subject of the biofuel industry and the relationship it has with stakeholders' interest, thus encouraging more in-depth research on the subject in the future.

## **1.2 Research Question & Objectives**

The purpose of this research thesis is to investigate the interests of different groups of stakeholders involved in the biofuel industry. The focus is on determining the relative importance of criteria derived from the literature review as relevant to the different stakeholder groups. Also, I asked participants about their perspectives regarding different biofuel policies. Put simply, the purpose of this research is to answer the following questions:

1. What are Canadian stakeholders' priorities in assessing biofuels?
2. What contributions do researchers expect to make to stakeholders?
3. What policies do stakeholders (and researchers) consider important to biofuel commercialization?

This thesis is part of a larger research project focusing on the relationship between biofuels research and its stakeholders, funded through BioFuelNet<sup>3</sup> Canada.

### **1.3 Thesis Organization**

In Chapter II, I will explain the background and review the most relevant papers and articles in the field, specifically the history of biofuels, biofuels in Canada, and the contribution of public and private sectors, different methodologies used in the study, their steps, and how they can be useful in the biofuel industry. At the end I outline government policies and programs relevant to biofuels.

Chapter III is related to the first part of the study presented in this thesis, the assessment of stakeholder interests in biofuels. It begins by outlining the Methodologies employed, and then proceeds with the Analysis and Results, followed by a Discussion for each of the stakeholders.

In Chapter IV, the second part of my research is discussed, i.e. the exploration of the impact of research on stakeholders, and stakeholder opinions on government policies

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3. <http://www.biofuelnet.ca/>

related to biofuels. In this chapter briefly touches on the Methodology, and then presents separate Analysis and Results, and Discussion sections for the two exploratory analyses.

Chapter V is the summary and conclusion, followed by limitations, contribution and future studies of this study.

Following the bibliography, the appendices provide additional details, as referred to throughout the thesis.

## **2 Chapter II: Literature Review**

To adequately position the work presented in this thesis, this chapter provides an introduction to the topic of biofuels in general, followed by a brief history of their development. Given the focus on biofuel stakeholders in this thesis, the chapter then includes a review of the literature on stakeholders, as well as a summary of Turcksin et al. (2011), a key reference for this study. It concludes by outlining key policies and programs related to biofuel development.

### **2.1 Biofuels**

The varying problems of fossil fuel consumption, which highly impact the lives of individuals, have forced scientists to consider alternative energy solutions. Today, nations' increased energy use, climate change, energy security, oil prices, support for agricultural interests, and carbon dioxide (CO<sub>2</sub>) emissions are tightly linked with fossil fuel consumption. (Fargione, Hill, Tilman, Polasky, & Hawthorne, 2008). The development and use of fuels based on renewable biomass may hold the potential to contribute to alternative solutions. Biomass can be converted into convenient energy-containing substances in three different ways: thermal conversion, chemical conversion, and biochemical conversion, and this conversion can produce fuel in solid, liquid, or gas form (Speight & Singh, 2014a).

“Biofuels are a potential low-carbon energy source, but whether biofuels offer carbon savings depends on how they are produced” (Gude, Patil, Grant, & Deng, 2012) (p.3). For example, in Brazil, Southeast Asia and the United States, converting rainforests, peat lands, savannas, or grasslands into farmland to produce any kind of crop-based biofuels creates a “biofuel carbon debt” by releasing around 17 to 420 times more CO<sub>2</sub> than the annual greenhouse gas (GHG) reductions. In contrast, biofuels made from waste biomass or from biomass grown on degraded and abandoned agricultural lands planted with perennials, incur little or no carbon debt and can offer immediate and sustainable GHG advantages (Fargione et al., 2008). These latter biofuels are also referred to as ‘second generation’ biofuels and are currently at various stages of commercialization, from lab-scale proof of concepts to first commercial plants (Carriquiry, Du, & Timilsina, 2011; Sims et al., 2010). Canada’s first commercial scale for second generation of biofuels plant, is located in Edmonton and started working in 2013 (Blackwell, 2013).

As the commercialization of second generation and more advanced biofuels proceeds, stakeholders have to consider a broad range of related issues: the impact of drop-in replacement biofuel requirements and certifications, emerging markets, new entrants, barriers to entry, return on investments, government policies and incentives, and military considerations for advanced biofuels.

There are many organizations that work in the Canadian biofuel industry and they have different functions in this industry. Some of them include Canadian Renewable Fuels Association<sup>4</sup> (CRFA), Natural Resources Canada<sup>5</sup> (NRCan), and a number of

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4. <http://www.greenfuels.org/>

government-funded research networks including BioFuelNet<sup>6</sup> (BFN). There are also some private firms involved in the industry, such as Enerkem<sup>7</sup> and Acadian Seaplants Ltd<sup>8</sup>.

Federal and provincial government support for the advancement of the biofuel industry is critical to economic vitality, environmental sustainability, and technological innovation in Canada. A number of other government initiatives have also been designed to contribute to building Canadian biofuel capacity. Examples include: the Ethanol Expansion Program (EEP) (Klein, Romain, Olar, & Bergeron, 2004), the ecoABC Program (ecoAgriculture Biofuels Capital Initiative) (Laan, Litman, & Steenblik, 2009), and the ecoEnergy for Biofuels Program (Laan et al., 2009; Mitrović & Malone, 2011).

## **2.2 History of Biofuels**

Although biofuels are widely perceived as new forms of energy, most of them are of ancient origin. Biofuels in the solid form have been in use ever since humanity discovered fire. Wood was the first form of biofuel that was used even by the ancient people for cooking and heating. Other materials such as crop residues, and dried manure have been used for centuries as solid fuels. Biofuels have also been used for a very long

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5. <http://www.nrc-cnrc.gc.ca/>

6. <http://www.biofuelnet.ca/>: The BioFuelNet Canada Network of Centres of Excellence (NCE) is a Government of Canada program that is operating on a five-year grant worth \$25 million. It is jointly funded by the Natural Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and the Canadian Institutes of Health Research (CIHR) in partnership with the biofuel industry ("Government Collaboration," n.p.).

7. <http://www.enerkem.com/>

8. <http://www.acadianseaplants.com/>

time for the production of electricity. This form of fuel was harnessed even before the discovery of the fossil fuels. Liquid biofuels soon followed the solid form and become popular across the world. For example, olive oil, as well as other oils derived from plants and animals, have been cultivated and used for lamp oil since antiquity (Sussman, 1983). It was only the exploration of the fossil fuels in the 1900's that led to the replacement of biofuels with fuels like gas, coal, oil and others, especially in developed countries (Hajar & Halim, 2010; Wallace & Palmer, 2007). Thus, it is not the use of biofuels itself that is novel and noteworthy. Rather, what makes it new is the attempt to make use of uniform feedstock or biomass to create liquid fuels, such as diesel, ethanol, and oil, on a commercial scale (Hajar & Halim, 2010; Wallace & Palmer, 2007).

The development of automotive engines is a particularly notable illustration of the transition from biofuels to fossil fuels, and the recurring recent interest in biofuels. Initially, several of the early automotive engines developed in the 1700s took advantage of steam power (Eckermann, 2001). As the development of automotive engines accelerated in the late 1800s and early 1900s, biofuels played a key role.

Ethanol and ethanol–gasoline blends have a long history as automotive fuels (Hunt, 1981; Kovarik, 1998). In the late 1800s, Henry Ford, Nikolaus Otto and others built different engines and cars that could run on ethanol. Ford was a supporter of home-grown renewable fuels and he equipped his Model T in early 1900s as a multi fuel vehicle, with carburetors that could be adjusted to use pure alcohol, gasoline, or a “gasohol” mix (DiPardo, 2000; Solomon, Barnes, & Halvorsen, 2007). Ethanol was used to fuel cars

well into the 1920s and 1930s as several efforts were made to sustain a U.S. ethanol program (DiPardo, 2000).

Ethanol was not the only early biofuel. German inventor Rudolph Diesel designed and developed the original diesel engine to run on vegetable oil. At the 1911 World's Fair in Paris, Dr. Diesel ran his engine on peanut oil and announced "the diesel engine can be fed with vegetable oils and will help considerably in the development of the agriculture of the countries which use it" (Ayhan, 2008; also see Nitske & Wilson, 1965). Thus, the use of vegetable oils in diesel engines is nearly as old as the diesel engine itself (Bartholomew, 1981), as is the claim that automotive fuels have a role to play in the development of agriculture.

As noted above, the large-scale exploration and commercialization of fossil fuels (Hajar & Halim, 2010; Wallace & Palmer, 2007) and their superior performance characteristics led to the general displacement of biofuels as automotive fuels in the early 1900s. During World War II, the demand for biofuels increased due to the increased use as an alternative for imported fuel (Nag, 2008). In that period, Germany underwent a serious shortage of fuel and as a consequence developed inventions such as the use of gasoline along with alcohol derived from potatoes. Similarly, Britain developed grain alcohol mixed with petrol as a fuel. Although these war-time applications of biofuels and their demonstrated use, the following period of peace in Europe brought access to cheap oil from the gulf countries as well as the Middle East, thus again easing off the pressure and allowing fossil fuels to remain the automotive fuel of choice ("History of biofuels," 2010).

World energy crises, such as the 1973 oil crisis caused by decision of OPEC (Organization of the Petroleum Exporting Countries) oil export embargo especially to the non OPEC nations, the 1979 oil shortage due to politic movements of some countries in Middle East and the radical increase in the price of oil in the early 1990s due to the Gulf War (again in Middle East), raised many governmental concerns over the supply of and access to worldwide energy resources. European nations, extremely dependent on energy resources from politically unstable countries, were particularly affected. Also at the same time, the global contribution from the consumption of energy for buildings was continuously increasing, to around 20–40% in some developed countries and exceeding the other major sectors, industry and transportation (Collier, 2012; Pérez-Lombard, Ortiz, González, & Maestre, 2009). The constant shortage of fuel and issues attracted the attention of the various academics and governments to reconsider the use of biofuels.

Nowadays, liquid biofuels are experiencing a resurgence in many industries such as the automotive industry. Biofuels for transport, including bioethanol, biodiesel, biogas and biopetrol have the potential to reduce the amount of fossil fuels used around the world in near future. Currently, some of the main reasons for individuals, companies and governments to turn their interest to biofuels are the rising prices of oil, emission of the greenhouse gases and interest like rural development (Hajar & Halim, 2010).

As noted above for the case of ethanol for automotive uses in the United States in the 1920s and 1930s (DiPardo, 2000), many governments around the world have long encouraged the use of biofuels through a broad mix of government policies (Rajagopal & Zilberman, 2007). This is especially the case since the renewed interest in the reduction

of fossil fuel use sparked by the oil crises of the 1970s and the 1990s, and Appendix 1 outlines the timeline of such developments relating to biofuels in Canada.

### **2.3 Stakeholders**

Freeman (1984) defines stakeholders as “any group or individual who can affect or is affected by the achievement of the organization” (p.52). Stakeholders have an interest in the activities of an organization and they have the ability to influence it (Savage, Nix, Whitehead, & Blair, 1991). By definition, they have some legitimacy, through mechanisms such as exchange transactions, moral impact (Brenner & Cochran, 1993), and without their support the organization would cease to exist (Bowie, 1988).

There are many ways to identify stakeholder groups. Depending on different situations, the definition of stakeholders may be different. Hall et al. (2014) have proposed a model (based on the management of technology and research and development (R&D) literature, stakeholder theory and risk) that highlights the roles of stakeholders with regards to emerging technologies. Technologies that emerge may have different trajectories and paths, such as irritant quadrants or even dangerous quadrants if poorly managed. An irritant quadrant is when the information about the technology is relatively understood with ease, and more stakeholders can realize relevant risk mitigation activities and would consider the innovation less harmful. However, since management of the firms sometimes excludes stakeholders in the standard decision-making process, such mitigation activities can develop and are clarified independently by the firm, resulting in controversy. As a result, issues between the firm and their stakeholders may begin to develop, but this is not necessarily enough to delay the development of the technology.

When inaccurate information about the technological advances begins to develop, some stakeholders will draw on previous beliefs and erroneous cues to make potentially false judgments about theoretically harmful effects and consequences of the technological innovation. This perception may result in stakeholders taking more direct action against the industry. Taking into account the firms that establish trust based on prior credible attempts to resolve stakeholder concerns, most of the time these firms are able to communicate the benefits of their technology easier, rather than only having to defend the potential hazards (Hall et al., 2014).

In the context of biofuels, the lack of support by key stakeholders has become a major concern. The success of policy measures not only depends on general economic and agricultural conditions, but also on the support by the greater society as a whole (Turcksin et al., 2011).

## **2.4 Stakeholder Analysis**

Stakeholder analysis is the process of determine and classifying all stakeholders and categorize them in a desired fashion (Freeman, 2010), or in another words, stakeholder analysis is the process of identifying and prioritizing stakeholders and outline their values and interests relative to a particular organization, project, or policy (Sears & Hogg-Johnson, 2009). “Stakeholder analysis should be viewed as an aid to properly identify the range of stakeholders to be consulted and whose views should be taken into account in the evaluation process” (Turcksin et al., 2011, p.204).

The interest of stakeholders can take many forms and the degree of their participation can

vary widely. I conducted a review of the current research on stakeholders and biofuel stakeholders in preparation for this study. I particularly considered studies that provide detailed information on the survey tools employed. The key point regarding these papers is that all of them are survey based. It means these papers helped me to design the questionnaire and review the approaches and methodologies in order to analyze the stakeholders.

Megel (2011), Duvenage et al. (2012), Singer (2013), Dockerty et al. (2012) and Villamil et al. (2012) specifically targeted biofuels stakeholders. Skipper (2007), Van Dam & Junginger (2011), Chang (2009), McDonald et al. (2007), Zografakis et al. (2010), Johnson et al. (2013) and Cuppen et al. (2010) targeted bioenergy stakeholders, but their focus is broader, for example on cities and countries. Zhang et al. (2011), Halder et al. (2010), Plant (2009), studies focused on stakeholders that are not related to biofuels but their approaches have been considered.

There were many empirical studies that did not provide such level of detail and I considered them with regard to the potential involvement of relevant concepts. These papers are quantitative papers as well, but unfortunately the surveys were not provided. However their studies help to understand the broad meaning of stakeholder analysis and provide examples for this method in different areas. The idea of this study is coming from Turcksin et al. (2011) and this paper has the key role in this study. Srebotnjak & Hardi (2011), Jensen & Andersen (2013), Cope et al. (2011), Caniëls et al. (2013), Dam & Junginger (2011), Tate et al. (2012), Panoutsou (2008) Whitmarsh & Nykvist (2008) are related to biofuels, its stakeholders and analysis of them. Obidzinski et al. (2012), Reddy

et al. (2009), (Jussi et al. (2008), Hofmann & Khatun (2013) are about biofuels and policy programs, which later in this study, there is a section regarding them.

Table 2 and 3 in appendix 1 show the different papers and the key information that aided in the generation of the literature review, methodologies, analysis, and survey design.

## **2.5 Summary of Turcksin et al. (2011)**

Turcksin et al (2011) present a stakeholder analysis conducted with the specific goal of assessing several biofuel options for Belgium, namely biodiesel, ethanol, biogas and synthetic biodiesel, and a reference fossil fuel option. The study's goal is to identify which biofuel option (or combinations of options) policy developers should support in their quest to meet European targets for renewable fuels. The explicit consideration of relevant stakeholders is of particular interest in this situation, as the authors suggest that the lack of support by key stakeholders had been a barrier to increased adoption of biofuels in Belgium.

The authors adopt Multi-Actor Multi-Criteria Analysis (MAMCA) to evaluate the different alternatives of biofuels. This method was originally developed by one of the authors (Macharis, 2010), combining the commonly used multi-criteria analysis (Macharis, De Witte, & Ampe, 2009) with an explicit inclusion of stakeholders in the decision making process. This approach involves seven steps.

The first step deals with the definition of both the problem and the alternatives. The alternative can be actions or policy options to be adopted. The four biofuels have been selected as the alternative biofuels. In this first step, a reference fossil is included for

evaluation.

In the second step, the relevant stakeholders and their key objectives are selected from different sectors, which include agricultural, fuel distributors, car manufacturers, end users, NGOs and Governments among others. At this point, a consideration is undertaken based on highly representative stakeholders drawn from stakeholders groups. The viewpoint of 31 highly representative stakeholders from 7 different stakeholder groups is considered.

The third step is divided into two parts, 3a is mainly the defining criteria, which is based on the stakeholders' objectives and the alternatives identified. MAMCA can adopt an identical criteria if specific criteria for each group of stakeholders. Each stakeholder group has a stake on the various concerns on legal, environmental, and technical aspects. The legal aspect covers the laws governing the body. The environmental aspect looks into issues touching on the environment, while the technical issues include human influence on the process. The 3b step deals with allocation of weights to the defined criteria. The importance of each criterion is measured using a procedure developed by Saaty (1980). The weight distribution allocated to each stakeholder is computed and the economic criteria obtained the highest performance from biofuel producers, vehicle manufactures, feedstock producers, and fuel distributors.

The fourth step is the "criteria, indicators, and measurement methods." In this step, operationalization of identified stakeholders' criteria is carried out by introducing indicators that help ascertain the extent to which the alternatives contribute to every criterion. Overall analysis and ranking is done in step five. This involves construction of

a matrix where the alternatives are added using Saaty's AHP method (Saaty, 1990). Combining the alternatives helps in improving the objectives of individual stakeholders.

In step six, the results of the MAMCA are obtained. From this, it is observed that different stakeholder groups support ethanol, BTL, and Biodiesel. Ethanol option is highly preferred by the feedstock producers. This is because this form of fuel is used for many uses, unlike the other forms. In the Belgian market, BTL is highly preferred by the biofuel producers. Putting into consideration the use existing infrastructure, fuel distributors prefer fossil fuels to biofuels. These fossil fuels are also the best option for the vehicle manufacturers. Fossil fuels have less effect on the environment, a factor often considered when choosing the best fuels. End users prefer both biodiesel and fossil fuels. Use of biogas has been supported by the government due to its positive contribution on 'local air quality' and 'greenhouse gas balance.' For a greener economy, many governments of the world today have adopted these types of fuels.

Lastly the seventh step is the "implementation." This comes after the policy maker has chosen the alternatives to be implemented. This last step will determine whether the other steps were followed correctly or not. If not, there is a choice to make corrections, when the whole loop starts again. The implementation pathway is identified based on the information gathered from the various stakeholders. However, new alternatives can be included in this step or the existing ones are modified. This will create a feedback loop that leads to the start of the procedure.

The MAMCA approach highlights barriers and disadvantages relating to each of the stakeholders, thus allowing policy developers to make founded decisions on which

platform to support. In its last step, the MAMCA analysis presented by Turcksin et al. (2011) refers to the implementation steps policy developers can take based on the analysis, however without providing a framework for this.

The key contribution of the study is the explicit consideration of the opinions of a wide range of stakeholders with different interests. In particular, the process allows comparison between stakeholders and their specific interests. This comparative analysis is of particular interest to the present study.

The MAMCA showed that for biofuels producers, the ability to competitively sell biodiesel and ethanol on the Belgian market and utilize the available capacity of production is quite low. In countries which have car industries, a greater success is observed when high blends are introduced because of their relationship with the vehicle manufacturers.

In practical terms, the Turcksin et al. (2011) study illustrates that, in Belgium, “fossil fuels are still most preferred by vehicle manufacturers and end users, whereas for feedstock producers, biofuel producers and the government; this is clearly not an option in view of their goals.” (p. 213)

## **2.6 Multi-Actor Multi-Criteria Analysis**

Multi-Actor Multi-Criteria Analysis (MAMCA) is the extension of Multi-Criteria Analysis (MCA). “MCA is a decision-making tool applied to evaluation problems where one is faced with a number of different alternatives and desires to find optimal solutions with regard to several conflicting criteria” (Antunes, Santos, & Videira, 2006,

p.45). MAMCA allows researchers and decision makers to assess alternatives and opportunities with respect to the objectives of the different stakeholders involved in the project. By using MAMCA, the objectives of the various relevant stakeholders will be clear and allow for a better understanding of the stakeholders' objectives. The MAMCA method aims to evaluate different policy measure where improve understanding of the stakeholders' point of view. This approach has been used in some biofuel projects (Macharis, Turcksin, & Lebeau, 2012) such as assessing stakeholders' interest (Turcksin et al., 2011), to incorporate uncertainty in stakeholder based evaluation process (Baudry, Macharis, & Vallée, 2014) and inclusion of stakeholder in transport projects (Macharis, 2010).

## **2.7 Analytic Hierarchy Process**

Since its development in the 1970s by Tomas L. Saaty, the Analytic Hierarchy Process (AHP) has been a useful tool for researchers and decision makers. AHP is considered a multi-criteria decision support tool and it has been widely used by researchers. A review by Vaidya and Kumar (2006) covers 150 papers in which researchers/decision makers used AHP as an analysis tool. These works introduced the usage of AHP applications in different fields, such as resource allocations (Gholamnezhad & Saaty, 1982), selecting a best alternative (Arbel, 1987), resolving conflict (Saaty & Wedley, 1988), planning (Emshoff & Saaty, 1982), and optimization (Vaidya & Kumar, 2006; Vargas, 1990; Zahedi, 1986).

AHP is a useful approach for pair-wise comparisons. It provides the methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative

performances. “The scale ranges from 1/9 for ‘least valued than’, to 1 for ‘equal’, and to 9 for ‘absolutely more important than’ covering the entire spectrum of the comparison” (Vaidya & Kumar, 2006). Table 1 shows the scale of absolute numbers (pair-wise comparison).

<b>Intensity of Importance</b>	<b>Definition</b>
9	Objective 1 Much More Important
5	Objective 1 Moderately More Important
3	Objective 1 Slightly more Important
1	Equal Important
1/3	Objective 2 Slightly Less Important
1/5	Objective 2 Moderately Less Important
1/9	Objective 2 Much Less Important

**Table 1: The fundamental scale of absolute numbers (Pair-wise Comparison).**

**Source 1: Saaty (2008).**

The AHP methodology involves three main steps. The first step is to break down the problem into its component parts in a hierarchical manner. Second step is pairwise comparison with a computer program and the goal is to estimate the priorities of the elements of the hierarchy. The last step is to combining these numbers into overall weights, which rank and provide priority measures for the decision outcomes (Saaty & Wedley, 1988).

In this study, the Stakeholder Questionnaire Methodology was used for data collection and designing the survey. Then the Multi-Actor Multi-Criteria Analysis (MAMCA), with the Analytic Hierarchy Process (AHP) as a tool, was used to analyze the data and determine the stakeholders' interests. I used the AHP approach to calculate and find the priorities, which will help support, my arguments.

## **2.8 Biofuel Policy Development**

The final part of this study explores the perceived usefulness of biofuels-related policies and programs with regards to successful commercialization of biofuels research. It has been suggested that acceptable policy measures are of vital importance to facilitate the market uptake and development of biofuels (Faaij, 2006). To contextualize this aspect of the present study, this section summarizes fundamentals of policy development as they relate to biofuels policies and programs.

The public policy support for biofuel consumption and production is motivated by the following key objectives:

- Creation of an alternative outlet for farm produce and development of rural areas;
- Reduction of greenhouse gas emissions from the transport sector; and
- Increasing supply security by reducing the oil import dependency of the transport sector (Wiesenthal et al., 2009).

As conventional biofuels are a mature fuel, the policy focus now often falls on facilitating their market entry rather than R&D support. This implies that demand in the market is created by policies as the production costs of biofuels are above those of fossil fuels –

unless very high oil and/or carbon dioxide emission prices are attained. This can be done through two instruments: subsidization or prescription of a mandatory production (Wiesenthal et al., 2009).

In the last section of this thesis, there are fourteen different policy tools included in the questionnaire: Biofuel Tax Credit, Biofuel Mandate, Carbon/Gasoline Tax, Efficiency Standard, Vehicle Subsidy, Price Support, Acreage Control, Import Tariff, Export Subsidy, Export Quota, Technology Mandate, Public R&D, Support for Private R&D, and Technology Transfer Networks. This list of policies is based on Rajagopal and Zilberman (2007), a World Bank report cited widely in the academic literature investigating biofuels policies around the world. It has also been considered relevant to the Canadian context, for example in the studies of Calvert (2009), De Gorter & Just (2010), Sparks & Ortmann (2011).

The original Rajagopal and Zilberman (2007) report contains limited definitions of the respective policies and programs. The following paragraphs therefore draw on the broader academic literature to provide a definition of the policies.

**Biofuel Tax Credit:** Tax credits reduce the amount of taxes incurred for specific expenses, in this case relating to biofuels.

**Biofuel Mandate:** Biofuel mandates are imposed through regulations requiring a certain biofuel content. In Canada the Environmental Protection Act Bill C-33 mandates a 2% renewable energy content in diesel fuel a 5% renewable energy content in gasoline by 2010 and heating oil by 2012 (Sorda, Banse, & Kemfert, 2010).

**Carbon/Gasoline Tax:** This is a tax that is imposed on the sale of Carbon/Gasoline. The tax is applied to fossil fuels to tip the scale in favour of biomass as an energy source (Rajagopal & Zilberman, 2007).

**Efficiency Standard:** There are different definitions for efficiency standard; it defines the minimal requirements for efficiency or the measured energy consumption for the household appliances (Marousek & Schwarzkopf, 1992). Duffy (1996) described it as government mandated standards, which define minimum levels of efficiency and/or maximum levels of energy consumption that must be met by all products sold in the particular jurisdiction. There is another definition that many researchers believe is the most accurate one: energy efficiency standard is the recommended energy performance of a manufactured product, sometimes forbidding the manufacture of products with less energy efficiency than the minimum standards (Mahlia, Masjuki, Choudhury, & Saidur, 2001; McMahan & Turiel, 1997).

**Vehicle Subsidy:** A subsidy is a kind of financial aid or support extended to different economic sectors such as people or businesses. Commonly, the purpose of it is to promote public objectives and social policies (Kent, 2001; Mahoney, Angell, Serino, & Hoang, 2007). When it comes to vehicle subsidies, the definition is about the financial support of the government to individuals who want to buy vehicles that support renewable energy or specifically biofuels.

**Price Support:** In the economics perspective, price support may be either a subsidy (which I described above) or a price control. The goal of both of these is to keep the market price of a good or service higher than the competitive equilibrium level.

More specifically, in terms of a price control, a price support is defined as the lowest legal price a seller may charge, commonly placed over equilibrium, which is the support of certain price levels at or above market values by the government (Frank, 2012).

**Acreage Control:** This is a group of policy tools commonly used by governments of many different countries in order to cope with over-production of agricultural products (Gönenc, Tanrıvermiş, & Bülbül, 2006). The central goal of these tools is to make agricultural land artificially scarce. This, in turn, translates into higher price increases for agricultural products (Hertel & Tsigas, 1991). Takahashi (2012) suggests that acreage control meets the government's objective of transferring income to producers with minimal costs to government.

**Import Tariff:** Tariff is a tax on imports and/or exports. This kind of tariff is known as an international trade tariff. It may be imposed on products, such as fossil fuels or biofuels, or more specifically, for example, on fossil fuels from a certain country or biofuels produced from a certain feedstock.

**Export Subsidy:** The subsidy is defined as a kind of financial aid or form of support extended to different economic sectors, commonly for the purpose of promoting public objectives and social policies (Kent, 2001; Mahoney et al., 2007). When it comes to export subsidies, the definition is about the financial support of the government in exporting the products.

**Export Quota:** "Quotas can be defined as a limited quantity of a particular product which under official controls can be produced, exported, or imported" (O'Donovan, 2012, p.13).

**Technology Mandate:** Technology Mandates are typically imposed through standards and regulations demanding specific technological solutions, rather than performance outcomes.

**Public R&D:** Public R&D refers to research and development activities performed by and / or funded by the public sector.

**Support for Private R&D:** Public support for private R&D can take the form of loans, grants, advice, brokerage or coordination activities, or performance of R&D activities in the public sector in support of private sector interests.

**Technology Transfer Networks:** “Technology transfer is the process of transferring skills, knowledge, technologies, methods of manufacturing, and facilities” (Yamane et al., 2012, p.1796). Technology transfer networks typically refer to formally or informally organized networks to facilitate the transfer of technologies and knowledge between the public and private sectors.

### **3 Chapter III: Stakeholder Interests in Biofuels**

The first research question addressed in this thesis is, as noted above: What are Canadian stakeholders' priorities in assessing biofuels? This chapter presents this part of the study, starting with an outline of the methodology, followed by the analysis and results, and a discussion of the findings.

#### **3.1 Methodology**

This chapter presents the research methods that were used in this part of the study. Its aim is to analyze the role of stakeholders' interests regarding biofuels in Canada. I am investigating this topic in order to establish a link between stakeholders' interests and research projects, from the onset of the projects.

The work by Turcksin et al. (2011) applies a Multi-Actor Multi-Criteria Analysis (MAMCA) framework aimed to combine the opinion of different stakeholders with different interests to assess the different biofuels options. The stakeholder analysis and identification of stakeholder interests at the center of this thesis are part of this process, so the following sections will describe the MAMCA framework, as well as the Analytic Hierarchy Process (AHP) used within it.

### **3.1.1 Multi-Actor Multi-Criteria Analysis**

As I mentioned before MAMCA has seven steps. In order to adopt this methodology in my study, I needed to complete two steps. Step 2 and step 3 are adopted from MAMCA in order to analyze stakeholders and define criteria and weight for them. However, there are brief explanations of first three steps in order to understand this methodology.

#### ***Step one***

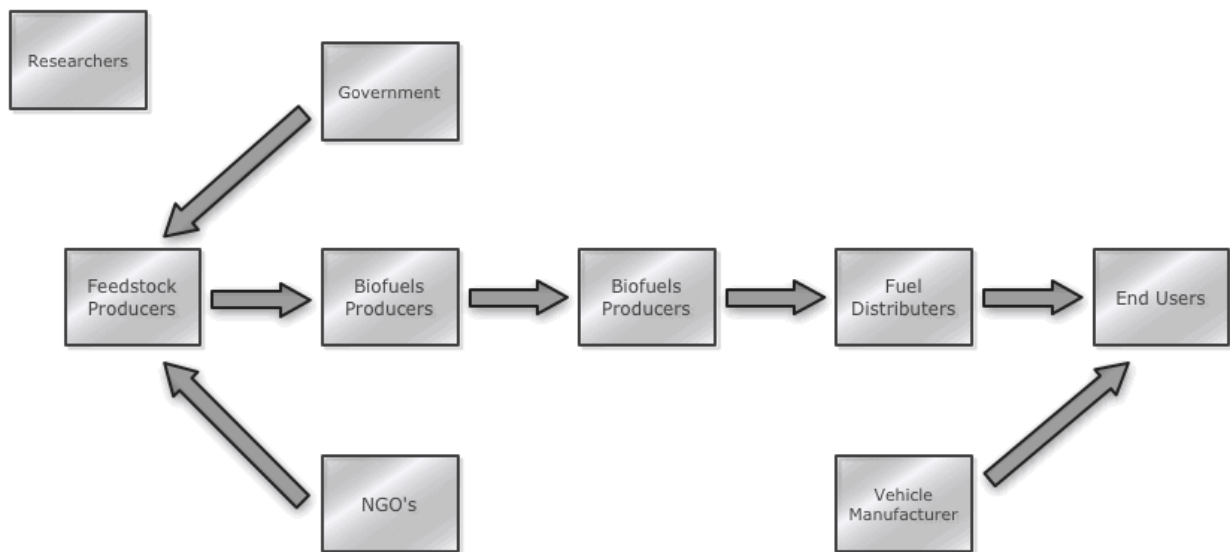
The first step is “Define problems and alternatives”. In this step, the researcher identifies the possible alternatives submitted for evaluation. For example one might aim to compare different energy platforms, such as fossil fuels, biofuels, hydrogen and renewable electricity sources. The focus is to measure the priority of different criteria related to each stakeholder. In the following steps, the criteria will briefly be explained.

#### ***Step two***

The second step is “Stakeholder analysis”. In this step, I needed to define the range of stakeholders to be consulted and whose views should be taken into account. As noted in Chapter II, stakeholders are the range of people who are using a system or being influenced directly or indirectly by its use (Macharis & Stevens, 2003). There are a variety of stakeholders in the biofuel industry and the literature review defines who these stakeholders are; these stakeholders are represented in Figure 1. In this study, for instance, feedstock producers (as one of the stakeholders) are not just represented by the agricultural sector or biomass-based industry, but also by the wood sector, waste processors and traders, and any other sectors that provide material to make biofuels

(Macharis et al., 2012). According to the Turcksin and Macharis' (2009) during dedicated workshop for biofuel representatives these stakeholders validated.

**Figure 1: Stakeholders relationship in biofuels.**



**Source 2: Adapted from Turcksin et al. (2011)**

### ***Step three***

Step three has two parts. The first is “Defining criteria” (Turcksin et al., 2011), which is based on an in-depth understanding of each stakeholder’s objectives and opinions in order to appropriately assess different criteria and options.

In this study, for instance, feedstock producers (as one of the stakeholders) are not just represented by the agricultural sector, but also by the wood sector, waste processors and traders, and any other sectors that provide material to make biofuels. The biofuels producers are represented by the different generations of biofuels and using different

types of biomass to produce biofuels. Biofuels are primarily relevant to federal and provincial government departments and agencies, although considerations of feedstock production, pollution, or associated economic development opportunities could presumably also be concerns for municipalities. Finally, NGOs can cover a broad range of concerns, including representing other stakeholder groups.

As shown in Figure 2, the Turcksin and Macharis' (2009) study demonstrates a clear means in which representatives from each stakeholder group were given the opportunity to evaluate and validate the pre-defined criteria during a workshop. The evaluation of these criteria for each stakeholder group first tracked by the literature review and during the same workshop for identifying the stakeholders, members from each stakeholder group had the opportunity to approve and evaluate the pre-defined criteria. Figure 2 presents the final assessment criteria for each of the different stakeholder groups.

As shown in the Figure 2, the first row after "Biofuels in Canada" box, the lists of stakeholders shown. The criteria for each stakeholder are presented by vertical line under it.

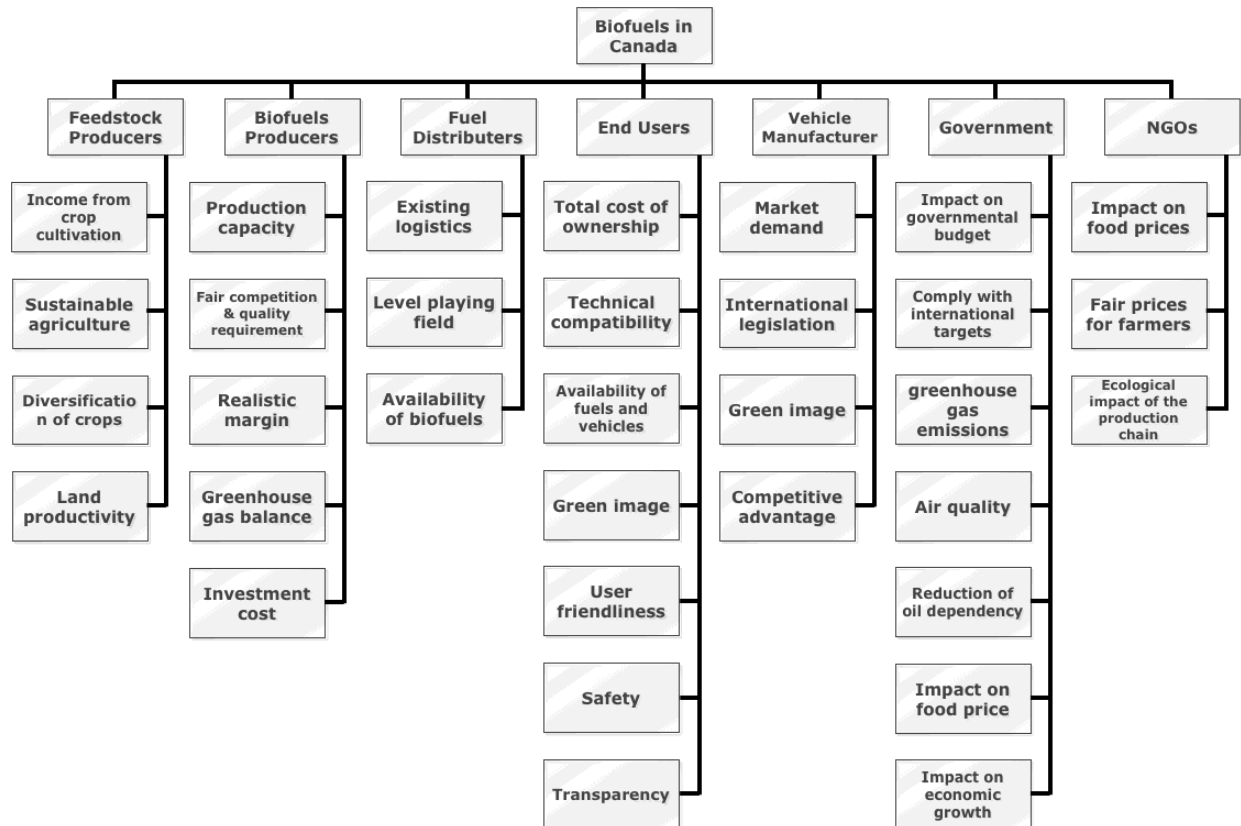


Figure 2: Criteria tree.

Source 3: Adapted from Turcksin et al. (2011)

The second part of step three is “Allocation of weights to the criteria”. In order to obtain an aggregate measure of stakeholders’ preferences for the different criteria, weights are allocated. There are different methods for determining the weights, such as direct rating or point allocation, but one of the most common ways is pair-wise comparison, which is the method I used. The pair-wise comparison procedure, developed by Saaty (1980), provides very interesting and applicable results for the biofuels industry. The relative priorities of each element in the hierarchy are determined by comparing each criterion against other criteria. For doing this task, the decision support software PriEsT, based on

Saaty’s Analytical Hierarchy Process (AHP), was used. I will describe PriEsT and AHP later in this chapter.

Figure 3 shows a screenshot of the survey, in which biofuels producers had to express their preferences for a specific pair of criteria (Turcksin et al., 2011). Figure 3 provides the example of ‘Product capacity’, ‘Fair competition & quality requirement’, ‘Realistic margin’, ‘Greenhouse gas balance’ and ‘Investment cost’ criteria.

	<i>Much more important</i>			<i>Equal</i>	<i>Much more important</i>			
<b>Objective 1</b>								<b>Objective 2</b>
Production capacity								Fair competition & quality requirements
Production capacity								Realistic margin
Production capacity								Greenhouse gas balance
Production capacity								Investment cost
Fair competition & quality requirements								Realistic margin

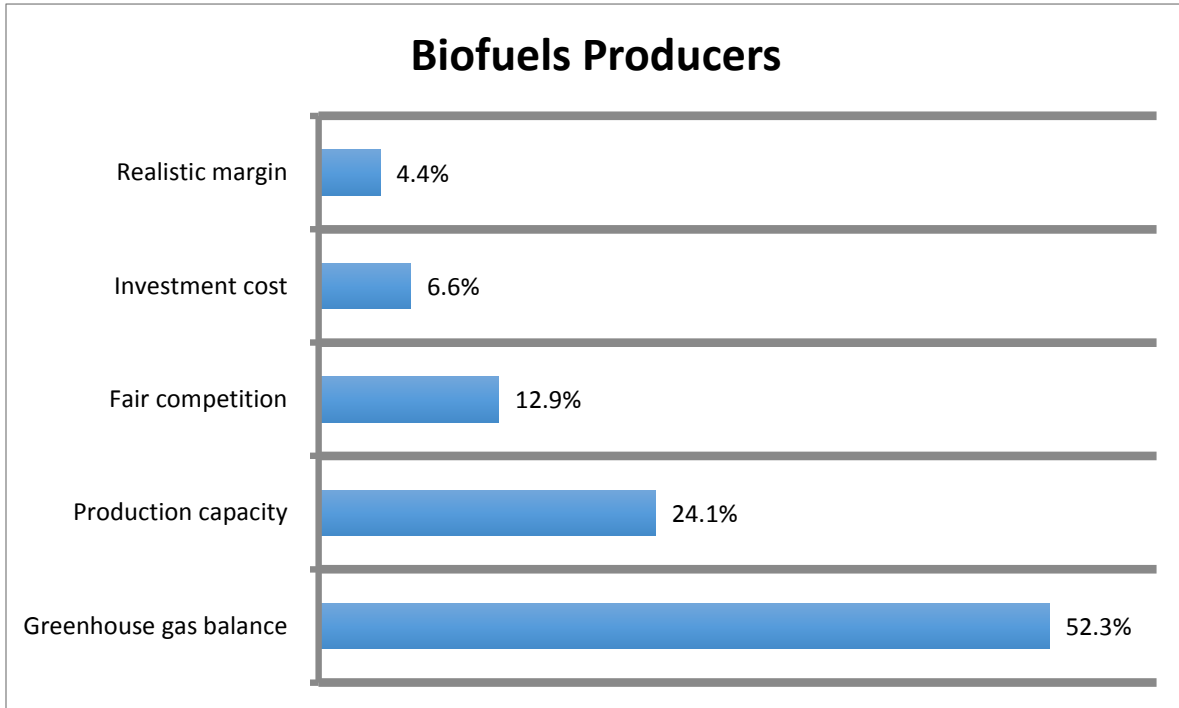
Figure 3: Screenshot of survey used in this study.

Source 4: Adapted from Saaty (2008)

The respondents’ answers to the questionnaire were transformed to Saaty’s (2008) scale of absolute numbers, or scale of pair-wise comparison. There is a complete description of this in the AHP section. They were then aggregated to provide relative weights for the

importance of each objective.

Figure 4 is an example of the weight distribution obtained from this step of analysis, which is one of the most important outputs of this study. In the Analysis & Results section of this chapter, I will describe and discuss this figure in detail.



**Figure 4: Weight distribution.**

The results of step three are one of the most important outcomes of this study. By conducting a survey and analyzing it appropriately, the results show us the weight distribution of our stakeholders' criteria, which can assist in the evaluation process of further studies.

The first three steps of the MAMCA are the steps that I needed for this study. Because the goal of this study was to find the relationship between each pair of criteria in different

stakeholder groups, by applying the first three steps and using AHP software, the expected results were calculated; however, I will continue with the explanation of the other steps below.

### *Steps four through seven*

The “Criteria, indicators and measurement method” is step four of the MAMCA process. In this step, the criteria that were identified in step two become “operationalized” by establishing indicators. These indicators can be used to measure whether, or to what extent, an alternative contributes to each particular criterion.

The fifth step is “Overall analysis and ranking.” The goal of this step is to assess different alternatives. It is possible to use different methods of analysis depending on the stakeholder concepts. The important factor in this step is a proper and intricate evaluation of alternatives.

The sixth step is “Results of the MAMCA”. The MAMCA developed in the previous step leads a manifestation of a multi-actor view on the different biofuel options. The analysis that is performed in this step shows whether the results changed when the weights were adjusted.

The seventh and final step of MAMCA is “Implementation”. When policy makers make decisions, steps have to be taken in order to implement the chosen alternatives by constructing deployment schemes.

Previous research shows that the results can be reliable with a small number of representative respondents per stakeholder group (Macharis, De Witte, & Turcksin, 2010; Macharis et al., 2012; Turcksin et al., 2011).

### **3.1.2 Analytic Hierarchy Process**

AHP is considered a MAMCA tool, which means that in order to use MAMCA, I needed to have a tool and that tool was AHP. In step three in the MAMCA, I used the AHP method to analyze the data and evaluate the priority of criteria.

### **3.1.3 Software Selection**

There are several types of AHP software available on the market, which have been developed by different developers and firms for different usages. As I mentioned in the methodology section, AHP is used in a variety of fields, so it follows that AHP software design and algorithm may differ because the intended usage and results may vary. However, the overall base and structure is the same.

In order to have very accurate, precise results in this study, I had to find the one that best met my needs. Using Priority Estimation Tool (PriEsT), I ran two different tests with this software. One of them was extracted from Saaty (2009) and was related to drink consumption in the USA. The other was extracted from Saaty (2006, 2008) and the software showed the exact same results as the examples from Saaty's papers. To then revalidate the results and be more accurate, I used online software that provides the exact result to the PriEsT software and ran both of them to compare and validate my final result

in terms of accuracy. AHP calculation software by CGI is the online software that I used ("AHP (Analytic Hierarchy Process) Calculation software by CGI," 2004).

PriEsT is a decision-making and decision analysis tool, developed based on the Analytic Hierarchy Process, which provides an extensive and comprehensive framework for decision problems. PriEst is used for rating the options you have, or the alternatives and criteria. It can be use for resource allocation (budgeting) problems, selecting, evaluating, or other usages as mentioned before. In PriEsT, the user enters a list of available options and then defines the criteria (such as different stakeholders) to find the priority for each of them and the relationship between them. After determining the criteria, the software allows the user to enter judgments against each criterion, which are then used to calculate the final ranking or weights (Siraj, Mikhailov, & Keane, 2013).

#### **3.1.4 Consideration of Multiple Respondents**

Saaty's original method focused on the comparison of criteria by a single respondent. The goal of this survey was to obtain multiple respondents from each category, i.e. researchers and each stakeholder group. The common practice for obtaining weights for each group is to aggregate individual scores using the geometric mean (Saaty, 1988; Turcksin et al., 2011).

The geometric mean is the recommended method combine group judgments: "As different members within a stakeholder group were consulted, the geometric mean is calculated to bring the evaluations together" (Turcksin et al., 2011, p.206; suggestion of Saaty, 1999). The purpose of using the geometric mean, for example rather than the

arithmetic mean, is to ensure that the combined values are measured on the same scale as the original measures.

The following example illustrates the difference between these two mathematical means. The weight of two oranges is compared subjectively by two individuals. Both individuals assess orange one as heavier than orange two, but they show a slight difference in their assessment of the strength of the difference: One individual suggests the difference is a five on a scale from zero (equal) to five (e.g. extremely heavier), the other individual assesses the difference as a four (e.g. much heavier). Using the arithmetic mean to combine the two judgments, the combined value is:

$$5 + 4 = 9$$

The key characteristic of the Saaty (1999) scale is that it accounts for the comparison in both ways. In this case the above assessments imply that individual one considers orange two as 1/5 (e.g. extremely lighter) and individual two considers orange two as 1/4 (e.g. much lighter). While the individual assessments are reversed, the arithmetic mean of these reversed assessments is not equal to the reverse of the combined measure calculated above:

$$\frac{1}{9} \neq \frac{1}{5} + \frac{1}{4} = \frac{9}{20}$$

However using the geometric mean, both comparisons remain the inverse of each other.

The geometric mean calculated here:

$$\sqrt{5} \times \sqrt{4} = \sqrt{5 \times 4} = 4.472$$

$$\frac{1}{\sqrt{5} \times \sqrt{4}} = \frac{1}{\sqrt{5 \times 4}} = \frac{1}{4.472}$$

This relationship holds more generally for the geometric mean, therefore providing a method to combine the assessments of a number of individuals while maintaining the integrity of the scale.

### **3.1.5 Questionnaire Design**

The team on this project designed a survey based on the concept and mix methodologies mentioned above. The survey questions were collected from various academic papers (Please refer to tables 2 and 3 in Appendices 1 and 2), which were related to previous studies conducted by many biofuel researchers in different countries. We reviewed and analyzed those questionnaires with respect to the goal of our project and we made our own questionnaire to fit our research question.

## **3.2 Data Collection**

The data collection for this research project occurred during the 2014 Advanced Biofuel Symposium – the Annual General Meeting of the BioFuelNet, which was held in Ottawa at the end of May 2014. Most of the conference attendees were researchers and government representatives, as well as a small number of other stakeholders.

We obtained responses from 17 stakeholders from three different stakeholder groups. The group of biofuel producers includes five companies involved in the production of biofuels. The governmental group comprises eight people working at different Canadian government departments or agencies. Finally, the input from NGOs was obtained through

four representatives. The number of respondents per stakeholder group is comparable to the sample considered in Turcksin et al. (2011).

Based on the nature of the conference at which we collected the data, these respondents can be considered well informed and representative of their respective stakeholder groups.

### **3.2.1 BioFuelNet Community**

Canada has a wealth of biomass products, as well as many other agricultural and forestry waste and by-products. These materials can be used to manufacture biofuels; however, before manufacturers can use these sources to produce advanced biofuels, additional research is required to ensure they can be produced sustainably, economically, and in large enough quantities to have an impact on Canada's fuel consumption and make the whole process feasible. Focused research must be conducted on the most efficient conversion processes, while rigorous testing must ensure the final fuel products are acceptable for use in today's market ("BioFuelNet Strategic Plan," 2014).

BioFuelNet Canada is a network that brings together the Canadian biofuel research community in order to address the challenges and obstacles that block or disturb the growth of an advanced biofuels industry in the region. This group includes renowned, multi-disciplinary experts from academia, government, and industry working together in a concerted and synergistic way. BioFuelNet is working to develop and apply unique and innovative science, engineering, and socio-economic strategies that will increase environmental sustainability for future generations. As mentioned on their website, their

vision is “a Canada with a thriving advanced biofuels industry that is socially, economically and environmentally sustainable” (Webb, 2014, paragraph 1) and their mission is “to support the growth of Canada’s advanced biofuels industry through coordinated research, innovation, effective education, smart policy and strategic partnerships” (Webb, 2014, paragraph 2).

### **3.2.2 Ethics**

This study consists of the thoughts and opinions from different individuals in the biofuels industry. Collecting this kind of data and using it ethically in order to protect the privacy of those individuals is critical in this study.

According to the University of Ottawa’s Office of Research Ethics and Integrity, any research project or thesis involving human participants (including interview and survey), regardless of whether it is funded or not, must receive ethics approval from a Research Ethics Board (REB) prior to the start of the project (“Office of Research Ethics and Integrity,”). This study received the approval from the ethics review board of the University of Ottawa and the certificate is available in Appendix 4.

A letter informing respondents about the privacy of their information, even after this study is completed, was provided to them, and the questionnaire didn’t require any personal information about participants. To review this information letter, please refer to Appendix 5.

### **3.3 Analysis & Result**

By using the AHP approach and AHP software, we can do pair-wise comparisons. In this study, I used AHP methodology to calculate the priorities of criteria for every stakeholder group in order to understand their ideas and interests in their specific area of biofuels.

#### **3.3.1 Government**

The research team explained to respondents that the goal of this questionnaire was to understand their priorities regarding biofuels. The stakeholders were asked to pick a biofuel platform (ex. feedstock producers, biofuels producers or others) that they are familiar with and then answer the questions, which asked them to do a pair-wise comparison between all of the criteria.

The first stakeholder to be analyzed was Government. The criteria were described in page 29 are: comply with international targets (Inter), impact on governmental budget (Gov), air quality (Air), reduction of oil dependency (Oil), impact on food prices (Food), impact on economic growth (Eco), and greenhouse gas emissions (Green). There were a total of eight responses from this stakeholder group. By using the PriEsT software and validating it with online software, the relationship between each criterion was found; this is shown in Figure 5 (the criteria are shown in Figure 2, page 21).

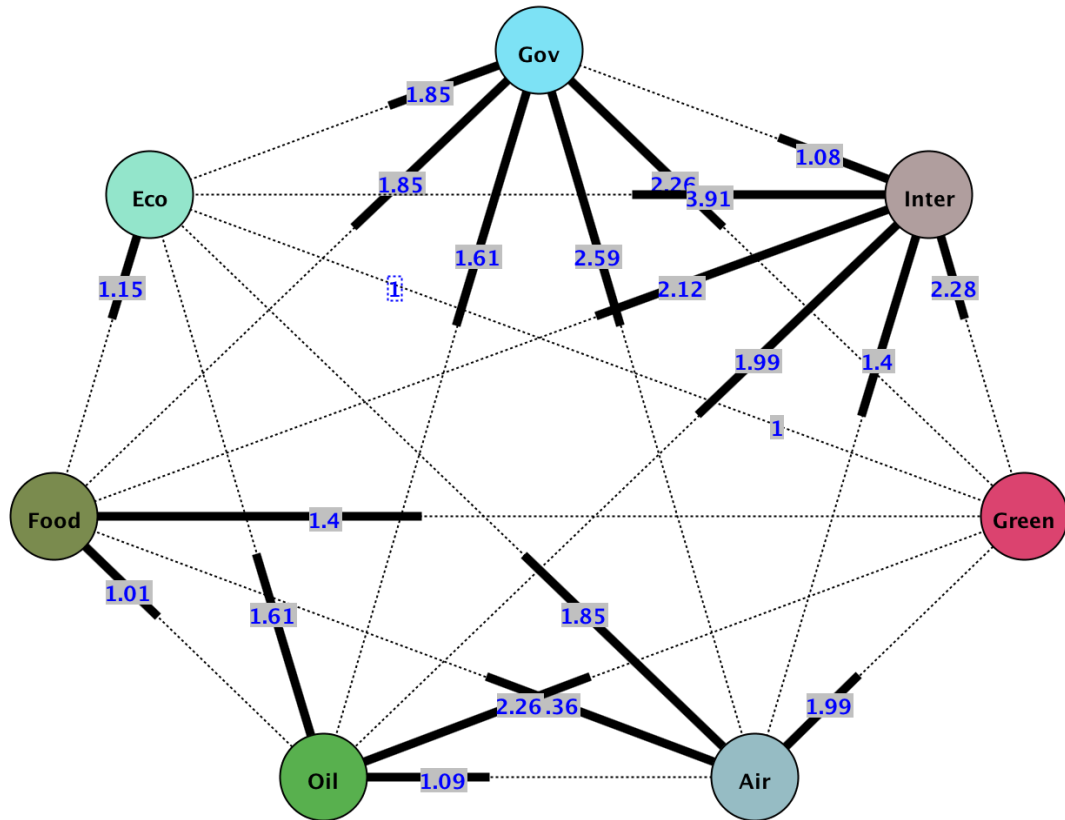


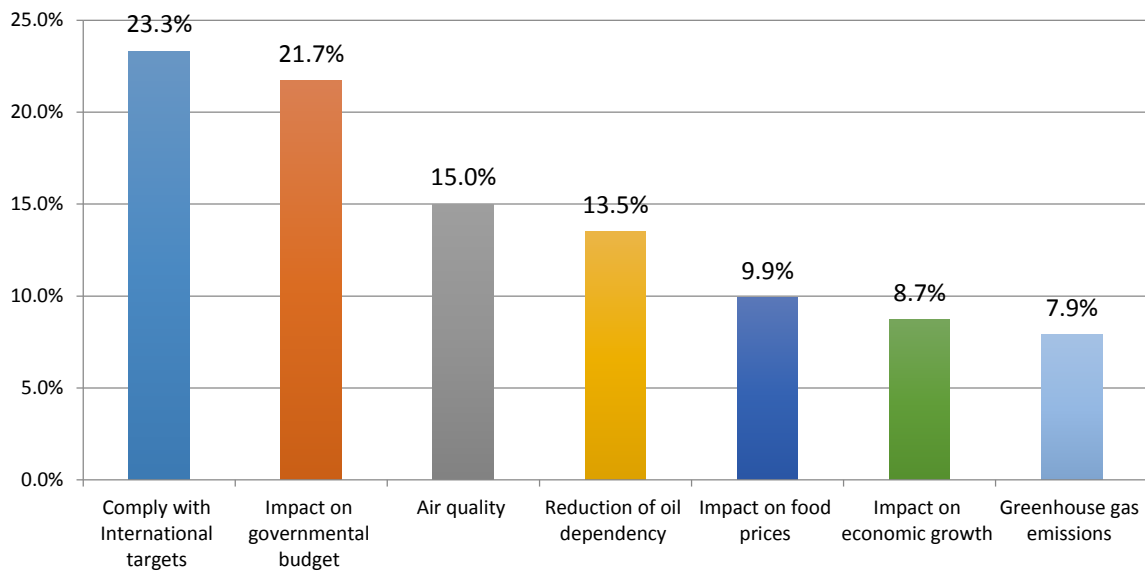
Figure 5: Graph view of stakeholder criteria relationships: Government.

Using the relationship between “impact on government budget” (Gov) and “air quality” (Air ) as an example, we see that from the “impact on governmental budget” criterion view, the line starts with the number 2.59, then changes to a dotted line to reach the “air quality” criterion. The line with the number (weight) shows that the “impact on governmental budget” criterion is in the top of Saaty’s pair-wise comparison table when

compared to the “air quality” criterion. This means the comparison of Air and Gov will

be  $\frac{1}{2.59}$ <sup>9</sup>.

As we can see in Figure 5, the “comply with international targets” (Inter) criterion is the most important among the criteria considered. On the other hand, “greenhouse gas emissions” (Green) is the least important criterion, with none of the pair-wise comparisons indicating higher importance than any other criteria. Please refer to the priorities of criteria in Figure 6 to see the aggregated weights for each criterion. The weights in Figure 6 have been calculated by PriEst software and validated by online software.



**Figure 6: Criteria priorities for government.**

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<sup>9</sup> . Those numbers calculated based on Saaty (1980) approach by PriEst software. The numbers represents the judgments between criteria.

According to Figure 6 and based on the observations in Figure 5, “comply with international targets” has the highest priority among government respondents with 23.3%. “Impact on governmental budget” is the second most important criterion at 21.7%. The priority of these two criteria covers 45% of the whole weight distribution, and both have more than 20% of the weight.

In terms of priority, “reduction of oil dependency” and “air quality” are very close together, they do not have high priority, and their weights are 15% and 13.5%, respectively.

“Impact on food prices”, “impact on economic growth”, and “greenhouse gas emissions” have the lowest priority. Their priorities are 9.9%, 8.7% and 7.9%, respectively.

### **3.3.2 Biofuel Producers**

Another stakeholder to analyze is Biofuel Producers. These respondents were asked to do a pair-wise comparison between all of the following criteria: greenhouse gas balance (Green), production capacity (Production), fair competition (Competition), investment cost (Investment), and realistic margin (Realistic). The total number of responses from this stakeholder group was five. The relationship between each criterion is shown in Figure 7.

Figure 7 shows the relationship of criteria for biofuel producers. According to this figure, “greenhouse gas balance” (Green) has the highest weight over all the other criteria; the numbers on the lines are quite high, which means high priority is expected from this criterion. “Production capacity” (Production) is in second place, followed by “fair

competition” (Competition) and “investment cost” (Investment). The last criterion is “realistic margin” (Realistic), which does not have any weight over the other criteria; there are only dotted lines around this criterion. Table 5 in appendix 3 shows the pairwise comparison.

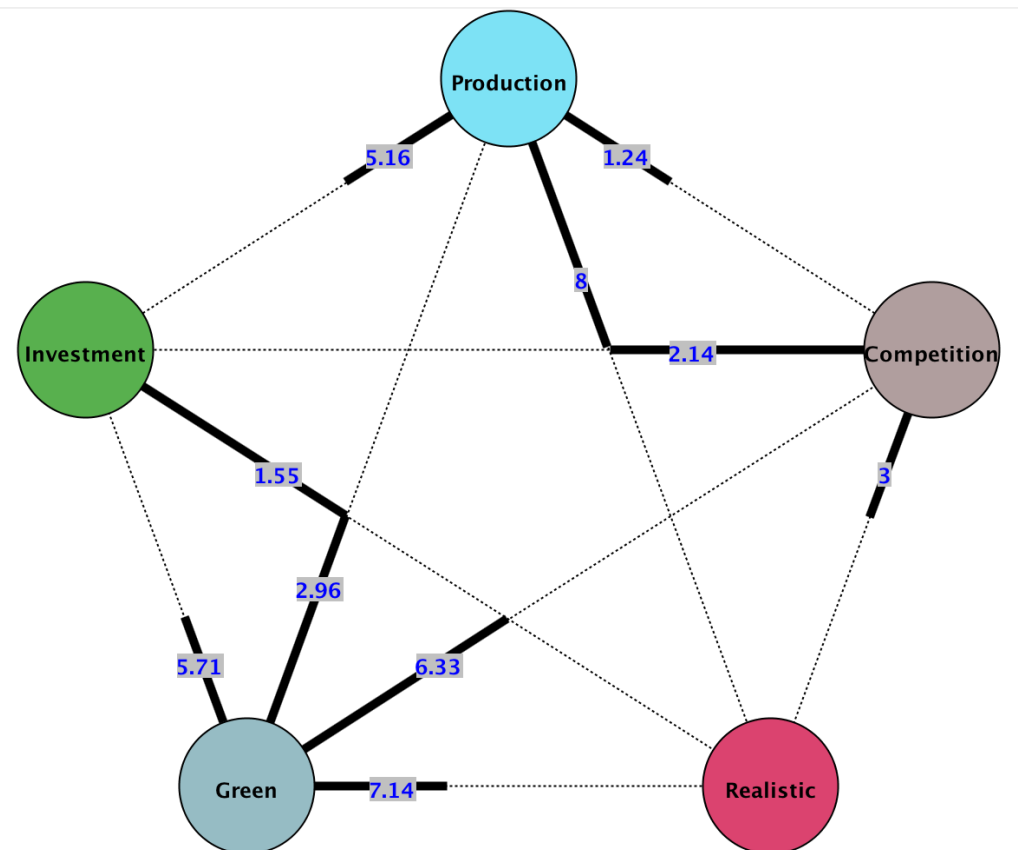
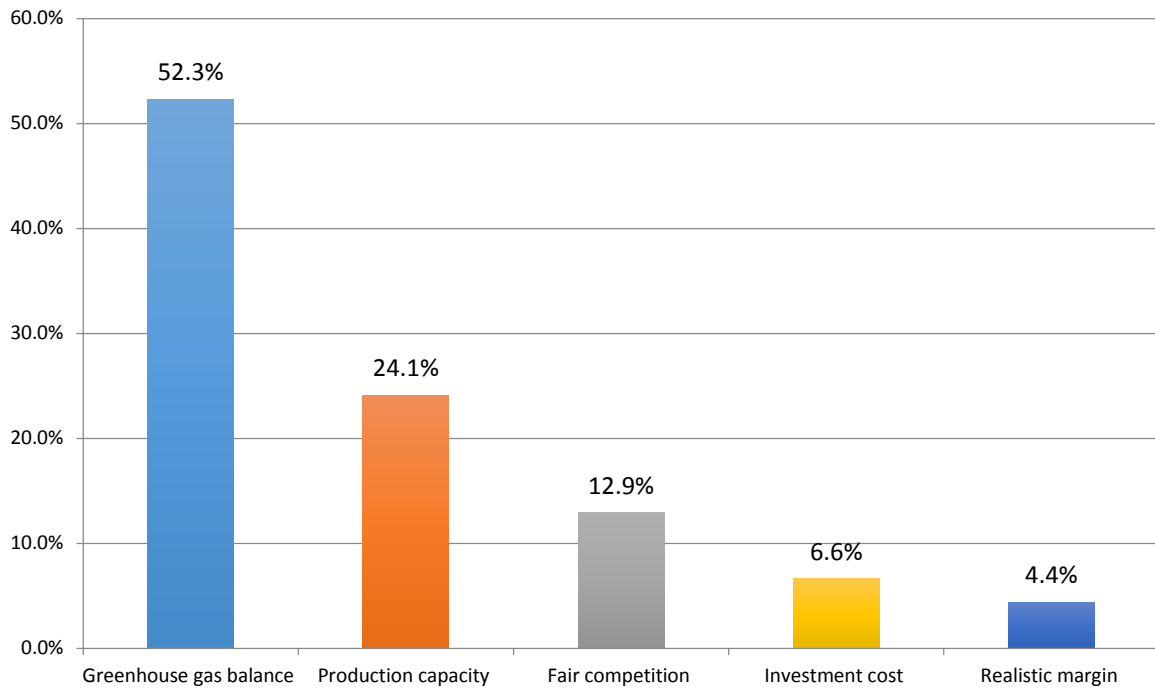


Figure 7: Graph view of stakeholder criteria relationships: Biofuel producers.

The priorities in Figure 8 have been calculated by the PriEst software and validated by online software. Figure 8 shows the priorities of criteria for biofuel producers. As shown, “greenhouse gas balance” has a very high number. This means that this criterion should be considered more important than all other criteria relevant to biofuel producers. On the other hand, “realistic margin” does not have any priority over other criteria, which means,

based on the responses from biofuel producers, the “realistic margin” criterion is not as important as the other criteria. The reader can refer to the aggregated weights for the criteria in Figure 8.



**Figure 8: Criteria priorities for biofuel producers.**

According to figure 8 and observations in Figure 7, “greenhouse gas balance” has the highest priority among other criteria. The priority of this criterion is 52.3%, which is more than 50% of all the criteria, making it very important. “Production capacity” is the second highest priority criterion, with 24.1% of all of the criteria. “Fair competition” does not have very high priority. According to our study and the judgment of our respondents, the priority of “fair competition” is only 12.9%. “Investment cost” and “realistic margin” are the last two criteria, which have the lowest priorities at 6.6% and 4.4%, respectively.

### 3.3.3 Non-Governmental Organizations or Association Representatives (NGO)

The third stakeholder is Non-Governmental Organizations or Association Representatives (NGO). These respondents were asked to do a pair-wise comparison between all of the following criteria: impact on food prices (Food Price), fair price for farmers (Fair Price), and ecological impact (Ecological). There were a total of four responses from this stakeholder group. Table 6 in appendix 3 shows the pair-wise comparison for this group. The relationship between each criterion is shown in Figure 9.

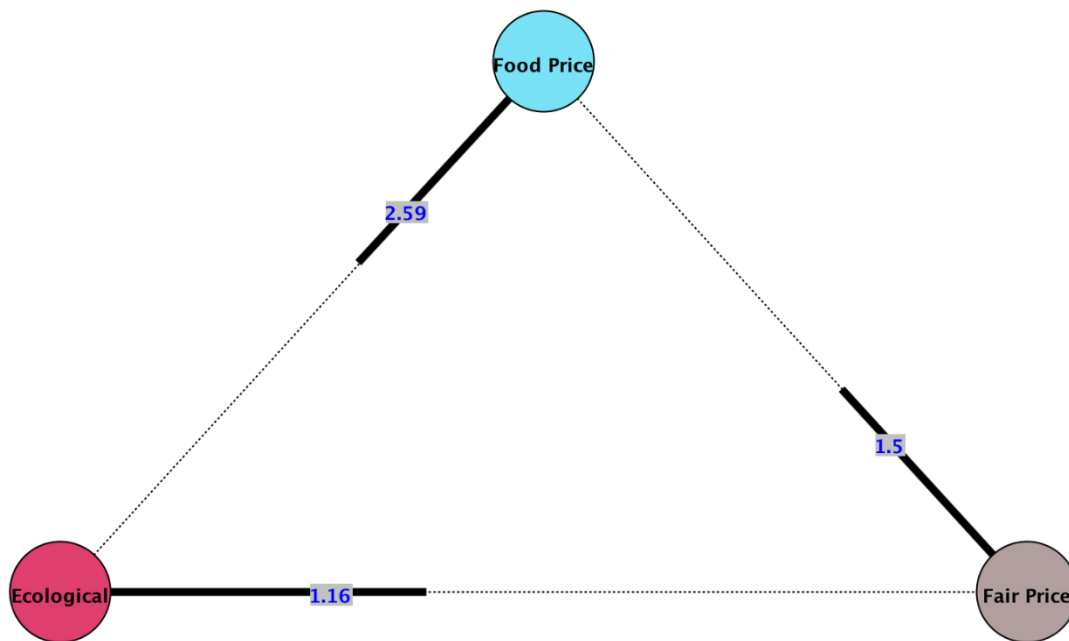
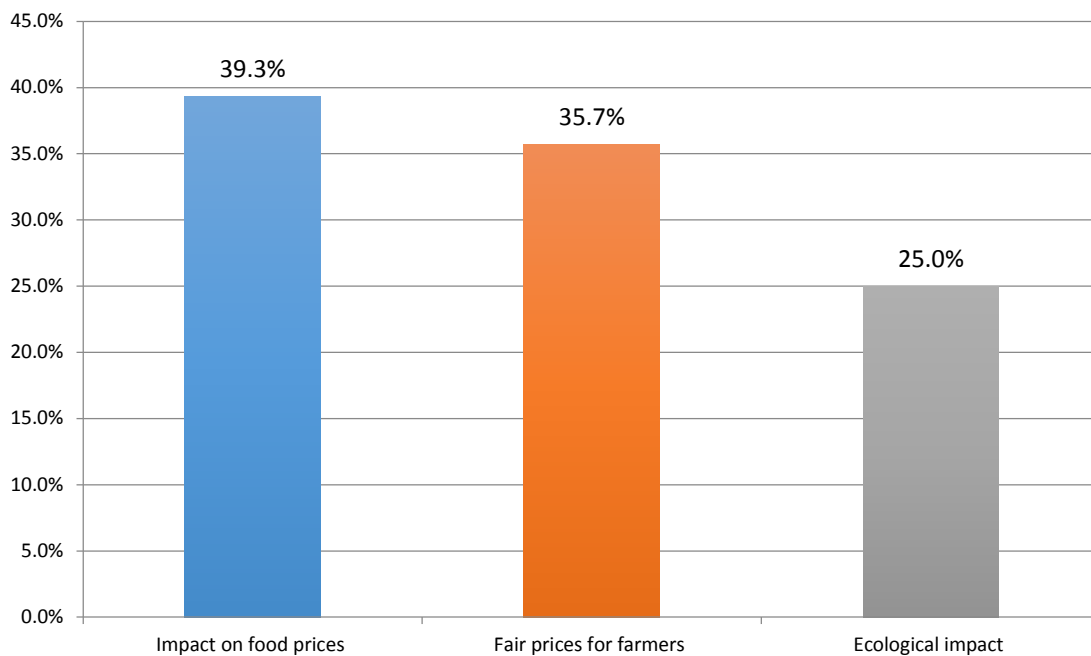


Figure 9: Graph view of stakeholder criteria relationships: NGOs.

According to Figure 9, the relationships between the three criteria are high. The numbers for Ecological & Fair Price are pretty close, which means all three are important to NGOs. The “impact on food prices” has the highest priority, followed by “fair price for farmers”, with “ecological impact” having the lowest relation.



**Figure 10: Criteria priorities for NGOs.**

According to figure 10 and based on observations of Figure 9, these criteria have high priorities, which is also due to the fact that there are only three criteria. “Impact on food prices” has highest priority at 39.3%. The second highest criterion is “fair prices for farmers” with 35.7%. This shows that protecting the farmers is important to NGOs. The lowest criterion is “ecological impact”; although it is hard to say this alternative is unimportant with 25% priority. Ecological impact is a general category and many criteria such as GHG emissions and air quality are included, which are one of the reasons of using biofuels. The priorities in figure 10 have been calculated by the PriEst software and validated by online software.

### **3.4 Discussion**

Each of the three stakeholder groups above will be discussed separately in the following sub-sections.

#### **3.4.1 Government**

The results suggest that the government respondents, in terms of biofuels, considers following and respecting international expectations a priority. Budget considerations and return on investment is another important alternative for them. As mentioned in the Analysis & Result (section 3.3), “comply with international targets” and “impact on governmental budget” have the highest priorities, covering 45% of the weight distribution. This means these two criteria are key components for policy makers and that other biofuel stakeholders who want to interact with the government for future plans should consider these two factors.

It is worth to pay attention to this factor that this stakeholder rated ‘comply with international targets’ higher than ‘impact on governmental budget’. In contrast to US and EU policies the Canadian government does not require sustainability standards be met for biofuels producers to benefit from them (Mondou & Skogstad, 2012). Rather, in 2011 Canada withdrew from the Kyoto Protocol (Hovi, Skodvin, & Aakre, 2013). To reconcile this issue, future research is suggested.

The next two criteria are “reduction of oil dependency” and “air quality”, which are very close together in terms of weight distribution. They have medium priority, but considering them in our study as important criteria will help us to understand more about

government stakeholders. “Reduction of oil dependency” can be considered from a political, environmental and economy perspective.

By focus on the criteria in government stakeholder group, we can divide air quality and greenhouse gas emissions in environmental category and impact on food price and impact on economic growth in economical category.

In environmental terms, one of the most important reasons for using biofuel is that by using cleaner energy we can have a cleaner environment (Kojima & Johnson, 2006); this view of having cleaner air is one of the goals of government as well ("Human Health Risk Assessment for Biodiesel Production, Distribution and Use in Canada – Executive Summary," 2012). Further, one of the biggest advantages of using biofuel and the goal of many countries is, as previously mentioned, to reduce greenhouse gas emissions and be more environmentally friendly (Bozbas, 2008). Therefore, it can be seen that there are contradictory responses between Belgian and Canadian stakeholders. However, this might also mean that Canadian government respondents may apply their answers to the 2<sup>nd</sup> generation biofuels, because the 2<sup>nd</sup> generation of biofuels have better results in greenhouse gas emissions compare to 1<sup>st</sup> generation of biofuels (Bioenergy, 2008).

As shown in figure 6, when compared to the others, the last three criteria have lower priorities. The Canadian government as a whole tends to place much emphasis on economic growth, and biofuels have been shown to have positive impact on the economy and economic growth (Evans, 2013).

### **3.4.2 Biofuels Producers**

According to the high priority of “greenhouse gas balance”, it seems having environmentally friendly energy is an essential task for biofuel producers in Canada. However, comparing this criterion in regards to government stakeholders and biofuel producers raises questions.

GHG emissions in government stakeholder, GHG balance in biofuels producers and ecological impact in NGOs are some of the criteria, which are have some common definitions and they are related. That’s the reason they are compared together.

According to OECD/FAO 2011 report, the demand for biofuel products is increasing annually ("OECD-FAO Agricultural Outlook 2011-2020," 2011), so it is important for producers to increase their production capacity in order to meet the increasing demand. In addition, biofuel, as a new source of energy, needs to compete with other sources of energy. Increasing production could be the way to compete with other local and international suppliers and to meet the high demand. This is one of the reasons to highlight the role of “production capacity”.

The “fair competition” criterion can change quickly based on many factors, such as establishing new biofuel manufacturers, the import/export of biofuels, government policy, and pricing, which can impact the fairness of competition in this field.

Based on the survey and responses regarding “investment cost” and “realistic margin”, biofuel producers are not as concerned about them. One of the reasons could be that growth of biofuel as a new and more reliable energy source, and the high demands for it,

allow biofuel producers to achieve satisfactory profits. This leads us to assume that the investment cost is not a biggest challenge for them. According to research by Harvard College, the second generation of biofuels is much more profitable than the first generation (Gokianluy, 2014). In our study, we surveyed biofuel producers from both categories and based on the result that we got, it seems most of the respondents are making second generation of biofuels.

### **3.4.3 NGOs**

“Impact on food prices” has the highest priority, which shows the focus of NGOs is on specific group who are affected by it such as end-users and farmers. As I explained earlier, biofuel is made from alive or recently dead organisms. The organism could be corn, sugarcane, starch, wood, wastes, and many other biomass products. In the first generation, the biofuel is made from real food not food wastes, which means it can have an impact on food prices. For example, instead of growing corn to meet human needs in Canada, a portion of it is used for biofuels, which means the demand for corn will go up and there is no enough supply. This would cause the food price to increase. Thus, this is one of the reasons that NGO stakeholders really care about.

Farmers as feedstock producers have an important role in biofuels and they are considered as one of the categories of stakeholders in this study. In order for the biofuel industry to run, it needs feedstock as raw materials, such as real food (especially for first generation biofuels). Therefore, paying attention to farmers and ensuring they are making a fair profit from their products is essential for the future of this industry. Also, in

general, agriculture has an important effect on economy growth in every country (Turcksin et al., 2011).

The 25% priority makes the “ecological impact” criterion pretty important. As I mentioned before, one of the reasons for using biofuels is to have a cleaner environment, less greenhouse gas emissions, and to help deal with the issue of climate change.

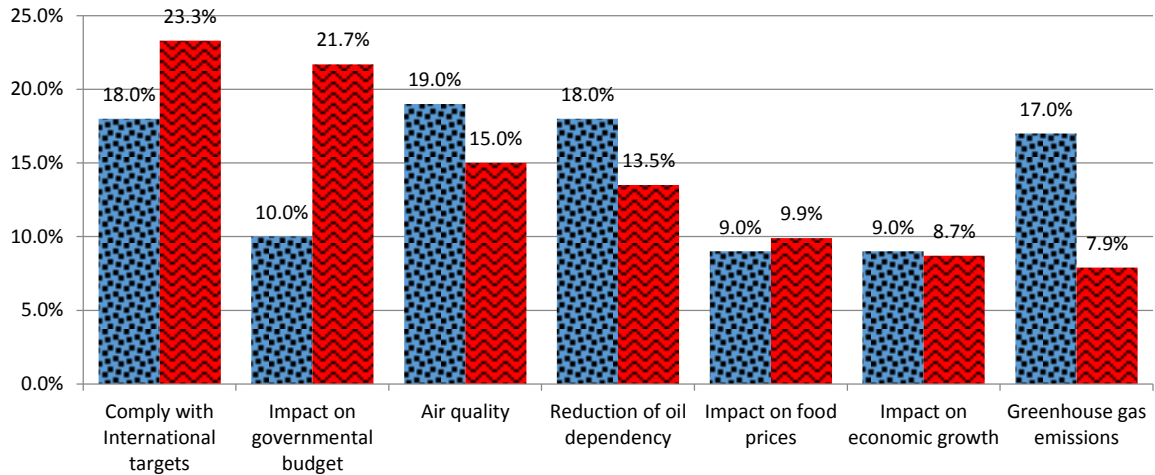
### **3.5 Comparison with Belgium**

One of the outcomes of this study is the difference between stakeholders’ interests between Belgium and Canada. By paying attention to the same stakeholders and comparing the mutual criteria, there are some factors that are worth discussing. The information of Belgium stakeholders is retrieved from Turcksin et al. (2011).

Figure 11 is comparing the government stakeholders for Canada and Belgium.

# Government

■ Belgium ■ Canada



**Figure 11: Comparison of priorities for government - Canada and Belgium.**

According to Figure 11, the impact on governmental budget is an important factor for the Canadian government and, with 21.7%, it is the second highest priority criterion. On the other hand, the Belgian government thinks this element is not very essential for their future goals and it has one of the lowest priorities among the criteria in the Belgian study. One of the causes of this diversity is because of the differing goals and visions of these two countries. Also, Belgium is located in Europe so the Belgian government has to abide by European Union (EU) rules and regulations regarding energy policies.

Another criterion with a big difference according to the government of these two countries is greenhouse gas emissions. Greenhouse gas emissions is one of the highest priorities for Belgians and lowest for Canadians. Both of these countries ratified the

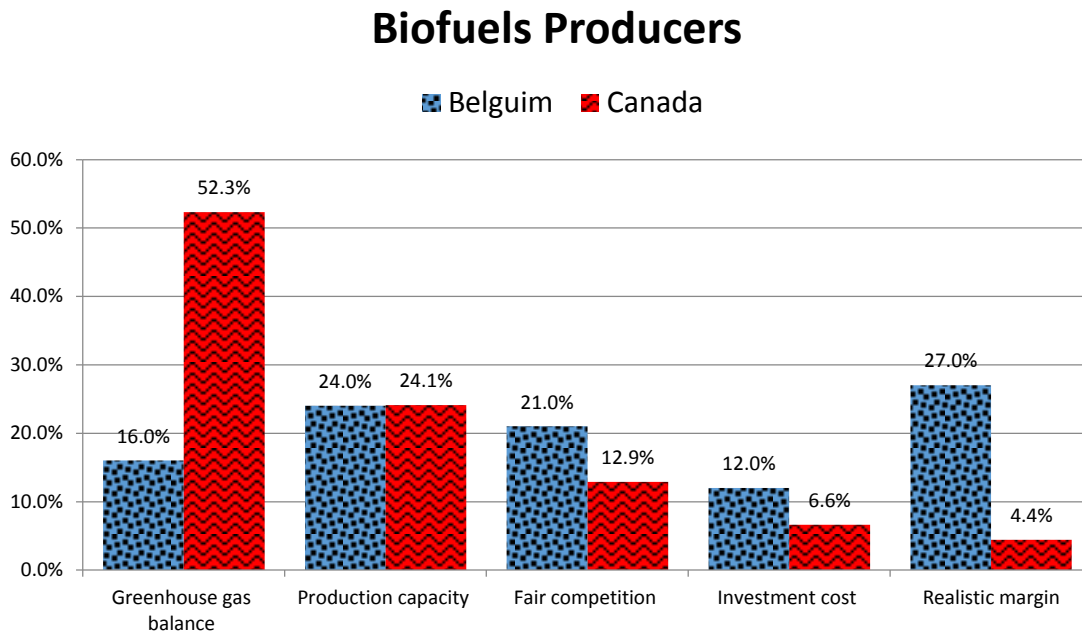
Kyoto Protocol<sup>10</sup> in 2002; however, Belgium made much progress to decrease its greenhouse gas emissions ("Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014," 2014) while Canada failed its attempt to reduce GHG emissions to 6% below the Kyoto Protocol between 2008 and 2012. Canada is still one of the world's largest GHG emitters ("Greenhouse Gas (GHG) Emissions," 2013). Belgium must follow EU regulations plus the Kyoto Protocol, and it seems they accomplished it during the past.

There are some other minor differences between Canada and Belgium in Figure 23, but the two above-mentioned criteria have the biggest contradiction and are worth discussing.

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10. "The Kyoto Protocol allows reductions in emissions of several 'greenhouse' gases to be credited against a CO<sub>2</sub>-equivalent emissions limit, calculated using 'global warming potential' indices for each gas" (Reilly et al., 1999, p.549).

Figure 12 is comparing the biofuel producer stakeholders for Canada and Belgium.



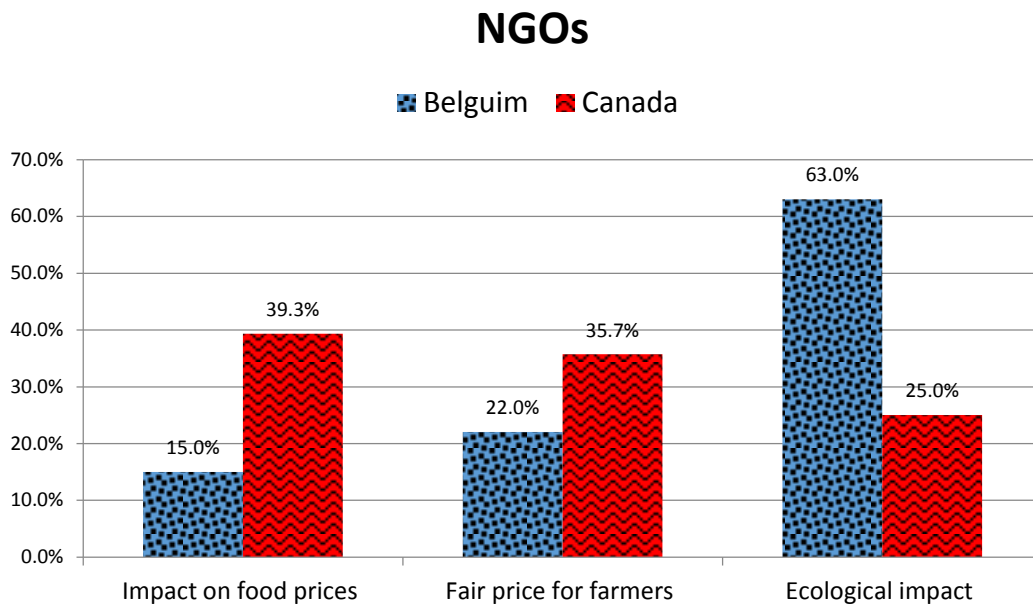
**Figure 12: Comparison of priorities for biofuel producers - Canada and Belgium.**

The biggest contradiction is among biofuel producers. The responses from Belgian and Canadian biofuel producers are totally different. According to Figure 12, greenhouse gas balance is the most important priority among Canadian biofuel producers and it has more than 50% priority compared to all other criteria. Belgian producers believe this criterion is not that important and that there are other essential factors before this. According to a EU report ("Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014," 2014), GHG emissions were most effectively controlled in Belgium, which may suggest that that this particular factor is no longer a concern for Belgium. However, the biggest question is why Canadian biofuel producers are so focused on GHG emissions, even more than the government is. One of the reasons could be the considerable profit, which is related to realistic margin and another reason could be the

rule in place by the government or pressure from NGOs. From a business point of view, it is rather difficult to believe that Canadian biofuel producers are paying more attention to GHG emissions than their own profit (realistic margin), especially when the difference between them is more than 10 times. To investigate this issue, further study needs to take place.

Realistic margin, which is the economic criterion, has the highest priority among other criteria on the Belgian side. This is pretty normal because this factor brings money and profit to producers. However, for Canadian producers, realistic margin has the lowest priority. As I explained before, it seems Canadian biofuel producers are not worried about the profit that they make. One possible explanation might be the high demand of different types of biofuels and the annual increase of this demand ("OECD-FAO Agricultural Outlook 2011-2020," 2011).

Figure 13 is comparing the NGO stakeholders for Canada and Belgium.



**Figure 13: Comparison of priorities for NGOs - Canada and Belgium.**

According to Figure 13, Canadian NGOs rank all of the criteria relatively evenly. As shown, the NGO stakeholders in Belgium are not very interested in the food prices or impact of biofuel on food prices. On the Canadian side, impact on food price has the highest priority. There are around 50 plants located in Canada where renewable fuels are produced and approximately 20 of them use food to make biofuels; this means they are using first generation biofuels, which use edible food ("Plant Locations," 2010). Using edible food has some negative impacts on food prices due to the competition with food crops. In contrast, in Belgium there are only around 4 major biofuel plants (Harteveld, Godfroid, Neeft, Samson, & Rogulska, 2009).

Ecological impact has the highest diversity between Canada and Belgium. The difference is around 40%. The Belgian NGOs are focusing on ecological impact and the protection of planet Earth as well as reducing GHG emissions, in which they are doing a great job. NGOs in Canada are not targeting the ecological impact factor that has a negative impact on the environment. To understand the reasons of this point, future study is recommended.

## **4 Chapter IV: Research Impact and Government Policy**

The second part of my study draws on data obtained from the same questionnaire described above. It aims to provide a first empirical exploration of two separate research questions: What contributions do researchers expect to make to stakeholders?, and: What policies do stakeholders (including researchers) consider important to biofuel commercialization? Subsection 4.1 addresses the first research question, and subsection 4.2 the second.

### **4.1 Anticipated Impact of Research on Stakeholders**

#### **4.1.1 Methodology**

This section focuses solely on the responses of researchers to a separate section of the questionnaire (see Appendix 6). The purpose is to obtain information on the kinds of impacts researchers expect to have on their stakeholders. The stakeholders under investigation are biofuel producers, feedstock producers, fuel distributors, end-users, vehicle manufacturers, government, and NGOs.

The researchers were asked to assume the project that they were working on was already finished and commercialized, and then we asked what the impacts of this project (along

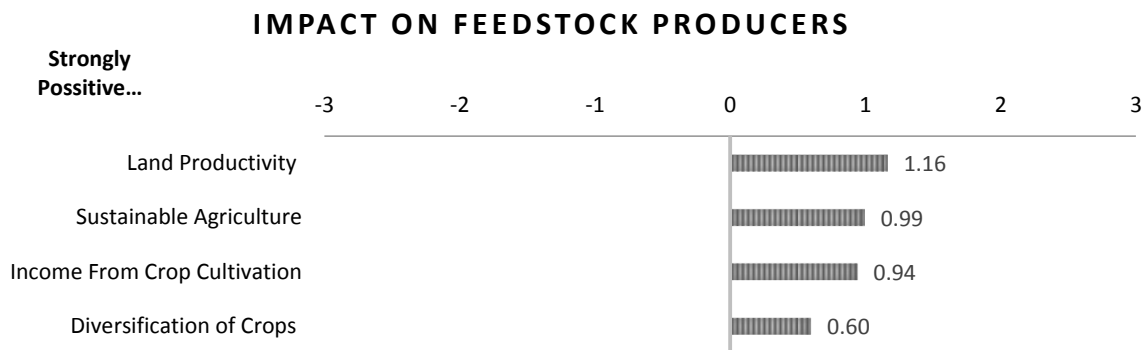
with related technologies and infrastructure) would be on the stakeholders, compared to existing, commercially available biofuels.

The questionnaire prompted researchers to identify whether the impact of this project on the different categories was ‘strongly negative’, ‘moderately negative’, ‘slightly negative’, ‘neutral or not applicable’, ‘slightly positive’, ‘moderately positive’, or ‘strongly positive’. The middle category combines neutral and not applicable based on the assumption that research would not have any impact on a dimension that is not applicable. For analysis purposes, this scale was transformed into a scale from -3 to +3, allowing the calculation of the averages presented below. There are a total of 9 responses used in this section. This section used the shorter format of the traditional 7-point Likert scale rather than the pairwise comparison in order to keep the questionnaire to a manageable length and complexity and not dissuade respondents from completing it.

#### **4.1.2 Analysis & Results**

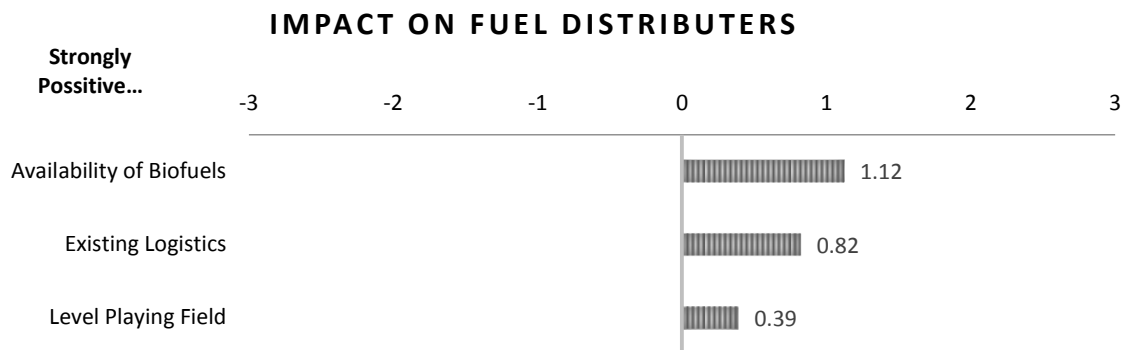
There are three stakeholders (biofuel distributors, government, and NGOs), which have the same criteria from section 3.3 Analysis & Result. However, the extended stakeholders (feedstock producers, fuel distributors, vehicle manufacturers, and end-users) have new and different criteria that were considered more relevant as potential impact dimensions of biofuels research.

Average responses with regards to impacts of the focal research projects on the dimensions indicated are presented in the following figures.



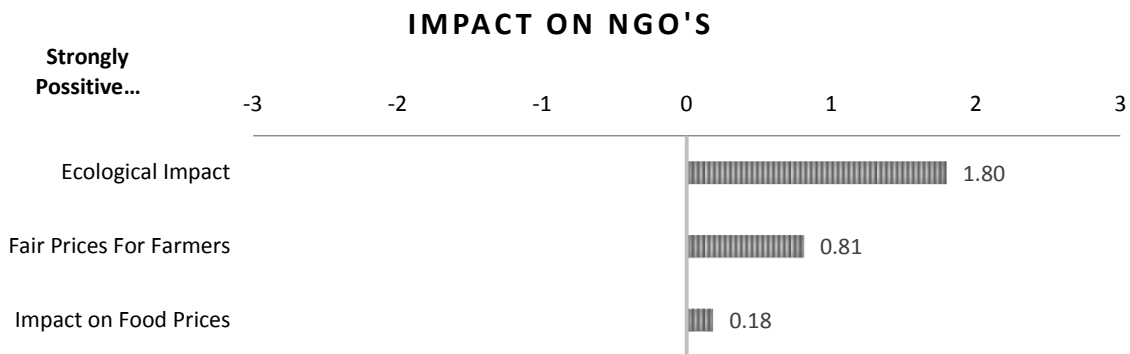
**Figure 14: Impact of researchers' projects on feedstock producers' dimensions.**

Figure 14, displays the four dimensions relating to feedstock producers: “land productivity”, “diversification of crops”, “sustainable agriculture”, and “income from crop cultivation”. The figure shows that the researchers believe their projects have a slightly positive impact on all of these dimensions. As we can see, researchers anticipate impacts on “land productivity”, “sustainable agriculture”, and “income from crop cultivation” to be similar, in the ‘slightly positive’ range. Impact on “diversification of crops” is slightly less, at 0.6.



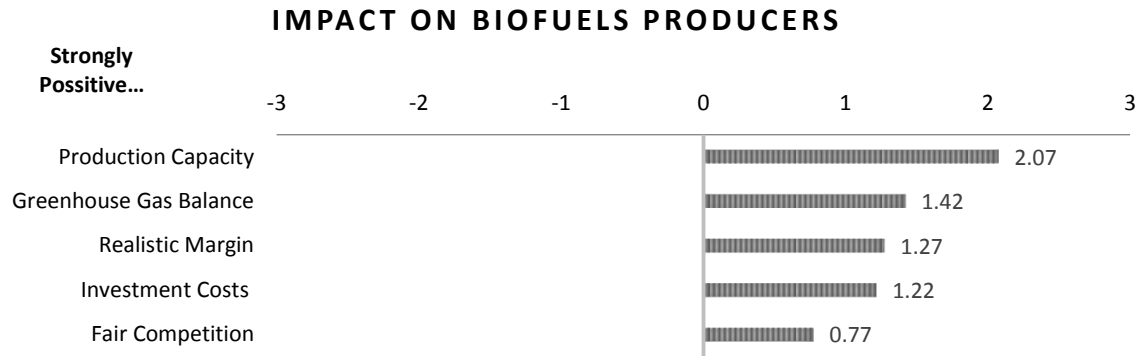
**Figure 15: Impact of researchers' projects on fuel distributors' dimensions.**

In Figure 15, which belongs to fuel distributors, there are three dimensions: “availability of biofuels”, “level playing field” and “existing logistics”. The figure shows that the researchers believe their projects have a slightly positive impact on the fuel distribution stakeholders. As shown in the figure, “availability of biofuels” and “existing logistics” are both close to +1 on the vertical axis, and “level playing field” has a smaller impact, which is around 0.4.



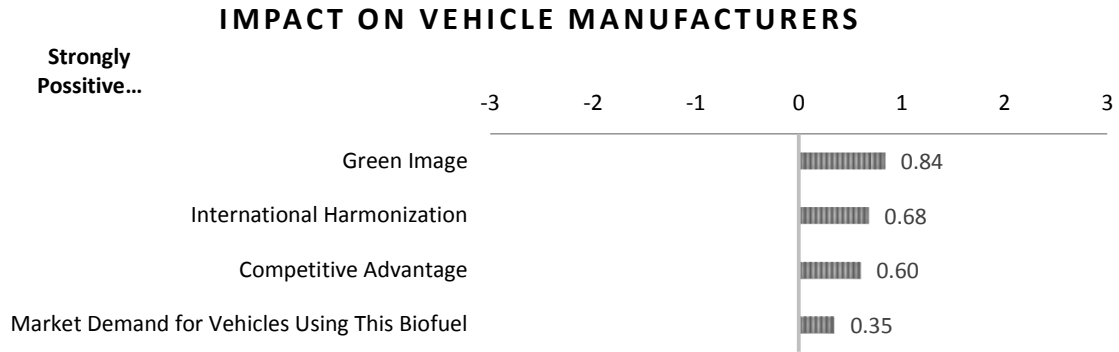
**Figure 16: Impact of researchers' projects on NGOs' dimensions.**

Figure 16 is about NGOs. Like biofuel distributors, there are three dimensions here as well: “ecological impact”, “fair price for farmers”, and “impact on food prices”. As we can see from Figure 16, according to the researchers, the first dimension, “ecological impact” has the highest impact at 1.8. The second dimension, which is “fair price for farmers”, has less impact compared to the previous; the number associated to it is around 0.8. The last dimension is “impact on food prices”, which has a very small positive effect. If we believe 0 is in the middle and, therefore, neutral, this dimension is slightly more positive than neutral.



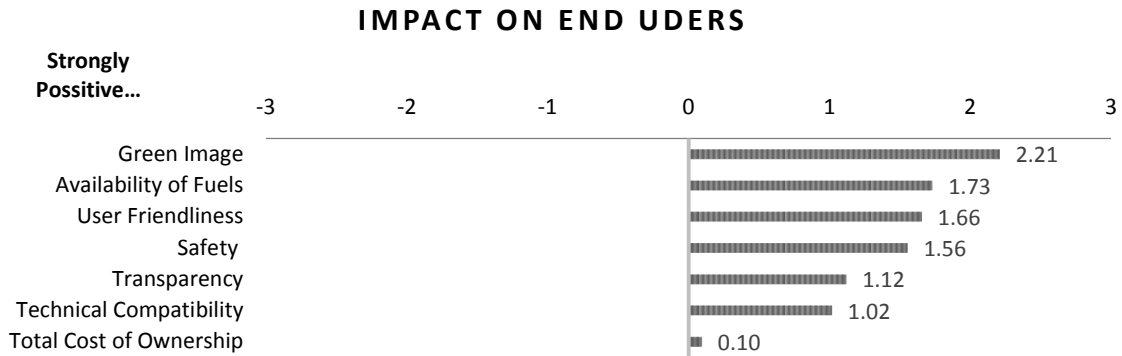
**Figure 17: Impact of researchers' projects on biofuel producers' dimensions.**

According to Figure 17, there are five dimensions available for biofuel producers. These are: “investment cost”, “greenhouse gas balance”, “realistic margin”, “fair competition”, and “production capacity”. This figure shows that researchers believe their work to have a pretty high impact on biofuel producers. The first three dimensions, which are “investment cost”, “greenhouse gas balance”, and “realistic margin”, have very similar impact levels, their range is from 1.20 to 1.42. The “fair competition” dimension has the lowest impact among all of the dimensions and the number that represents it is around 0.8. On the other hand, “production capacity” has the highest impact; at almost 2.1 out of 3, this dimension is strongly positive.



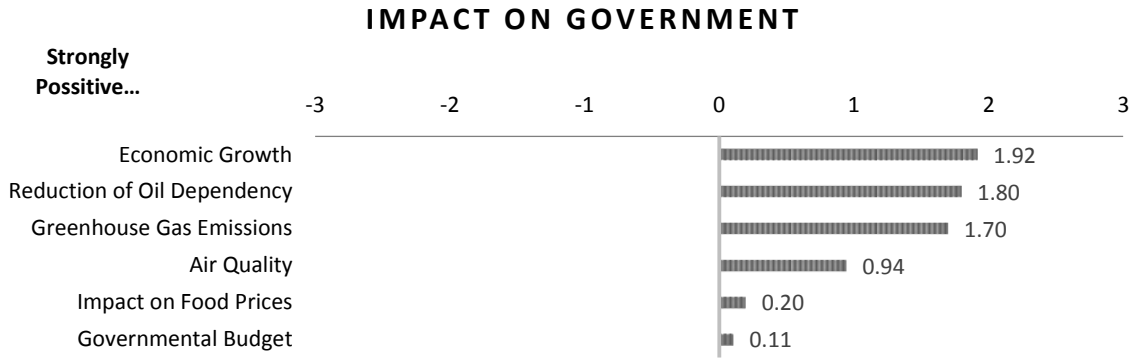
**Figure 18: Impact of researchers' projects on vehicle manufacturers' dimensions.**

Figure 18 represents vehicle manufacturers. There are four dimensions, which are “competitive advantage”, “green image”, “international harmonization”, and “market demand for vehicles using this biofuel”. According to the figure, researchers have positive impacts on this stakeholder group, but the impacts are not far above the neutral middle. “Green image” has the highest impact at 0.84, and the lowest is “market demand for vehicles using this biofuel” at 0.35. The other two dimensions are within this range; “competitive advantage” is 0.6 and “international harmonization” is around 0.7.



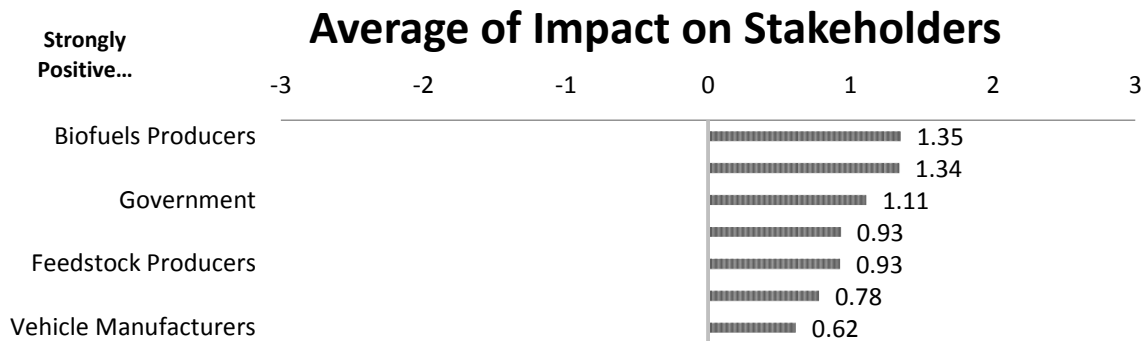
**Figure 19: Impact of researchers' projects on end-users' dimensions.**

Figure 19 belongs to end-users. This stakeholder has the highest number of dimensions among other stakeholders, which are “transparency”, “safety”, “user friendliness”, “green image”, “availability of fuels”, “technical compatibility”, and “total cost of ownership”. According to the figure, all of these dimensions have a positive impact on end-users. “Green Image” has the most positive impact at 2.21. There are three dimensions, “availability of fuels”, “user friendliness”, and “safety”, which are very close to each other with a range between 1.7 and 1.5. “Technical compatibility” and “transparency” are also very close; both of these are around +1. All of these dimensions have a positive impact, but the last dimension, “total cost of ownership”, is quite close to the neutral line. This dimension is slightly higher than 0, which means it is still positive, but it is not comparable with the other dimensions.



**Figure 20: Impact of researchers' projects on government dimensions.**

According to Figure 20, there are six dimensions available for government. These are: “economic growth”, “impact on food prices”, “reduction of oil dependency”, “air quality”, “greenhouse gas emissions”, and “governmental budget”. The figure shows that the researchers believe their projects have quite a positive impact on some dimensions for this stakeholder. As we can see, “economic growth”, “reduction of oil dependency”, and “greenhouse gas emissions” all have the highest impact. The range of these dimensions is from 1.92 to 1.7. Researchers believe “air quality” has a positive impact too, at 0.94. The last two dimensions, which are “impact on food prices” and “governmental budget”, are close to the neutral line. It seems these two dimensions do not have a high impact in researchers' projects regarding government.



**Figure 21: Impact of researchers' projects on all the stakeholders'.**

Figure 21 shows the average impact of researchers' projects on stakeholders. As we can see and according to their feedback, biofuels producers receive the highest impacts and positive effects, followed by end users, government, NGOs, feedstock producers, fuel distributors and vehicle manufacturers. An important note to consider is that all of these stakeholders receive positive effect and none of them are below zero.

### 4.1.3 Discussion

Overall, the researchers believe that the project that they are working on will have positive effects all stakeholder groups (Figure 21). With regards to feedstock producers (Figure 14), researchers expect the greatest positive impact on 'land productivity', followed by 'sustainable agriculture' and 'income from crop cultivation', and they have lower expectations of contributing to 'crop diversification'. It is important to keep in mind that the researchers surveyed are primarily investigating second or later generations of biofuels, which do not use food crops for the production of biofuels. In this sense, the

expected positive impact of research on both productivity and sustainability in agriculture is not a contradiction. Rather one might suggest that the stakeholder objections to first generation biofuels has potentially had an influence on the research agendas pursued by publicly funded researchers.

Figure 15, shows that researchers also anticipate a positive effects on fuel distributors. Respondents suggest their research may aid increase the availability of biofuels, which are not very accessible in Canada. Finding a gas station that provides biofuel is very limited; in 2007, there were only two public filling stations that provided biofuels to customers ("Biofuel vehicles need more places to fill up," 2007). The number of stations has increased, but more development is needed in this field.

In terms of the factors affecting NGOs, the researchers' focus is on the ecological impact (Figure 16). Fossil fuels cause many negative environmental impacts such as global warming, air pollution, and water and land pollution (Lvovsky, Hughes, Maddison, Ostro, & Pearce, 2000). One of the most important reasons for using new energy sources, like biofuel, is to deal with these issues (Fargione et al., 2008). These problems require long-term plans for full recovery, making the "ecological impact" factor very important among the others. The level of awareness from researchers makes this point clear and they expect their projects to have a positive effect on ecological impacts.

In Figure 17, researchers' projects have a positive impact on all of the categories related to biofuels producers. "Production capacity" receives the highest score for this stakeholder group, and overall the second highest score across all stakeholder groups. Production capacity might not typically be considered the key impact engineering and

science researcher aim to have. Presumably, this is an expression of the difficulty of scaling emerging biofuels technology to commercial capacities, which necessitates contributions by researchers. Second and later generation biofuels are generally at a stage now where they have been demonstrated in laboratories, but they have not yet achieved commercial maturity. Many small companies do not have sufficient internal research capabilities to address all the issues associated with scale-up and commercial production by themselves.

Further research should consider whether this focus is at least partially due to effective interactions between researchers and biofuel producers, in that biofuel producers have managed to garner the attention of researchers more than, e.g. feedstock producers. As with regards to other stakeholders, researchers also anticipate positive impacts on the GHG balance as related to biofuel producers.

Based on the responses from the researchers in Figure 18 relating to vehicle manufacturers, researchers anticipate the greatest impact on the manufacturers' ability to claim a 'green image'. However, they see their impact in this regard as much lower than the similar impact for end users. Indeed, impacts on all of the categories relating to this stakeholder group are relatively small, indicating that they are close to neutral.

Paying attention to the impacts on end-users is essential (Figure 19). End-users are the people who pay for biofuel, so having the proper knowledge and information about the products that they want to buy (transparency) is very important. "Green image", "Safety", "Availability", and "user-friendliness" of biofuels are significant factors for end-users. "Safety", "green image", "user friendliness", and "transparency" have a positive

psychological impact on end-users and could encourage them to pay for this product. Availability of fuels was discussed in the fuel distributor section, which can cover end-users as well. Potential impact on “Technical compatibility” could benefit vehicle manufacturers and end users. It is important to note that researchers overall rated their anticipated impacts as highest for end users, specifically with regards to the end-users’ ability to project a ‘green image’.

Finally, with regards to impacts on government interests (Figure 20), researchers anticipated high impacts for ‘economic growth’, ‘reduction of oil dependency’, and ‘greenhouse gas emissions’. They anticipated much lower impacts on ‘air quality’, ‘food prices’, and ‘governmental budgets’. The anticipated positive impact on economic growth and oil dependency aligns well with the anticipated impacts on increasing land productivity for feedstock providers and production capacity for biofuels producers. Given the ongoing debate on the GHG balance of various biofuel platforms, and the early development stage of many of the second and especially third generation biofuels, the source of optimism for the relatively high and positive anticipated impact on GHG emissions is not immediately clear. Finally, to comment in a point addressed in the last part of this thesis, researchers do not anticipate noticeable impacts on government budgets. This result seems to some extent contradictory to the other impacts anticipated by researchers, for example with regards to increased land productivity, which might reduce the requirement for agricultural subsidies, or with regards to economic growth, which presumably would increase the tax base. Thus, one might ask whether such impacts are truly not anticipated, or whether researchers are not aware of them.

## **4.2 Impacts of Government Policies on BioFuel Commercialization**

This section explores the perceptions of the different stakeholder groups with regards to the importance of government policies and programs in facilitating the commercialization of biofuels. The stakeholder groups included in this section are researchers, biofuels producers, government, and NGOs. The aim of this section is to answer the research question: What policies do stakeholders (and researchers) consider important to biofuel commercialization?

### **4.2.1 Data and Methodology**

The analyses in this section are based on the survey as the previous sections. In this case, responses all stakeholder groups, including researchers were considered. The number of respondents varies from those in the previous sections (9 researchers, 5 biofuels producers, 9 government respondents, and 5 NGO respondents) due to the incomplete responses.

Respondents were asked to answer the following question: ‘From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels’ for each of a number of policy and program options. These answer categories were derived from the seminal Rajagopal & Zilberman (2007) report, as adapted by Schillo and Isabelle (2014).

#### 4.2.2 Analysis & Results

We asked these stakeholders about their assessment of the importance of government policies and programs in ensuring successful commercialization of the next generation of biofuels. As per Figures 21 to 24, we had them scale their ideas from High, Medium, and Low. The number 1 represents Low and 3 represents High. To aggregate the responses from individual stakeholders, I calculated the geometric mean and used it in the following figures in order to have a more accurate analysis and precise figures.

Figure 21 presents the assessment of researchers. In their view, the biofuel tax credit is the most important factor among the policies with 2.6 out of 3, and this is followed by the biofuel mandate. There are four policies that have the same average level of importance: carbon/gasoline tax, public R&D, support for private R&D, and technology transfer. The importance of these policies is higher than average. After this point, the importance of the other policies is lower than average. Price support is the closest policy to the average line with a scale of 1.9. Efficiency standard and technology mandate are in the same position. The import tariff, with 1.7, is next and acreage control and export subsidy follow it. Vehicle subsidy and export quota have the lowest importance among the policies; according to the researchers' perspective, these two policies are not as important as the other policies in ensuring the success of the next generation of biofuels. These two policies are represented by 1.5 each. There is a total number of nine responses from researchers in this section.

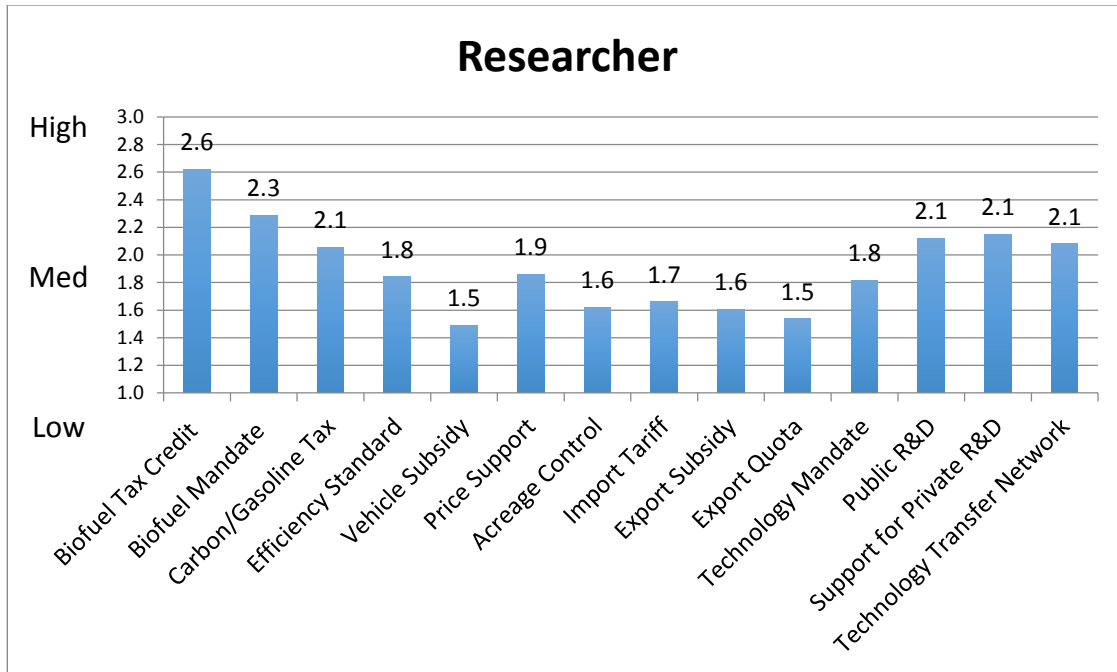


Figure 22: Researchers' opinions on biofuel policies (N=9).

Figure 22 is the biofuel producers' perspectives regarding the importance of the aforementioned policies regarding the commercialization of the next generation of biofuels. Support for private R&D policy is the most important factor here with a 2.4. It is also the only factor that is above the average line. Efficiency standard and technology transfer are both on the average line and all the other policy programs are below the line; however, they are all very close to each other. Biofuel tax credit, vehicle subsidy, price support, and public R&D have the same influence of 1.9, which is almost the average. Biofuel mandate, carbon/gasoline tax, import tariff, and export quota have same value as well at 1.8. Technology mandate and acreage control are the lowest two, represented by 1.7 and 1.6, respectively. The total number of responses from biofuel producers in this section is five.

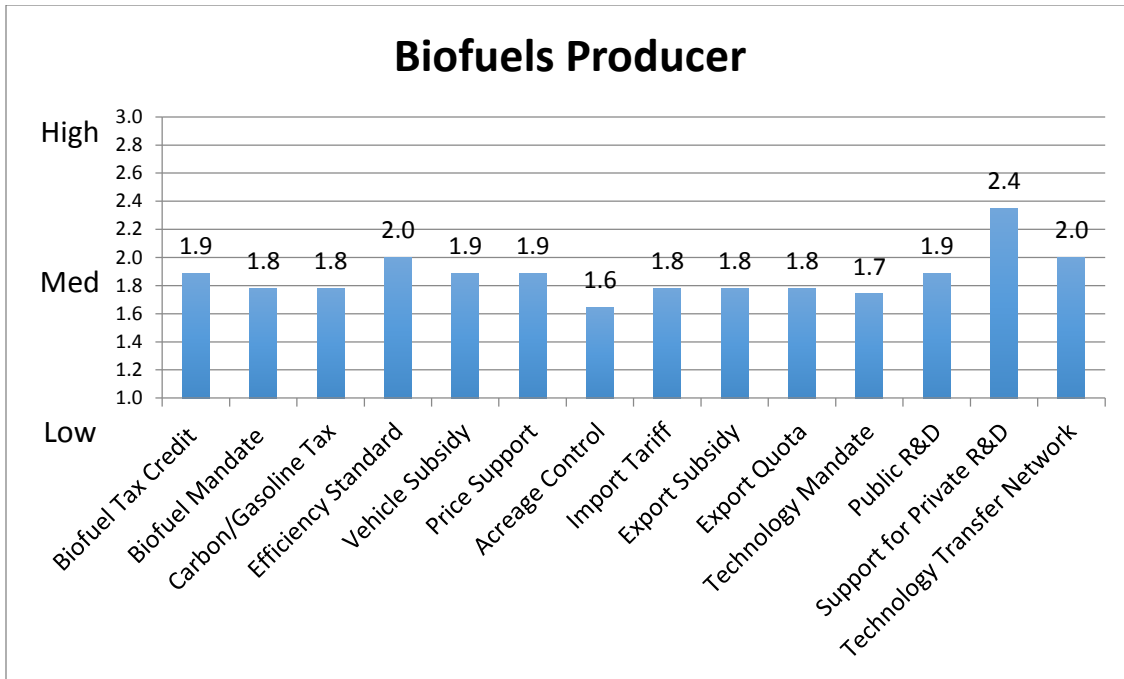


Figure 23: Biofuel producers' opinions on biofuel policies (N=5).

The government respondents differentiate more strongly between the different policy tools than the other stakeholder groups, as shown in Figure 23. The biofuel mandate is a very high priority compared to the other policies, with a 2.9 out of 3 for this factor. The second factor, carbon/gasoline tax, is also very important for government representatives at 2.5. There is a significant gap between these two factors and next one. Support for private R&D and technology transfer have the same influence at a value of 2.0. Biofuel tax credit and efficiency standard are the next policies, which are very close to average with 1.9. There is another 0.5-unit gap after this with the next two factors having the same weight; these factors are acreage control and import tariff and both their weights are 1.4. Price support and vehicle subsidy are the next policies with 1.3 and 1.2, respectively. At the lowest end are export subsidy and export quota policies, which government

representatives believe have the lowest values regarding the commercialization of the next generation of biofuel. Both of these two policies are related to exporting. The total number of responses from the government in this section is nine.

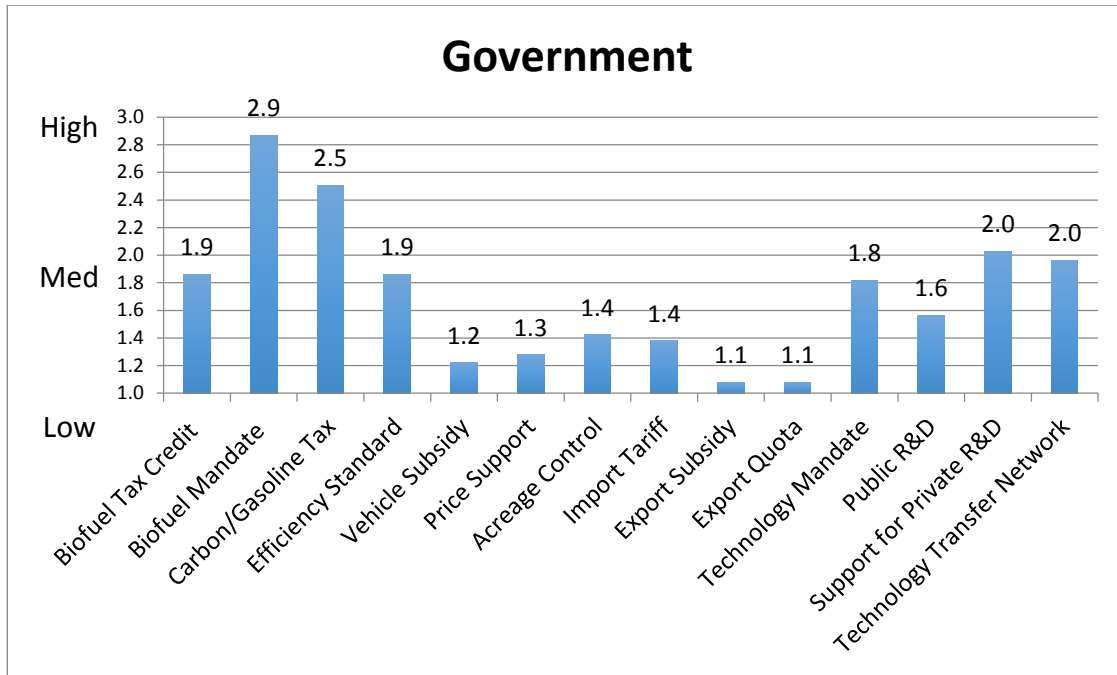


Figure 24: Government opinion on biofuel policies (N=9).

The perspective of non-governmental organizations is shown in Figure 24. There are three policies that have the highest influence among the others: biofuel mandate, carbon/gasoline tax, and public R&D all have the highest priority at 2.6, according to NGOs. The next policies with the same level of interest are efficiency standard, technology mandate, and technology transfer, each with a weight of 2.2. Support for private R&D is exactly on average line, meaning it has medium influence. The biofuel tax credit, at 1.9, is the next policy. Vehicle subsidy and price support have 1.6 units,

followed by acreage control at 1.5. The last three policies are import tariff, export subsidy, and export quota. They have the lowest value among the other policies at 1.3, and all of them are related to the import and export policies. The total number of responses from NGOs in this section is five.

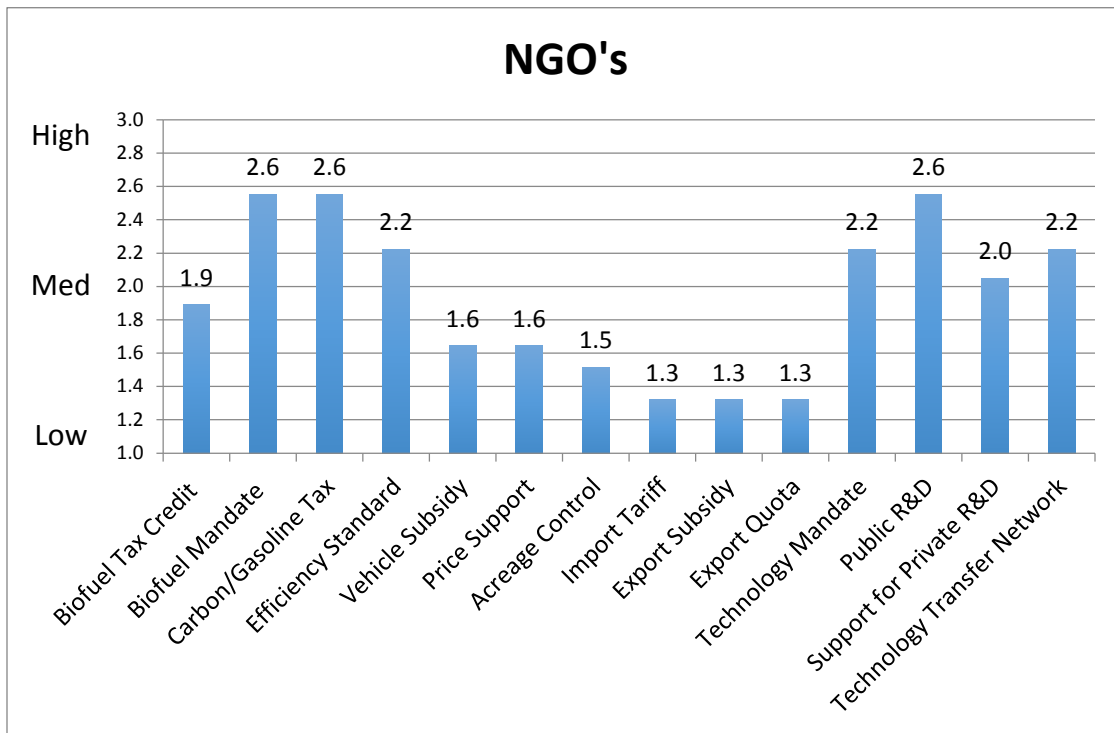


Figure 25: NGOs' opinions on biofuel policies (N=5).

### 4.2.3 Discussion

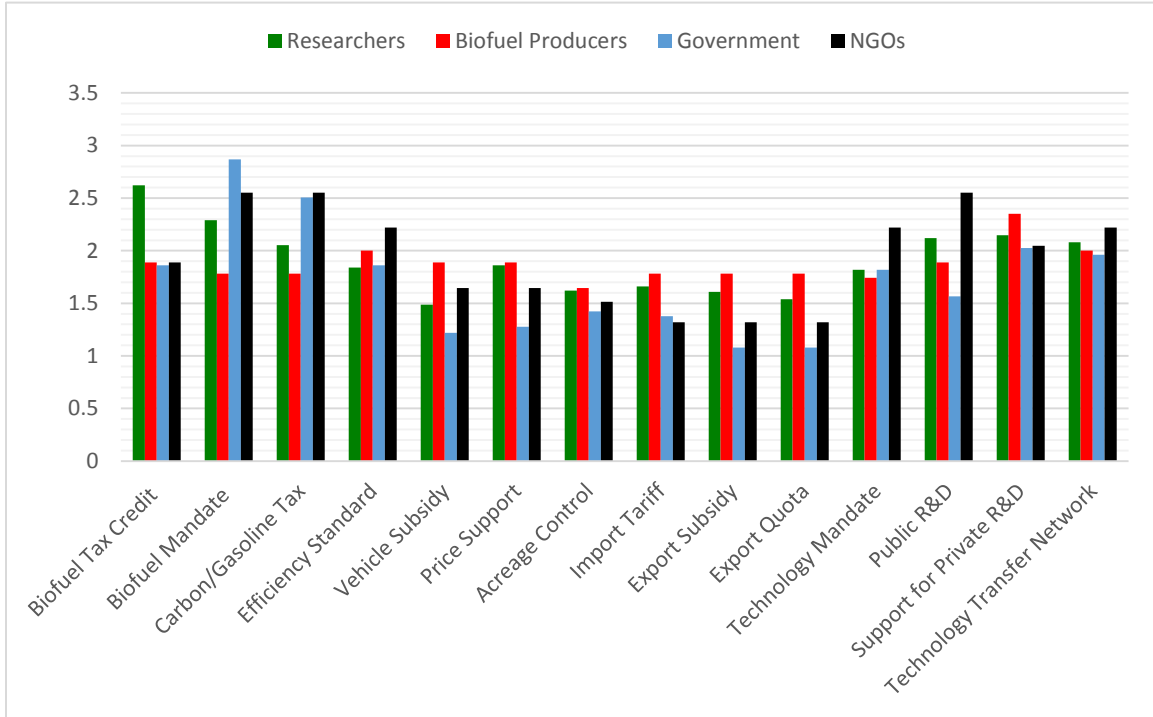
Figure 25 is the combination of the above-mentioned figures (Figures 21 to 24). It shows that Government and NGO have similar response patterns. Acreage control, import tariff, export subsidy and export quota policy, they are in pretty close range. On the other hand, researchers and biofuel producers have quite similar response patterns, as well.

Researchers believe the biofuel tax credit and biofuel mandate are more important factors compared to biofuel producers but, after that point, the rest of the policies received similar responses. According to this figure, the government stakeholders identify the most important policy as biofuel mandate and the least important policies as export subsidy and export quota.

There are three important areas in this figure. The first area is at the very starting point. Three of the stakeholders agree about the level of importance of the biofuel tax credit; however, the researchers believe this policy is the most important factor among others, while the other three stakeholders focus on different policies. Government and NGOs believe the biofuel mandate and carbon/gasoline tax are quite important, but the researchers believe their influence is less, and biofuel producers view it as lower than average. Efficiency standard is the policy that all the stakeholders view as of average importance.

The second important area of the figure is in the middle where there are other policies such as vehicle subsidy, price support, acreage control, import tariff, export subsidy, and export quota – all of which are below the average line from the perspective of all four stakeholders. The figure shows that there are no substantial differences for these priorities.

The third area starts at technology mandate for government and NGOs. Their responses show the public R&D for them is important also researchers and biofuel producers have more preferences on them as well. Support for private R&D and technology transfer network have very similar responses from all these stakeholders.



**Figure 26: Opinions of all stakeholders on biofuel policies.**

By analyzing the three stakeholder groups' responses regarding and their point view regarding the related criteria and comparing their answer with researchers contribution and goals base on two category of environment and economy, the table 2 has been draw.

In this table the main priority of both group has been shown.

It seems government stakeholder main focus is regarding economy, and researchers contribution is mainly on economy too, which shows both stakeholders are in the same line. However in comparison for biofuels producers and NGOs, the responses don't seem to be well aligned. Biofuels producers focus on environmental criteria more than economic factors, but the researchers' main focus is economic factors. For NGOs

stakeholder the situation is similar. NGOs' main priority is on economy factors, but the main focus of researchers is on environmental factors.

<b>Stakeholders</b>	<b>Priorities</b>	<b>Research Contribution</b>
<b>Government</b>	Economy	Economy
<b>Biofuels Producers</b>	Environment	Economy
<b>NGOs</b>	Economy	Environment

**Table 2: Stakeholders & researchers main focus.**

## **5 Chapter V: Summary & Conclusion**

### **5.1 Summary**

Biofuels derived by converting biomass into products such as bio-ethanol or bio-diesel have captured the collective imagination of governments, farmers, and individuals due to their potential contributions to reducing greenhouse gas emissions, increasing farming income, and reducing the dependency on fossil fuels. Biofuels have been available at least since the early days of automotive development, with both Henry Ford and Rudolph Diesel anticipating their wide-spread use. Despite the fact that the technological feasibility of biofuels use has been documented in numerous contexts since the early automobile days, fossil fuels have captured the vast majority of the market share, with the ensuing negative environmental and geopolitical consequences.

Thus, it seems that factors other than technological feasibility drive the adoption of fuel platforms. Perhaps most obviously, economic factors can be expected to play a major role, but the recent efforts to introduce commercial-scale biofuels based on food products show that stakeholder objections can have strong negative impacts on the viability of biofuel innovations. This study has explored the perspectives of a range of stakeholder groups in terms of their interests and perceptions.

The purpose of the first part of this study is to identify the interests of different stakeholder groups involved in the biofuel industry in Canada. It is based on primary data collected from representatives of each stakeholder group. It follows a framework developed by Turcksin et al. (2011), who use a similar stakeholder analysis as input to a Multi-Actor Multi-Criteria Analysis (MAMCA) to assess different biofuel alternatives and opportunities. This study draws on the definition of stakeholders, as well as the list of potential interests these stakeholders may have with regards to biofuels. This study uses pairwise comparisons of potential interests for each stakeholder group. The results are analyzed using a methodology commonly used in the Analytic Hierarchy Process (AHP, Saaty 1990) to derive a ranking of stakeholder interests for each group, along with the respective weights expressing the importance of each interest. The key results of this study are the weighted rankings of interests for each stakeholder group. These results also allow for a comparison between Canada and Belgium, based on the earlier work of Turcksin et al. (2011).

The second part of this project explores the potential impact of public research and public policies and programs on the development of the biofuels industry. It loosely draws on the criteria identified in the first part as important and assesses perceptions of researchers with regards to the potential impacts of their work. In addition, all stakeholder groups were asked to rate the importance of fourteen different policy tools to the successful commercialization of biofuels. The policies are based on the seminal work by Rajagopal and Zilberman (2007).

## 5.2 Limitations

In terms of limitations, there are three key factors to keep in mind that are worth mentioning. These limiting factors are related to use of validated measurement tools, means of data collections and the use of representative respondents.

With regard to the development of measures and theory, this study was limited by the relative dearth of validated measurement tools and theoretical frameworks specifically relating to biofuels. This is particularly evident in the section regarding links between policy tools and biofuels commercialization: There is little theoretical exploration of policies for biofuels, therefore this thesis draws on more general policy concepts that are of potential relevance to biofuels.

With regards to data collection, the biofuels community in Canada is relatively small. This means that large data sets, e.g. are required for regression analyses or similar are very difficult if not impossible to obtain. However, it also means that the smaller sample sizes are more representative of the small population. It is important to note, however, that this thesis relied on representative stakeholders, much like the earlier Turcksin et al. (2011) study. The assumption is that the respondents were able to provide answers that reflect the views of their general stakeholder group, thus it does not rely on statistical concepts of representative samples. The results of this thesis suggest that this assumption of representative stakeholders is worth further investigations.

The results from certain stakeholder groups varied dramatically from the Belgian sample, as well as from the results that may have been expected based on contextual knowledge.

This particularly applies to biofuel producers and government stakeholders. It is possible that the use of 'representative' respondents is not an appropriate methodology, given that these respondents may respond based on preconceived notions, rather than actual stakeholder evaluations. However, there are many studies such as Neyman (1983), Yates (1935) and Lee, Lindquist & Acito (1997) that applied the same methodology in their studies and got the satisfying results. Another possibility is that this study failed to appropriately identify representative stakeholders. Future studies should explore whether the unanticipated results of this study are a consequence of the methodology or whether they are accurate reflections of the perceptions of Canadian stakeholders.

### **5.3 Future Studies**

I deeply believe that by doing more research, I could answer many other questions regarding my study, but there are some key points that will be very useful for future study. One of the most important points is to conduct the same analysis, using MAMCA and AHP, with other stakeholders in the industry.

In AHP pair-wise comparison, for the biofuel producers, there is a big gap between greenhouse gas balance and the other criteria, especially realistic margin. I believe there are many reasons that impact this decision, which needs to be researched more; studying this point further may reveal the reason why biofuel producers are more concerned about GHG emissions than the government is (Sims et al., 2010).

Another point that I believe needs further research is NGOs. By comparing the priorities of Canadian and Belgian NGOs, the results show Belgian NGOs are more curious about

ecological impact than Canadians are, but the question is: why are Belgian NGOs so concerned about it when they have successfully controlled their GHG emissions, yet Canadian NGOs, whose government has failed to fulfill expectations, are not as concerned about it?

#### **5.4 Contribution**

The information on each stakeholder group can be extremely useful in helping to identify new policy measures and improve existing policies.

As a result of the different methodologies used, this study offers the opinions of stakeholders with various interests in the evaluation process of biofuels. It has allowed a deeper analysis of the point of view of each stakeholder. By having this analysis and understanding, it is possible to meet the different aims and objectives of each group of stakeholders. For example, perhaps biofuel producers know that the government aims to comply with international targets, but there was no previous measurement regarding it in Canada; or the government may take action when it realizes that biofuel producers are so curious about greenhouse gas emissions and have a very low realistic margin priority, which is not very realistic. The NGOs also have quite a fair view in all the criteria; they do not really focus on ecological impact and their real concern is food price.

The researchers have a key role in the future of biofuels. Having them examine each group of stakeholders and observe the outcomes of the questionnaires is tremendously useful in the application of future projects on biofuel. For example, in terms of feedstock producers, researchers believe the economic impact is the most important factor, and

producers should be satisfied financially because the material for this industry is coming from them. Another example is end-users, to whom the green image of biofuels is very important because they feel they are participating with many people in the world to fix the issue of GHG emissions.

This study identified potential mismatch between researcher contributions and stakeholder priorities by comparing their points of view in terms of the economy and environment aspects. Awareness may be a crucial factor in helping researchers better position their work.

The last section of this study provides information of the four different stakeholders regarding some policies. By doing the literature review, the definition of all of the policies was explained and an analysis of the data revealed the stakeholders' perspectives. For instance, Figure 26 shows us that the government and NGOs are following a similar path for some points while the researchers have a different viewpoint.

In addition, differing opinions on the utility of policy tools identified among four different stakeholders have been compared and suggest the importance of developing more systemic analysis of stakeholder perceptions and needs.

Suggests importance of more systematic analysis of stakeholder perceptions and needs.

Such a study as this has never existed before in Canada. The criteria for stakeholders were not identified and there was no measurement regarding them. The results of this study will help those who investigating stakeholders to understand their areas of interest and will benefit them in terms of understanding and communication.

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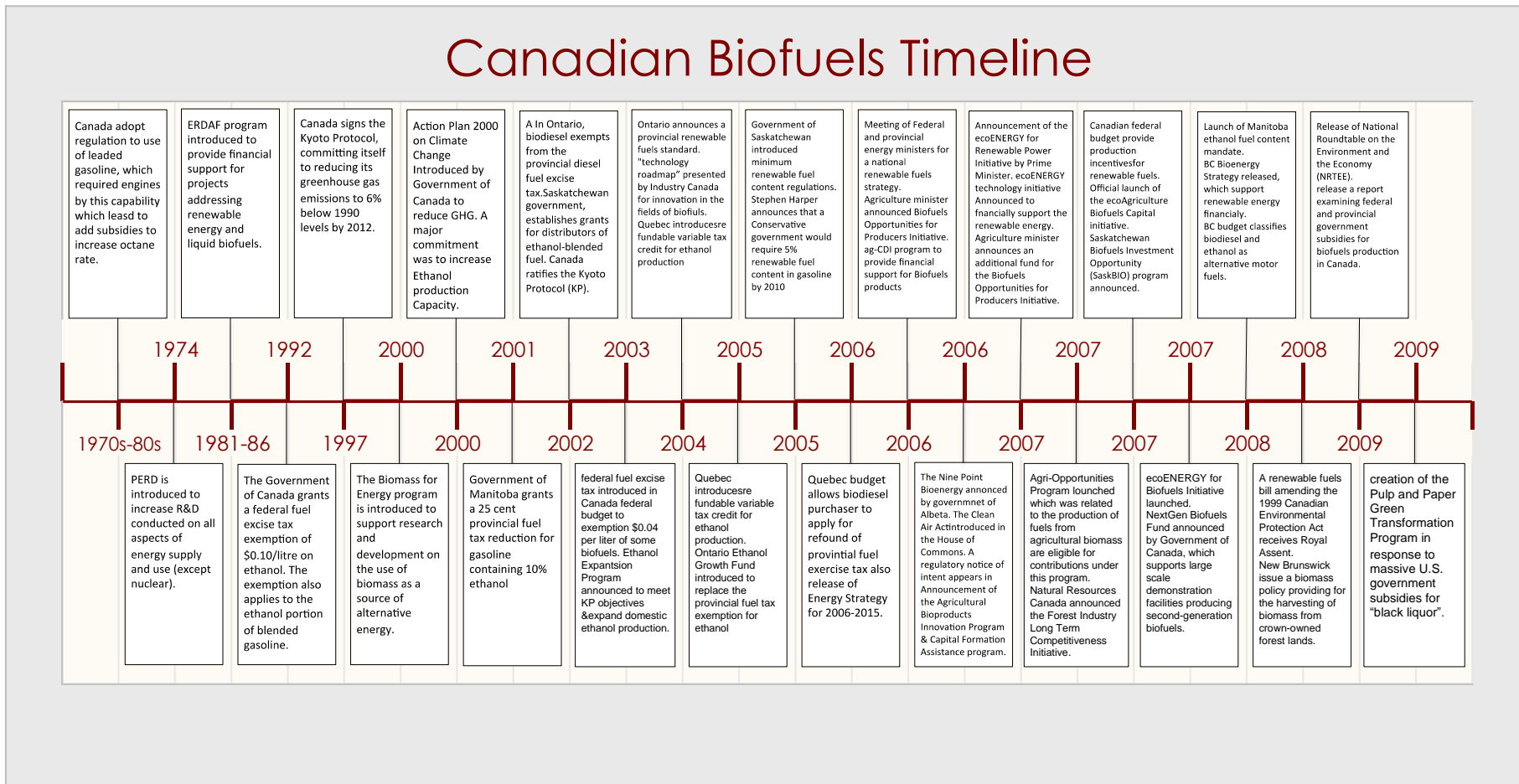
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## 6 Appendices

### Appendix 1: The Timeline of biofuels in Canada.

Figure 27: Canadian Biofuels Timeline



Source 5: Adopted from Charrière (2009)

## Appendix 2: The list of academic papers that reviewed to design the survey and types of study, methodology & stakeholders

**Table 3: Reviewed papers with survey for this study**

Author	Year	Journal	Topic	Sample N	Methodology	Study Set up	Stakeholders
Skipper, H. D.	2007	-	Consumer attitudes regarding biofuels	605	Survey Methodology	Master Thesis	Random people in Northwest Arkansas, US & Genk, Belgium
Megel, A. J.	2011	-	Utilizing quality function deployment to create a quality requirement matrix for biofuel refinery inputs via voice of customer techniques	-	QDF Methodology, single pass Delphi technique	Master Thesis	Biofuel customers
Zhang et al.	2011	Energy Policy	Analyzing public awareness and acceptance of alternative fuel vehicles in China: The case of EV	299	Stated Preferences Method	Paper	Driving schools in Nanjing, China
Villamil et al.	2012	Renewable and Sustainable Energy Reviews	Producer perceptions and information needs regarding their adoption of bioenergy crops	1002	Focus Group Methodology	Quantitative Paper	Farmers in the state of Illinois, USA
Halder et al.	2010	Energy Policy	Young citizens' knowledge and perceptions of bioenergy and future policy implications	495	Curriculum analysis	Paper	9th grade students in North Karelia, Finland
Duvenage et al.	2012	Environment, Development and Sustainability	Towards implementation and achievement of sustainable biofuel development in Africa	38	-	Paper	Experts in the fields of environmental, social and economic sustainability relating to biofuels in Africa
Chang, S.	2009	-	The influence of media frames on the public's perception of biofuels	253	Content analysis	Master Thesis	3 cities in Iowa US (Des Moines, Cedar Rapids and Davenport)
Singer, C.	2013	-	Stakeholder Attitudes Toward Forest-Residual Based Biofuels in Washington State	61	Deductive and inductive qualitative methods and NVivo software	Master Thesis	Native American, political, government, and industry.nongovernment organizations
Dockerty et al.	2012	Journal of Environmental Planning and Management	Public opinion on energy crops in the landscape: Considerations for the expansion of renewable energy from biomass	490	Landscape Character Assessment Methodology	Paper	Local government and other relevant agencies, UK
McDonald et al.	2007	The Journal of Product and Brand Management	Developing a stakeholder analysis to aid bio-based product innovation	-	Stakeholder Analysis	Paper	New Zealand
Zografakis et al.	2010	Renewable and Sustainable Energy Reviews	Assessment of public acceptance and willingness to pay for renewable energy sources in Crete	1440	CV methodology, DB-DC methodology, Delta methodology	Paper	Citizens in Crete
Johnson et al.	2013	Journal of Agricultural Systems, Technology, and Management	Consumer Awareness, Use, and Perceptions of Biodiesel	134	-	Paper	Fuel customers in Northwest Arkansas
Plant, L. P.	2009	-	* Innovation systems in agriculture: Managing stakeholder interaction for learning and innovation in the 21st century	-	Qualitative& Quantitative approach through Mixed	PhD Thesis	Krishna district in Andha Pradesh India & Chitwan District in Nepal
Cuppen et al.	2010	Ecological Economics	Q methodology to select participants for a stakeholder dialogue on energy options from biomass in the Netherlands	-	Q Methodology	Paper	Netherlands
Pretty et al.	2010	International Journal of Agricultural Sustainability	The top 100 questions of importance to the future of global agriculture	-	-	Paper	-

### Appendix 3: The list of academic papers that reviewed to in order to understand the types of study, methodology & stakeholders

**Table 4: Reviewed papers without survey for this study**

Author	Year	Journal	Topic	Sample N	Methodology	Study Set Up
Srebotnjak et al.	2011	Ecological Indicators	Prospects for sustainable bioenergy production in selected former communist countries	-	Mix Methodology	Literature Review
MacHaris et al.	2012	Decision Support Systems	Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use	-	Multi actor multi criteria analysis	Research Paper
Jensen et al.	2013	Sustainability: Science, Practice, & Policy	Biofuels: a contested response to climate change	-	???	Qualitative Paper
Cope et al.	2011	Annals of the Association of American Geographers	Farmer attitudes toward production of perennial energy grasses in east central Illinois: Implications for community-based decision making	-	GIS-Aided Focus Group	Research Paper
Obidzinski et al.	2012	Ecology and Society	Environmental and social impacts of oil palm plantations and their implications for biofuel production in Indonesia	386	Standard Methodology for Environmental & Socioeconomic Impacts	Quantitative Paper
White et al.	2013	Environmental Management	Shifting Lands: Exploring Kansas Farmer Decision-Making in an Era of Climate Change and Biofuels Production	360	Mix Methodology	Quantitative Paper
Caniëls et al.	2013	Journal of Purchasing and Supply Management	Participation of suppliers in greening supply chains: An empirical analysis of German automotive suppliers	54	Partial Least Squares Methodology	Quantitative Paper
Tate et al.	2012	Energy Policy	A comparison of the drivers influencing farmers' adoption of enterprises associated with renewable energy	55	Chi squared and Mann Whitney U test analysis	Quantitative Paper
Reddy et al.	2009	Energy Policy	Universalization of access to modern energy services in Indian households-Economic and policy analysis	-	Life Cycle Costing Method	Quantitative Paper
Jussi et al.	2007	International Journal of Energy Sector Management	Views on the international market for energy biomass in 2020: results from a scenario study	14	Scenario Planning Methodology	Research Paper
Hofmann, M. Khatun, K.	2013	Energy Policy	Facilitating the financing of bioenergy projects in sub-Saharan Africa	-	-	Quantitative Paper
Whitmarsh, L. Nykvist, B.	2008	International Journal of Innovation and Sustainable Development	Integrated Sustainability Assessment of mobility transitions: Simulating stakeholders' visions of and pathways to sustainable land-based mobility	-	Mobility Transition Model	Research Paper
Van Dam, J. Junginger, M.	2011	Energy policy	Striving to further harmonization of sustainability criteria for bioenergy in Europe: recommendations from a stakeholder questionnaire	285	Stakeholder Participation Method	Quantitative Paper
Panoutsou, C.	2008	Energy Policy	Bioenergy in Greece: Policies, diffusion framework and stakeholder interactions	-	Mix Method & Analysis	Research Paper

Appendix 4: The judgments detail results base on Saaty (1980)

Table 5: Pairwise comparison with AHP detailed results (Government)

	Government	International	Greenhouse	Air Quality	Oil	Food	Economy
Government	1	0.92916	2.25768	2.59002	1.60935	1.84626	1.84626
International	1.07624	1	2.27951	1.40285	1.98701	2.11803	3.91042
Greenhouse	0.44293	0.43869	1	0.50327	0.44293	0.71283	1
Air Quality	0.38610	0.71283	1.98701	1	0.91946	2.35773	1.85296
Oil	0.62137	0.50327	2.25768	1.08760	1	0.99043	1.60935
Food	0.54164	0.47214	1.40285	0.42414	1.00967	1	0.87169
Economy	0.54164	0.25573	1	0.53968	0.62137	1.14720	1

Appendix 4 (cont'd)

Table 6: Pairwise comparison with AHP (Biofuels Producers)

	Production	Competition	Realistic	Green	Investment
Production	1	1.24573	8.00181	0.338504	5.15632
Competition	0.802742	1	3	0.158096	2.14113
Realistic	0.124972	0.333333	1	0.140562	0.644394
Green	2.95418	6.32527	7.11432	1	5.71096
Investment	0.193937	0.467044	1.55185	0.175102	1

Table 7: Pairwise comparison with AHP (NGO)

	Food Price	Fair Price	Ecological
Food Price	1	0.66874	2.59002
Fair Price	1.49535	1	0.86334
Ecological	0.386097	1.15829	1

Appendix 5: The Ethics approval letter by University of Ottawa in order to conduct a survey.

File Number: 03-14-12

Date (mm/dd/yyyy): 05/26/2014



**Université d'Ottawa**  
Bureau d'éthique et d'intégrité de la recherche

**University of Ottawa**  
Office of Research Ethics and Integrity

**Ethics Approval Notice**  
**Social Science and Humanities REB**

**Principal Investigator / Supervisor / Co-investigator(s) / Student(s)**

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Sandra	Schillo	School of Management / School of	Principal Investigator
Diane	Isabelle	Others / Others	Co-investigator
Fred	Pries	Others / Others	Co-investigator

**File Number:** 03-14-12

**Type of Project:** Professor

**Title:** Positioning Biofuel Research vis-a-vis Policy and Stakeholder Interests - Exploring QFD Methodology

<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>
05/26/2014	05/25/2015	Ia

(Ia: Approval, Ib: Approval for initial stage only)

**Special Conditions / Comments:**

N/A



**Université d'Ottawa**  
Bureau d'éthique et d'intégrité de la recherche

**University of Ottawa**  
Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: <http://www.research.uottawa.ca/ethics/forms.html>.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: <http://www.research.uottawa.ca/ethics/forms.html>.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: [ethics@uOttawa.ca](mailto:ethics@uOttawa.ca).

**Signature:**

(Due to the University of Ottawa ethics and regulations any personal information has been kept anonymous)

Appendix 6: The sample of questionnaire distributed to stakeholders.

### **Letter of Information**

**Title of the study:** Positioning Biofuel Research vis-à-vis Policy and Stakeholder Interests

**Principal Investigator(s):**

(Due to the University of Ottawa ethics and regulations any personal information has been kept anonymous)

**Research Assistants:**

(Due to the University of Ottawa ethics and regulations any personal information has been kept anonymous)

**Invitation to Participate:** You are invited to participate in the abovementioned research study conducted by Dr. Sandra Schillo. This project is funded by BioFuelNet Canada.

**Participation:** If you wish to participate in this study, please complete this questionnaire and return it to us before the end of the conference. Your decision to complete and submit this survey will be interpreted as an indication of your consent to participate. The survey should take you approximately 15 min. to complete. You do not have to answer any questions that you do not want to answer.

**Purpose of the Study:** From this study we wish to learn how strongly stakeholders value various interests in biofuels, how they perceive policy interventions, and what research is required from their perspective to achieve commercial development of biofuels.

**Benefits:** This study will help researchers and policy developers improve the management of research programs and government policies and programs. In addition, respondents may gain insights on the topic by considering the questions asked in the questionnaire.

**Confidentiality and Anonymity:** The information that you will share will remain strictly confidential and will be used solely for the purposes of this research. The people who will have access to the research data are listed above. Abtin Shakiba has access to this data to using it for his thesis. Any other students wishing to use the data for theses or similar work will file secondary use applications through our ethics office. Results will be published in pooled (aggregate) format, verbatim responses may be used if they do not provide any identifying information. Anonymity is guaranteed since you are not being asked to provide your name or any personal information. If you choose to provide your name and email address for further contact, we will remove this information from the data set before conducting any analyses or sharing the data with additional students, and we will keep that information in a separate location.

**Conservation of data:** The paper surveys will be kept in a locked filing cabinet in the office of Dr. Schillo at the University of Ottawa for at least 5 years. Electronic records will be password protected and kept indefinitely to potentially allow longitudinal analysis of changes in stakeholder perceptions over time.

**Voluntary Participation:** You are under no obligation to participate and if you choose to participate, you may refuse to answer questions that you do not want to answer. Completion and return of the questionnaire by you implies consent to participate. Given the anonymous nature of this survey, if you decide to withdraw from the research after having submitted the questionnaire we will not be able to find it and destroy it. So we will use your data.

**Information about the Study Results:** If you would like to receive a copy of the results, please indicate so on the questionnaire and provide your email address.

If you have any questions or require more information about the study itself, you may contact the researchers.

If you have any questions with regards to the ethical conduct of this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5, tel.: (613) 562-5387 or [ethics@uottawa.ca](mailto:ethics@uottawa.ca).

Please keep this form for your records.

Thank you for your time and consideration.

Sandra Schillo, May 2014

Appendix 6

**STAKEHOLDER SURVEY**

**Positioning Biofuel Research vis-à-vis Policy and Stakeholder Interests**

Dear Participant,

The objective of this research project is to document the link between research projects and their external environment, primarily stakeholder interests and policy objectives. This is a confidential questionnaire, you may choose to provide us your name and email address at the end, if you wish to receive further information from us.

We have separate questionnaires for each stakeholder group, so please indicate which stakeholder group best describes your involvement in biofuels:

- Researcher
- Feedstock producer
- Biofuel producer
- Fuel Distributors
- Vehicle Manufacturer
- End User
- Government
- Non-government organization or association representative

(Due to the University of Ottawa ethics and regulations any personal information has been kept anonymous)

### Survey Questionnaire - Researchers

Please pick one research project you are particularly familiar with to answer this questionnaire.

1) The research project relates to the following

Feedstock: \_\_\_\_\_

Conversion Process: \_\_\_\_\_

Utilisation: \_\_\_\_\_

Other, please specify: \_\_\_\_\_

2) What is your role in this project?

Principal Investigator    Collaborator    Research Assistant    Student

Other: \_\_\_\_\_

3) How long have you been involved with this particular project to date? \_\_\_\_\_ years / months

4) How many years of biofuels experience do you have in general? \_\_\_\_\_ years

5) Is this project part of BioFuelNet?    yes    no

6) What is the expected duration of the project? \_\_\_\_\_ years

7) What are the sources of funding for this project? Please indicate approximate percentages

\_\_\_\_\_ % University funding

\_\_\_\_\_ % Canadian competitive public funding (NSERC, SSHRC, BFN etc.)

\_\_\_\_\_ % Canadian private sector funding

\_\_\_\_\_ % International funding (public / private)

\_\_\_\_\_ % other, please specify \_\_\_\_\_

8) Are industry partner(s) involved in this project?    Yes    No

If yes:

Is industry providing funding?    Yes    No

Is industry participating in discussions about the overall direction of the project?    Yes    No

Is industry actively involved in conducting research under the project?    Yes    No

9) Are you collaborating with international partners (Universities, Government, NGOs, industrial partners or others)?    Yes    No

10) If commercialized, what would be the impacts of this project (along with related technologies and infrastructure) on the stakeholders below, compared to currently commercially available biofuels?

Please mark your response with a check-mark according to the following scale:

Stakeholders	Criteria	strongly negative	moderately negative	slightly negative	neutral or not applicable	slightly positive	moderately positive	strongly positive
<b>Feedstock Producers</b>								
	Land productivity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Diversification of crops	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Sustainable agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Income from crop cultivation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Fuel Distributors</b>								
	Availability of biofuels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Level playing field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Existing logistics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>NGOs</b>								
	Ecological impact	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Fair prices for farmers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Impact on food prices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Biofuel producers</b>								
	Investment costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Greenhouse gas balance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Realistic margin	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Fair competition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Production capacity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Vehicle manufacturers</b>								
	Competitive advantage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Green image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	International harmonization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Market demand for vehicles using this biofuel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>End users</b>								
	Transparency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Safety	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	User friendliness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Green image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Availability of fuels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Technical compatibility	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Total cost of ownership	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Government

Economic growth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Impact on food prices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduction of oil dependency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Air quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Greenhouse gas emissions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comply with international targets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Governmental budget	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3/3

11) In your opinion, who is going to benefit most from your research?

- |  |  |
|--|--|
| <input type="checkbox"/> Feedstock producers | <input type="checkbox"/> Vehicle Manufacturers |
| <input type="checkbox"/> Biofuel producers   | <input type="checkbox"/> End Users             |
| <input type="checkbox"/> Fuel Distributors   | <input type="checkbox"/> Governments/NGOs      |

12) Please estimate the following to the best of your knowledge:

- a) Probability of technical success of the project: \_\_\_\_\_%
- b) Probability of economic viability: \_\_\_\_\_ %
- c) Years to commercial availability: \_\_\_\_\_

13) What changes will be required to successfully bring your technology to market?

- |  |   |
|--|---|
| <input type="checkbox"/> Changes in feedstock production | <input type="checkbox"/> Changes in distribution infrastructure |
| <input type="checkbox"/> Changes in feedstock processing | <input type="checkbox"/> Changes in combustion motors           |
| <input type="checkbox"/> Other, please specify _____     |   |

14) How important will the following policies/programs be for successful commercialization?

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15) Please provide any additional comments you may have.

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May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

**Survey Questionnaire – Feedstock Producers**

The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel feedstock/platform you are familiar with (maybe you are producing feedstock for it, or have considered it) and answer the following questions with this platform in mind.

Chosen feedstock / platform :  
 (e.g. use of logging residues for ethanol)

---

1) Comparing each objective 1 with objective 2, please check the box that best indicates their relative importance.

	<i>Much more important</i>	<i>Moderately more important</i>	<i>Slightly more important</i>	Equal	<i>Slightly more important</i>	<i>Moderately more important</i>	<i>Much more important</i>	
<b>Objective 1</b>								<b>Objective 2</b>
Income from crop cultivation								Sustainable agriculture / forestry
Income from crop cultivation								Diversification of crops
Income from crop cultivation								Land productivity
Sustainable agriculture / forestry								Diversification of crops
Sustainable agriculture / forestry								Land productivity
Diversification of crops								Land productivity

Are any important objectives missing? Please specify

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2) How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Availability of feedstock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial viability and risk assessment for feedstock producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Improved feedstock varieties	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pest and disease management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Harvesting and handling processes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pre-treatment/processing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact assessments at the local level (e.g., impact on soil conditions, water usage)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Critically important	Somewhat important	Irrelevant
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers )	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3) What requirements would need to be in place for this research to be successfully used?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4) From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We appreciate your participation!**

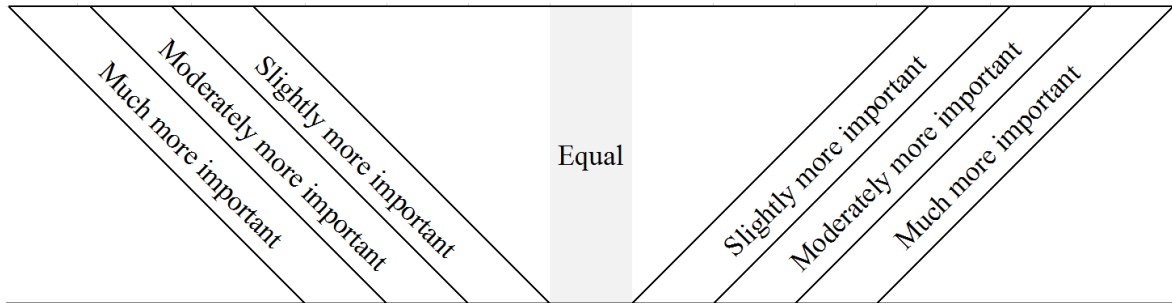
**Survey Questionnaire – Biofuel Producers**

The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel feedstock/platform you are familiar with (maybe you are producing it, or have considered producing it) and answer the following questions with this platform in mind.

Chosen feedstock / platform :

(e.g. conversion of cellulosic material to ethanol)

1. Comparing each objective 1 with objective 2, which is more important in your opinion?



Objective 1								Objective 2
Production capacity								Fair competition & quality requirements
Production capacity								Realistic margin
Production capacity								Greenhouse gas balance
Production capacity								Investment cost
Fair competition & quality requirements								Realistic margin
Fair competition & quality requirements								Greenhouse gas balance
Fair competition & quality requirements								Investment cost
Realistic margin								Greenhouse gas balance
Realistic margin								Investment cost
Greenhouse gas balance								Investment cost

Are there any important objectives missing? \_\_\_\_\_

2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Financial viability and risk assessment for biofuel producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pre-treatment/processing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production efficiency/optimization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production scale-up	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production product quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production catalysts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production of higher value biofuel products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Value added co-products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Integration with existing complementary production facilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

p. 2/2

	Critically important	Somewhat important	Irrelevant
Impact assessments at the local level (production greenhouse gas emissions, water usage, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (impact on greenhouse gases, waterways etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What requirements would need to be in place for this research to be successfully used?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	High	Medium	Low
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?

Yes  No

Would you like to receive a copy of your responses by email?

Yes  No

Would you like to receive a summary of the results by email?

Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

### Survey Questionnaire – Fuel Distributors

The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel feedstock/platform you are familiar with (maybe you are producing it, or have considered producing it) and answer the following questions with this platform in mind.

Chosen feedstock / platform :

(e.g. conversion of cellulosic material to ethanol)

1. Comparing each objective 1 with objective 2, which is more important in your opinion?

	<i>Much more important</i>	<i>Moderately more important</i>	<i>Slightly more important</i>	<b>Equal</b>	<i>Slightly more important</i>	<i>Moderately more important</i>	<i>Much more important</i>	
<b>Objective 1</b>								<b>Objective 2</b>
Existing logistics								Level playing field
Existing logistics								Availability of biofuels
Level playing field								Availability of biofuels

Are there any important objectives missing?

2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Improvement of fuel characteristics (e.g., stability, effect on existing distribution infrastructure, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact of optimal biofuel production plant size on transportation logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers and groundwater, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What requirements would need to be in place for this research to be successfully used?

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4. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other, please specify:

May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

### Survey Questionnaire – End Users

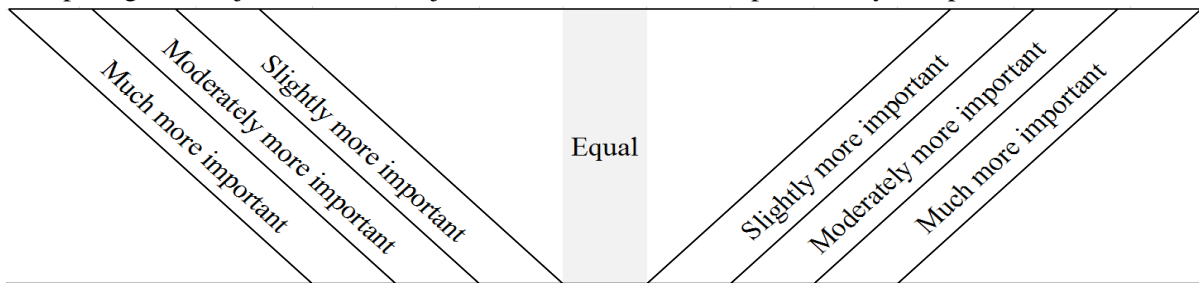
The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel platform you are familiar with (maybe you are using it, or have considered using it) and answer the following questions with this platform in mind.

Chosen platform:

\_\_\_\_\_

(e.g. ethanol or biodiesel)

1. Comparing each objective 1 with objective 2, which is more important in your opinion?



Objective 1				Equal				Objective 2
Total cost of ownership								Technical compatibility
Total cost of ownership								Availability of fuels and vehicles
Total cost of ownership								Green Image
Total cost of ownership								User friendliness
Total cost of ownership								Safety
Total cost of ownership								Transparency
Technical compatibility								Availability of fuels and vehicles
Technical compatibility								Green Image
Technical compatibility								User friendliness
Technical compatibility								Safety
Technical compatibility								Transparency
Availability of fuels and vehicles								Green Image

Availability of fuels and vehicles								User friendliness
Availability of fuels and vehicles								Safety
Availability of fuels and vehicles								Transparency
Green Image								User friendliness
Green image								Safety
Green image								Transparency
User friendliness								Safety
User friendliness								Transparency
Safety								Transparency

p. 2/2

2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Technical compatibility with existing engines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel safety and handling requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact on food production and prices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers and groundwater, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What requirements would need to be in place for this research to be successfully used?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

**Survey Questionnaire – Vehicle Converters**

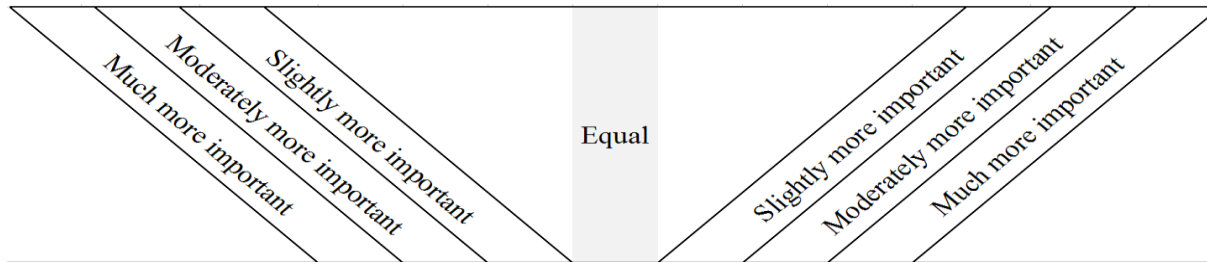
The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel platform you are familiar with (maybe you are using it, or have considered using it) and answer the following questions with this platform in mind.

Chosen platform:

\_\_\_\_\_

(e.g. ethanol or biodiesel)

1. Comparing each objective 1 with objective 2, which is more important in your opinion?



Objective 1								Objective 2
Market demand								International legislation / targets
Market demand								Green image
Market demand								Competitive advantage
International legislation / targets								Green image
International legislation / targets								Competitive advantage
Green image								Competitive advantage

2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Combustion properties	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technical compatibility with existing engines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engine efficiency improvements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel safety and handling requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What requirements would need to be in place for this research to be successfully used?

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4. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

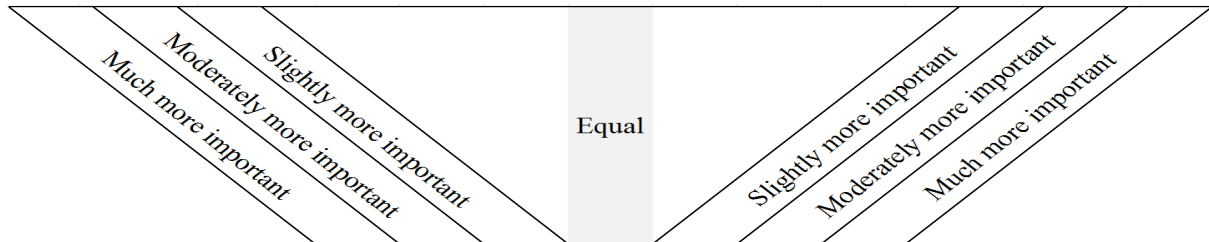
### Survey Questionnaire – Government

The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel platform you are familiar with and answer the following questions with this platform in mind.

Chosen platform (e.g. ethanol from agricultural residue):

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1. Comparing each objective 1 with objective 2, which is more important in your opinion?



Objective 1								Objective 2
Impact on governmental budget								Comply with International targets
Impact on governmental budget								Greenhouse gas emissions
Impact on governmental budget								Air quality
Impact on governmental budget								Reduction of oil dependency
Impact on governmental budget								Impact on food prices
Impact on governmental budget								Impact on economic growth
Comply with International targets								Greenhouse gas emissions
Comply with International targets								Air quality
Comply with International targets								Reduction of oil dependency
Comply with International targets								Impact on food prices
Comply with International targets								Impact on economic growth
Greenhouse gas emissions								Air quality
Greenhouse gas emissions								Reduction of oil dependency

Greenhouse gas emissions								Impact on food prices
Greenhouse gas emissions								Impact on economic growth
Air quality								Reduction of oil dependency
Air quality								Impact on food prices
Air quality								Impact on economic growth
Reduction of oil dependency								Impact on food prices
Reduction of oil dependency								Impact on economic growth
Impact on food prices								Impact on economic growth

2/3

Are any important objectives missing in the above table? If so, which ones?

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2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Financial viability and risk assessment for feedstock producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial viability and risk assessment for biofuel producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact of fuel characteristics (e.g., stability, effect on existing distribution infrastructure, etc.) on transportation logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technical compatibility with existing engines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel safety and handling requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact on food production and prices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What requirements would need to be in place for this research to be successfully used?

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4.  
5. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?

Yes  No

Would you like to receive a copy of your responses by email?

Yes  No

Would you like to receive a summary of the results by email?

Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We greatly appreciate your participation!**

**Survey Questionnaire – NGOs**

The goal of this study is to understand your priorities with regards to biofuels. Please pick one biofuel platform you are familiar with and answer the following questions with this platform in mind.

Chosen platform (e.g. ethanol from agricultural residue):

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1. Comparing each objective 1 with objective 2, which is more important in your opinion?

	<i>Much more important</i>	<i>Moderately more important</i>	<i>Slightly more important</i>	<b>Equal</b>	<i>Slightly more important</i>	<i>Moderately more important</i>	<i>Much more important</i>	
<b>Objective 1</b>								<b>Objective 2</b>
Impact on food prices								Fair prices for farmers
Impact on food prices								Ecological impact of the production chain
Fair prices for farmers								Ecological impact of the production chain

Are any important objectives missing in this table? If so, which ones?

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2. How important do you believe each of the following general research areas are to supporting the increased adoption of advanced biofuels?

	Critically important	Somewhat important	Irrelevant
Financial viability and risk assessment for feedstock producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial viability and risk assessment for biofuel producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact of fuel characteristics (e.g., stability, effect on existing distribution infrastructure, etc.) on transportation logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technical compatibility with existing engines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel safety and handling requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact on food production and prices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmental impact assessments at the regional/national level (e.g., impact on greenhouse gases, lakes, rivers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other: please list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

p. 2/2

3. What requirements would need to be in place for this research to be successfully used?

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4. From your perspective, please indicate the importance of government policies and programs in ensuring successful commercialization of next generation biofuels.

Policy/Program & Importance	Low	Medium	High
Biofuel Tax Credit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biofuel Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon/Gasoline Tax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Efficiency Standard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vehicle Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acreage Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Import Tariff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Subsidy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Export Quota	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Mandate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Support for Private R&D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Transfer Networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

May we follow up with you if we have any additional questions?  Yes  No

Would you like to receive a copy of your responses by email?  Yes  No

Would you like to receive a summary of the results by email?  Yes  No

If you answered yes to any of the above questions, please provide your name and email address:

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**We appreciate your participation!**