CONSUMER PERCEPTION OF BIOFUELS IN COUNTRIES WITH DIFFERENT LEVELS OF MARKET DEVELOPMENT: A CASE STUDY OF GAINESVILLE, FLORIDA (U.S.) AND WARSAW, POLAND

By

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To my mother

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LIST OF ABBREVIATIONS

AFS	Alternative Fuels Standards
ARRA	American Recovery and Reinvestment Act
CAGR	Compound Annual Growth Rate
CALS	College of Agriculture and Life Sciences
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EU	European Union
FAME	Fatty Acid Methyl Ester
FFV	Flex-Fuel Vehicle
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
NEP	New Environmental Paradigm
NIT	National Indicative Target
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
PCE	Perceived Consumer Effectiveness
RFS	Renewable Fuel Standard
SPSS	Statistical Package for the Social Sciences
UF	University of Florida
UN	United Nations
U.S.	The United States
USDA	U.S. Department of Agriculture
WULS	Warsaw University of Life Sciences

Abstract of Thesis Presented to the Graduate School
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This research analyzes consumer perception of biofuels in the United States and Poland, countries with different levels of market development in biofuels. An e-mail survey was administered to students at the University of Florida (UF) in Gainesville, Florida in the United States and at Warsaw University of Life Sciences (WULS), Poland. The primary data were collected during April 2011. The data from this survey was used to run a Tobit regression analysis and determine the importance of variables related to the beliefs of biofuels. This research shows that there is no statistical difference between the perception of students in the United States and students in Poland based only on the country they are from. However, considering country as an interaction variable with other independent variables, some differences were identified, as well as many similarities. Research revealed that age and gender were not significant in determining views on biofuels. This was not surprising given the lack of variation in these variables. However, the college the students were enrolled in was significant, showing that Polish students from the Faculty of Agriculture and Biology were less supportive toward biofuels than their U.S. counterparts from College of Agriculture and Life Sciences. The level of objective knowledge positively affected the perception of biofuels; however the

impact was stronger in Poland. Subjective knowledge was not significantly related to perceptions. Overall, respondents in both countries placed equal importance on a quality factor and cost factor indicating that environmental friendliness and biofuel's economy are crucial and positively influence students' beliefs in biofuels. Also respondents in both countries who believe in impact of consumers' individual behavior towards the environment, positively perceived biofuels. This belief had a stronger impact among Polish students compared to U.S. students. Interestingly, though U.S. and Polish students recognized that the production of biofuels impacts food availability and food prices, it did not have a statistically significant effect on the overall belief in biofuels. Both U.S. and Polish respondents who believed that biofuels are a pathway towards economic development, were equally more likely to have a positive view on biofuels. Finally, television and radio; internet; and newspapers and journalists are important information sources influencing biofuels perception for students. Though television and radio is not the most popular source of information, it does positively impact perceptions of biofuels among students from both countries. Surprisingly, information received from internet, which is recognized as the most popular source of information influences student views differently. Students who use the internet more than average as a source of information in Poland were less likely to have positive perceptions of biofuels, where students from the United States had a more positive perception. Interestingly, information provided by newspapers and journalists had equally negative impacts the perception of biofuels in both countries. Information received from this research identifies some factors that lead to positive and negative feelings towards biofuels. This information can be used to help determine educational and marketing actions in order to popularize knowledge and create system of incentives for biofuels.

CHAPTER 1
INTRODUCTION

Problem Description

A century ago, Winston Churchill recognized that "Safety and certainty in oil lie in variety and variety alone" (Fontes, 2010). This holds true today. As in Churchill's day, energy security still depends on variety. But now that variety needs to be sought in alternative energy sources, rather than sources of oil alone. Currently, the global transport systems remain based on oil. The demand for energy is growing; therefore, the demand for oil is increasing as there are not currently substitutes available on a large scale. Because of these reasons, there is the need to look to other sources of energy. The cornerstone of the future of energy security is the creation of a diverse supply through a varying mix of renewable energy sources and technologies.

Recently, the Intergovernmental Panel on Climate Change (IPCC) released a report on renewable energy, finding that by 2050, nearly 80% of the world's energy supply could be provided by renewable energy sources. "These sources can substantially contribute to human wellbeing by sustainably supplying energy and stabilising the climate" (Edenhofer, Pichs-Madruga, & Sokona, 2011). IPCC projections indicates that the investments in the renewable energy sources will contribute from 1.4 to 5.1 trillion dollars for the coming decade, and another 1.5 to 7.2 trillion dollars for 2021-2030.

One possibility that may significantly help in achieving increased energy demand and become regarded as an integral part of the energy mix are biofuels (Fontes, 2010). Recently, biofuels have attracted increased attention of policy makers, industry, research and the public. By some, biofuels are characterized as a panacea presenting a high technology solution in the fight against climate change. However others criticize them as a diversion from the climate mitigation actions or a

threat to food security (Bringezu, Schütz, & O´Brien, 2009). In general biofuels use is increasing around the globe, increased fueling debate between supporters and opponents.

The purpose of biofuels differs around the world depending on various aspects, including economic, social and environmental issues. Looking ahead, the biggest biofuels challenge is to meet global expectations in terms of sustainability and efficiency without competing with the food chain and creating a negative carbon footprint.

The demand for energy is growing very fast, with projections showing the need to achieve double the current level of energy produced by the middle of the 21st century (Fontes, 2010). However, the middle of the first decade of the 21st century was accompanied by the growing crude oil prices and increasing food prices. This situation has led to political and public attention on the role of biofuels in terms of the transportation. According to the U.S. Energy Information Administration (EIA), biofuels will contribute to 27% of fuels in the transport sector by 2050. These economic, social and environmental aspects about biofuels have been recently studied by many international organizations like The World Bank, United Nations (UN) agencies, the Organization for Economic Cooperation and Development (OECD), and the International Energy Agency (IEA).

Currently, there exists a lot of information regarding biofuels, however little research was done about existing consumer awareness about this issue in both countries. In general the United States and Poland are countries representing two different levels of biofuels market development. The United States being the largest producer of biofuels, represents an advanced market, however the Polish market is defined as the market in the early stages of development, with a large scope for

increasing production capacities. The biofuels topic in both countries is a crucial issue, showing an increase of public interest. By most people, biofuels are recognized as an alternative energy source, however they lack specific information about this product.

Without proper knowledge and environmental awareness about biofuels aspects, development of this market segment will be constrained. In general people have to know what are the advantages and disadvantages of biofuels, and having this knowledge they will be able to stimulate the market development of biofuels. Currently there are a lot of biofuel myths existing in global society, which can be verified by the efficient system of educational and promotional activities. So only people with adequate knowledge will be able to affect the level of biofuels development in their countries.

General Objectives

The main aim of this study is to analyze consumer perception of biofuels in the United States and Poland with high attention on the complexity of consumer awareness, within the aspect of the societal awareness.

This study will gauge societal attitudes and understanding of the roles that biofuels share in the daily lives of students. These views will then be evaluated in how they contrast between American versus Polish University students concerning the biofuels issues.

Specific Objectives

The research will describe the following issues:

- Consumer's level of subjective and objective knowledge about biofuels
- General feelings of consumers about biofuels
- General consumer's attitude towards environmental aspects of biofuels
- Consumer's perception about biofuels in terms of biofuels economy
- Factors influencing decision of purchasing biofuels
- Perspectives of biofuels market development
- Information sources of biofuels

Hypotheses

The following hypotheses are proposed:

I. Consumers' perceptions about biofuels in the United States and Poland are different

II. Consumers in the United States and Poland believe that biofuels are environmentally-friendly and safe

This Master thesis is based on primary data sources. A survey was conducted among students at the University of Florida in Gainesville, United States and among students at the Warsaw University of Life Sciences, Poland. Students as the homogenous group in terms of age were chosen in order to avoid having too much influencing factors. Students are an interesting target group, and they can be recognized as the consumers of the future.

Participants were not selected randomly; therefore the results are limited in that they cannot be generalized to the population. Participants were recruited using convenience sampling methods due to cost restrictions and were limited to students from the University of Florida in Gainesville and from the Warsaw University of Life Sciences in Poland.

Structure of the Thesis

This master's thesis is structured into eight chapters. The first chapter presents the overall description of the research problem, following by the aims of the study including general and specific objectives and two hypotheses.

The second chapter describes the biofuels industry in general according to the world energy information, renewable energy facts and biofuels market data in terms of definitions, division and sustainability aspects. The data sources based on the reports from International Energy Agency (IEA), Department of Energy in the European Commission (EC), U.S. Department of Energy (DOE), and the Organization for Economic Cooperation and Development (OECD).

The third chapter provides information about the biofuels market in the United States, with a focus on the market in Florida. Legal aspects of the biofuels market are presented, as well as a general overview including available technologies consisting of bioethanol and biodiesel. The data sources based on the reports from the U.S. Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA) and U.S. Department of Energy (DOE).

The fourth chapter mirrors Chapter 3, but with a focus on the biofuels market in Poland. The data sources based on the reports from the Department of Energy in the European Commission (EC), Polish Central Statistical Office and the Energy Regulatory Office and the Energy Market Agency in Poland.

A literature review of existing research about consumer perceptions of biofuels is included in Chapter 5. The data sources based on the reports from the United States, while some was from Poland. Several others have conducted similar studies based on different countries.

Chapter 6 contains the survey methodology, identifying information about the sample used for the survey. The data sources based on the publications of Robinson, Shaver, & Wrightsman, (1991), Peterson (1994), and Hair, Black, & Babin, (2006).

Model specifications and results are presented in the seventh chapter, including data sources based on social science research of Amemiya (1984), Long (1997), Sigelman & Zen (1999) and Gujarati (2004).

The final chapter includes concluding thoughts and identifies opportunities for future research. The survey form is included as an appendix, followed by description of the universities in the United States and Poland.

CHAPTER 2
BIOFUELS INDUSTRY

World Energy

The proper functioning of the world economy depends on the energy sector, therefore for each country the main priority is to ensure energy security. Increasing energy consumption is the result of technology development, increase living standards of people, and a consumptive model of society of the twenty-first century.

According to the Reference Scenario (Capros, Mantzos, & Tasios, 2010), over the next 20 years global demand for primary energy will steadily increase. In relation to current situation, demand will increase more than 50% of total primary energy demand, while demand in some groups (such as oil and gas) will increase by up to 60% (Kupczyk, Rudnicki, & Borowski, 2011). Before 2030 the world will use 16.3 btoe (billion tonnes of oil fuel equivalent (toe), or 5.5 btoe more than now and over one-third of demand will be indicated by developing countries, where the fastest economic and population growth is recorded (Figure 2-1).

Currently, international markets of oil and gas sector are extremely competitive, especially in the field of exploitation and development of natural gas and crude oil. High developed countries, accompanied by economic development, are becoming consumers of more and more energy and thus becoming producers of more CO_2.

The challenge for the economies of the highly developed countries, is to search for solutions in order to separate economic growth from increasing energy consumption. These activities are supported by a number of legislative initiatives, energy efficiency programs and policies concerning use of competitive and efficient renewable energy. Currently World needs a new industrial revolution by reducing energy consumption, increasing energy efficiency and energy production from renewable sources (Kupczyk, Rudnicki, & Borowski, 2011).

Renewable Energy

The UN Intergovernmental Panel on Climate Change indicates that “close to 80% of the world’s energy supply could be met by renewables by mid-century” (Edenhofer, Pichs-Madruga, & Sokona, 2011). However, currently the renewable energy share of global energy consumption is still relatively small. The IPCC indicates that only 13% of the total world energy supply comes from renewable sources, including bioenergy, solar energy, ocean energy, wind energy, geothermal energy and hydropower (Figure 2-2). Almost three-fourth of renewable energy share is dominated by bioenergy/biomass (10.2%). In general biomass is the biodegradable portion of products, waste and residues from agriculture, forestry and related industries, as well as the biodegradable fractions of industrial and municipal waste. It is used for heating, cooling, producing electricity and transporting biofuels. Currently, biofuels are one of the possible sources of energy that can be used to substitute for fossil fuels in the transportation sector (Directorate General for Energy, 2011).

Biofuels Characteristics

The main objective of biofuels development is sustainability. This concept is recognized as the paradigm, explaining social, economical and environmental aspects. In case of energy, sustainability means the provision of energy in such a way that it meets the needs of the present generations without compromising the ability of future generations to meet their needs. Sustainable energy sources are most often considered to be renewable energy sources, including biofuels. Environmental sustainability specifies the alternative path of reduction of greenhouse gas emissions. Economic sustainability explains sustainable production of biofuels for energy transportation. Social sustainability presents how the production and use of biofuels, impacts local development (Fontes, 2010).

Definitions, Types and Generations of Biofuels

"Biofuels are a liquid or gaseous fuel for transport produced from biomass" (European Commission, 2003). The most commonly used biofuels are bioethanol and biodiesel, that can be used in pure form by suitably adapted engines or may be blended in a mixture with gasoline or diesel, respectively. In this master thesis, when we refer to biofuels, we are referring to liquid biofuels for cars.

Bioethanol

Bioethanol is an alcohol, made by fermenting any biomass with a high content of carbohydrates. It is derived through the fermentation of sugar from cereals like wheat, maize, rye, and barley, and from sugary feedstocks such as sugarcane and sugarbeet. Though today's bioethanol is made from starches and sugars, in the future, cellulosic material may be used. Bioethanol is currently the most popular biofuel and many countries have gasoline fuel standards that require 10% bioethanol blends (Fontes, 2010).

Biodiesel

Biodiesel, known as "Fatty Acid Methyl Ester" (FAME), is produced from pure or recycled vegetable oil or animal fats and oils. Raw materials include corn, soybean, palm, coconut, canola, cottonseed, flax, peanut, sunflower, and rapeseed oils, as well as algae. Biodiesel can be used in two forms: as an additive to reduce vehicle emissions; and in its pure form as a renewable alternative fuel in terms of blending. Biodiesel can be legally mixed with petroleum diesel in any percentage, like B20 for a blend including 20% biodiesel and 80% petroleum diesel or B100 for 100% biodiesel (Fontes, 2010).

Four generations of biofuels

Biofuels can be classified into one of four “generations” based on the nature of the raw material and technology used to produce them:

- First Generation - derived from raw materials, mainly from food crops or plant and animal fats. Biofuels made from sugar, starch, vegetable oil, or animal fats using conventional technology.

- Second Generation - derived from non-food raw materials, agricultural and municipal waste and from conversion of cellulose. These include waste biomass, the stalks of wheat, corn, wood, and special energy or biomass crops. Second generation biofuels use biomass to liquid technology including cellulosic biofuels from non food crops.

- Third Generation - derived with a suitably modified material at the stage of cultivation. These crops require further research and development to become commercially feasible, such as perennial grasses, fast growing trees and algae. They are designed exclusively for fuels production and are commonly referred to “energy crops”.

- Fourth Generation - derived from biological processing of carbon (Kupczyk, Rudnicki, & Borowski, 2011).

World Biofuels Market

Rudolph Diesel, German designer and creator of the diesel engine, in April 1900 at the World Exhibition in Paris, powered his new diesel engine with peanut oil. Diesel was convinced of the great future of his new idea of engine for the transportation industry. In a 1912 speech Diesel said, "the use of vegetable oils for engine fuels may seem insignificant today but such oils may become, in the course of time, as important as petroleum of the present time" (European Commission, 1994).

Also in 1925 Henry Ford, the American founder of Ford Motor Company said, “The fuel of the future is going to come from fruit like that sumac out by the road, or from apples, weeds, sawdust - almost anything. There is fuel in every bit of vegetable matter that can be fermented" (Geyer, Chong, & Hxue). He was convinced that the fuel of the future is ethyl alcohol. These words of the pioneer automobile nobody took seriously for a long time, except the Brazilians.

The first country that used biofuels on a big scale was Brazil. It started with ethanol production mixed with gasoline. At that moment the main reason for using biofuels was to improve the inequality between sugar supply and demand on the international markets. In the 60s and 70s, the perception of biofuels as a possible replacement for fossil fuel started to emerge and many countries started implementing programs related to biofuels policy and technologies (Fontes, 2010).

According to International Energy Agency (IEA), global fuel demand at the end of 2010 amounted to 86.9 million barrels per day and the supply of biofuels was estimated at about 1.8 million barrels a day. Between 2000 and 2007 (Figure 2-3), the global biofuel production has tripled from 4.8 billion gallons to about 16.0 billion, but still accounted for less than 2% of the global transportation fuel supply (Coyle, 2007). About 90% of biofuels production is concentrated in the United States, Brazil, and the European Union (Figure 2-4). In the case of bioethanol production, the United States and Brazil are the world leaders, producing mostly bioethanol from corn (United States) and sugar cane (Brazil) (Fontes, 2010). However, the biofuels production in EU is mainly dominated by biodiesel produced from rapeseed. Other major producers of biofuels, especially of bioethanol include China and India. There are also huge opportunities for other countries, situated in Africa and Asia to become the major biofuels producers and exporters. One example are the South-East Asian countries. These countries are large scale palm oil producers, and have the opportunity to develop competitive a biodiesel production.

One of the most important issues regarding biofuels production are biofuels mandates established for domestic biofuels use, in the form of pure fuel or blended with conventional fuel. Many countries has different biofuels mandates, typically requiring 5-10% of ethanol in gasoline and 5-7% of biodiesel in diesel. In order to

satisfy these mandates, governments provide various support measures and incentives, often consisting of special loan and grant programs, tax credits, tax penalties on refineries and road tax exemptions.

According to International Energy Agency (IEA), biofuels in 2050 may account for up to 27% of all transport fuels, compared to 2% of biofuels for transport in the world today. The perspectives for global biofuels market will depend on a several factors, including the future oil price and availability of low-cost feedstocks. It is also necessary to increase financial funding for research and popularize biofuels production and improve the efficiency of conventional technologies. The IEA believes that the popularity of biofuels could increase considerably in the next 10 years, but in order to do so, their production should be based on the biofuels of the second and third generation (Coyle, 2007).

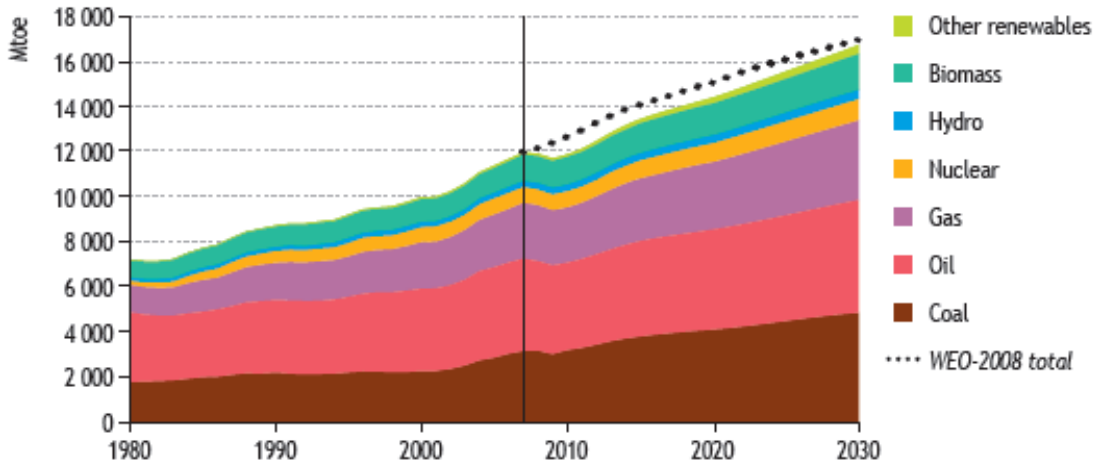


Figure 2-1. World primary energy demand by fuel in the Reference Scenario by 2030 (Edenhofer, Pichs-Madruga, & Sokona, 2011)

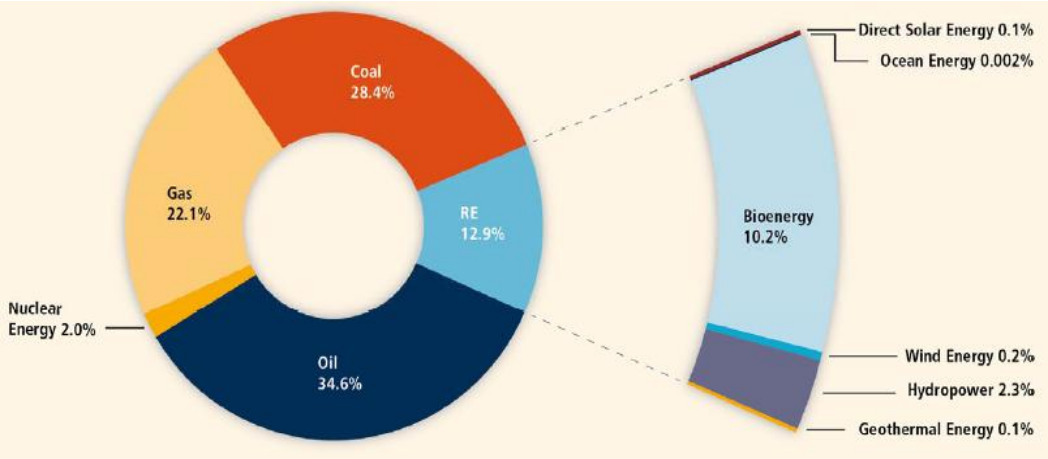


Figure 2-2. Renewable energy share of global energy consumption (Edenhofer, Pichs-Madruga, & Sokona, 2011)

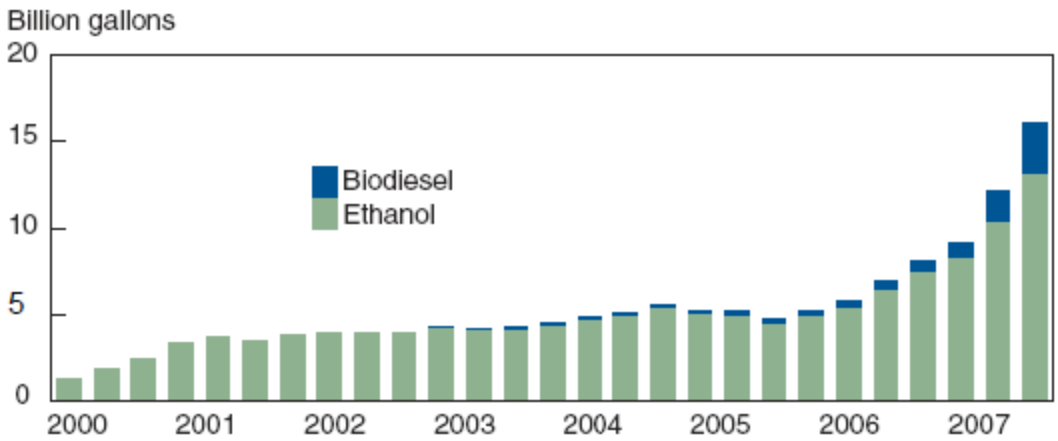


Figure 2-3. Global biofuels production between 2000 and 2007 (Coyle, 2007)

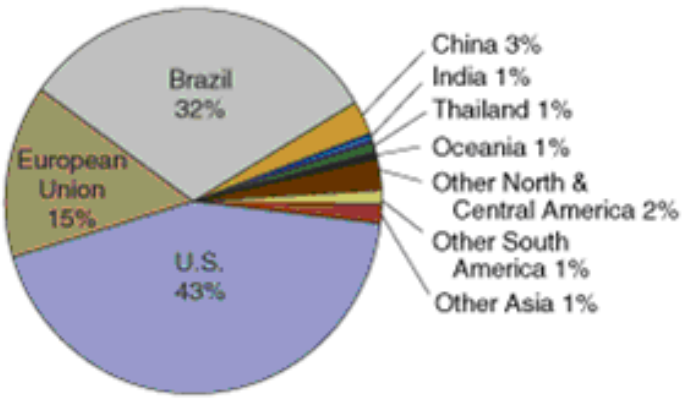


Figure 2- 4. Global biofuels production in 2007 (Coyle, 2007)

CHAPTER 3
THE BIOFUELS MARKET IN THE UNITED STATES

The United States is the largest consumer of oil in the world, and therefore the fastest growth was observed in the biofuels sector in this country. In the United States consumption accounts for nearly 21 million barrels of oil per day, of which only 8.5 million are produced in the U.S. In order to reduce the country's dependence on imported oil, one of the possible solutions are biofuels.

Biofuels market in the United States is a very advanced market, and is the largest producer of biofuels in the world. The U.S. biofuels production industry had total revenue of $19,984.9 million in 2010, with a compound annual growth rate (CAGR) of 22.2% during 2006-2010. Industry production volumes went up with a CAGR of 23.3% during 2006 and 2010, to obtain 35,606.1 thousand tons in 2010 (Datamonitor, 2011b).

In the United States the most rapidly growing is the bioethanol market, based on the corn production. The other type of biofuels is biodiesel produced mainly from soybean. However, compared to the ethanol industry, which accounted for 91% of biofuels capacity, the amount of biodiesel production is marginal (Schnepf, 2010)

The production of ethanol has risen from about 175 million gallons in 1980 to 10.7 billion gallons per year in 2009 (Figure 3-1). U.S. biodiesel production is much smaller than its ethanol counterpart, but has also shown strong growth, rising from 0.5 million gallons in 1999 to a 776 million gallons in 2008. Despite this rapid growth, total biofuels production accounted for only about 4.3% of total U.S. transportation fuel consumption in 2009 (Schnepf, 2010).

Biofuels Policy in the United States

The first incentives from the government for ethanol production originated around thirty years ago. The Energy Policy Act of 1978 introduced a 4 cent subsidy

per gallon of a mixture of gasoline and 10% ethanol known as E10, and a 40 cent per gallon subsidy for pure ethanol. Over time the subsidy level was differentiated. The ethanol subsidy offered by the federal government is a tax incentive called the Volumetric Ethanol Excise Tax Credit, which currently amounts to 45 cents for every gallon of pure ethanol blend with gasoline gallon. In the case of biodiesel, there is allowed a 1 dollar per gallon subsidy as a tax credit for biodiesel producers. In April 2011 U.S. Senate voted to eliminate bioethanol subsidies. It is estimated that the annual support for bioethanol production costs U.S. tax payers $6 billion.

According to the U.S. Environmental Protection Agency (EPA) in the United States over 90% of U.S. gasoline contains up to 10% ethanol (E10). Ethanol is blended with gasoline in various amounts for use in vehicles. Low-level blends, up to E10 (10% ethanol, 90% gasoline), are classified as "substantially similar" to gasoline by the, meaning they can be used legally in any gasoline-powered vehicle. In seven states, including Minnesota, Missouri, Montana, Hawaii, Oregon, Washington and recently in Florida (since 2011) there exist mandatory blending law, requiring E10 usage, which is sold at the pump as a regular gasoline. Bioethanol, E85 (85% ethanol, 15% gasoline) is also used in the united States but can be used only in flexible fuel cars. Another, less popular type of fuel used in the United States is diesel. The most popular blends are B2 (2% biodiesel, 98% diesel) and B5 (5% biodiesel, 95% diesel). There exist also higher biodiesel blends, such as B20 (20% biodiesel blends and 80% diesel fuel) and B100 (pure biodiesel).

According to the Energy Information Administration (EIA) in the United States the price of fuel, containing up to 10% bioethanol is as following: Pb87 (3.66$), PB89 ($3.80) and Pb93 (3.93$). However the price of bioethanol (E85) is cheaper, thus

only $3.20. In the case of the price of diesel ($/gallon), is $3.94. However the price of biodiesel is as following: B20 ($3.60) and B100 ($3.85).

In Florida the price of regular fuel (E10) is as following: Pb87 ($3.69), Pb89 ($3.85) and Pb93 ($3.96). However the price of E85 ($/gallon) is cheaper and accounts for $3.26. In the case of the price of diesel ($/gallon), is $3.92. However the price of biodiesel is as following: B20 ($3.55) and B100 ($3.70).

The first biofuels mandate in U.S. was established under the Energy Policy Act of 2005. It established the Renewable Fuel Standard (RFS), which set a minimum level on the quantity of biofuels used in the United States. Afterwards, there was expansion of the original RFS by the Energy Independence and Security Act of 2007 (EISA). The new RFS established a requirement of 36 billion gallons of biofuels for road transportation by 2022, which possibly could account for 25% of all transport fuel sales by that year. Fifteen billion gallons will be contributed by conventional biofuels like corn ethanol. Advanced biofuels will account for 21 billion gallons, including a cellulosic biofuel requirement of 16 billion gallons. Additionally, at least 1 billion gallons of these 21 advanced biofuels should be contributed by biomass-based diesel (Josling, Blandford, & Earley, 2010).

Currently, the crucial issue for biofuels development and production is the financial support provided by the U.S. government. According to the “New Energy for America” plan, President Barack Obama identified the need for $150 billion investment for the next 10 years to boost private sector involvement, in order to provide clean energy future, with special attention to biofuels. The U.S. President additionally created the Biofuels Interagency Working Group to work with the U.S. Department of Agriculture (USDA), the Department of Energy (DOE) and the Environmental Protection Agency (EPA), on improving the biofuels market through

specific policies to expand production of flexible fuel vehicles, and assess aspects of greenhouse gas emissions, land use and resource management. For DOE, the funds from the American Recovery and Reinvestment Act (ARRA) of 2009 ($786.5 million) are used to incentivize the biofuels industry. In case of USDA, the Farm Bill of 2008 provides two kinds of support. First, loan guarantees for commercial-scale biorefineries were instituted in order to develop and construct advanced biofuels biorefineries, and second, grants for demonstration-scale biorefineries to produce advanced biofuels were established (Curtis, 2010).

An Overview of Biofuels in the United States

Corn ethanol is the most widely used liquid biofuel in the United States. The other commonly used biofuel in the United States is biodiesel, primarily produced from soybean oil. Currently in the United States there are 201 ethanol and 168 biodiesel facilities in production. There are also a number of facilities under construction. The main biorefineries are situated in the North Central region of the country, including Iowa, Nebraska, Illinois, Minnesota, South Dakota, Indiana, and Ohio. The nature of agriculture in the North Central region provides the best opportunity for production, followed by the Southeast, Northwest, Northeast, and West (USDA, 2010).

Production of Biofuels

Bioethanol

The ethanol production started in 1980 with 175 million gallons, and has reached almost 13 billion gallons in 2010. The last 15 years brought incredibly high number of structural changes in the industry. In 1991 there were only 35 plants with the possibility of 865 million total gallons of ethanol production. The majority of these plants were wet mill plants with production capacity of 96 million gallons per year

(MGY). The second group of dry mill plants had an average production capacity of 16.5 MGY.

Nowadays there exist more than 200 plants with volume of almost 13.5 billion gallons. Seventy percent of capacity comes from dry mill plants with the trend toward dry mills using grain as a feedstock or so-called second-generation plants which produce ethanol from advanced biofuels feedstocks such as any form of cellulose (DOE, 2010). Cellulosic ethanol is ethanol produced using a variety of feedstocks such as chopped wood pellets, yard waste, or curn husks. There is a trend toward government support of cellulosic ethanol similar to that for corn ethanol (Stockwell, 2009).

Along with increased production capacity, there have been changes in technologies which allows for the production of E85 (an ethanol fuel blend of up to 85% ethanol fuel and gasoline). With the introduction of E85 pumps at filling stations, there became many advantages for the production and sale of flex-fuel vehicles (FFVs) adjusted to use E85. In 2009 around 1,950 U.S. fueling stations were selling E85, and currently there are more than 7 million FFVs in operation which can use E85 gasoline. Production of FFV began in the late 1990s. In 2004 there were only available 8 models of FFV on the market. Four years later production had increased to 28 models, mainly from GM, Chrysler, and Ford. In the case of foreign manufacturers, Nissan, Mercedes-Benz, Toyota and Mitsubishi all produce at least one FFV model.

In general, the ethanol industry has been the major biofuels industry over the last 25 years with the high potential for the future. It have been predicted that conventional corn-based ethanol production will be the dominant biofuels source until 2015, with a significant increase in cellulosic production after that (DOE, 2010).

Biodiesel

The biodiesel industry is basically dominated by small plants from local supplies, mostly derived from vegetable oils like soy, and palm oil. In 2008 and 2009 this industry experienced difficult times. Food prices increased, followed by decline of diesel prices which contributed to the decrease of the industry operation with much lower level of total production accounting for 2.7 billion gallons per year. In general, many factors influence the difficulty of production of biodiesel, including the cost and availability of vegetable oil and the relative cost of petroleum. Its disadvantages are also related to its relative ineffectiveness when cold and its limited time of storage. As a result of these negatives, there has been growing interest in algae-based biodiesel as the alternative to vegetable oils (Curtis, 2010).

Algae-based biodiesel is in the center of attention nowadays due to high potential in terms of land efficiency and possibility to produce around 2,000 to 10,000 gallons per acre per year compared to other plant-oil crops like jatropha (200 gallons per acre), soybean (48 gallons per acre), rapeseed (127 gallons per acre), and oil palm (636 gallons per acre). According to DOE estimates, an area of 15,000 square miles could sustain enough algae-based fuel production to cover the current level of petroleum consumption (Curtis, 2010). This huge potential could do a significant reduction in the demand for of land to produce other feedstocks for biofuels. According to Solix Biofuels CEO Douglas Henston, “If we were to replace all of the diesel that we use in the United States with an algae derivative, we could do it on an area of land that’s about one-half of one percent of the current farm land that we use now" (Stockwell, 2009).

The Biofuels Market in Florida

The U.S. Department of Energy reports that Florida is consuming a 7.6 billion gallons of gasoline per year and burns 8.36 billion gallons of blended fuel each year, mainly a 10% average ethanol mix. In 2009 the state's residents spent about $20.2 billion on imports of gasoline and ethanol, mostly from Midwest, the Caribbean Basin and Brazil.

According to the Florida Department of Revenue, only about 1.4 billion gallons of diesel are sold in the state annually, while Florida is sending around $3.2 billion dollars for diesel outside the state (American Biofuels Now, 2010).

Currently, there are no ethanol production facilities in Florida and there is only one biodiesel production facility(Genuine Biofuel). However, there are eight projected production facilities for ethanol and four biodiesel production facilities projects.

According to economic estimates for Florida, it has been shown that in order for the state to be able to produce its own ethanol, there would need to be 19 plants built which in the long term would provide 627 full time jobs opportunities, followed by the 1,560 jobs through the local area, bringing in a minimum $1.3 billion into local economies every year. In the case of biodiesel, if only 5% of Florida's 1,4 billion gallons of diesel were to be blended with Florida biodiesel, about 70 million gallons would have to be produced, which could generate around $70 million and create 400 jobs (American Biofuels Now, 2010).

Another advantage of Florida is related to Renewable Fuel Standard, mandates a 10% of ethanol blend which began December 31, 2010. That is, all gasoline that a terminal supplier, importer, blender, or wholesaler sells in Florida must contain 10% ethanol by volume. Florida hast about 600,000 flex fuel vehicles with possibilities to refuel 44 E85 stations across 34 cities in the State.

Unfortunately, law does not address biodiesel, which provides a greater opportunity for the state. There is no doubt that Florida could improve its energy technologies investment tax credit and consider also other ways to boost the percentage of biodiesel coming from Florida producers. It should be noted that at the end of the 2012 the Cellulosic Ethanol Producer Tax Credit will expire, which has the potential to devastate the biofuels industry nationally. But this presents a huge opportunity for Florida, which could create its own sustainable market in biofuels in order to decrease dependence on other both in case of petroleum and in bio-based products. By having its own biofuels sector, sustainability issues could be satisfied, profits could improve to state businesses and communities, boosting state's economy and improving its environment (American Biofuels Now, 2010).

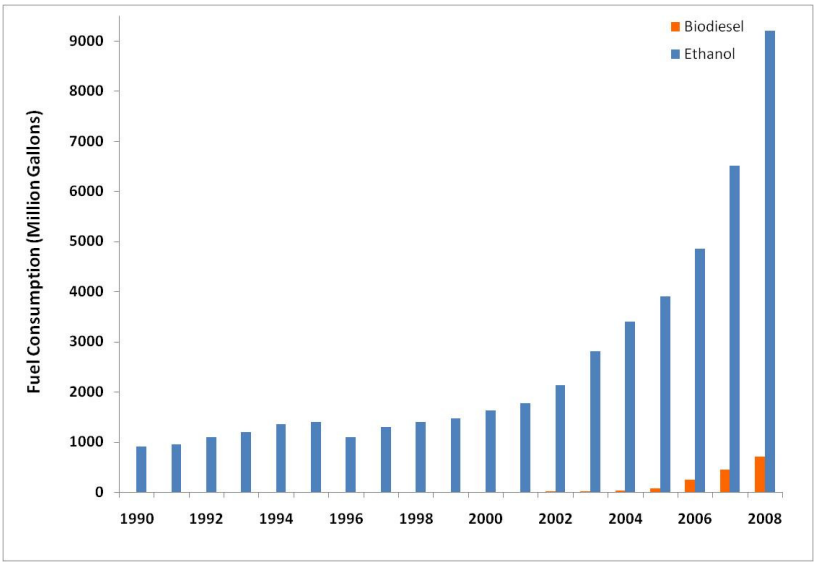


Figure 3-1. Biofuels production in the United States between 1990-2008 (Global Climate Change, 2009)

CHAPTER 4
THE BIOFUELS MARKET IN POLAND

Poland is a European country with great potential for the production of biomass and biofuels, but so far this potential has not been realized. Having an area of 18.3 million ha devoted to agricultural production and 8.9 million ha of forest area, Poland presents biomass opportunities from agricultural residues, wood and wood wastes from forestry and industry, as well as energy crops grown specifically for biofuels (Frost & Sullivan, 2008).

The Polish market is defined as the market in the early stages of development, with a large scope for increasing production capacities. The Polish biofuels production industry had total revenue of $447.2 million in 2010, with a compound annual growth rate (CAGR) of 30.2% during 2006-2010. Industry production volumes went up with a CAGR of 22% during 2006 and 2010, to obtain 468.9 thousand tons in 2010 (Datamonitor, 2011a).

In Poland, there are two kinds of biofuels that are currently of economic importance: bioethanol that is blended with gasoline and biodiesel blended with diesel, or as a self-contained biofuel. Currently, first-generation biofuels are used in Poland as biocomponents to fuel vehicles produced from crude oil. These biofuels are produced mainly from edible plants using conventional technology like fermentation (bioethanol) or transesterification (biodiesel). However it is expected that over the next few years second-generation biofuels produced from non-edible energy plants or residues will be introduced (Kupczyk, Rudnicki, & Borowski, 2011).

The production of ethanol as a fuel for engines began in Poland in 1928. Pre-war production was estimated at about 10 million liters / year. After the war, the production of ethanol was reintroduced and reached up to 80 million liters / year. During this time, gasoline blended with ethanol contained up to 20% ethanol. The

1990s represented a time of an introduction of bioethanol to gasoline, with a gradual growth until 1997 (during this time a record volume of about 111 million liters was produced).

Biodiesel was introduced to the Polish market much later, appearing on an industrial scale between 2004 and 2005, when the production of biodiesel started in Trzebinia Refinery. This production was initially devoted for export, and in small quantities for the domestic market (Kupczyk, Rudnicki, & Borowski, 2011).

Biofuels Policy in Poland

Biofuels and biocomponents are currently regulated in Poland by a pair of laws adopted on August 25th, 2006: the Biocomponents and Liquid Biofuels Act (Journal of Laws, 2007a) and the Fuel Quality Monitoring and Control Act (Journal of Laws, 2007b). The currently binding legal regulations allow for adding up to 5% of bioethanol additive to petrol and 5% of fatty acid methyl esters (FAME) additive to diesel. The regulation adopted the principle that the share of biocomponents up to 5% by volume is recognized as a standard fuel, which does not have to be marked in a special way. Only when the share of biofuels is larger than 5% does the fuel have to be identified differently, thus are recognized as biofuels.

The Regulation of the Minister for Economic Affairs of 8 September 2006 on quality requirements for liquid biofuels (Ministry for Economic Affairs, 2006), created the conditions for placing two types of biofuels on the market such as fatty acid methyl esters used as direct fuel and diesel containing 20% of such esters.

In Poland, there are currently debates on the legislative progress relating to the adjustment of Polish law to the EU Directive. On the 12 of April, 2011, the Polish Council of Ministers adopted a regulation proposal amending the Fuel Quality Monitoring and Control Act of August 25th, 2006. This project permits the increase in

content in the traditional biofuels to 7% of biocomponents for diesel, which is only 2% more than currently producers are blending with diesel. However, this project does not introduce changes to permit the 10% bioethanol mixture in gasoline. This is because in Poland almost 45% of the vehicles are not adapted to E10 gasoline.

Recently there was presented a pilot phase of launching the ethanol-based E85 gasoline on the market in Poland. The new fuel is currently available only at the one gas station in Warsaw since the end of May 2011. In Poland flex-fuel vehicles (FFVs) which are suitable for E85 are sold by Ford, Opel, Saab and Volvo. In the case of the Polish biofuels situation, E85 can become a success, especially for the Polish oil company giants like Orlen and Lotos. However, a spokesperson for Orlen identified important issues, “first the demand has to be high enough that production is economically justified”. Therefore the company is currently researching the Polish market’s potential.

National Indicative Targets

In January 2008 the National Indicative Target (NIT) was implemented. The NIT was defined as the "minimal percentage share of biofuels and other renewable fuels in the total amount of liquid fuels and liquid biofuels consumed in transport during the calendar year, calculated according to the calorific value”. The NIT, which was determined by the Regulation of the Council of Ministers of 15 June 2007 on National Indicative Targets for 2008-2013 (Council of Ministers, 2007) sets the following targets: 3.45% of energy in 2008, 4.60% in 2009, 5.75% in 2010, 6.20% in 2011, 6.65% in 2012 and 7.10% in 2013 (Ministry of Economic Affairs, 2009). The National Indicative Targets presented above reflects obligations stemming from Poland’s membership in the European Union. In 2010 the target of 5.75% specified in Directive 2003/30/EC was achieved. It is assumed that the rate of increase of the NIT

up to 2020 will make it possible to reach 10% in 2020. Failure to achieve the compulsory share of biocomponents in total fuels by fuel companies introducing liquid fuels or liquid biofuels result in fines. Under current law, for every ton of bio-NIT below the level of the year the company has to pay PLN 17 000.

Another important biofuels policy document in Poland is the Long-term Plan on the Promotion of Biofuels and Other Renewable Fuels of 24 July 2007, adopted by the Council of Ministers for 2008-2014 (Ministry of Economic Affairs, 2007). This plan aimed to improve the cost effectiveness of the process as a whole, from the cultivation of the agricultural raw materials through the production of biocomponents, to the manufacture of liquid biofuels and liquid fuels blended with biocomponents, and ending with the use of the biofuels (Ministry of Economic Affairs, 2009).

Fiscal policy

Poland currently promotes the use of biocomponents by offering financial incentives through a system of tax exemptions and tax relief. Preferential excise duty treatment, entered into force on 6 July 2007 (Journal of Laws No 99, item 666). Under this provision the following fuels meeting the relevant quality requirements were exempt from excise duty until the end of April 2011:

- petrol - PLN 1.565 on each litre of biocomponents added to it,
- diesel - PLN 1.048 on each litre of biocomponents added to it;

The removal of the exemption from excise duty after April 2011 resulted in negative effects for biofuels industry. Before, contributed to the situation where the greater allowance of biocomponents did not cause a significant increase in fuel prices. After the removal of the exemption from excise duty, Poland will be able to save about PLN1.5 billion per year, but the consequences will be mainly related to car drivers, because of the more expensive gasoline. It is estimated that the price of

1 liter of gasoline, which is already very expensive will increase by a few percent (Kupczyk, Rudnicki, & Borowski, 2011)

According to the Agricultural Market Agency the price of regular fuel in Poland ($/gallon), is as following: Pb95 ($7.20) and Pb98 ($7.47). However the price of bioethanol (E85) is cheaper and accounts for $6.63. In the case of the price of diesel ($/gallon), is $6.94. However the price of biodiesel is as following: B20 ($5.72) and B100 ($5.87).

Biofuels Policy in the European Union

After the Polish accession to the European Union in May 2004, national trends in the development of biofuels have been similar to trends in the EU, where policy is aligned toward EU requirements. The biofuels sector in Poland is mainly driven by European incentives and directives aiming at considerably increasing biofuels production and use.

Due to the low efficiency of existing EU actions on energy, the European Council and European Parliament have recognized the need for a new European Energy Policy. In January 2007 the European Commission put forward a proposal regarding climate change and energy supply issues, which was later agreed as a climate and energy package, known as the “20-20-20” targets. This plan assumed for all Member States 20% increase in energy efficiency, 20% reduction in greenhouse gas emissions, 20% share of renewables in overall EU energy consumption by 2020 and 10% biofuels component in vehicle fuel by 2020 (Josling, Blandford, & Earley, 2010).

The strategic document for the development of the biofuel market in the European Union was the European Directive 2003/30/EC of 8 May 2003 “on the promotion of the use of biofuels or other renewable fuels for transport" (European

Commission, 2003), which was valid until the end of 2010. In order to achieve the European renewable energy targets, the EU adopted another European Directive 2009/28/EC of 23 April 2009, setting requirements of a 20% share of renewable energy sources in energy consumption along with a of 10% minimum target for renewable fuels in transports by 2020 for each Member States (European Commission, 2009a). Furthermore, in order to facilitate a more widespread blending of biofuels into petrol and set ambitious sustainability criteria for biofuels another Directive on the specifications of fuels and biofuels was adopted (European Commission, 2009b). This European Directive allows for a higher content of biocomponents in conventional fuels up to 7% for biodiesel and 10% for bioethanol, instead of the current 5% target (Kupczyk, Rudnicki, & Borowski, 2011).

An Overview of Biofuels in Poland

The Agricultural Market Agency data shows that as of 13 September 2010, the register of manufacturers contained entries for 13 bioethanol producers, declaring an annual production of 590 million liters of bioethanol and 19 methyl ester producers, declaring an annual production of 772 million liters of ester (Ministry of Economic Affairs, 2009).

In the first half of 2010, the domestic market included 556 thousand tons of biocomponents, including 115 thousand tons of bioethanol and 441 thousand tons of esters (Table 4-1). Compared to the corresponding period of 2009, the use of biocomponents increased by 167 thousand tons. The share of domestic production of bioethanol in the quantity marketed in the first half of 2010 increased compared to the same time in 2009 from 45% to 81%. In the case of esters there was a reduction of domestic share production from 61% to 40%.

Production of Biofuels

Bioethanol

An analysis of the data compiled by the Central Statistical Office, the Ministry of Finance, the Energy Regulatory Office and the Energy Market Agency on petrol consumption shows that in the first half of 2010 compared to same period in 2009, the reduction of the amount of gasoline marketed was recorded at 7% with an increase in the bioethanol consumption by 7%.

Biodiesel

At the same time in the first half of 2010, the percentage share of biocomponents in fuel consumption in transport increased by 5% in case of diesel and 56% of esters (Kupczyk, Rudnicki, & Borowski, 2011).

Support for Agricultural Production

The Common Agricultural Policy of the European Union provides a system of subsidies for agricultural production with intention for energy purposes. In the case of Poland, one of the financial support instruments included aid for energy crops providing the raw materials for biocomponent production (Kupczyk, Rudnicki, & Borowski, 2011). This aid is provided by enabling farmers to receive European Union subsidies for the cultivation of energy crops of €45 per hectare. Moreover there exists additional national payment for farmers who had been awarded payments for the cultivation of energy crops accounting for PLN 176 per 1 ha of rape seed cultivation (Journal of Laws, 2008).

In general, the utilization rate of 10% for biofuels by 2020 will be achievable only with development of the second generation biofuels. These biofuels are produced from biomass containing cellulose, such as grass, straw and forest waste. Because these raw materials cannot be used as food, the biofuels production is not in conflict with this market. Around 2012, there will be second-generation biofuels on

the market, and in 2020 the first generation biofuels will be maximally utilised, followed by decline and finally the rate of using the first and second generation of biofuels will be equal. One of the most important thing is that the European biomass energy resources required for the production of transport biofuels are largely situated on the Polish territory.

Table 4-1. Quantity of transport fuels and percentage share of biocomponents placed on the market in the period 2000-2010 (Kupczyk, Rudnicki, & Borowski, 2011)

	Consumption In transport ('000 tones)				
Year	**Petrol**	**Diesel**	**Bioethanol**	**Esters**	**Share in terms of calorific value**
2000	4841	2343	40.6	0	0.35
2001	4484	2562	52.4	0	0.46
2002	4109	2940	65.3	0	0.57
2003	3941	3606	60.1	0	0.49
2004	4 011	4 303	38,3	0,0	0.29
2005	3 915	5 075	42,8	17,1	0.47
2006	4 048	6 042	84,3	44,9	0.92
2007	3 998	7 212	70,9	37,3	0.68
2008	4 110	10 066	185,6	473,4	3.62
2009	4 125	10 387	232,2	632,5	4,.61
I term 2009	2 026	4 781	107,4	282,1	4.43
I term 2010	1 884	5 016	114,9	441,3	6.25

CHAPTER 5
RESEARCH ABOUT CONSUMER PERCEPTION

Consumer Behavior Aspects

The problem of consumer perception is the main issue of many scientific disciplines such as sociology, economics, law and social psychology. Consumers are frequently making choices about certain issues, the consequences of which they may not be fully aware. It is not only related to a lack of information, but even more it is about issues of quality and type of information. Consumers often think that they have knowledge about biofuels, but in reality, they have incorrect information. There exist a lot of information about economic, environmental and technical issues about biofuels, however many times people are lacking information about sociological aspects of biofuels. There has been very limited sociological research made so far regarding perception of biofuels because it is still in the emerging side of its development (Thompson, 2007). That is why this chapter will focus to examine a few previous research regarding the perception towards biofuels in terms of specific characteristics (Diamantopoulos, Schlegelmilch, & Sinkovics, 2003).

Overview of the Previous Reports about Consumer Perception towards Biofuels

Associations between consumer's behavior toward biofuels, and specific variables characteristics - consciousness measures, are relatively complex (Diamantopoulos, Schlegelmilch, & Sinkovics, 2003). There have been only a limited studies done, which have summarized associations between consumer perceptions toward biofuels and specific groups of key variables like demographics, knowledge, fuel economy and fuel efficiency, environmental issues including Perceived Consumer Effectiveness (PCE) scale, New Environmental Paradigm (NEP) scale and food versus fuel preference.

Some of the research came from the United States, while some was from Poland. Several others have conducted similar studies based on different countries such as the United States and Belgium. The sample population differs from research to research, showing various impacts depending on the respondents' groups.

Interestingly, research of Ulmer, Huhnke, & Bellmer (2004), was related to a mail survey on consumer perceptions and knowledge towards ethanol-blended gasoline in the United States and was conducted in the Fall 2002. This study set a sample at 2400 registered voters in the State of Oklahoma.

Furthermore, another biofuels study was conducted under cooperation between University of Ghent (Belgium) and University of Arkansas (the United States). In both analyzed places there were surveyed 1,200 and 1,510 people, respectively, during November 2006. The first issue investigated consumer interest in fuel economy (Popp, Van Huylenbroeck, & Verbeke, 2009), while the second one measured consumers' perception regarding tradeoffs between food and fuel expenditures (Skipper, Van Huylenbroeck, & Verbeke, 2009).

The third study, which focused on public perceptions of biofuels, was performed by researchers in the Department of Life Sciences Communication at the University of Wisconsin-Madison in April 2009 (University of Wisconsin-Madison, 2009). The reported results represented a subsample of 1,191 people surveyed online between November and December 2008.

A further study by Delshad, Raymond, & Sawicki (2010) examined the public attitudes toward political and technological options for biofuels. The research was conducted in Indiana among 34 focus groups, including 17 groups of students at the Purdue University and 17 groups of public between November 2008 and May 2009.

According to another research by Johnson, Halvorsen, & Solomen (2011), data were collected from among upper Midwestern U.S. consumers about their knowledge, beliefs and consumption related to ethanol and climate changes. The survey was distributed via mail among 1500 residents in Michigan, Minnesota and Wisconsin during 2007-2008.

The most recent study (Lane, 2011) was made by the Biofuels Digest Newsletter in Florida on the issue related to food versus fuel concerns entitled “Are Biofuels Moral or Immoral?”. The questionnaire surveyed 2700 readers of newsletter.

The following reports examined the European perception towards biofuels with significant attention to Polish respondents.

The interesting study titled, “Attitudes on issues related to EU Transport Policy” (Eurobarometer, 2007) covered 27 Member States of the European Union on a randomly selected sample of around 26,000 citizens on issues related to urban and public transport and environmental aspects, especially biofuels.

The next investigated research, "The planned investments in renewable energy in 2009-2011" was commissioned by the Law Firm Rachelski and Partners in April 2009 (Polish Public Opinion Research Center, 2009a). The survey was sampled among 77 companies from the renewable energy sector in Poland.

Another study entitled "Environmental awareness in Poland- sustainable development” was coordinated by the Institute for Sustainable Development (Polish Public Opinion Research Center, 2009b). The questionnaire was conducted in April 2009 in a sample of Polish people older than 18 years of age. The total number of completed interviews accounted for 1013.

Furthermore, the survey entitled “Biotechnology” was commissioned by the European Commission’s Directorate General for Research (Eurobarometer, 2010a).

This survey measured the overall attitudes and awareness of Europeans in the 27 EU Member States towards biotechnology, including biofuels.

Another survey on “Life sciences and biotechnology” was carried out in February 2010 and was based on representative samples from 32 European countries (27 Member States of the European Union plus Croatia, Iceland, Norway, Switzerland and Turkey) (Eurobarometer, 2010b).

The recent European study entitled “Environmental awareness in Poland” (Institute for Sustainable Development, 2010) was conducted in November 2010 on a nationwide, representative sample of Polish people older than 18 years of age. In total, 999 telephone interviews were completed.

In the following section an analysis of the results of the above mentioned research will be presented.

Analysis of Influencing Factors

Demographic variables

Many times classical and easily identifiable demographics are found to be significant in terms of indicating and providing information targeted to specific market segments. These actions very often increase the possibility of communication effectiveness for future decisions and, based on these characteristics, it is possible to create specific messages to certain groups of individuals taking into account their specific needs and preferences.

According to the study by Popp, Van Huylenbroeck, & Verbeke (2009), all demographic variables including gender, age and education do not show significant associations with fuel economy rankings. Therefore, providing information to specific demographic segments on the basis of age, gender or education showed that they were not effective from the basis of the results in this research.

Similarly in terms of the second study Skipper, Van Huylenbroeck, & Verbeke, (2009), almost all described demographic variables like gender, education and income were not impacting the tradeoff between food versus fuel prices. The only exception was age, showing that older respondents pay more attention on lower food prices than lower fuel prices.

When investigated demographics in the research of Johnson, Halvorsen, & Solomen (2011), only gender and income were statistically significant, asking about different feedstocks and consumer willingness to pay for cellulosic ethanol. On the other side, whether a respondent was coming from urban versus rural area was not significant.

The study by Delshad, Raymond, & Sawicki (2010), considering consumer attitudes towards improvement of biofuels technologies and policy changes, showed that the older and wealthier respondents were, the more contradictory opinions they present than average U.S. resident.

Another study of Ulmer, Huhnke, & Bellmer (2004), when asked people how their vehicle would perform if they switched to ethanol-blended gasoline, there was indicated highly positive significant relationship with income and gender.

Regarding Eurobarometer studies (Eurobarometer, 2010), the key findings of this survey show that majority of respondents (72%) feel that biofuels should be encouraged. In case of Poland 80% of respondents were in favor of biofuels. Europeans who live in rural areas (74%) tend more often to feel that biofuels should be encouraged than those who live in large towns (68%). Those aged 15 to 24 are more supportive (76%) than those aged 55 and over (63%).

Knowledge, fuel economy and fuel efficiency

Taking into account the increasing amount of biofuels production and specific ongoing public policy activities on biofuels, little research has been done so far on the public knowledge about biofuels. In order to determine personal knowledge about biofuels in the study of Ulmer, Huhnke, & Bellmer (2004), when people were asked about future purchasing decisions, more than half of respondents (63.20%) pointed towards buying ethanol-blended gasoline.

Analyzing another study by Popp, Van Huylenbroeck, & Verbeke (2009) 90.30% of respondents in the United States and 87.80% in Belgium presented a general tendency of positively ranking the fuel economy when buying a new car. Thus, when choosing a new car, respondents placed a high importance on whether the car engine type takes a low-priced fuel.

In relation to another study by Skipper, Van Huylenbroeck, & Verbeke (2009), in terms of the respondents' weekly fuel consumption, this variable had the greatest impact on the preference for lower food versus fuel prices. It was significant, however it also shows a reverse relationship between higher fuel consumption and favoring lower fuel prices rather than lower food prices.

The next national survey measuring public perceptions of biofuels (University of Wisconsin-Madison, 2009) revealed that 67% of people were interested in learning more about biofuels. According to Hernando Rojas, the co-investigator for the study, "these findings indicate people are really interested in this issue".

Regarding the study by Delshad, Raymond, & Sawicki (2010), the majority of respondents (92%) had heard about biofuels. In general, when people were asked to chose current policy, respondents were unable to distinguish which policy was actual or not.

In terms of the European study on environmental awareness (Institute for Sustainable Development, 2010), half of the respondents admitted that they are well informed on this subject, although only 10% declared that they definitely well-assess the level of their knowledge. The remaining respondents (46%) answered that they are not knowledgeable in this topic, of which almost one-third said that they definitely do not feel well informed.

Environmental issues

According to the study of public perceptions of biofuels (University of Wisconsin-Madison, 2009), 53% of respondents believed that biofuels can have positive impacts on climate change by reducing greenhouse gas emissions.

In the study of Ulmer, Huhnke, & Bellmer (2004), majority of respondents (57.7%) tended to say that ethanol is better for the environment than current gasoline. When questioning about the effect of gasoline on air quality, the majority (82.80%), responded that pure gasoline has a negative influence on the environment, so biofuels might be a good solution for current fuel alternatives.

Regarding the research on the planned investments in renewable energy in Poland (Polish Public Opinion Research Center, 2009a), most Polish people positively support initiatives leading to an increase use of renewable energy sources. The majority of Polish respondents (57%) strongly believe that the use of renewable energy protects the environment against climate changes.

Another Polish study (Institute for Sustainable Development, 2010), revealed that the most environmentally friendly energy source is wind energy, followed by water energy, solar power, and geothermal power. As the least environmentally friendly energy Polish people considered energy using biofuels, which shows the lack of respondents' knowledge about green energy use.

Perceived Consumer Effectiveness (PCE)

Nowadays more and more people are informed about the environmental problems, however there are still a lot consumers who do not show their environmental friendly behavior. One of the reasons can be related to the lack of belief in the effectiveness of the individuals' actions. It is known that the media makes great effort to inform people on environmental consequences. This importance of belief in the role of consumer actions is getting more and more important. Therefore PCE should be the center of the attention in terms of the role of individuals and their consumption.

PCE was first analyzed by Kinnear, Taylor and Ahmed in 1974," as the measurement of one's belief in the results of his/her own actions. The intention and behavior of a person is the function of his/her conviction that the occurrence or stopping of an event depends on his/her activity" (Thompson, 2007). Considering the study conducted in the United States in 2003, 64% of the respondents felt that they can contribute to a better world by buying environmentally friendly products. On the other hand, 17% showed lack of trust in the effectiveness of their own actions at all (Majláth, 2010).

According to Popp, Van Huylenbroeck, & Verbeke (2009), the belief that one has the ability to influence environment increased, the importance of fuel economy also increased. Therefore both consumers in the United States and Belgium, who felt strongly about their own ability to impact the environment, placed high importance on fuel economy.

New Environmental Paradigm (NEP)

Understanding the environmental paradigm and the adoption of pro-environmental beliefs is a critical issue in this century. Environmental paradigms were

studied in environmental sociology and also in environmental psychology creating a wide knowledge about consumers' values, beliefs and perceptions regarding the natural world.

There were several scales established in order to identify patterns within certain paradigms. One example by Dunlap and Van Liere (1978) was a New Environmental Paradigm Scale measuring beliefs about the nature of the earth and humanity's relationship with it. Since its development, the scale has become a widely used measure of pro-environmental orientation (Dunlap, Van Liere, & Mertig, 2000).

It has been used most often with samples of the general public, but it has also been used with samples of specific sectors such as farmers and members of interest groups. Additionally, it has recently helped to compare the environmental orientations of college students in several Latin American nations and Spain with those of American students. In general, these studies have found a relatively strong support of NEP beliefs across the various samples (for a review see Putnam, (2006)).

Taking into account another research by Skipper, Van Huylenbroeck, & Verbeke (2009), both respondents from the United States and Belgium with high NEP scores recognize that the development of renewable fuels are strictly linked with the higher cost of food prices. One of the examples is related with the fact that corn conversion to ethanol was not in favor of both respondents.

Food versus Fuel Preference

According to the research of Skipper, Van Huylenbroeck, & Verbeke (2009), there was a general preference of lower food prices versus lower fuel prices, both in the United States (67.6%) and Belgium (79.8%). This trend revealed that government support for the first generation biofuels was negatively perceived by the citizens.

The other results from the study by Johnson, Halvorsen, & Solomen (2011), indicated that there can be only small differences in terms of choosing cellulosic ethanol from different feedstock. These differences can be related to the fact that some consumers may be more adverse to purchasing cellulosic ethanol from farm or forestry residues than solid waste, since some residues need to remain in the soil.

In general, as Delshad, Raymond, & Sawicki (2010) indicated, people were more interested in higher development of second generation biofuels. The majority of respondents were driven by economic impacts like higher food prices and worries about environmental benefits.

There were also some mixed opinions about advantages and disadvantages of the first generation biofuels, particularly corn-based biofuels at the UW-Madison (University of Wisconsin-Madison, 2009). Almost half of respondents believed that this type of production creates pressure on the food supply, and local water supplies.

In Florida, when asked about morality versus immorality of biofuels (Lane, 2011) in case of food versus fuel concerns, respondents answered that “it depends entirely on the feedstock”. A majority of concerns were related to specific cases like crops for food or feed.

Another European research study on life sciences and biotechnology (Eurobarometer, 2010b) presented the positive overall feelings towards all kinds of biofuels. Almost three-fourth of Europeans supported crop-based biofuels. However, Europeans were even more optimistic about the second generation biofuels, and 83% approved the use of sustainable biofuels made from non-edible material. In case of Poland, 87% supported first generation biofuels and 93% sustainable biofuels.

Biofuels perspectives

Regarding the Ulmer, Huhnke, & Bellmer (2004), U.S. respondents perceived biofuels as a factor of decreasing dependence in foreign oil and an essential benefit to society. The majority of U.S. respondents believed that ethanol would positively impact their home state economy. In the UW-Madison study (University of Wisconsin-Madison, 2009) of public perception toward biofuels, a majority of respondents perceive biofuels positively, showing 66% in agreement that biofuels can help their country to reduce their reliance on foreign oil.

When Delshad, Raymond, & Sawicki (2010) examined the public attitudes toward political options for biofuels, higher attention was paid to alternative fuels standards rather than support represented by fixed subsidies and cap and trade policies. In general there was little support given to biofuels, however there was presented a positive attitude towards second generation biofuels.

In case of the European perspectives (Eurobarometer, 2007), 36% of EU citizens believed that the best method to encourage the use of biofuels is to make it cheaper via tax incentives. In every Member States, less than 25% of the population considered crop subsidies for biofuels production as the best method to encourage the use of biofuels. In case of Poland 20% of respondents indicated positive attitude for this option. In terms of tax incentives to produce biofuels cheaper, 45% of Polish respondents agreed with this option. The most recent European study (Polish Public Opinion Research Center, 2009b), revealed that Polish government should take a strategic decisions about directions of development of domestic energy. On the one hand, government should take into account the needs and financial capacity of the economy, while on the other hand the European Union restrictions to reduce CO^2 emissions.

CHAPTER 6
SURVEY METHODOLOGY

A survey was designed to test the objectives of this study. The aim of this study was to gain information on consumer perceptions of the biofuels in the United States and Poland. Respondents of the survey were asked to answer a series of questions about the knowledge, attitudes and perceptions related to biofuels. Issues related to biofuels and environmental, societal and economic problems were covered.

Sampling Description

To collect data in both the United States and Poland, an e-mail survey (Appendix A) was administered to students at the University of Florida (UF) in Gainesville, United States and at Warsaw University of Life Sciences (WULS), Poland. The survey was created and hosted using Qualtrics research software. The survey was administered in both countries during April 2011.

At UF, the questionnaire was sent to four groups using a convenience sampling method. The first group was composed of students in the course “AEB 3341-Selling Strategically.” Of 135 students in the class, 91 successfully completed the survey. The second group was from a course called “AEB 3671-Comparative World Agriculture.” Of the 88 students in this class, 68 completed the survey. The third group was from the course “AEC 3033C-Technical Writing in Agriculture,” consisting of 100 students of which 72 completed the survey. The final group consisted of graduate students from the Food and Resource Economics Department. Of 76 graduate students, 15 completed the survey. In total, 315 respondents started the survey, however only 241 successfully completed the survey. Thirty-seven respondents started, but did not complete the survey, and an additional 37 did not complete a validation question correctly. The validation question asks respondents to enter a specific answer to a specific question to ensure they are properly reading the

questions before answering. This item asked to select "Have Never Heard of" for the question about preferences of the type of engine.

In Poland, the survey was distributed among students from different faculties at the Warsaw University of Life Sciences using a convenience sampling method. The number of respondents who started the survey was 315. However, only 150 students fully completed the questionnaire. Ninety-four respondents started, but did not complete the survey, and an additional 71 did not complete a validation question correctly.

In total, there were 391 successfully completed surveys from both universities (Appendix B).

Description of Measurements

The questionnaire was divided into 5 sections covering: knowledge about biofuels; environmental aspects about biofuels; behavioural intention and behavior, perspectives of biofuels and information sources; and demographic characteristics.

First, respondents were allowed to indicate their level of subjective knowledge of biofuels based on a five-point scale, ranging from “not knowledgeable at all” to “very knowledgeable”

Second, the students’ feelings about biofuels were measured on a five-point scale ranging from “very negative” to “very positive”.

Third, students objective knowledge of biofuels was measured on a five-point scale ranging from “strongly disagree” to “strongly agree” based on items related to raw materials converted to biofuels.

Fourth, students perception of biofuels characteristics, wa measured on a five-point scale ranging from “strongly disagree” to “strongly agree”. All characteristics of biofuels included 10 items.

Fifth, in the case of the perception of availability of biofuels, it was measured on a five-point scale ranging from “not available” to “very available”.

Sixth, respondents were asked to compare biofuels to traditional fuels on a five-point scale from “strongly disagree” to “strongly agree”.

Seventh, 4 items related to level of agreement on the impact of biofuels on specific environmental issues were measured on a five-point scale ranging from “strongly disagree” to “strongly agree”.

Eight, to investigate how individuals felt their behavior impacts pollution, the Perceived Consumer Effectiveness (PCE) scale was used. This five-point frequency scale ranging from “strongly disagree” to “strongly agree” contains four questions, with two positively coded and two reverse coded. An individual’s answers to the four questions are summed (after the two negative questions are reverse coded).

Ninth, perception towards the environment was measured using the New Environmental Paradigm (NEP) scale. This 10-item scale examines the relationship between humans and nature. In this scale, half of the questions are scaled 1=strongly disagree to 5=strongly agree, while the other half are scaled the reverse way: 1=strongly agree to 5=strongly disagree. The total scale score is found by summing the ten questions, and can range from 10 to 50 with higher scores reflecting a “take charge” attitude towards the environment.

Tenth, perceptions of the influence of biofuels on food production and prices were measured on a five-point scale ranging from “strongly disagree” to “strongly agree”.

Eleventh, respondents were asked to indicate if they own a car (yes/no). For participants that did not own a car, they were asked to answer the remainder of the questions as if they owned a car.

Twelfth, preferences related to the type of brand of fuel were indicated: Shell, BP, Chevron, Orlen. Furthermore, preferences related to kind of fuels were identified: gasoline, diesel, gasoline-ethanol blend, diesel-biodiesel blend.

Thirteenth, frequency of purchasing biofuels was measured on a five-point scale ranging from “never” to “very often”.

Fourteenth, the availability of biofuels for refueling current car was measured on a five-point scale ranging “not available” to “very available”.

Fifteenth, students were asked about the price of biofuels in comparison to traditional fuels on a five-point scale ranging from “strongly disagree” to “strongly agree”.

Sixteenth, amount of money spend on fuel in a typical month was indicated, followed by the proportion of monthly income spent for fuel, which was measured on a scale ranging from 0-5%, 6-10%, 11-15%, 16-20%, 21-25%.

Seventeenth, students were asked to identify how many miles (miles/ week) they drive during an average week, followed by indication of the fuel efficiency (milles/gallon) of their car.

Eighteenth, students preferences about car characteristics, were measured on a five-point scale ranging “not at all important” to “very important”. All car characteristics included 13 items. Furthermore, preferences for the engine type for future cars were measured on a four-point scale ranging from “definitely would not consider” to “definitely would consider”. Also importance of fuel characteristics for the next car purchase was measured on a five-point scale ranging from “not at all important” to “very important”. These characteristics included 9 items.

Nineteenth, students were asked about biofuels production as a pathway towards economic development, which was measured on a five-point scale ranging from “strongly disagree” to “strongly agree”.

Twenty, the importance of characteristics related to the increase of biofuels share in the fuel market was measured on a five-point scale ranging from “not at all important” to “very important”. Characteristics included 4 items.

Twenty-one, students were asked about their thoughts about government involvement in the biofuels industry, which was measured on a five-point scale ranging from “strongly disagree” to “strongly agree”.

Twenty-two, 4 items related to level of agreement on decisions about biofuels over next years were measured on a five-point scale ranging from “strongly disagree” to “strongly agree’.

Twenty-three, students were asked where they obtain information about biofuels. For each source of information students indicated: no information, a little bit information, much information or most information. These included 7 items.

Demographics

The majority of U.S. students (60.0%) were connected to the College of Agricultural and Life Sciences (Figure 6-1). The second biggest group was students from the College of Business Administration (16.3%), and the third largest was from the College of Engineering (14.2%). The remainder of the students (6.7%) were from the Liberal Arts and Sciences College, with a few each from other colleges including Journalism and Communication, Design, Construction and Planning, Education, Health and Human Performance, and the Pharmacy College.

The majority of Polish students (52.0%) were from the Faculty of Agriculture and Biology, followed by the Faculty of Production Engineering (26.7%), and

Interfaculty Study of Regional Planning and Management (13.3%) (Figure 6-2). The rest of the students (8.0%) were from the Faculty of Forestry, Faculty of Economic Sciences, Interfaculty Study of Environmental Protection and Faculty of Civil and Environmental Engineering.

Respondents in the United States were at various stages in college, with the majority (46.5%) classified as seniors, followed by juniors (32.4%), freshman and sophomores (14.9%), and graduate students (6.2%) (Figure 6-3). In Poland, the majority of students (66.7%) were in their first or second year of the graduate master program and the remainder of respondents (33.3%) were classified as bachelor/engineer students representing one of three stages of undergraduate programs (Figure 6-4). None of the respondents was PhD students. The largest group of U.S. students was undergraduate respondents (93.7%), while in Poland the majority (66.7%) were graduate students.

The majority of U.S. students were males (58.2%). Though students did range in age from 19-43, the majority were born between 1987 and 1991. In Poland, more females (56.7%) participated in the survey. Again, though there was a range of ages (21-33), the majority were born between 1985 and 1990.

Data Analysis

In this section, analytical techniques were presented for analyzing data.

Descriptive analysis

The consumer data were analyzed using the statistical software SPSS (version 17.0). Descriptive statistics are used to describe the basic information and characteristics of data, and to present a simple summary about the responses in the survey. Moreover the graphic representation of questions may help form the framework for further quantitative data analysis.

Factor analysis

Factor analysis is a mathematical tool which can be used to examine a wide range of data sets (Hair, Black, & Babin, 2006). Factor analysis refers to a collection of statistical methods for reducing correlational data into a smaller number of dimensions or factors. Factor analysis finds relationships where variables are maximally correlated with one another and minimally correlated with other variables, and then groups the variables accordingly. The most common type of factor analysis is Principal Component Analysis (PCA), which is used for the data reduction.

Reliability test

Reliability is synonymous with the consistency of a test, survey, observation, or other measuring device. A reliability coefficient is often the statistic of choice in determining the reliability of a test. There are several different ways to estimate reliability, including test-retest reliability, inter-rater reliability, parallel-forms reliability and internal consistency reliability. The most common form of internal consistency reliability coefficient is Cronbach's alpha coefficient, which is an estimate of the degree to which items on the scale form a homogenous measure (Peterson, 1994). The generally agreed threshold value for a satisfactory scale is 0.7 (Robinson, Shaver, & Wrightsman, 1991) which denotes that the different items measure one single construct and therefore may be aggregated for further analyses.

Results

Knowledge about Biofuels

The first part of the survey asked specific questions about knowledge toward biofuels. The initial question allowed respondents to indicate their level of subjective knowledge of biofuels. Subjective knowledge refers to a person's belief in their own level of knowledge. A person with high subjective knowledge believes they know a lot about the subject, regardless of their actual level of knowledge. The majority of the

students from the United States stated that they are not knowledgeable or have low knowledge about biofuels (70.1%) (Figure 6-5). Just over one-fifth (22.4%) of the respondents felt they had an average level on knowledge, and only 7.4% felt they were knowledgeable about biofuels. Similarly, the majority of Polish students indicated that they are not knowledgeable or have low knowledge about biofuels (60.0%) (Figure 6-6). Almost one-third of respondents (32.7%) felt they had an average knowledge, followed by 7.3% felt they were knowledgeable about biofuels. These outcomes show that both, U.S. and Polish students do not believe they have a strong level of knowledge about biofuels (7.5% and 7.3%).

Respondents were asked to indicate whether they felt positively or negatively towards biofuels. Many U.S. students (47.7%) have positive or very positive feelings towards biofuels. Another 46.0% indicated a neutral feeling. In contrast, only 5.8% indicated they felt very negative or negative towards biofuels (Figure 6-7). Results from the Polish survey differed, with the biggest group of Polish students (70.7%) indicating they have positive feelings towards biofuels (Figure 6-8). Above one-fifth (22.0%) had neutral opinion and 7.3% felt negative towards biofuels. Though Polish students indicated more positive feelings towards biofuels than U.S. students (70.7% and 47.7%, respectively), the negative attitudes were similar (7.3% and 5.8%).

To determine how much each U.S. student knew about biofuels, a question was presented with different raw materials that can be converted to biofuels. Students were then asked to identify which raw materials could be used to make biofuels. The highest number of respondents agreed or strongly agreed (79.4%) that crops grown for animal feed can be converted into biofuels, followed by crops grown for energy (70.5%) and crops grown primarily for food (63.1%) (Figure 6-9). In total, 74.3% of the students correctly answered all the raw material questions, where 25.7%

answered all questions incorrectly. When Polish students were asked to recognize which raw materials could be used to make biofuels, the majority of respondents strongly agreed or agreed (87.8%) that crops grown for energy can be converted into biofuels, followed by animal waste (58.4%) and residues (57.0%) (Figure 6-10). Overall, 65.5% of the students correctly answered all the raw material questions, where 34.5% answered all questions incorrectly. Though there were minor differences in which crops they knew could be converted, overall levels of objective knowledge were similar, with over 65% of students answering all questions correctly.

Next, participants were asked about their perception on biofuels characteristics through a series of 10 questions. The majority of U.S. respondents agreed or strongly agreed that biofuels are environmentally friendly (69.3%) (Table 6-1). In terms of safety, 67.2% believed in the positive impact of biofuels. On the other hand, the highest rate of disagreement and strong disagreement was related to two issues. Students claimed that biofuels are not cheaper than regular fuels (34.9%), and that biofuels would not lead to lower maintenance costs for the vehicle compared to regular fuels (24.1%).

The majority of Polish students agreed or strongly agreed with the two issues; that biofuels are environmentally friendly (75.3%), and that biofuels are safe to use (64.0%) (Table 6-2). In contrast, the highest number of students disagreed or strongly disagreed (30.0%) that biofuels are cheaper than regular fuels, and lead to lower maintenance costs for the vehicle compared to regular fuel (26.0%).

Taking into account biofuels characteristics, there are a lot of similarities between countries. Both, U.S. and Polish respondents claimed that biofuels are environmentally friendly and safe. These results indicate positive perception towards

biofuels in both countries, however for all students, there is a perception that biofuels are not cheaper than regular fuels and do not lead to lower maintenance cost.

A factor analysis was run on the results from these ten questions, which resulted in the development of three factors. These included a quality factor, a cost factor and a factor measuring trust in technology. The “quality” factor included perceptions of characteristics of environmental friendliness, biofuels safety, high quality fuel, high performance fuel, general quality standards and importance of not damaging the car. All items in this factor having factor loadings more than 0.60. The second factor was the cost factor, developed from questions about the overall and maintenance cost of biofuel in comparison to regular fuel. The factor loadings of the each item of this component were more than 0.80. The third factor, called trust in technology, was related to belief that biofuels are in the experimental stage of development and that biofuels can only be used in vehicles with modified engines. The factor loadings of this factor were more than 0.66.

In terms of the availability of biofuels in Florida (higher blends than 10% of ethanol due to Florida biofuels’ mandate since January 2011) most respondents (46.1%) felt these renewable fuels are slightly available, followed by 26.6% of students feeling that biofuels are not available at all in Florida (Figure 6-11). The highest number of Polish respondents (64.0%) felt that biofuels are slightly available. More than one-fourth of the students (26.0%) felt than renewable fuels are moderately available and only 4.0% of respondents indicated that biofuels are not available at all (Figure 6-12).

To gather more information about consumer perceptions of biofuels, students were asked to compare biofuels to traditional fossil fuels. The majority of UF respondents agreed and strongly agreed that biofuels are an alternative to traditional

fossil fuels (59.3%) (Figure 6-13), and that biofuels can be a significant replacement for fossil fuels (59.8%) (Figure 6-15).

The majority of Polish respondents also agreed that biofuels are an alternative to traditional fossil fuels (64.7%) (Figure 6-14), and that biofuels can be a significant replacement for fossil fuels (66.0%) (Figure 6-16). Comparing these results, both U.S. and Polish students are indicating positively and very similar perception towards biofuels as an alternative to traditional fossil fuels. They also similarly believe that biofuels can be a significant replacement for fossil fuels in the future.

Environmental Aspects about Biofuels

The next section of the questionnaire is assigned to perception about biofuels and the environment. Attention of people's attitude towards specific environmental issues was measured by a set of questions related to the impact of biofuels on specific environmental issues. In the United States there is a high level of agreement or strong agreement that biofuels have a positive impact on lowering carbon emissions (72.2%), decreasing pollution in the waterways (65.9%), reducing global climate change (57.7%) and using fewer chemicals in biofuels production (52.7%) (Figure 6-17).

In Poland, the largest group of respondents agreed or strongly agreed that biofuels positively impact the environment by using fewer chemicals in biofuels production (70.6%), followed by decreasing pollution in the waterways (66.7%), lowering carbon emissions (60.7%), and reducing global climate change (54.0%) (Figure 6-18). This outcome shows that both U.S. and Polish strongly believe that biofuels have positive impact on the environment. The results between both countries are very similar.

To investigate how individuals felt their behavior impacts pollution, the Perceived Consumer Effectiveness (PCE) scale was used (Figure 6-19). The average scale was 16.16 out of 20, a relatively high score, indicating the U.S. students feel their behavior impacts the environment. Cronbach's alpha for the scale was 0.75, indicating the scale is reliable (Hair, Black, & Babin, 2006). In the case of Poland, the average PCE scale was 15.44 out 20, also presenting quite a high average score (Figure 6-20). It means that students felt they can impact positively the environment. Cronbach's alpha for the scale was 0.63, showing the scale is reliable.

Students perception towards the environment was measured using the New Environmental Paradigm (NEP) scale. The average scale for UF students was 34.04 out of 50 (Table 6-3). The Cronbach's alpha for this scale is 0.80, indicating a high level of reliability. Investigating Polish students perception towards the environment, the average scale of NEP was 33.71 out of 50 (Table 6-4). The Cronbach's alpha for this scale is 0.68, indicating also a high level of reliability. In general, the results in both countries are similar with both U.S. and Polish students indicating a relatively strong support of NEP.

In order to determine students' opinions about the food versus fuel debate, two questions were asked about their perception of the influence of biofuels on food production and prices. In the United States fewer students (45.6%) agreed that production of biofuels impacts food availability than those that believed it impacts food prices (65.6%) (Figures 6-21 and 6-23). In Poland, a higher number of students agreed that biofuels production impacts food prices (31.33%) than those that believed it influences food availability (20.9%) (Figures 6-22 and 6-24). These low results in Poland indicate that students are not aware of linkage between biofuels and agro-food issues. Among U.S. students this awareness is two times higher .

Behavioural Intention and Behaviour

The next series of questions are about behavioural intention and behaviour of students. Most U.S. students (85.9%) indicated they own a car. For those that owned a car, there were 206 different vehicles types reported, ranging in age from 10 years old to new. In Poland, more than half of the respondents (60.7%) indicated they have a car. Those students reported 121 different types of car, in a range age from 20 years old to new.

To determine if students have strong preferences related to gasoline, they were asked to identify their favorite brand of gasoline. More than half of U.S. respondents (60.2%) indicated they do not have a preferred brand (Figure 6-25). For those that did, the companies they preferred included Shell (12.5%), BP (7.1%) and Chevron (6.2%).In Poland, the most preferable brand was Orlen (37.8%), followed by BP (33.8%), Neste 24 (10.8%) and Shell (7.4%) (Figure 6-26).

The majority of UF students (78.0%) prefer E10 (mandated since January 2011), including: regular gasoline (87 octane), followed by 11.2% preferring premium gasoline (93 octane), and plus gasoline (89 octane) with 6.6% of respondents. The remaining types of fuel include Diesel (D), Biodiesel (B20), Ethanol (E85) and Propane (LPG), and together only account for 2.5% of the students.

When asked about preference of the gasoline in Poland, the majority of students (41.6%) prefer regular gasoline (PB 95), followed by 26.1% of respondents preferring ON (Diesel Standard), 11.4% Autogas (LPG). Small number of respondents indicated preference for Ekodiesel, ON bio or BIO 100 (2.7%). In general, in Florida the most common type of fuel is E10. In Poland, the most popular type of fuel is gasoline, diesel, and autogas.

A large number of UF students (39.0%) report never buying or rarely buying (22.8%) high biofuels blends (Figure 6-27). More than one-fifth of the students (20.8%) were not aware if they are purchasing biofuels or not. Only 6.6% stated that they buy higher blends of biofuels quite often or very often. The majority of Polish students (75.3%) report never buying or almost never buying (12.7%) biofuels (Figure 6-28). Only 7.3% of respondents were not aware if they purchase biofuels and just 1.3% answered that they buy biofuels often or very often.

U.S. students seem unaware of the availability of biofuels for refueling their current car. Nearly half (48.3%) thought biofuels were not available for their engine at all, while another third thought they were only slightly available (32.1%) (Figure 6-29). Similarly, Polish students believed that biofuels are slightly available for their engine (46.9%), however over than one-fifth of students (21.5%) thought that biofuels were not available at all for their engine (Figure 6-30).

When asked about the price of biofuels in comparison to traditional fuels, 75.7% of U.S. students didn't agree or disagree that the cost is appropriate (Figure 6-31). Almost one-fifth of respondents (19.3%) thought that price of biofuels is too high. Similarly, the majority of Polish students (73.3%) had neutral opinion about price appropriateness (Figure 6-32). Almost one-fourth of Polish students (24.7%) indicated that the price is too high. The majority of U.S. and Polish respondents didn't have an opinion about biofuels price.

Taking into account respondents' monthly expenses on fuel, U.S. students indicated that they spent from $10 and $400, with the majority spending $50-70. Most people (36.7%) spent between 6-10% of their monthly income on fuel (Figure 6-33). By contrast, only 8.4% of UF students indicated they spent more than 20% of their monthly income on fuel.

In Poland students were asked to indicate their monthly income in polish currency (PLN), which was later converted into dollars ($). Polish respondents spent from $10 and $420, with the biggest group spending $60-80. The majority of people (27.2%) spent between 0-5% of their income on fuel (Figure 6-34). Only 10.8% of students spent on fuel between 21-25% of their income.

The majority of U.S. respondents indicated that they drive an average of 50-80 miles per week, with a range of 5 and 475 miles. They reported a fuel efficiency ranging from 10-70 miles per gallon, with the average between 20 and 30 miles/gallon. Polish students reported that they drive between 50 and 90 miles per week, with a range of 20 and 310 miles. Their reported fuel efficiency ranged from 7-30 miles per gallon, with the average between 10 and 15 miles/gallon.

In order to reveal consumer preferences for vehicle and fuel characteristics, a series of questions were asked about the importance of different characteristics a car offers. The most important factor for U.S. students was the price of the car (95.4%), followed by fuel efficiency (91.7%) and safety (89.6%) (Table 6-5). All characteristics received more than 70% of importance except issue regarding CO^2 emission (40.3%). Similar to U.S. students, in terms of car characteristics in Poland, the majority answered that the most important factor was the price of the car (96.6%), followed by fuel efficiency (93.3%), and safety (91.3%) (Table 6-6). The highest rate of lack of importance was associated with CO^2 emission (35.3%).

Students were also asked their preference for the engine type for future cars. The majority of U.S. students preferred a gasoline powered engine (87.1%), followed by hybrid (82.8%) (Table 6-7). On the other side, the highest rate of lack of interest was associated with the diesel powered engine (39.8%) and electric engine (35.3%). In addition, many U.S. students have never heard of flex fueled engines (14.2%).

In Poland, the majority of respondents preferred a diesel powered engine (82.4%), followed by gasoline powered engine (72.5%) (Table 6-8). By contrast, the lowest interest was associated with the electric engine (49.3%) and hybrid (23.9%). Additionally, 14.18% of Polish students have never heard of flex fueled engines.

When asked about the importance of fuel characteristics for the next car purchase, the majority of UF students (87.2%) indicate the most important issue is the price of fuel, followed by quality assurance (85.5%), top performance (82.2%), availability at gas stations (73.4%), and environmental friendliness (68.9%) (Figure 6-35). The least important characteristics were related to domestic fuel production (38.6%) and odor characteristics (15.4%).

Results for Polish students differed slightly. Like the UF students, price was the most important issue (88.8%). Rankings after the top differed slightly, with top performance (81.9%), engine modification requirements (80.0%), quality assurance (77.6%), availability at gas stations (76.1%), and environmental friendliness (50.2%) all rated as important by the majority of respondents (Figure 6-36). Similar to UF students, the two least important factors were the odor characteristic (33.1%) and domestic fuel production (16.1%).

Biofuels Perspectives and Information Sources

The last section of the survey was about biofuels perspectives and information sources. In the United States, the highest number of respondents (68.9%) agreed that biofuels can lead to economic development (Figure 6-37). In Poland, many students (46.7%) also agreed that biofuels can lead to economic development (Figure 6-38). Though many students thought that biofuels can lead to economic development in their countries, there was a large difference between those who agreed and those who felt neutral between the countries.

In response to the question about the importance of characteristics related to the adoption of biofuels in the fuel market, the majority of U.S. students indicated that the most important issue is technological development (83.8%), followed by social awareness (80.1%), and intensive promotion (73.0%) (Figure 6-39). Similarly, students from Poland had technological development as the most important factor (88.0%), social awareness (86.7%), and intensive promotion (82.7%) (Figure 6-40).

In order to determine students' opinion about government involvement in the biofuels industry, many (70.5%) U.S. respondents believed that government subsidies impact production and use of biofuels (Figure 6-41). In terms of the government as a controlling function for biofuels production, most respondents (40.3%) had a neutral opinion (Figure 6-43).

When investigated Polish students perception, the majority (76.7%) of respondents also believed that government subsidies impact production of biofuels, with only 17.3% of students having a neutral opinion (Figure 6-42). Taking into account the government as a controlling function for biofuels production, almost the same number of people agreed with this issue (36.0%) and had neutral opinion (38.0%) (Figure 6-44). In general, both U.S. and Polish students strongly believed that government subsidies impact production of biofuels. A large number of U.S. and Polish students thought that biofuels should not be controlled by the government.

When asked about the future of biofuels, 76.8% of U.S. students disagreed that biofuels will affect only the current generation (Figure 6-45). There was a high level of agreement that biofuels will strongly influence future generations (68.1%). The majority of Polish students (61.3%) also disagreed that biofuels will affect only the current generation (Figure 6-46). More than half (52.0%) indicated strong agreement that biofuels will influence future generation.

The last issue in this section investigated sources of biofuels information. The majority of UF students did use information provided by government (90.5%), fuel sector (89.6%) or television and radio (81.3%) (Figure 6-47). The most used source of information was the internet (50.2%) and universities and scientists (41.9%).Most of the Polish students also did not use information from government and fuel sector (both at the level of 76.7%) (Figure 6-48). As with the UF students, the most used source of information was the internet (67.3%) and universities and scientists(52.0%).

At the end the questionnaire, respondents were given the opportunity to comment or remark on the topic. The following paragraph summarizes the thoughts of U.S. participants. Many students indicated they were glad to take part in this survey and wrote that it was an interesting and relevant issue. Some respondents presented an extremely positive opinion about this research as being fascinating and great topic for further investigation. A few people had little information regarding biofuels and indicated the questionnaire prompted them to want to search for more information. Additionally a few students had a desire to focus their career on biofuels after graduating. In addition to the positive remarks, there were some critical views about the food versus fuel debate and government involvement in the biofuels.

The final thoughts of Polish students indicated that the questionnaire was designed in a very clear and understandable way. A few people stated that the questions were really concrete, well-considered and the responses were adequately developed. A lot of respondents wrote that it was a very interesting survey. Some people revealed their field of interest regarding specific type of engine cars, for example electric cars. Others presented positive opinions about biofuels, indicating that this research should be dedicated not only to students but also to other segments of population. In general, people were glad to participate in this survey.

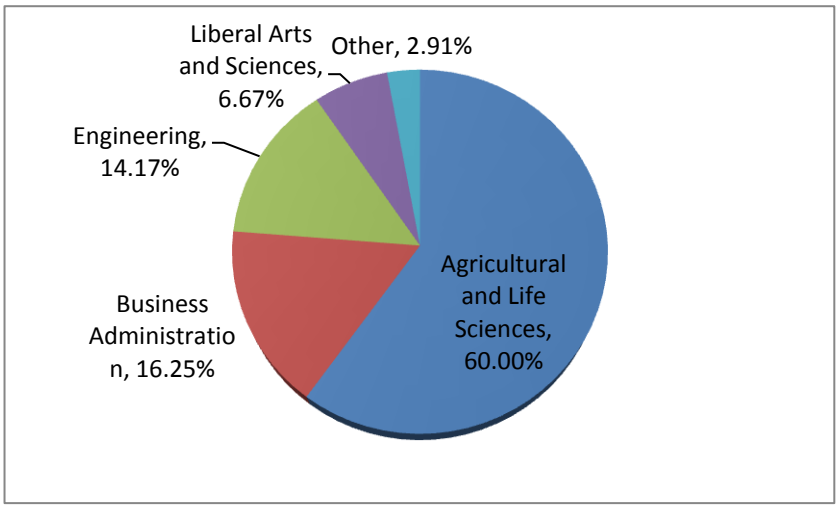


Figure 6-1. University of Florida respondents, divided by College.

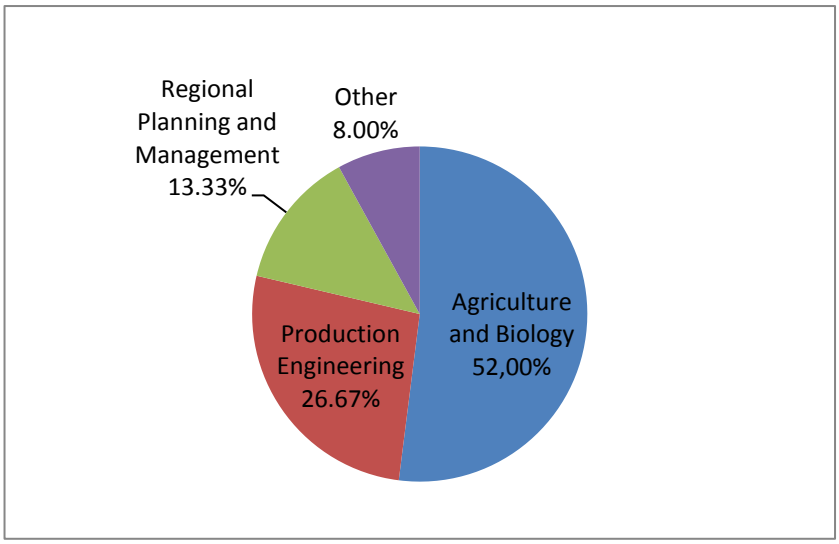


Figure 6-2. Warsaw University of Life Sciences respondents, divided by College.

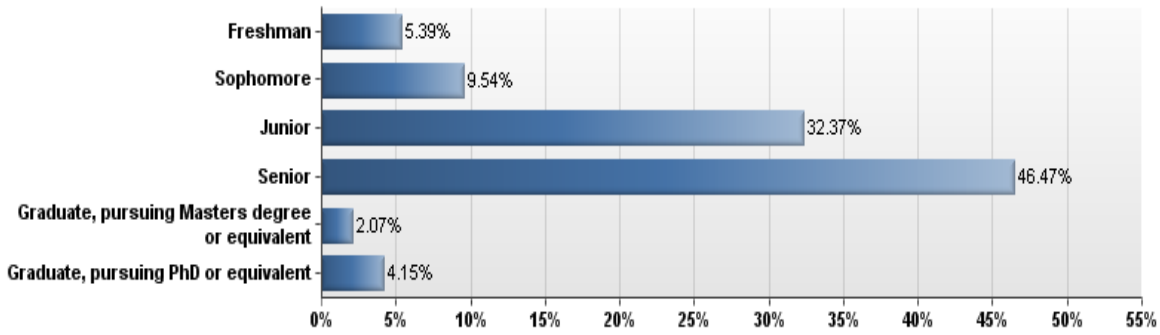


Figure 6-3. Standing of the respondents at the University of Florida

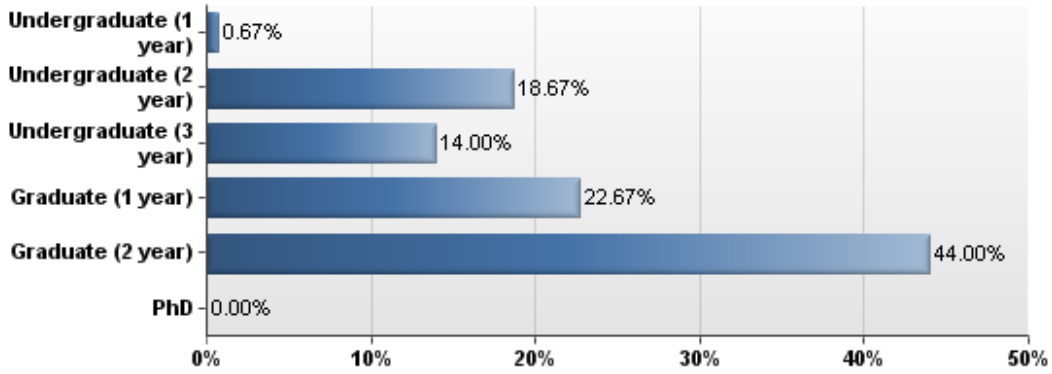


Figure 6-4. Standing of the respondents at the Warsaw University of Life Sciences

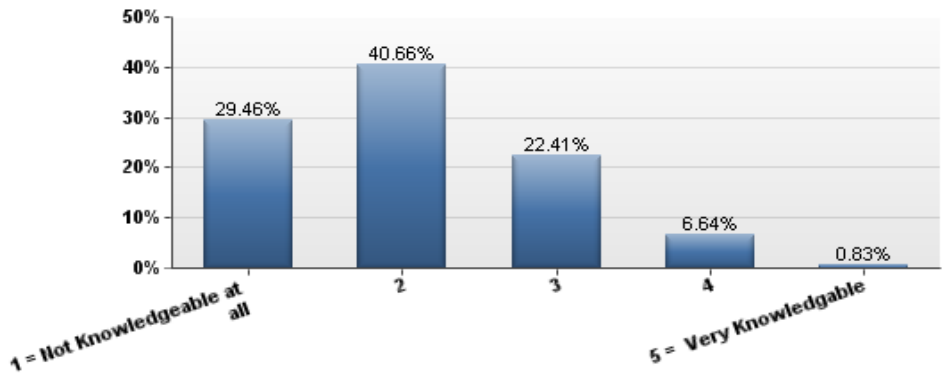


Figure 6-5. Level of knowledge about biofuels among student at the University of Florida

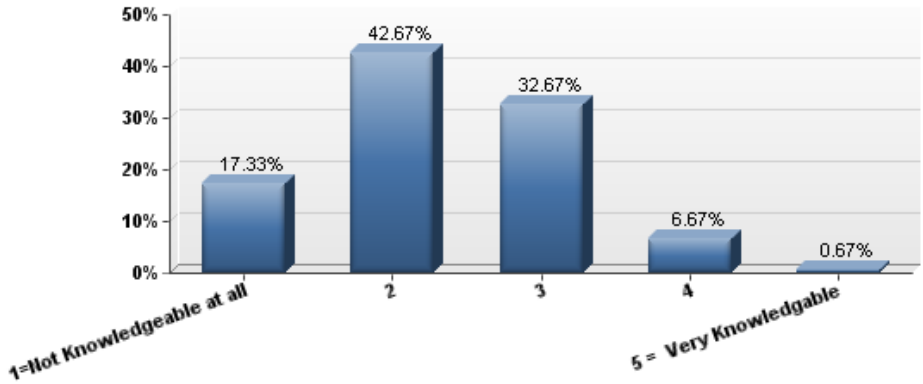


Figure 6-6. Level of knowledge about biofuels among student at WULS

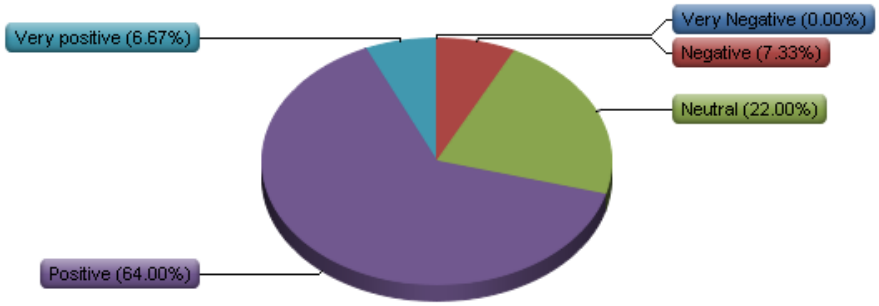


Figure 6-7. General U.S students' feelings about biofuels.

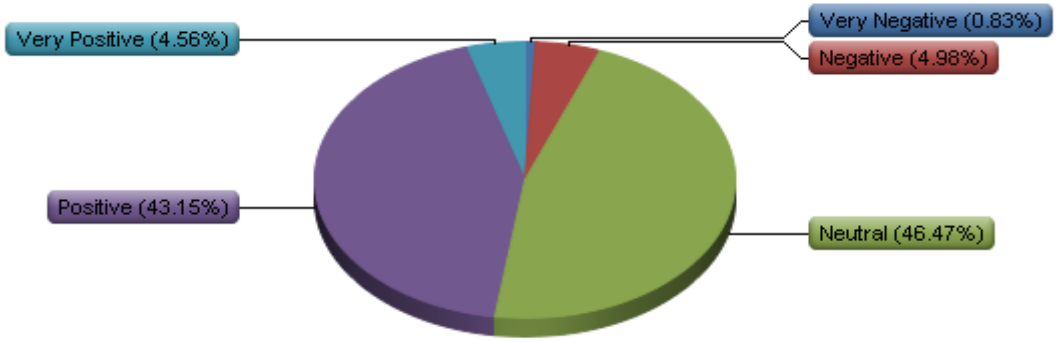


Figure 6-8. General Polish students' feelings about biofuels.

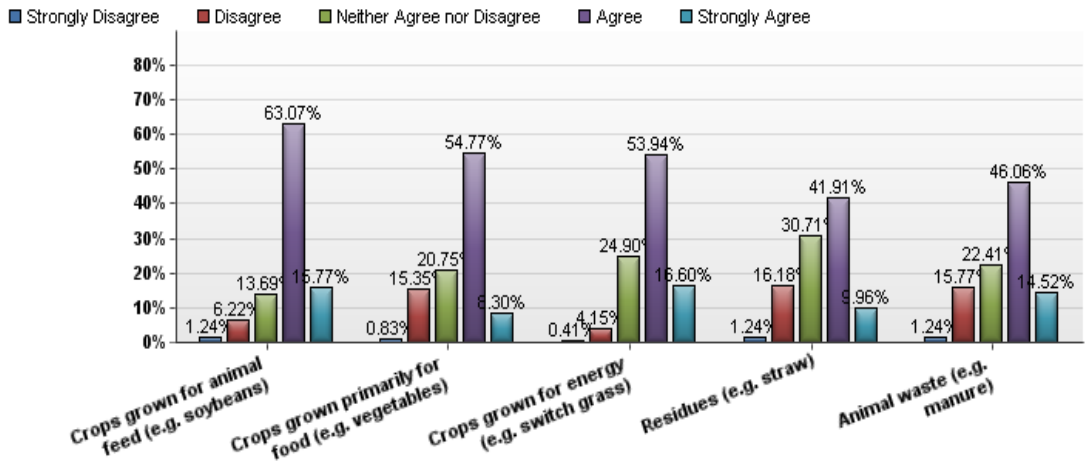


Figure 6-9. U.S. student knowledge of raw materials that can be converted to biofuels.

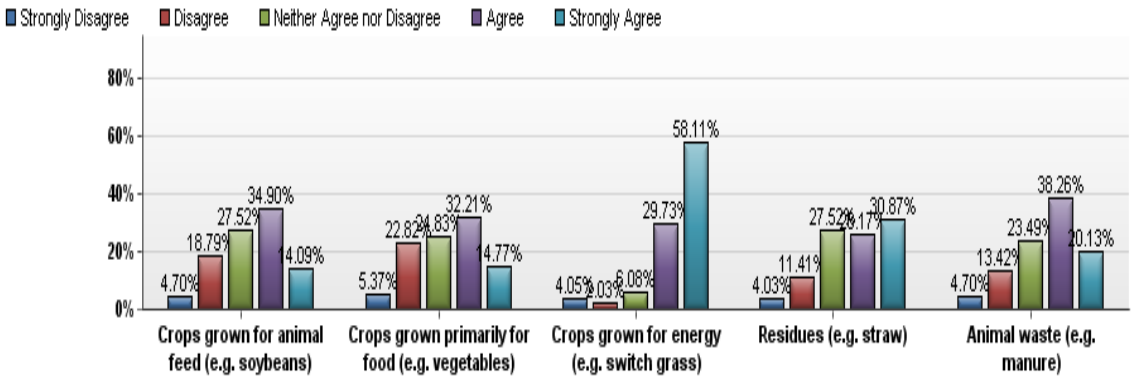


Figure 6-10. Polish student knowledge of raw materials that can be converted to biofuels.

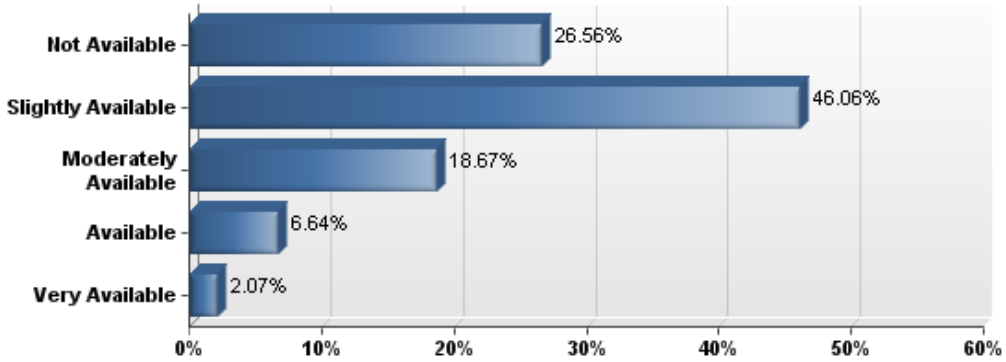


Figure 6-11. UF student belief in availability of biofuels in Florida.

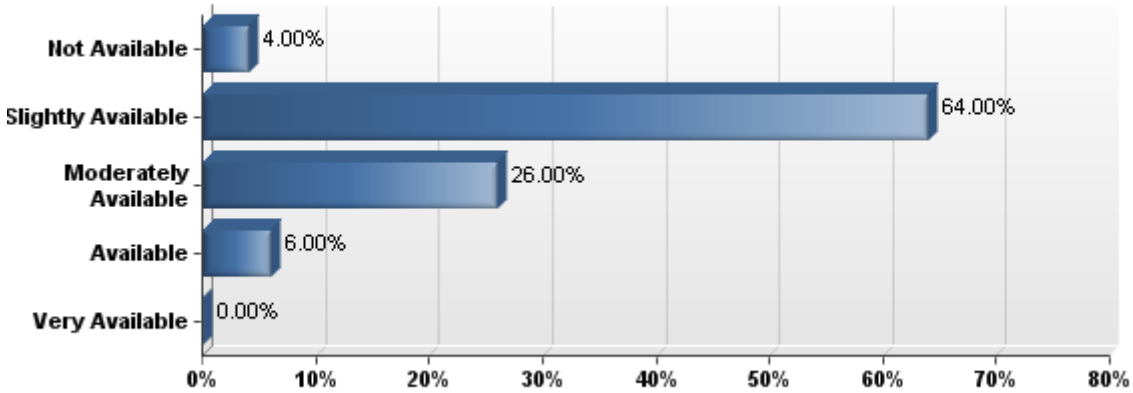


Figure 6-12. WULS student belief in availability of biofuels in Florida.

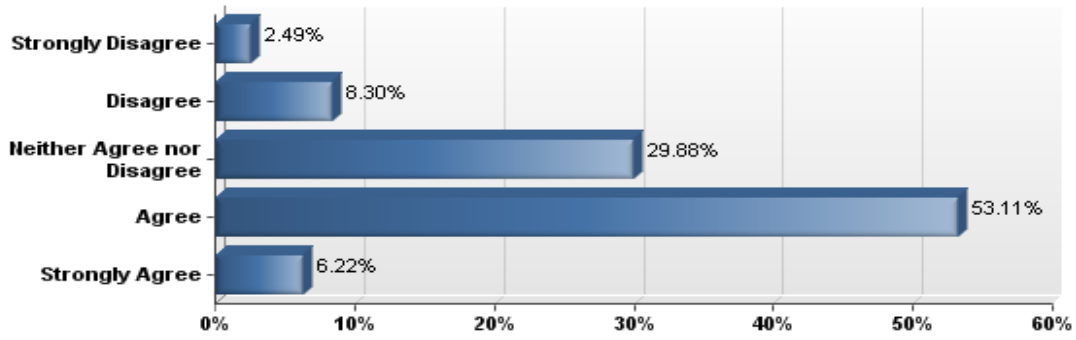


Figure 6-13. UF student belief of the sustainable alternative of biofuels compared to traditional fossil fuels.

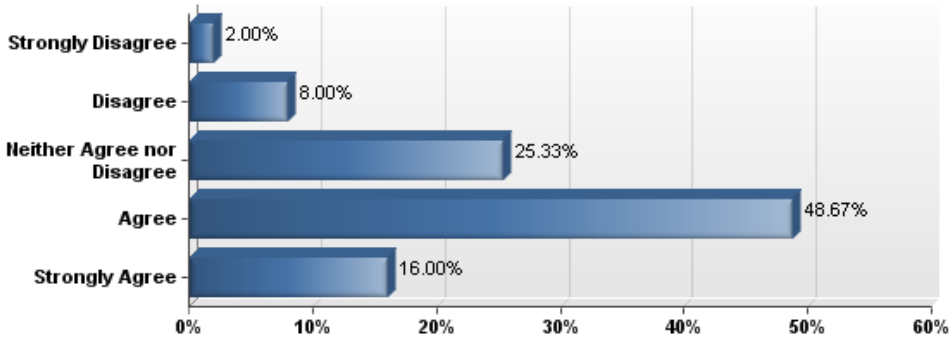


Figure 6-14. WULS student belief of the sustainable alternative of biofuels compared to traditional fossil fuels.

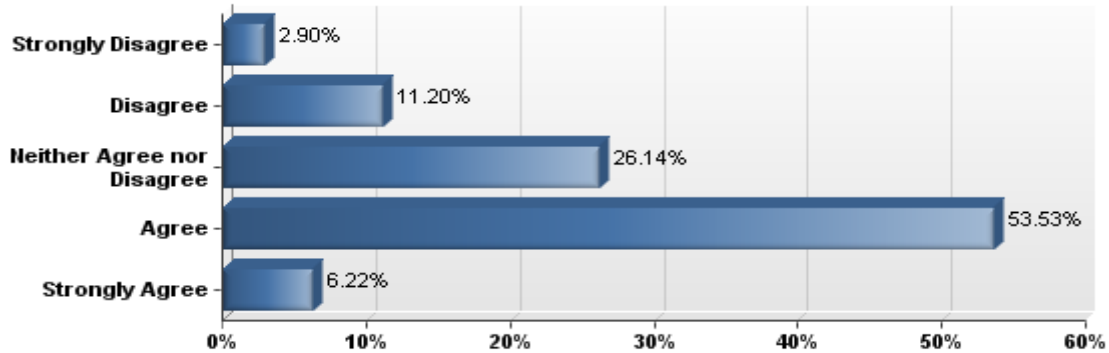


Figure 6-15. U.S. students' belief in fossil fuels replacement by biofuels.

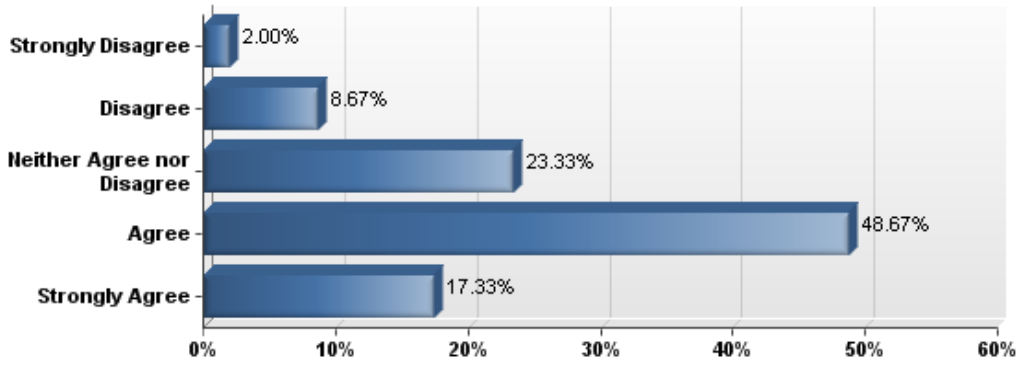


Figure 6-16. Polish students' belief in fossil fuels replacement by biofuels.

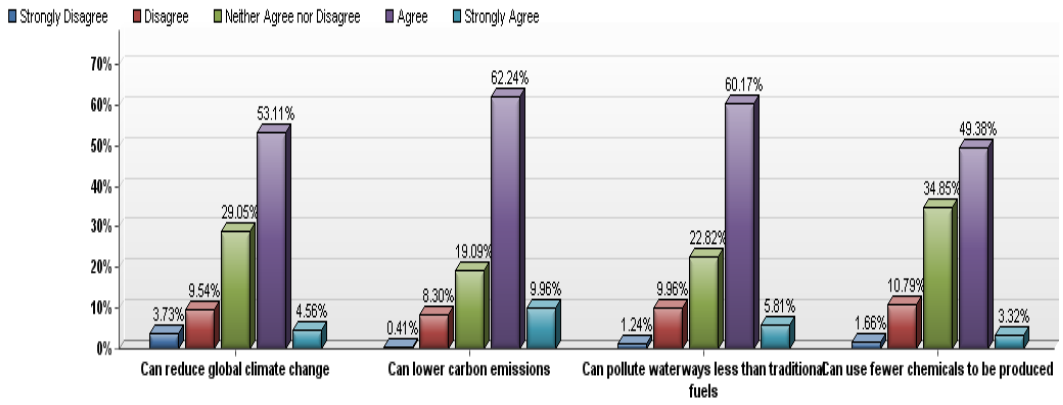


Figure 6-17. UF students' views about impact of biofuels on the environmental issues.

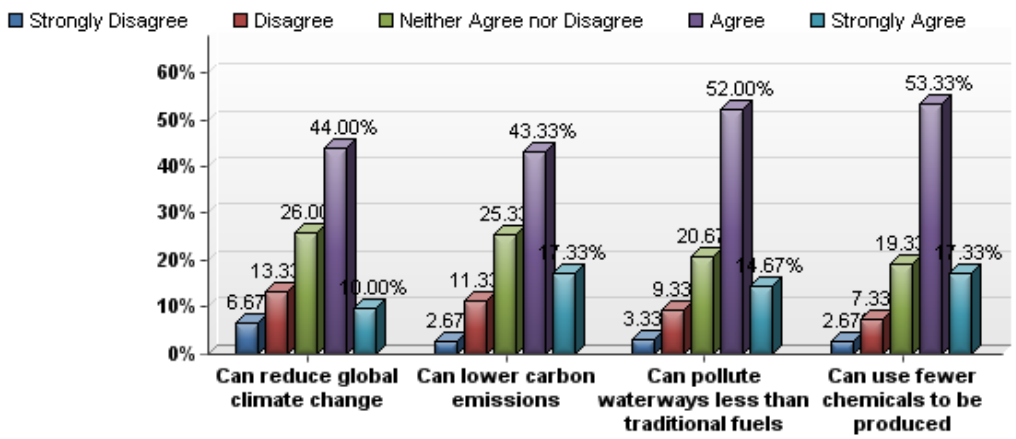


Figure 6-18. WULS students' views about impact of biofuels on the environmental issues.

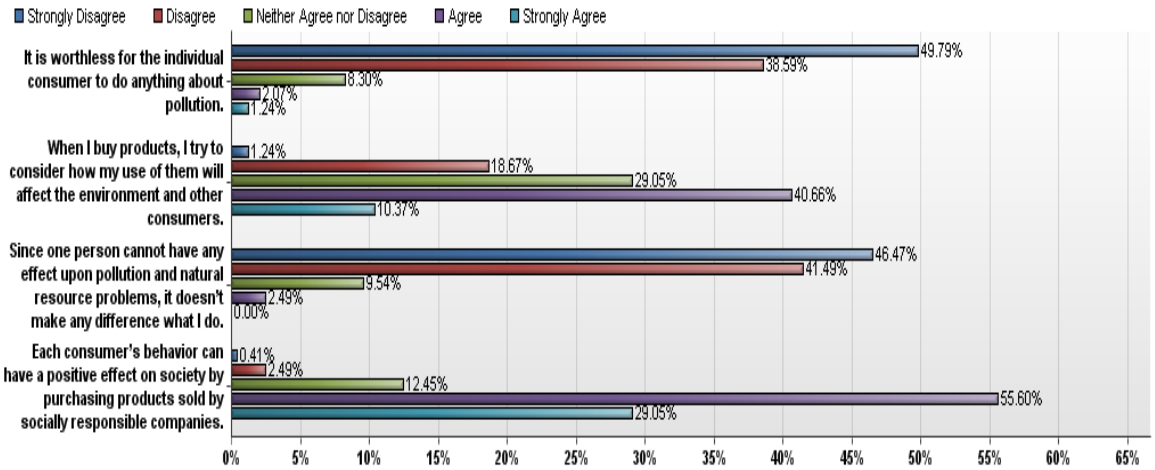


Figure 6-19. Perceived Consumer Effectiveness (PCE) scale in the United States.

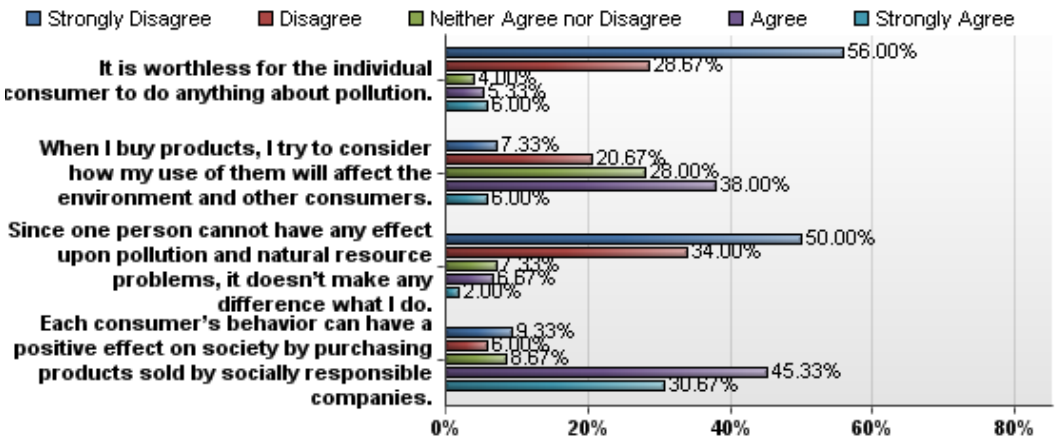


Figure 6-20. Perceived Consumer Effectiveness (PCE) scale in Poland.

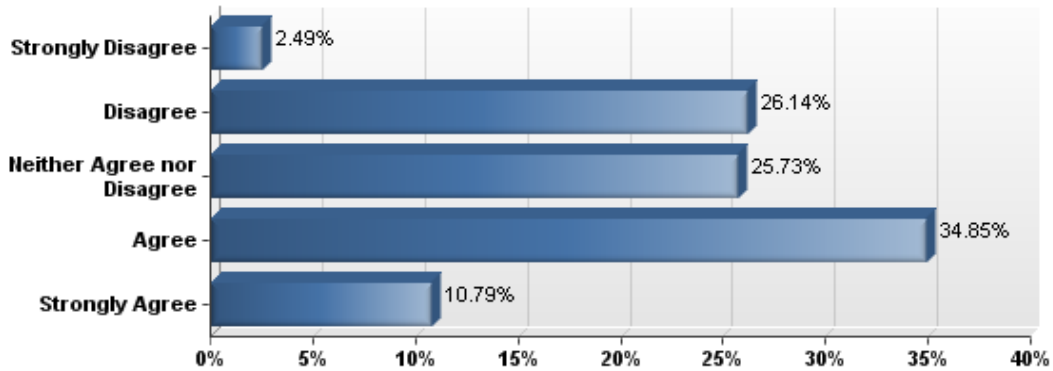


Figure 6-21. UF student belief about biofuels' influence on agricultural production.

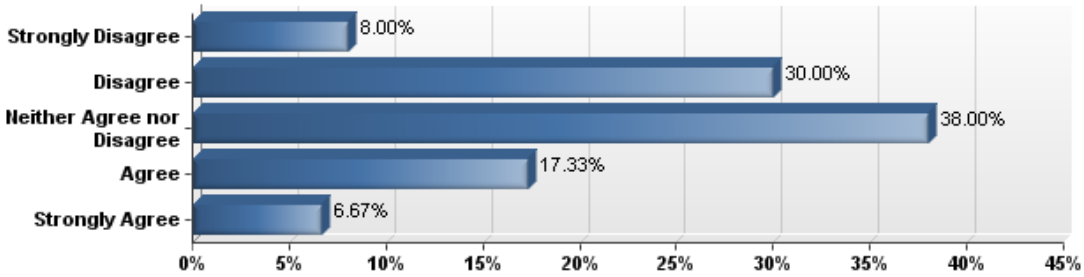


Figure 6-22. WULS student belief about biofuels' influence on agricultural production.

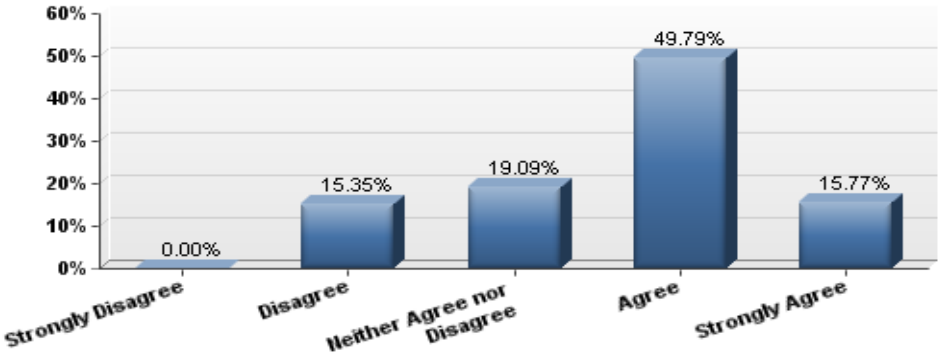


Figure 6-23. Influence of biofuels production on the food price in the United States

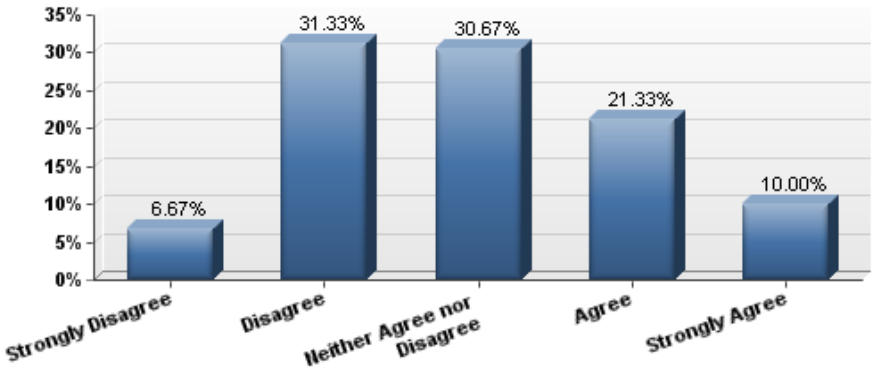


Figure 6-24. Influence of biofuels production on the food price in Poland

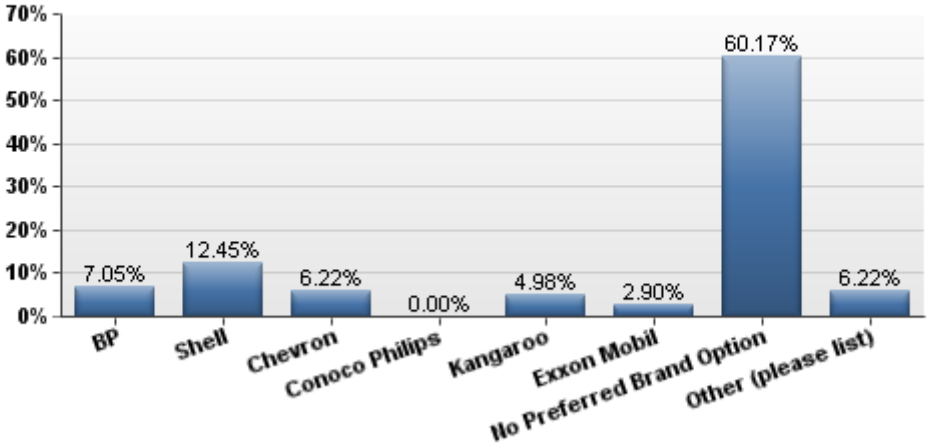


Figure 6-25. Preference of gasoline brand by UF students.

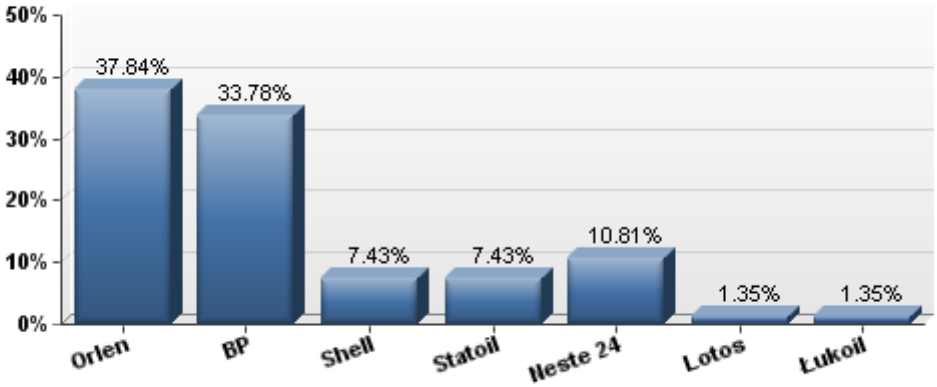


Figure 6-26. Preference of gasoline brand by WULS students.

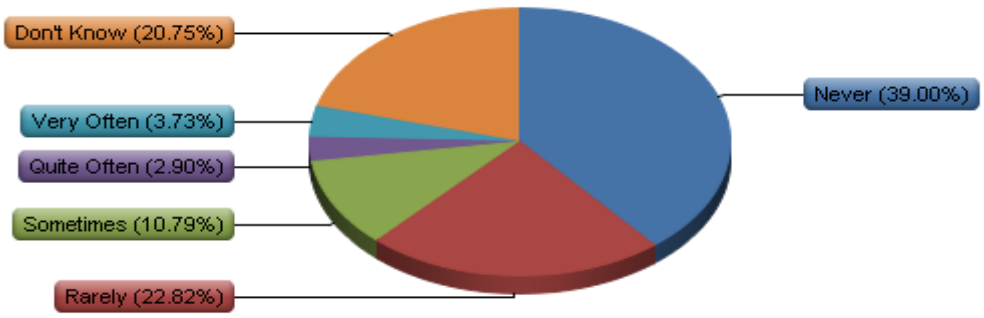


Figure 6-27. U.S. students' perception of biofuels use.

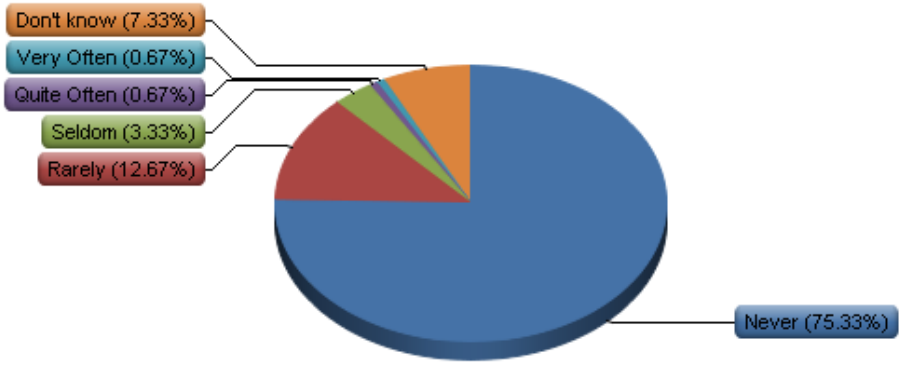


Figure 6-28. Polish students' perception of biofuels use.

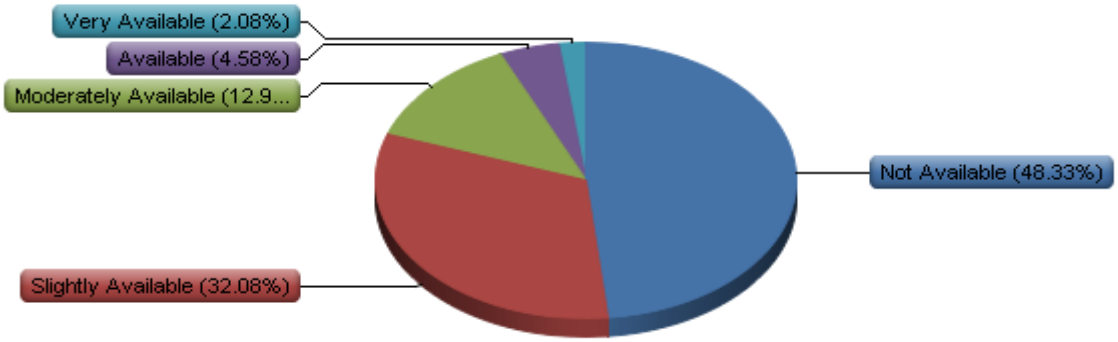


Figure 6-29. Availability of biofuels for refueling UF students' current car.

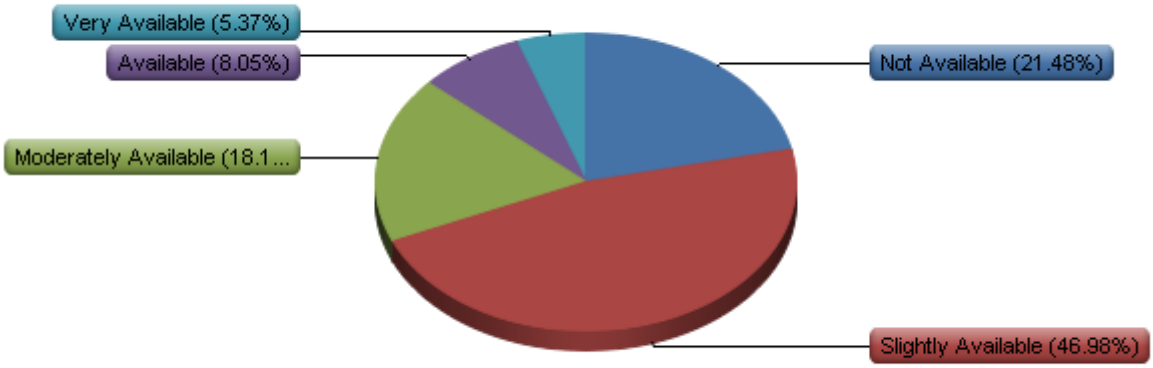


Figure 6-30. Availability of biofuels for refueling WULS students' current car.

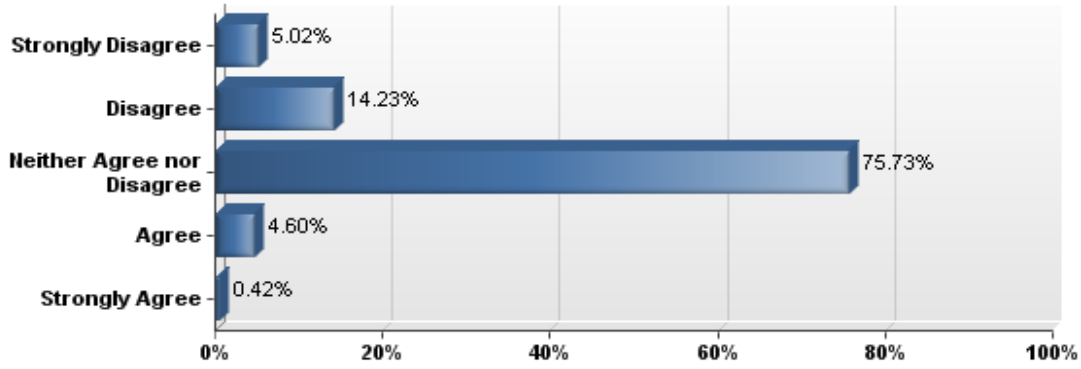


Figure 6-31. Level of appropriateness of biofuels price in the United States

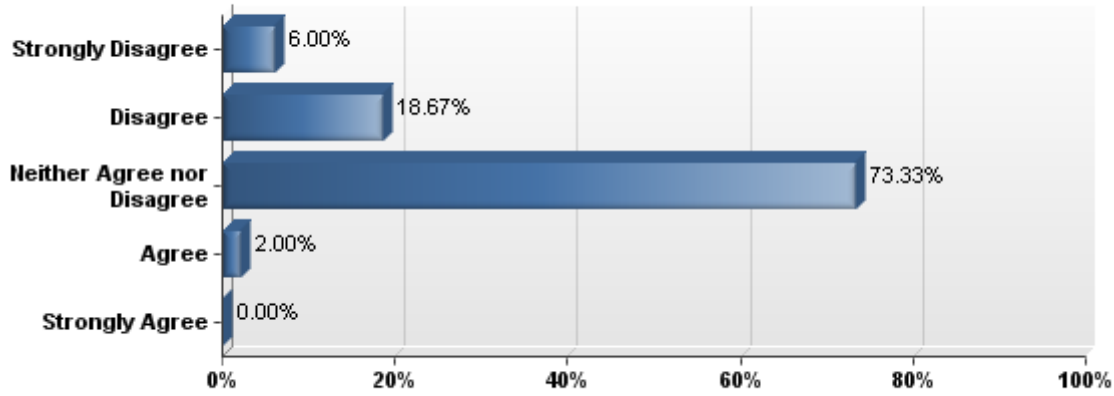


Figure 6-32. Level of appropriateness of biofuels price in Poland

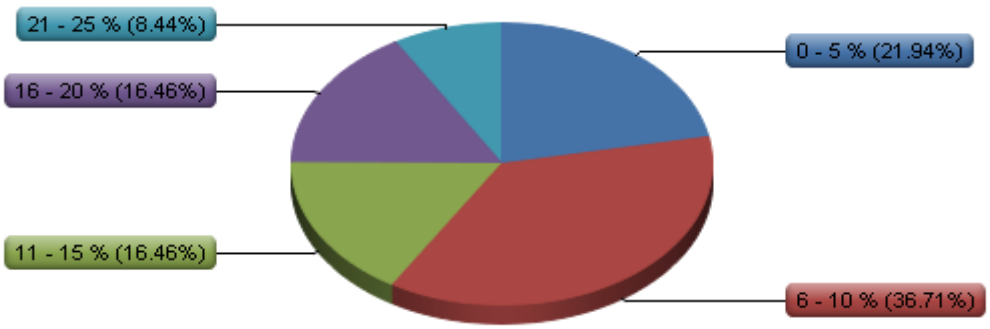


Figure 6-33. Proportion of monthly expenses spent on fuel by UF students.

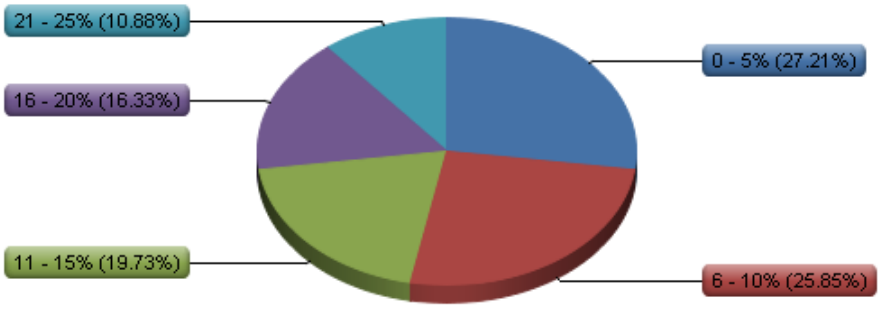


Figure 6-34. Proportion of monthly expenses spent on fuel by WULS students.

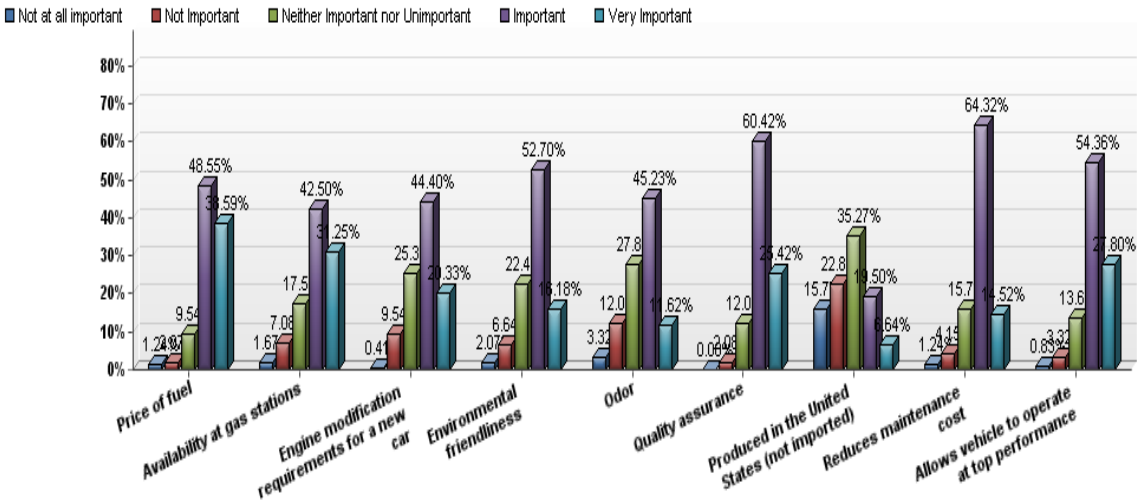


Figure 6-35. Fuel characteristics' importance for the future car in the United States

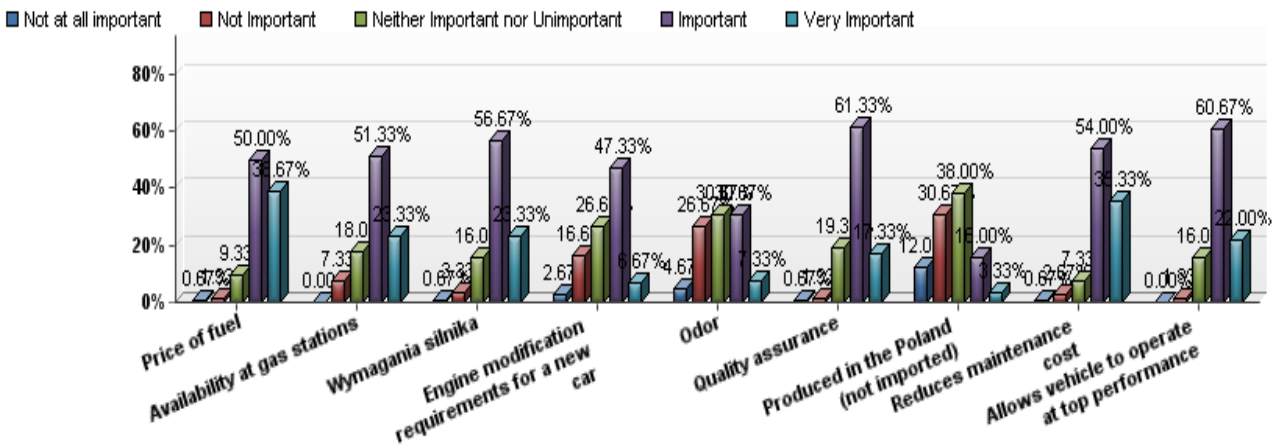


Figure 6-36. Fuel characteristics' importance for the future car in Poland

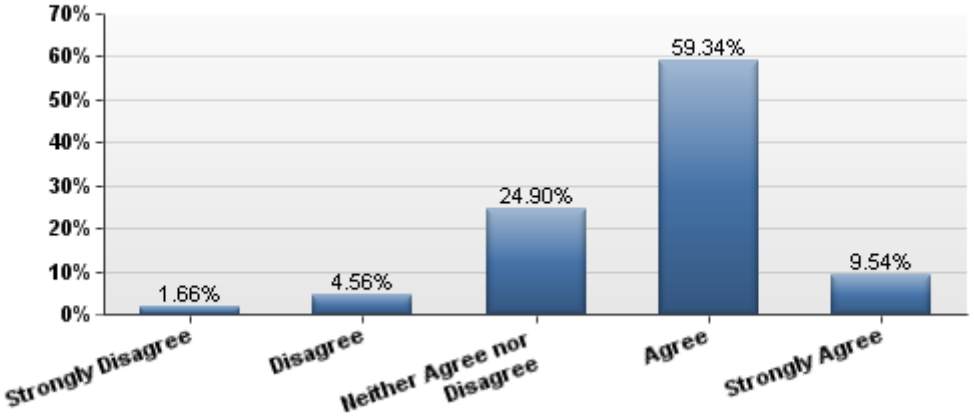


Figure 6-37. Students' belief of biofuels leading to economic development in the United States.

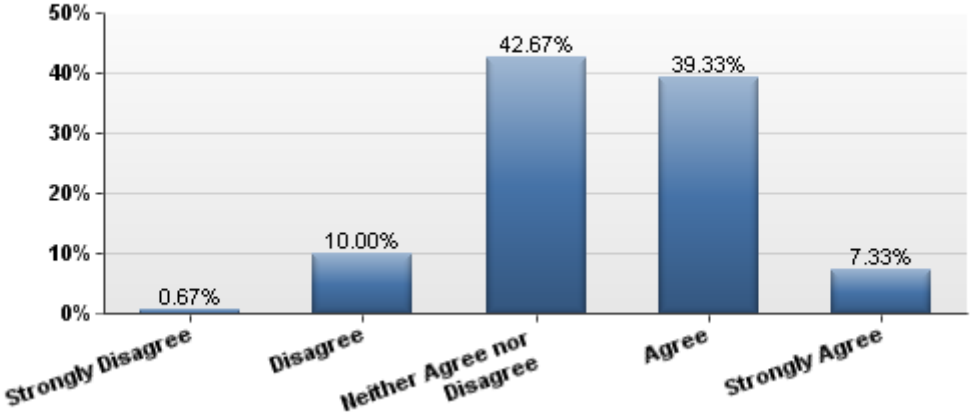


Figure 6-38. Students' belief of biofuels leading to economic development in Poland

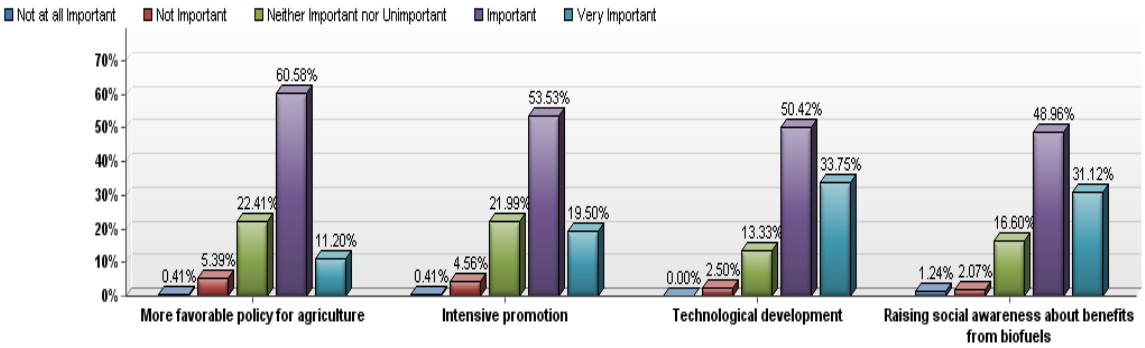


Figure 6-39. Importance of biofuels adoption in the fuel market perceived by UF students.

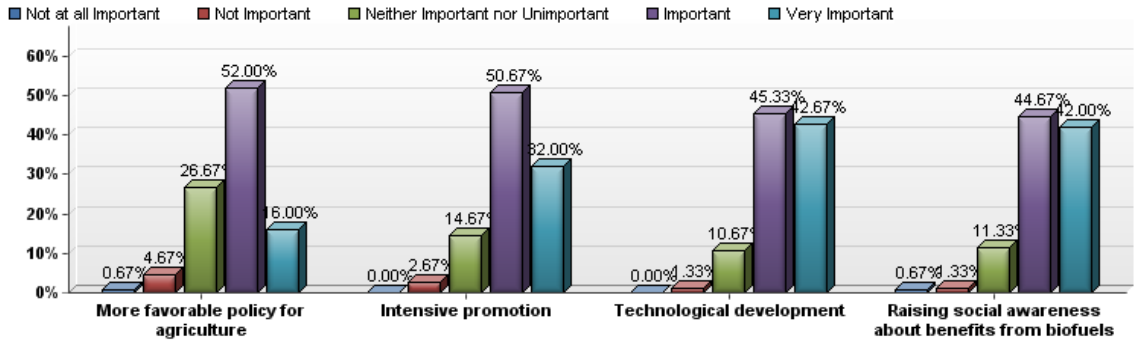


Figure 6-40. Importance of biofuels adoption in the fuel market perceived by WULS students

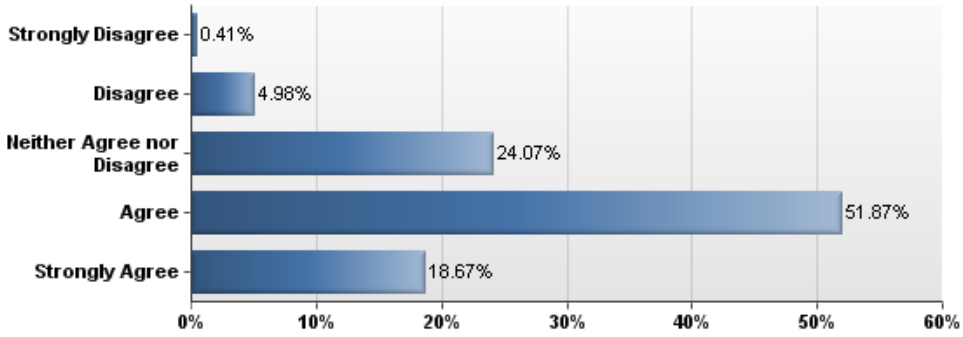


Figure 6-41. UF Student opinion about government subsidies' influencing biofuels production

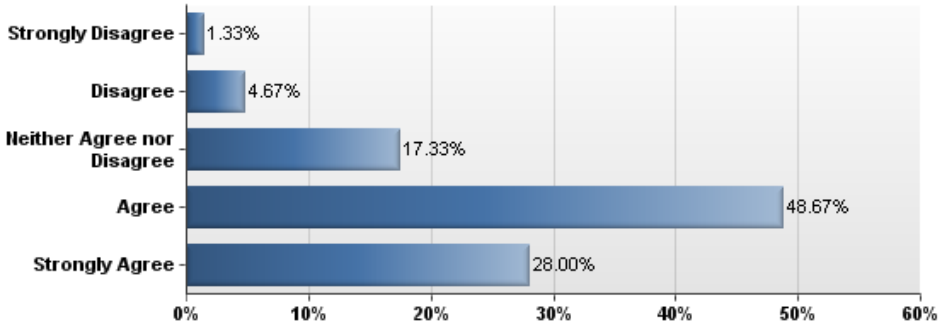


Figure 6-42. WULS Student opinion about government subsidies' influencing biofuels production

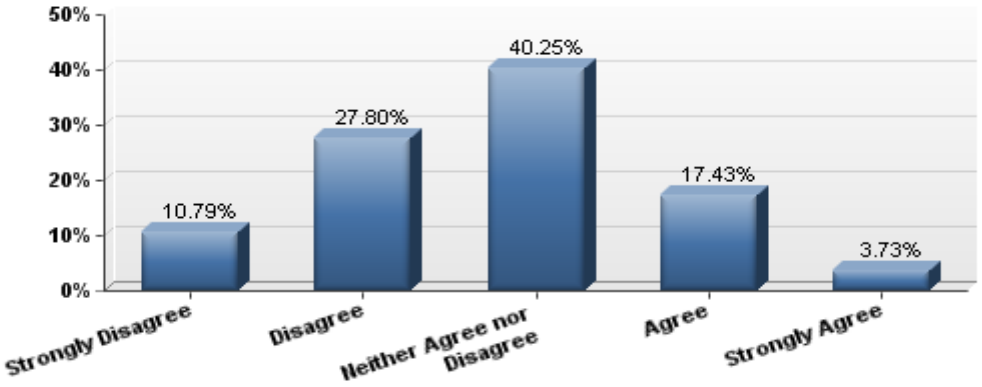


Figure 6-43. UF student views of government control over biofuels production.

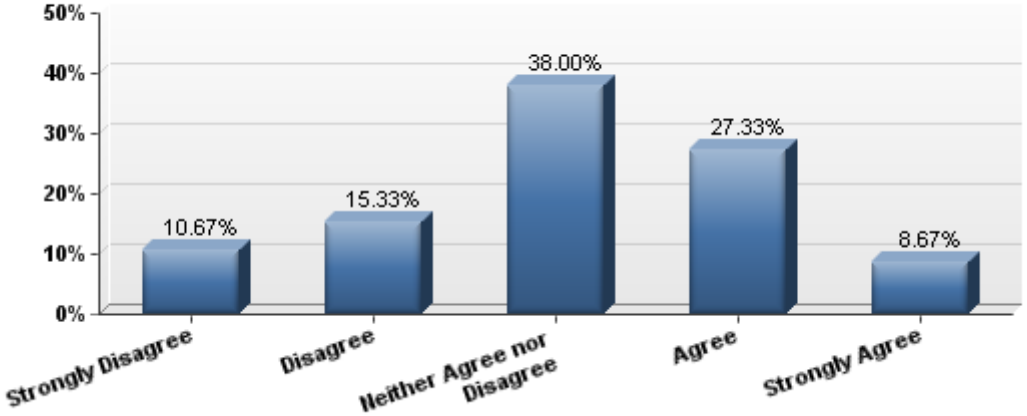


Figure 6-44. WULS student views of government control over biofuels production.

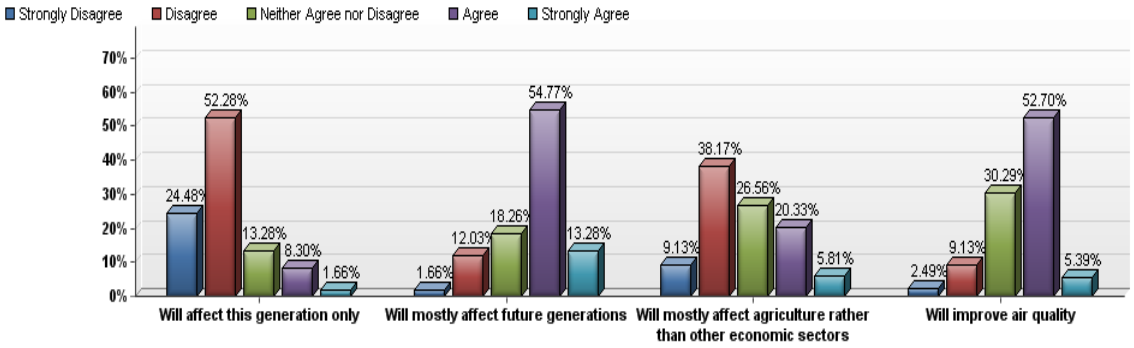


Figure 6-45. UF student belief of biofuels decisions impacting future situation

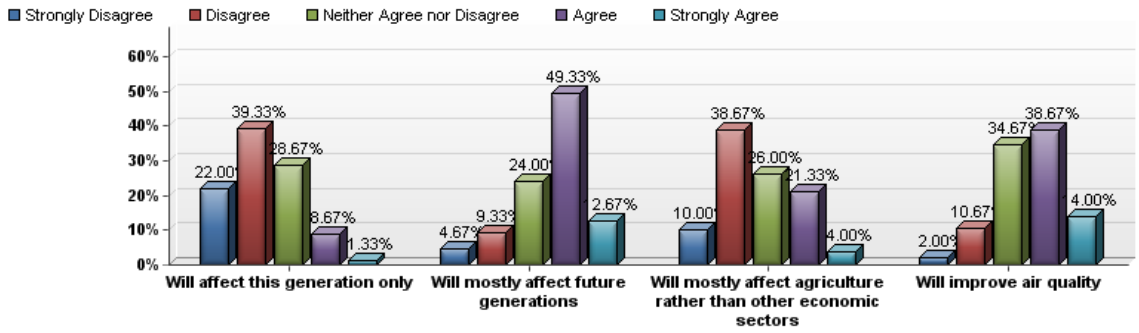


Figure 6-46. WULS student belief of biofuels decisions impacting future situation

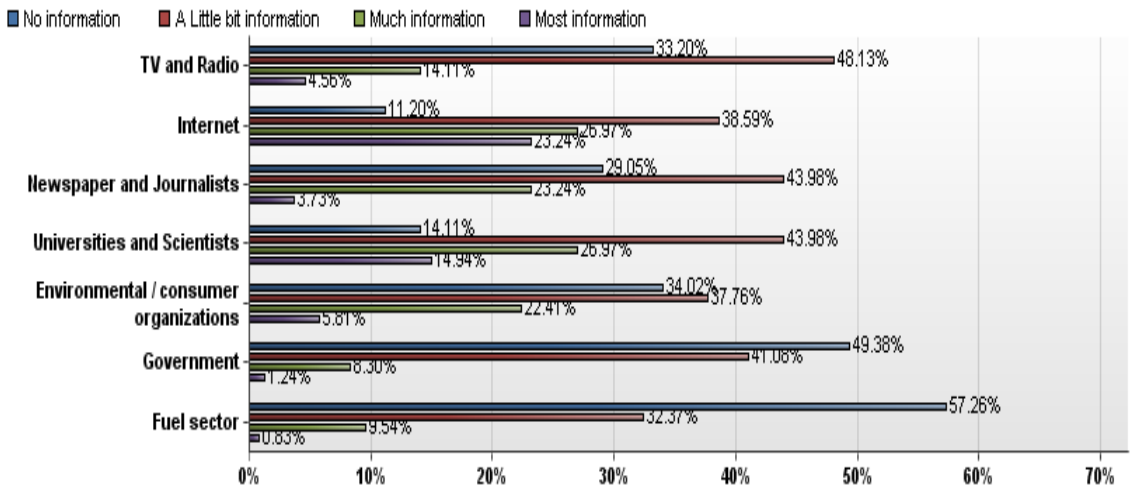


Figure 6-47. U.S. student sources of information about biofuels.

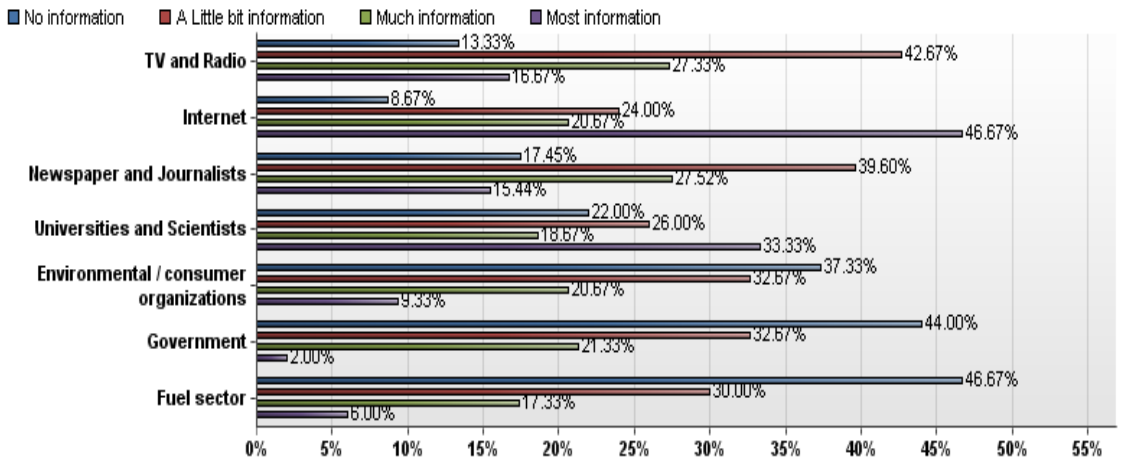


Figure 6-48. Polish student sources of information about biofuels.

Table 6-1. UF student opinion with the characteristics of biofuels.

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
Are high quality fuels	1.66%	15.77%	45.64%	34.02%	2.90%	3.21
Are safe to use	0.00%	6.22%	26.56%	57.26%	9.96%	3.73
Are a high performance fuel	3.73%	29.88%	39.00%	24.07%	3.32%	2.93
Will not damage the car	1.66%	16.18%	44.81%	32.78%	4.56%	3.22
Are cheaper than regular fuels	4.98%	29.88%	35.27%	27.39%	2.49%	2.93
Are enviromentally friendly	2.07%	8.30%	20.33%	53.11%	16.18%	3.73
Lead to lower maintenance costs for the vehicle compared to regular fuel	2.49%	21.58%	54.77%	19.50%	1.66%	2.96
Are still in the experimental stage of product development	1.66%	10.37%	19.92%	52.28%	15.77%	3.70
Meet quality standards	0.41%	9.13%	53.53%	34.44%	2.49%	3.29
Can only be used in vehicles with modified engines	1.24%	13.28%	32.37%	43.98%	9.13%	3.46

Table 6-2. WULS student opinion with the characteristics of biofuels.

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
Are high quality fuels	0.67%	23.33%	42.00%	25.33%	8.67%	3.18
Are safe to use	1.33%	5.33%	29.33%	51.33%	12.67%	3.69
Are a high performance fuel	2.68%	26.85%	40.94%	24.16%	5.37%	3.03
Will not damage the car	3.33%	22.00%	52.00%	16.67%	6.00%	3.00
Are cheaper than regular fuels	5.33%	24.67%	28.67%	26.67%	14.67%	3.21

Table 6-2. Continued

Are environmentally friendly	4.67%	6.67%	13.33%	41.33%	34.00%	3.93
Lead to lower maintenance costs for the vehicle compared to regular fuel	6.00%	20.00%	42.67%	22.00%	9.33%	3.09
Are still in the experimental stage of product development	2.00%	9.33%	20.00%	52.00%	16.67%	3.72
Meet quality standards	0.00%	6.67%	44.67%	42.00%	6.67%	3.49
Can only be used in vehicles with modified engines	6.00%	16.67%	33.33%	32.00%	12.00%	3.27

Table 6-3. New Environmental Paradigm (NEP) scale in the United States

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
The so-called “ecological crisis” facing humankind has been greatly exaggerated	11.62%	35.68%	31.54%	16.18%	4.98%	2.67
If things continue on their present course, we will soon experience a major ecological catastrophe	2.90%	8.71%	21.99%	48.13%	18.26%	3.70
Humans will eventually learn about how nature works to be able to control it	9.54%	26.14%	32.78%	27.39%	4.15%	2.90
The balance of nature is very delicate and easily upset	1.24%	12.45%	24.90%	46.89%	14.52%	3.61
Humans were meant to rule over the rest of nature	17.01%	29.05%	25.31%	21.99%	6.64%	2.72

Table 6-3. Continued

Plants and animals have as much right as humans to exist	2.49%	11.62%	22.41%	37.34%	26.14%	3.73
Human ingenuity will insure that we do not make the earth unlivable	7.47%	17.01%	31.95%	35.68%	7.88%	3.20
We are approaching the limit of the number of people the earth can support	3.73%	19,09%	27.80%	32.37%	17.01%	3.40
The balance of nature is strong enough to cope with the impacts of modern industrial nations	12.03%	42.74%	24.48%	18.67%	2.07%	2.56
The earth is like a spaceship with very limited room and resources	2.90%	12.03%	21.58%	43.57%	19.92%	3.56

Table 6-4. New Environmental Paradigm (NEP) scale in Poland

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
The so-called “ecological crisis” facing humankind has been greatly exaggerated	7.33%	30.67%	34.67%	22.67%	4.67%	2.87
If things continue on their present course, we will soon experience a major ecological catastrophe	2.00%	11.33%	26.67%	38.67%	21.33%	3.86
Humans will eventually learn about how nature works to be able to control it	4.67%	21.33%	34.00%	34.00%	6.00%	3.15

Table 6-4. Continued

The balance of nature is very delicate and easily upset	2.67%	4.67%	10.00%	43.33%	39.33%	4.12
Humans were meant to rule over the rest of nature	12.67%	27.33%	22.67%	27.33%	10.00%	2.95
Plants and animals have as much right as humans to exist	5.33%	6.00%	5.33%	28.00%	55.33%	4.22
Human ingenuity will insure that we do not make the earth unlivable	1.33%	10.00%	10.67%	45.33%	32.67%	3.98
We are approaching the limit of the number of people the earth can support	5.33%	15.33%	39.33%	31.33%	8.67%	3.23
The balance of nature is strong enough to cope with the impacts of modern industrial nations	23.33%	48.00%	22.00%	6.00%	0.67%	2.13
The earth is like a spaceship with very limited room and resources	5.33%	15.33%	18.67%	40.00%	20.67%	3.55

Table 6-5. Level of importance considering future car characteristics in the United States

Question	Not at all Important	Not Important	Neither Important nor Unimportant	Important	Very Important	Mean
Price of the car	0.83%	1.66%	2.07%	34.02%	61.41%	4.54
Fuel efficiency (miles/gallon)	1.24%	2.07%	4.98%	47.72%	43.98%	4.31
Safety	0.83%	2.49%	7.05%	44.40%	45.23%	4.31

Table 6-5. Continued

Comfort	0.00%	3.33%	10.83%	55.00%	30.83%	4.13
Size	0.41%	3.32%	9.13%	58.92%	28.22%	4.11
Insurance costs	1.24%	4.98%	9.96%	51.45%	32.37%	4.09
Fuel price	1.24%	4.98%	12.03%	50.62%	31.12%	4.05
Maintenance cost	0.83%	5.81%	11.20%	52.70%	29.46%	4.04
Appearance	1.66%	6.64%	15.35%	43.57%	32.78%	3.99
Brand	2.07%	9.13%	17.01%	51.87%	19.92%	3.78
Performance (horse power, acceleration, handling, speed)	2.49%	7.88%	18.67%	52.28%	18.67%	3.77
Engine type	2.07%	11.62%	33.61%	40.25%	12.45%	3.49
CO2 emmission	6.22%	17.84%	35.68%	30.29%	9.96%	3.20

Table 6-6. Level of importance considering future car characteristics in Poland

Question	Not at all Important	Not Important	Neither Important nor Unimportant	Important	Very Important	Mean
Price of the car	0.00%	1.33%	2.00%	37.33%	59.33%	4.55
Fuel efficiency (miles/gallon)	0.00%	2.67%	4.00%	43.33%	50.00%	4.41
Safety	0.00%	3.33%	5.33%	40.67%	50.67%	4.39
Comfort	0.00%	3.33%	10.67%	60.67%	25.33%	4.08
Size	0.67%	4.67%	8.00%	63.33%	23.33%	4.04
Insurance costs	0.00%	6.00%	14.67%	53.33%	26.00%	3.99
Fuel price	0.67%	3.33%	9.33%	48.67%	38.00%	4.20
Maintenance cost	0.00%	2.67%	5.33%	53.33%	38.67%	4.28
Appearance	0.67%	6.00%	8.67%	56.00%	28.67%	4.06
Brand	1.33%	10.00%	22.67%	54.67%	11.33%	3.65
Performance (horse power, acceleration, handling, speed)	0.67%	8.67%	17.33%	51.33%	22.00%	3.85
Engine type	0.00%	14.00%	16.67%	52.00%	17.33%	3.73
CO2 emmission	7.33%	23.33%	34.00%	29.33%	6.00%	3.03

Table 6-7. Preference of future engine types in the United States

Question	Definitely Would Consider	Would Not Consider	Would Consider	Idefinitely Would Consider	Have Never Heard Of	Mean
Gasoline powered (up to 10% bioethanol blend)	2.07%	3.32%	41.49%	45.64%	7.47%	3.53
Diesel powered (up to a 5% biodiesel blend)	12.45%	27.39%	32.37%	21.58%	6.22%	2.82
Hybrid (uses gasoline and electricity)	6.30%	10.08%	31.51%	51.26%	0.84%	3.30
Electric (battery powered)	12.86%	22.41%	30.29%	33.61%	0.83%	2.87
Flex fueled (can use gasoline or gasoline/ ethanol blends up to 85% ethanol)	4.60%	5.02%	39.33%	36.82%	14.23%	3.51
Other (please list)	5.88%	3.92%	19.61%	15.69%	54.90%	4.10

Table 6-8. Preference of future engine types in Poland

Question	Definitely Would Consider	Would Not Consider	Would Consider	Idefinitely Would Consider	Have Never Heard Of	Mean
Gasoline powered (up to 10% bioethanol blend)	3.52%	15.49%	60.56%	11.97%	8.45%	3.06
Diesel powered (up to a 5% biodiesel blend)	2.11%	5.63%	57.04%	25.35%	9.86%	3.35
Hybrid (uses gasoline and electricity)	9.15%	14.78%	42.25%	23.94%	9.86%	3.11
Electric (battery powered)	15.49%	33.80%	28.17%	14.78%	7.75%	2.65
Flex fueled (can use gasoline or gasoline/ ethanol blends up to 85% ethanol)	5.67%	12.06%	55.32%	12.77%	14.18%	3.18
Other (please list)	6.90%	6.90%	20.69%	6.90%	58.62%	4.03

CHAPTER 7
MODEL SPECIFICATIONS AND RESULTS

Tobit Model

A detailed review of the literature reveals that tobit models have been applied to a wide variety of problems and a variety of economic and sociological issues. Tobit models are particularly used to study censored and limited dependent variables, which have become increasingly common in applied social science research over the past two decades (Smith & Brame, 2003). Tobit analysis assumes that the dependent variable has a number of its values clustered at a limiting value. In economics, such a model was first suggested by James Tobin in 1958. The tobit model was developed in order to handle cross sectional data sets where some observations in the sample lacked data or had zero values for the dependent variable (Gujarati, 2004).

The tobit model was first used by Tobin to analyze household expenditure on durable goods, which was the classic example of censoring. By definition of Long (1997) “censoring occurs when we observe the independent variable for the entire sample, but for some observations we have only limited information about the dependent variable”. By contrast, “truncation limits data more severely by excluding observations based on characteristics of the dependent variable”. In general truncation changes the sample, but censoring does not.

Before 1970, the tobit model was used very rarely in econometric applications, however since the early 1970’s a variety of different applications have appeared and continue to appear (Amemiya, 1984). In comparison to the Ordinary Least Squares (OLS) regression model, tobit estimates are theoretically superior when using censored data (McDonald & Moffitt, 1980).

OLS estimates become biased and inefficient depending on the number of zeros in relation to the number of observations in the data set. The higher the number

of zeros in relation to the total number of observations, the greater is the instability of the OLS estimates and vice versa. By contrast, in cases where the number of zeros is low, then the difference between OLS and tobit estimates is usually marginal. Amemiya, (1984) showed that the presence of zeros in the dependent variable "destroys the linearity assumption so that the least squares method is clearly inappropriate". As a result, a Tobit analysis is used in preference to OLS.

According to Sigelman & Zeng (1999), the Standard Tobit model can be defined as follows:

$y^* = x_i'\beta + \varepsilon_i,$

$y_i = y^*$ if $y_i^* > 0,$

$y_i = 0$ if $y_i^* \leq 0.$ (7-1)

where:

y_i^* - non-observable variable,

y_i - observed outcome variable;

x_i - vector of independent variables,

β - vector of tobit regression coefficients,

ε - random, standard normal disturbance term,

i - number of observations,

Maximum likelihood estimation of the tobit model is straightforward. Let $f(\varepsilon)$ and $F(\varepsilon)$ denote the density function and the cumulative density function for y^*. Then the model implies that the probabilities of observing a non-zero y and a zero y are $f(y)$ and $p(y^*<0) = F(0)$, respectively (Sigelman & Zeng, 1999). The log-likelihood function for the model is therefore:

$$\ln L = \ln\left(\prod_{y1>0} f(yi) \prod_{yi=0} F(0)\right)$$

$$= \sum_{yi>0} \ln f(yi) + \sum_{yi=0} \ln F(0) \qquad (7\text{-}2)$$

Because *y* is* normally distributed*, f(ε) and F(ε),* and therefore the log-likelihood function, can be expresses in case of the density function and the cumulative density function of the standard normal distribution*, ϕ(ε)* and *ϕ(ε),* and the log-likelihood function can be written in the familiar form:

$$\ln \mathrm{L} = \sum_{yi>0}\left(-\ln\sigma + \ln\phi\left(\frac{\mathrm{yi}-\mathrm{xi}\beta}{\sigma}\right)\right) + \sum_{yi=0}\ln\left(1-\phi\left(\frac{\mathrm{xi}\beta}{\sigma}\right)\right) \qquad (7\text{-}3)$$

In order to interpret the estimation results, the marginal effects of the independent variables on some conditional mean functions should be examined. In the tobit model, there are three different conditional means. Those of the latent variable *y*,* the observed dependent variable y, and the uncensored observed dependent variable y / y > 0.

The interpretation depends on whether one is censored with the marginal effect of *x* on *y*, y, or y/y > 0.* Once one determines which marginal effect one is interested in, one simply examines the marginal effects of *x* on the appropriate conditional expectations (Sigelman & Zeng, 1999).

The three marginal effect expressions are derived using standard results on moments of censored normal distributions, as follows:

$$\frac{\partial \mathrm{E}\,[\mathrm{y}*/\,\mathrm{x}]}{\partial \mathrm{xi}} = \beta \qquad (7\text{-}4)$$

$$\frac{\partial \mathrm{E}\,[\mathrm{y}*/\,\mathrm{x}]}{\partial \mathrm{x}} = \beta\,\phi\left(\frac{x\beta}{\sigma}\right) \qquad (7\text{-}5)$$

$$\frac{\partial \mathrm{E}\left(\frac{\mathrm{y}}{\mathrm{y}}>0,\mathrm{x}\right)}{\partial \mathrm{x}} = \beta\left(1-\delta\left(-\frac{x\beta}{\sigma}\right)\right) \qquad (7\text{-}6)$$

In this study, the tobit model is used to measure people's beliefs about biofuels, and to learn about the relationship of those beliefs with societal, economic and environmental variables. The dependent variable, belief, was censored at both ends.

The level of respondents' beliefs towards biofuels is calculated using responses to a series of three questions:

- Sustainability of biofuels (Belief that biofuels are a sustainable alternative to traditional fossil fuels)
- Replacement of fossil fuels (Belief that biofuels can replace a significant amount of traditional fossil fuels in the near future)
- Impact of biofuels (Belief that biofuels reduce global climate change, lower carbon emissions, pollute waterways less than traditional fuels and use fewer chemicals to be produced)

All three questions are summed to create a scale measuring attitude towards biofuels. A Cronbach's Alpha test was run to determine if the scale was reliable, with a result of 0.743, indicating there is internal reliability.

A tobit model is then estimated using societal, economic and environmental variables as the independent variables and belief as the dependent variable. The Statistical Package for the Social Sciences (SPSS) and the LIMDEP were used to compute data from both countries - the United States and Poland.

The general format for the model is shown in Equation 7-7.

Belief = f(Demographic variables, Knowledge about biofuels, Food versus fuel preference, Perceived Consumer Effectiveness, New Environmental Paradigm, Current car characteristics and fuel consumption, Biofuels perspectives, Information sources) (7-7)

Specific variables included in the model are shown in Equation 7-8 and are described in detail in Table 7-1. Specific information on the means and responses for the variables included is provided in Chapter 6.

Belief = *f*(Sub_know, Obj_know, FAC1, FAC2, FAC3, Food_Prod, Food_Price, Car_owner, Availab, Econ_dev, Gov_subs, TV&Radio, Internet, News&Journ, Univ&Scient, Env/Con_Org, Governm, Fuel_Sec, Country, Expenses, Distance, Fuel_eff, Age, Gender, College, PCE, NEP, Sub_knowI, Obj_knowI, FAC1I, FAC2I, FAC3I, Food_ProdI, Food_PriceI, Car_ownerI, AvailabI, Econ_devI, Gov_subsI, TV&RadioI, InternetI, News&JournI, Univ&ScientI, Env/Con_OrgI, GovernmI, Fuel_SecI, ExpensesI, DistanceI, Fuel_effI, AgeI, GenderI, CollegeI, PCEI, NEPI) (7-8)

Tobit Results

The dependent variable, belief, was censored at both ends, with a mean of 15.5 and range of 1 to 24. In total, 370 observations were used to estimate the model in equation 7-8. Results are presented in Table 7-2.

Demographics

The dummy variable representing country did not have a statistically significant effect on the beliefs of biofuels. This implies that there is no statistical difference between students in the United States and Poland based only on the country they are from. However, country was included as an interaction variable with all other independent variables to see if belief in biofuels differs for different sub-groups between the countries. Age was also not significant in terms of students' beliefs, which is not surprising due to the relatively small range of ages among students. The majority of students were between the ages of 19 and 24, with a few age exceptions. Gender was also not statistically significant in determining perception of biofuels.

College was significantly related to students' beliefs. U.S. students in the College of Agriculture and Life Sciences (CALS) had a lower belief score than non-CALS students by 0.01 units. Respondents from Poland who were in the College of

Agriculture also had lower perceptions of biofuels than those not in agriculture, but by a greater amount than their U.S. counterparts (1.35 units).

Knowledge about Biofuels

Subjective knowledge was not statistically related to the belief score of biofuels. This effect is somewhat unexpected as people are often influenced by their subjective knowledge.

On the other hand, objective knowledge was statistically significant related to belief in biofuel for all students. In case of students from the United States, for every increased unit of objective knowledge, the belief score of biofuels increases by 0.10. Students in Poland had a stronger increase in belief for every unit increase in objective knowledge. For each additional unit of the objective knowledge in Poland, the belief score increases by 0.59.

Three factors (quality, cost, and trust in technology) were created based on the question related to biofuels characteristics. The first two, quality and cost, were statistically significant, indicating that environmental friendliness and biofuel's economy positively influence students' beliefs in biofuels. In both cases there was no statistically significant difference between the countries. Of these, the most important factor was the first, related to quality, including characteristics of environmental friendliness and safety of biofuels. For both the United States and Poland, for every one unit increase of biofuel quality factor, the belief score increased by 1.03 units. The second significant factor was the cost factor, which focuses on biofuels overall and maintenance costs in comparison to regular fuel. For Poland and the United States the cost factor was statistically significant at the same level with each additional unit of cost incurred, leading to an increase in belief score of 0.45 for students in both countries.

The third factor, related to trust in technology was not significant. This indicates that belief in biofuels is not influenced by an individual's overall trust in technology.

The variable representing the participant's perception of availability of biofuels is statistically significant in both countries. In the United States, for every additional unit a person increases their score on the availability of biofuels, the belief score increases by 0.27. However in Poland, the belief score will decrease by 0.65. This inverse relationship may well indicate that U.S. students associate product availability with other aspects of product quality, or, in another variation, that perceived experience with the good lends itself to the development of positive attitudes amongst this group. If students perceive that biofuels are available, American students think more positively about this fact. On the contrary, Polish participants think more negatively about biofuels the more they believe they are available.

Food versus Fuel Preference

Consumer concerns about biofuel production leading to changes in food availability and price are also included in the model. To account for the influence these perceptions might have on the acceptance of biofuels, respondents were asked specific questions about their beliefs on the interaction of biofuels production and agro-food issues. Belief in an impact on food production did not have a statistically significant effect on the overall belief in biofuels among respondents in the United States and Poland. Therefore, the linkage between biofuels production and food production, followed by linkage between biofuels production and food price did not influence respondents' overall belief in biofuels.

Perceived Consumer Effectiveness

The PCE scale was statistically significantly related to belief in biofuel in both countries. For every additional unit of PCE, the belief score of biofuels increased by 0.01 unit for U.S. students For the same increase in the PCE score in Poland, the

belief score increased by 0.24. Therefore,if Polish students felt they had more control over the environment, they believed more strongly in biofuels than U.S. students.

New Environmental Paradigm

The New Environmental Paradigm was not statistically significant at or above a 90% confidence level, nor was the interaction variable. This indicates that the NEP scale was not related to beliefs of biofuels among students in either country.

Biofuels Economy

Most characteristics about cars and fuel consumption were not statistically significant. This includes car ownership, fuel expenses and distance driven in an average week. The exception was fuel efficiency which was significant for both U.S. and Polish students. For every additional mile per gallon increase in fuel efficiency, the belief score of biofuels increases by 0.01 unit for U.S. students. For Polish students, the result was opposite, with a decrease in perceptions of biofuels of 0.06 units for every mile per gallon increase in fuel efficiency.

Biofuels Perspectives

Frequently the media presents investment in biofuels technology and production as a pathway towards economic development, stability and diversification. Respondents who believe that biofuels are tied to economic development were likely to have a belief score that was 1.27 units higher. Majority of students claimed that biofuels can help with economic development in their countries. Whether or not the respondent believed that government subsidies was not statistically significant for students in either country.

Information Sources

Students who use television and radio as a source of information were significantly more likely to have a higher belief toward biofuels. For every additional unit they rated television and radio as a source of information, the belief score

increased by 0.68. This did not differ by country. Both, U.S. and Polish students who rated television and radio as a more important source, they believed more strongly in biofuels than average students.

Internet is found as a very significant source of biofuels knowledge. For Americans, for every additional unit they rated internet as a source of information, the belief score increased by 0,16. By contrast, students in Poland when rating higher internet as an information source about biofuels, they exhibited a decrease in their belief score by 0.71. U.S. students who rated internet as a more important source of information, they believed more strongly in biofuels than average students. However, Polish students who rated internet as a more important information source, they less strongly believed in biofuels.

Considering newspapers and journalists as the source of information, for students in the United States and Poland this source was statistically significant. For every additional unit, the belief score decreased by 0.72 unit in relation to the average person. There was no country effect. Both, U.S. and Polish students who rated newspaper and journalists as a more important source, they believed less strongly in biofuels than average students.

Environmental and consumer organizations are significant and crucial only for the U.S. respondents. For every additional unit they rated these organizations as a source of information, the belief score increased by 0.63. Polish students, on the other hand, are not shown to have their views significantly impacted by considering information from environmental and consumer organizations. U.S. students who rated these organizations as a more important source of information, they believed more strongly in biofuels than average students.

The next two sources of biofuels information, the government and the fuel sector, were not significant for students from the United States and Poland in terms of the beliefs score. In general all students did not consider information about biofuels from government and fuel sector as being important.

Information gained from universities and scientists was not statistically significant in terms of biofuels beliefs among students from both countries.

Fifty three independent variables were entered into a tobit model on consumer beliefs of biofuels. All variables were grouped into 8 categories. Eighteen variables, had a statistically significant impact on belief score at a 10% or better level of significance.

Table 6-2 shows the estimated coefficients for one-unit changes in each of the chosen variables. Almost in each category there were significant variables except for the two categories called “food vs fuel preference” and “New Environmental Paradigm”.

In the following chapter further interpretation of the results from the tobit model in comparison to the previous research will be showed. There will be also presented more detailed interpretation of the U.S. and Polish descriptive statistics.

Table 7-1. Explanation of variable coding

Variable name	**Variable description**	**Coding**
Demographics		
Country	Country of residence	Poland (PL) = 0, United States (US) = 1
Age	Age of individual	Ranges from 19 to 45
AgeI	Interaction of age and country	= 0 if Country = PL = Age if Country = US
Gender	Gender of individual	Female = 0, Male = 1
GenderI	Interaction of gender and country	= 0 if Country = PL = Gender if Country = US

Table 7-1. Continued

College_Ag	College specification	Age = 1, Non-ag. = 0
College_AgI	Interaction of college and country	= 0 if Country = PL = College_Ag. if Country =US
Knowledge about biofuels		
Sub_know	Subjective knowledge of individual	Ranges from 1 to 5
Sub_knowI	Interaction of subjective knowledge and country	= 0 if Country = PL = Sub_know if Country = US
Obj_know	Objective knowledge of individual	Ranges from 1 to 5
Obj_knowI	Interaction of objective knowledge and country	= 0 if Country = PL = Obj_know if Country = US
FAC1	Quality Factor	Ranges from -3,43 to 0,09
FAC1I	Interaction of quality factor and country	= 0 if Country = PL = FAC1 if Country = US
FAC2	Cost Factor	Ranges from -2,86 to 0,03
FAC2I	Interaction of cost factor and country	= 0 if Country = PL = FAC2 if Country = US
FAC3	Trust Factor	Ranges from -4,15 to 0,23
FAC3I	Interaction of trust factor and country	= 0 if Country = PL = FAC3 if Country = US
Availab	Belief in availability of biofuels	Ranges from 0 to 5
AvailabI	Interaction of availability and country	= 0 if country = PL = Availab if country = US
Food vs Fuel preference		
Food_prod	Biofuels influence on food production	Ranges from 1 to 5
Food_prodI	Interaction of biofuels influence on food production and country	= 0 if Country = PL = Food_prod if Country = US
Food_price	Biofuels influence on food production	Ranges from 1 to 5
Food_priceI	Interaction of biofuels influence on food price and country	= 0 if Country = PL = Food_ price if Country = US
Perceived Consumer Effectiveness		
PCE	Individual score of PCE	Ranges from 4 to 20
PCEI	Interaction of PCE and country	= 0 if Country = PL = PCE if Country = US
New Environmental Paradigm		
NEP	Individual score of NEP	Ranges from 10 to 50
NEPI	Interaction of NEP and country	= 0 if Country = PL = NEP if Country = US
Current car characteristics and fuel consumption		
Car_owner	Car ownership	NO = 0, YES = 1
Car_ownerI	Interaction of car ownership and country	= 0 if Country = PL = Car_owner if Country = US
Expenses	Monthly money spent on fuel ($)	Ranges from $10 to 400
ExpensesI	Interaction of biofuels expenses and country	= 0 if Country = PL = Expenses if Country = US
Distance	Distance driven per week (miles)	Ranges from 5 to 475 miles
DistanceI	Interaction of distance and country	= 0 if Country = PL = Distance if Country = US

Table 7-1. Continued

Fuel_eff	Fuel efficiency (miles/gallon)	Ranges from 10-50 miles/gallon
Fuel_effI	Interaction of fuel efficiency and country	= 0 if Country = PL = Fuel_ eff if Country= US
Biofuels perspectives		
Econ_dev	Economic development	Ranges from 1 to 5
Econ_devI	Interaction of economic development and country	= 0 if Country = PL = Econ_dev if Country = US
Gov_sub	Government subsidies	Ranges from 1 to 5
Gov_subI	Interaction of government subsidies and country	= 0 if Country = PL = Gov_sub if Country = US
Information sources		
TV&Radio	Information source -TV and Radio	Ranges from 1 to 4
TV&RadioI	Interaction of TV & Radio and country	= 0 if Country = PL = TV&Radio if Country = US
Internet	Information source - Internet	Ranges from 1 to 4
InternetI	Interaction of Internet and country	= 0 if Country = PL = Internet if Country = US
News&Journ	Information source – Newspapers & Journalists	Ranges from 1 to 4
News&JournI	Interaction of Newspapers & Journalists and country	= 0 if Country = PL = News&Journ if Country=US
Uni&Scien	Information source – Universities & Scientists	Ranges from 1 to 4
Uni&ScienI	Interaction of Universities & Scientists and country	= 0 if Country = PL = Uni&Scien if Country = US
Env/Con_Org	Information source - Environmental/Consumer Organizations	Ranges from 1 to 4
Env/Con_OrgI	Interaction of Environmental/Consumer Organizations and country	= 0 if Country = PL = Env/Con_Org if Country = US
Governm	Information source - Government	Ranges from 1 to 4
GovernmI	Interaction of Government and country	= 0 if Country = PL = Governm if Country = US
Fuel_sec	Information source - Fuel sector	Ranges from 1 to 4
Fuel_secI	Interaction of Fuel sector and country	= 0 if Country = PL = Fuel_sec if Country = US

Table 7-2. Tobit analysis results

	Std.Error	**T-ratio**	**P-value**	**Coefficient**
Demographics				
Country	5,294	-0,659	0,510	-3,487
Age	0,153	-1,396	0,163	-0,214
AgeI	0,166	0,915	0,360	0,152
Gender	0,507	-0,544	0,586	-0,276
GenderI	0,639	-0,033	0,973	-0,021

Table 7-2. Continued

College_ag*	0,512	-2,627	0,009	-1,346
College_agI**	0,646	2,068	0,039	1,336
Current knowledge and perception about biofuels				
Sub_know	0,319	-0,405	0,685	-0,129
Sub_knowI	0,384	0,760	0,447	0,292
Obj_know*	0,171	3,447	0,001	0,589
Obj_knowI*	0,213	-2,288	0,022	-0,488
FAC1*	0,240	4,290	0,000	1,028
FAC1I	0,318	-0,019	0,985	0,006
FAC2*	0,204	2,222	0,026	0,454
FAC2I	0,302	1,356	0,175	0,409
FAC3	0,213	1,357	0,175	0,289
FAC3I	0,296	1,579	0,114	0,467
Availability***	0,384	-1,705	0,088	-0,654
AvailabilityI**	0,430	2,140	0,032	0,920
Food vs fuel preference				
Food_prod	0,418	1,438	0,150	0,601
Food_prodI	0,468	-0,686	0,493	-0,321
Food_price	0,380	0,060	0,952	0,023
Food_priceI	0,454	-1,508	0,132	-0,684
Perceived Consumer Effectiveness				
PCE*	0,090	2,627	0,009	0,235
PCEI***	0,126	-1,825	0,068	-0,229
New Environmental Paradigm				
NEP	0,063	0,808	0,419	0,051
NEPI	0,072	-0,394	0,693	-0,028
Current car characteristics and fuel consumption				
Car_owner	0,495	1,116	0,264	0,552
Car_ownerI	0,743	-0,324	0,746	-0,240
Expenses	0,004	1,130	0,258	0,004
ExpensesI	0,005	-0,230	0,818	-0,001
Distance	0,003	-0,683	0,495	0,002
DistanceI	0,003	0,054	0,957	0,000
Fuel_eff***	0,033	-1,861	0,063	-0,062
Fuel_effI***	0,039	1,721	0,085	0,067
Biofuels perspectives				
Econ_dev*	0,324	3,916	0,000	1,267
Econ_devI	0,416	0,525	0,599	0,219
Gov_subs	0,302	0,283	0,778	0,085
Gov_subsI	0,382	0,587	0,557	0,224
Information sources				
TV&Radio*	0,302	2,239	0,025	0,676
TV&RadioI	0,395	-0,536	0,592	-0,211
Internet*	0,298	-2,385	0,017	-0,710
InternetI*	0,373	2,331	0,020	0,869

Table 7-2. Continued

News&Journ*	0,303	-2,366	0,018	-0,716
News&JournI	0,408	1,355	0,176	0,552
Uni&Scienc	0,250	-0,207	0,836	-0,052
Uni&SciencI	0,338	-0,494	0,621	-0,167
Envi/Con_Org	0,281	-1,142	0,253	-0,321
Envi/Con_OrgI***	0,369	1,711	0,087	0,631
Governm	0,356	-1,051	0,293	-0,374
Governm	0,479	-0,719	0,472	-0,344
Fuel_sector	0,334	1,291	0,197	0,431
Fuel_sectorI	0,445	-1,470	0,141	-0,654

(*variable is significant with a 99% confidence level, ** variable is significant with a 95%confidence interval, *** variables is significant with a 90% confidence interval)

CHAPTER 8
CONCLUSIONS

Summary

The objective of this research was an analysis of consumer perceptions of biofuels. Due to the complexity of the concept, it should be treated as a descriptive category. In general in this research we measured knowledge, beliefs and pro or anti-biofuel attitudes.

This master thesis is a comparison of consumer perception towards biofuels in the United States and Poland. Many similarities and differences were distinguished concerning demographics, knowledge, environmental issues, biofuels economy and perspectives. The research allowed to verify hypotheses, assumed at the beginning of this study.

The first hypothesis of this thesis was that consumers' perception about biofuels in the United States and Poland are different. The results indicated that there is no statistical difference between students in the United States and Poland based only on the country they are from. However, using country as an interaction variable with other independent variables indicated there are differences between the countries related to different sub-groups. The differences were related to following aspects: demographics, knowledge, biofuels economy, environmental issues, biofuels perspectives and information sources. As a result of this finding, the first hypothesis is not rejected.

The second hypothesis suggested that consumers in the United States and Poland believe that biofuels are environmentally friendly and safe. Results were mixed on this hypothesis as some variables representing belief in biofuels were positive and others were negative.

In order to investigate the statistical significance of selected variables a regression analysis was performed.

Discussion of the Statistical Results

Demographics

Participants of the research were students from the University of Florida in the United States and Warsaw University of Life Sciences in Poland. Respondents from both countries were the homogenous group in terms of age. Both, U.S. and Polish students were the interesting and convenient target group and they can be recognized as the consumers of the future.

Research results revealed that age and gender did not influence consumer belief of biofuels. The only significant variable was type of college the students were enrolled in, showing that Polish students from the Faculty of Agriculture and Biology were less supportive toward biofuels than U.S. students from College of Agriculture and Life Sciences (CALS). It can be said that students from the College of Agriculture in Poland are either exposed to more negative information about biofuels, or less positive information, than their U.S. counterparts. One potential explanation for the difference in messages obtained in both countries might be the differences in the process of learning at both Universities in Gainesville and Warsaw.

Knowledge about biofuels

Both, U.S. and Polish students have a relatively good objective knowledge about biofuels. The relationship between respondents' level of objective knowledge and perception about biofuels is positively, however stronger in Poland. This indicates that Polish respondents are more likely to respond to increases in knowledge about biofuels in a positive manner.

Both U.S. and Polish students do not feel they are very knowledgeable about biofuels. It may mean that their subjective knowledge is small. This is consistent with the findings of a similar study (Polish Public Opinion Research Center, 2009b). Taking into account the low subjective and average objective knowledge, respondents seem to be uncertain about biofuels. This is similar to a previous study that found U.S. respondents have little knowledge about biofuels but most were interested in learning more (University of Wisconsin-Madison, 2009).

There was also a connection between belief in availability of biofuels and overall perception of biofuels. This relationship was opposite for students from both countries. When U.S. students feel that biofuels are more available, the belief in biofuels increases, however Polish students negatively perceive biofuels.

Biofuels economy

Cost factor (focuses on biofuels overall and maintenance costs in comparison to regular fuel) was positively associated with belief towards biofuels. Students in the United States and Poland, had belief that biofuels are not cheaper than regular fuels and that biofuels will not lead to lower maintenance costs for the vehicle compared to regular fuel. However in reality, the situation is different, because biofuels at the gas stations are cheaper than regular fuels due to government subsidies.

Another relationship between fuel efficiency and beliefs of biofuels was inverse for students from two countries. Students in the United States seem to be less satisfied about their current fuel efficiency and they are more likely to search for other solutions, such as higher biofuels blends. Polish students were happier with the fuel efficiency they currently have, suggesting that the more fuel efficient the car is, the more likely people are to stay with their current fuel and are not interested in biofuel alternatives.

Environmental issues

Three-fourth of students from the United States and Poland strongly believed that biofuels are environmentally friendly and safe. There was a relationship between quality factor (including characteristics of environmental friendliness and safety) and consumers' belief of biofuels. The higher the quality factor is, the stronger belief of biofuels. Overall, respondents in both countries, equally strongly, believe that by using biofuels, they may improve environmental condition, which positively influences perception of biofuels.

Moreover, three-fourth of U.S. and Polish students strongly believe that biofuels have a positive impact on lowering carbon emissions, which lead to decrease of global climate change. The results of this study were consistent with the findings of a similar U.S. study which showed that more than half of respondents believed that biofuels can have positive impacts on climate change by reducing greenhouse gas emissions (University of Wisconsin-Madison, 2009). Continuing emphasis of global climate changes, a Polish study revealed that more than a half of respondents strongly believe that the use of renewable energy, including biofuels, protects the environment against climate changes (Polish Public Opinion Research Center, 2009a).

There was also connection between the impact of consumers' individual behavior towards the environment protection and the belief of biofuels. It can be said that students from both countries positively believe in individual impact on the environment, however Polish students have a stronger belief.

Moreover, the regression model indicated that the New Environmental Paradigm (NEP) scale, was not related to beliefs of biofuels among students in either country. However, survey demonstrated importance of NEP.

Almost half of U.S. and Polish students also recognized that the production of biofuels impacts food availability and food prices. Surprisingly, this awareness did not influence respondents' overall belief in biofuels.

Biofuels perspectives

More than half of U.S. and Polish respondents strongly believed that biofuels can lead to the economic development of their countries. Respondents who believed in that were equally more likely to have a positive views on biofuels.

Three-fourth of U.S. and Polish students strongly believe that government subsidies impact production and the use of biofuels, however this belief is not related to their overall belief in biofuels.

Almost half of the students, believed that production and use of biofuels should not be controlled by the government. Another third had no opinion. These lack of acceptance towards government control among students are similar to negative views among the whole society in the United States and Poland, which is followed by certain actions. In April 2011 U.S. Senate voted to eliminate bioethanol subsidies. Similarly, In Poland, on the 1st of May 2011, the exemption from the excise duty was removed.

More than half of respondents in both countries believed that biofuels are an alternative to traditional fossil fuels and that biofuels can be a significant replacement for fossil fuels in the near future.

Moreover, majority of U.S. and Polish students believed that global perspectives of biofuels depend on technological development. Thus, advanced new technologies are necessary to produce next generations biofuels.

Information sources

Finally, a few significant information sources of biofuels were distinguished. Though television and radio is not the most popular source of information, it does positively impact perceptions of biofuels among students from both countries.

Surprisingly, information received from internet, which is recognized as the most used source of information influences student views differently. Students who use the internet more than average as a source of information in Poland were less likely to have positive perceptions of biofuels, where students from the United States had a more positive perception. One potential explanation for the difference between the two results might be the type of information provided by the internet source.

Furthermore, information provided by newspapers and journalists had equally negative impacts the perception of biofuels in both countries. One of the possible reasons can be related to lack of trust towards above-mentioned information source representing different political and economic options.

In both countries one-third of respondents use environmental and consumer organizations as a source of biofuel information, however only U.S. respondents were shown to have their views positively impacted by considering information from these organizations. It can be resulted from a big amount of organizations existing in the United States showing big potential impacting on consumer perceptions.

Further research revealed that information provided by the government, the fuel sector, and universities and scientists were not significant among students from both countries.

Final Remarks

Research results on perceptions of biofuels among students in the United States and Poland, countries with different levels of market development allow for the

formulation of several conclusions. American and Polish students indicated differences and similarities in perceptions of biofuels that may be associated with different levels of market development. The Polish market is defined as the market in the early stages of development, with a large scope for increasing production capacities. However, U.S. market is an advanced market, and is the largest producer of biofuels in the world. The lower level of market development in Poland means that the availability of biofuels is limited, which significantly affects the lower perception of biofuels. From the point of view of Polish consumers, a key issue is availability of biofuels in gas stations, which unfortunately is missing in Poland. In the United States, the availability of higher biofuels blends is much higher but still is not sufficient in the eyes of students.

Another issue is the price of biofuels. Currently biofuels are more expensive than conventional fuels and reliant on government support systems. In the United States and Poland biofuels availability at gas stations are cheaper than traditional fuel; however students are not aware of this fact. If students were more aware of the lower price of biofuels, there is a possibility that they would buy them more frequently, which in the long term might affect their popularity. This lack of biofuels price awareness might be a result of consumers' low level of subjective knowledge. Thus, providing more information in order to increase consumer's knowledge could significantly increase the perception of biofuels, and contribute to the market development.

Results of the study indicate that respondents' objective knowledge about biofuels is rather superficial. Students have basic knowledge about biofuels issues such as the belief that biofuels are environmentally friendly and safe. However, they

are lacking specific information. This is clearly seen on the example to answer the question about biofuels price in comparison to traditional fuels.

In order to persuade consumers to buy biofuels for their current or future car, there should be provided a system of additional incentives, educational activities and marketing. Therefore, major actions should be taken to promote and popularize knowledge about biofuels.

Education and Marketing Incentives

These above-mentioned actions should be consistent with trends observed in the global economy. An important element of promotional efforts toward biofuels use can be informational and educational initiatives. They should lead to an increase in awareness of the benefits of biofuels usage and an increase in the availability of information about conditions on the use of biofuels. One of the types of promotional activities can be actions directed to the public, especially car users. Issues concerning the use of biofuels should be introduced to training programs at all levels of education. Car users should also be provided with educational elements of the economic and environmental aspects of biofuels.

In addition, promotional techniques should be used, such as advertisements in television and radio in both countries. Another type of action should include activities directed to cars manufacturers. There should be provided compulsory information in new cars about whether the car is designed to burn biofuels or not.

Another type of actions should be aimed at increasing demand for biofuels. These may include local incentives for the purchase and use of vehicles on biofuels, such as a system of exemptions from parking fees, possibilities of free of charge entry to the city center and lower annual registration fees. It follows that the biofuels require additional incentives.

APPENDIX A
SURVEY

Please read this consent document carefully before you decide to participate in this survey. The aim of this survey is to gain information on consumer attitudes towards the biofuels market. The survey asks about your views on biofuels and their use.

This survey is a part of my research in pursuit of a Master's Degree. I appreciate your time and help. You will be asked to answer a series of questions about consumer perceptions of biofuels that should take you approximately 10 minutes to complete. Please note that there are no wrong or right answers. Only your opinion is important.

There are no expected risks or benefits to you for participating in this survey, and you will not receive any compensation for participating. The survey is anonymous and your participation is voluntary. You have the right to withdraw from the study at anytime by exiting the survey.

If you have questions about the survey, you can contact: Dr. Lisa House, PO Box 110240, Gainesville, FL 32611, phone 352 392-1826. For questions about your rights as a research participant in the study, you can contact: IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 352 392-0433.

By answering the next question, you are indicating that you voluntarily agree to participate in this survey.

- ❍ I agree to participate
- ❍ I choose not to participate

Here are some definitions of terms we will use during the survey. Though you might know what these are already, we define them so we all are thinking the same thing when we see the words.

- Biofuels - liquid or gaseous fuel for transport produced from biomass.
- Biomass - biodegradable fraction of products, waste and residues from agriculture (including plant and animal substances), forestry and related industries, as well as the biodegradable fractions of industrial and municipal waste.

The most commonly used biofuels are bioethanol and biodiesel.

- Bioethanol – ethanol produced from biomass and/or the biodegradable portion of waste.
- Biodiesel – methyl ester produced from vegetable or animal oil, of diesel quality.

Both fuels can be used in pure form by suitably adapted engines or may be blended in a mixture with diesel or gasoline, respectively. In this survey, when we refer to biofuels, we are referring to liquid biofuel for cars.

Biofuels can be classified into one of four "generations" based on the nature of the raw material and technology used to produce them. These are:

- First Generation - derived from raw materials, mainly from food crops or plant and animal fats.
- Second Generation - derived from non-food raw materials, agricultural and municipal waste and from conversion of cellulose.
- Third Generation - derived with a suitably modified material at the stage of cultivation and formed on the basis of the cultivation of algae.
- Fourth Generation - derived from biological processing of carbon.

The following questions are about your feelings on biofuels.

1. How knowledgeable are you about biofuels?

❍ 1 = Not Knowledgeable at all
❍ 2
❍ 3
❍ 4
❍ 5 = Very Knowledgable

2. Generally, how would you describe your own feelings about biofuels?

❍ Very Negative
❍ Negative
❍ Neutral
❍ Positive
❍ Very Positive

3. Please indicate your level of agreement or disagreement with the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
It is worthless for the individual consumer to do anything about pollution.	❍	❍	❍	❍	❍
When I buy products, I try to consider how my use of them will affect the environment and other consumers.	❍	❍	❍	❍	❍
Since one person cannot have any effect upon pollution and natural resource problems, it doesn't make any difference what I do.	❍	❍	❍	❍	❍
Each consumer's behavior can have a positive effect on society by purchasing products sold by socially responsible companies.	❍	❍	❍	❍	❍

4. Do you believe that biofuels are a sustainable alternative to traditional fossil fuels?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

5. Do you believe that biofuels can replace a significant amount of traditional fossil fuels in the near future?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

The following questions are about your current knowledge and perceptions on biofuels.

6. Please indicate if you think the following raw materials are converted to biofuels?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Crops grown for animal feed (e.g. soybeans)	❍	❍	❍	❍	❍
Crops grown primarily for food (e.g. vegetables)	❍	❍	❍	❍	❍
Crops grown for energy (e.g. switch grass)	❍	❍	❍	❍	❍
Residues (e.g. straw)	❍	❍	❍	❍	❍
Animal waste (e.g. manure)	❍	❍	❍	❍	❍

7. Please indicate your level of agreement or disagreement with the following statements. Biofuels...

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Are high quality fuels	❍	❍	❍	❍	❍
Are safe to use	❍	❍	❍	❍	❍
Are a high performance fuel	❍	❍	❍	❍	❍
Will not damage the car	❍	❍	❍	❍	❍
Are cheaper than regular fuels	❍	❍	❍	❍	❍
Are enviromentally friendly	❍	❍	❍	❍	❍
Lead to lower maintenance costs for the vehicle compared to regular fuel	❍	❍	❍	❍	❍
Are still in the experimental stage of product development	❍	❍	❍	❍	❍
Meet quality standards	❍	❍	❍	❍	❍
Can only be used in vehicles with modified engines	❍	❍	❍	❍	❍

8. How often, on average, do you purchase biofuels (in Florida higher biofuels blends than 10%)?

❍ Never
❍ Rarely
❍ Sometimes
❍ Quite Often
❍ Very Often
❍ Don't Know

9. How would you rate the availability of biofuels (in Florida higher biofuels blends than 10%)?

❍ Not Available
❍ Slightly Available
❍ Moderately Available
❍ Available
❍ Very Available

The next questions are related to your views about biofuels and the environment.

10. Please indicate your level of agreement or disagreement with the following statements.
Biofuels...

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Can reduce global climate change	❍	❍	❍	❍	❍
Can lower carbon emissions	❍	❍	❍	❍	❍
Can pollute waterways less than traditional fuels	❍	❍	❍	❍	❍
Can use fewer chemicals to be produced	❍	❍	❍	❍	❍

11. Please indicate your level of agreement or disagreement with the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The so-called “ecological crisis” facing humankind has been greatly exaggerated	❍	❍	❍	❍	❍
If things continue on their present course, we will soon experience a major ecological catastrophe	❍	❍	❍	❍	❍
Humans will eventually learn about how nature works to be able to control it	❍	❍	❍	❍	❍
The balance of nature is very delicate and easily upset	❍	❍	❍	❍	❍
Humans were meant to rule over the rest of nature	❍	❍	❍	❍	❍
Plants and animals have as much right as humans to exist	❍	❍	❍	❍	❍
Human ingenuity will insure that we do not make the earth unlivable	❍	❍	❍	❍	❍
We are approaching the limit of the number of people the earth can support	❍	❍	❍	❍	❍
The balance of nature is strong enough to cope with the impacts of modern industrial nations	❍	❍	❍	❍	❍
The earth is like a spaceship with very limited room and resources	❍	❍	❍	❍	❍

The following questions are intended to determine your thoughts about biofuel production and its influence on food production.

12. Do you believe that the production of biofuels impacts food availability?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

13. Do you believe that biofuel production influences the price of food?
- ❍ Strongly Disagree
- ❍ Disagree
- ❍ Neither Agree nor Disagree
- ❍ Agree
- ❍ Strongly Agree

The following questions are about your current car and gas usage.

14. Do you currently own a car?
- ❍ Yes
- ❍ No

15. What make, model and year is your primary car?

Make…

Model…

Year…

16. Do you have a preferred brand of gasoline?
- ❍ BP
- ❍ Shell
- ❍ Chevron
- ❍ Conoco Philips
- ❍ Kangaroo
- ❍ Exxon Mobil
- ❍ No Preferred Brand Option
- ❍ Other (please list) _____

17. What kind of fuel do you use in your primary car?
- ❍ Unleaded Regular
- ❍ Unleaded Plus
- ❍ Unleaded Premium
- ❍ Diesel (D)
- ❍ Biodiesel (B20)
- ❍ Biodiesel (B99-B100)
- ❍ Ethanol (E85)
- ❍ Other (please list) _____

18. How available are biofuels for refueling your current car?
- ❍ Not Available
- ❍ Slightly Available
- ❍ Moderately Available
- ❍ Available
- ❍ Very Available

19. Do you agree that the price of biofuels is appropriate?
- ❍ Strongly Disagree
- ❍ Disagree

❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

20. How much do you spend on fuel in a typical month?

_____

21. What is the proportion of your monthly expenses spent on fuel?
❍ 0 - 5 %
❍ 6 - 10 %
❍ 11 - 15 %
❍ 16 - 20 %
❍ 21 - 25 %

22. How many miles do you drive during an average week (miles / week)?

_____

23. What is the fuel efficiency of your car (miles / gallon)?

_____

The following questions are about your future car and gas usage.
24. When purchasing a new car, how important are each of these characteristics to you?

	Not at all Important	Not Important	Neither Important nor Unimportant	Important	Very Important
Price of the car	❍	❍	❍	❍	❍
Size	❍	❍	❍	❍	❍
Fuel efficiency	❍	❍	❍	❍	❍
Performance (speed)	❍	❍	❍	❍	❍
Engine type	❍	❍	❍	❍	❍
Brand	❍	❍	❍	❍	❍
Safety	❍	❍	❍	❍	❍
Fuel price	❍	❍	❍	❍	❍
Maintenance cost	❍	❍	❍	❍	❍
Comfort	❍	❍	❍	❍	❍
CO2 emission	❍	❍	❍	❍	❍
Insurance costs	❍	❍	❍	❍	❍
Appearance	❍	❍	❍	❍	❍

25. Which type of engine would you consider for your next car?

	Definitely Would Not Consider	Would Not Consider	Would Conside r	Definitely Would Consider	Have Never Heard Of
Gasoline powered (up to 10% bioethanol blend)	❍	❍	❍	❍	❍
Diesel powered (up to a 5% biodiesel blend)	❍	❍	❍	❍	❍
Hybrid (uses gasoline and electricity)	❍	❍	❍	❍	❍
Electric (battery powered)	❍	❍	❍	❍	❍
Flex fueled (can use gasoline or gasoline/ ethanol blends up to 85% ethanol)	❍	❍	❍	❍	❍
Please select "Have Never Heard of" for this question	❍	❍	❍	❍	❍
Other (please list)	❍	❍	❍	❍	❍

26. When considering your next car purchase how important are the following fuel characteristics?

	Not at all important	Not Important	Neither Important nor Unimportant	Important	Very Important
Price of fuel	❍	❍	❍	❍	❍
Availability at gas stations	❍	❍	❍	❍	❍
Engine modification requirements for a new car	❍	❍	❍	❍	❍
Environmental friendliness	❍	❍	❍	❍	❍
Odor	❍	❍	❍	❍	❍
Quality assurance	❍	❍	❍	❍	❍
Produced in the United States (not imported)	❍	❍	❍	❍	❍
Reduces maintenance cost	❍	❍	❍	❍	❍
Allows vehicle to operate at top performance	❍	❍	❍	❍	❍

The next section is on your perspectives of biofuels.

27. Do you believe biofuels can lead to economic development in the US?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

28. Which factors do you believe are important regarding the adoption of biofuels and increase their share in the fuel market?

	Not at all Important	Not Important	Neither Important nor Unimportant	Important	Very Important
More favorable policy for agriculture	❍	❍	❍	❍	❍
Intensive promotion	❍	❍	❍	❍	❍
Technological development	❍	❍	❍	❍	❍
Raising social awareness of biofuels	❍	❍	❍	❍	❍

29. Do you think that government subsidies influence biofuels production and use?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

30. Do you think that biofuels production should be controlled by government?

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree

31. What is your level of agreement or disagreement with the following statements? Decisions about biofuels made over the next five years...

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Will affect this generation only	❍	❍	❍	❍	❍
Will mostly affect future generations	❍	❍	❍	❍	❍
Will mostly affect agriculture rather than other economic sectors	❍	❍	❍	❍	❍
Will improve air quality	❍	❍	❍	❍	❍

32. From which sources do you get information about biofuels?

	No information	A Little bit information	Much information	Most information
TV and Radio	❍	❍	❍	❍
Internet	❍	❍	❍	❍
Newspaper and Journalists	❍	❍	❍	❍
Universities and Scientists	❍	❍	❍	❍
Environmental / consumer organizations	❍	❍	❍	❍
Government	❍	❍	❍	❍
Fuel sector	❍	❍	❍	❍

To help with our analysis, we need to know a little bit about you.

33. In what year were you born?

_____

34. Please indicate your gender.

❍ Female

❍ Male

35. What is your standing at school?

❍ Freshman

❍ Sophomore

❍ Junior

❍ Senior

❍ Graduate, pursuing Masters degree or equivalent

❍ Graduate, pursuing PhD or equivalent

36. Please indicate what College your major is in?

_____

37. If there is anything you would like to add, please feel free to add comments or remarks.

_____

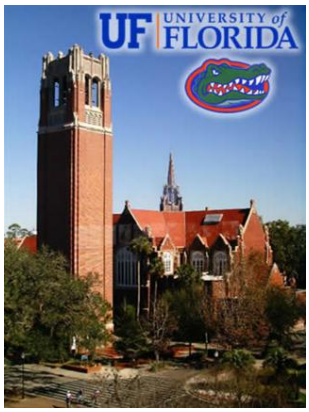
Thank you for completing the survey. If you are completing this survey for extra credit in a class, please select the link below to submit your name. This will be kept in a seperate file so your responses to this survey will remain anonymous. If you are not completing this for credit, please select finish below.

❍ Enter name for extra credit

❍ Finish survey

APPENDIX B
DESCRIPTION OF THE UNIVERSITIES IN THE UNITED STATES AND POLAND

University of Florida



The University of Florida (UF) was founded in 1853 and currently is the state's oldest university and one of the largest in the country. UF is a major land-grant, sea-grant, and space-grant research university in Gainesville, Florida.

University accounts for more than 50.000 students and 4.000 faculty members. It is the second-largest Florida university by student population. According to UF demographics, the majority is white population, followed by Hispanics, Black and Asian. In terms of gender, females are dominating.

The University of Florida offers more than 100 undergraduate majors and nearly 200 graduate programs. UF is home to more than 150 research centers and institutes and 16 academic colleges including: College of Dentistry, College of Design, Construction & Planning, College of Law, College of Education, College of Agricultural & Life Sciences, College of Business Administration, College of Medicine, College of Engineering, College of Fine Arts, College of Veterinary Medicine, College of Pharmacy, College of Nursing, College of Liberal Arts & Sciences, College of Journalism & Communications, College of Health & Human Performance, and College of Public Health & Health Profession.

The University of Florida is well-known for its excellent graduate programs including engineering, business law and medicine. In fact, all of these curriculums are held on one adjoining site, which administers 123 master's degree programs and seventy-six doctoral degree programs in eighty-seven schools and departments.

UF is a member of the Association of American Universities, a confederation of the top research universities in North America. It has been also included among the so-called "Public Ivy" universities - one of the 20 top public universities in the United States. The University of Florida is currently ranked fifty-third among all national universities, public and private, in the current 2011 U.S. News & World Report rankings and consistently ranks within the top 100 universities worldwide.

Warsaw University of Life Sciences

Warsaw University of Life Sciences (WULS-SGGW) is the oldest agricultural university in Poland. Its history dates back to 1816, to the creation of the Institute of Agronomy in Marymont, the first agricultural institution of higher education in Poland and only the fourth one in Europe. The campus of Warsaw University of Life Sciences is located in Ursynow district, in the south part of Warsaw.

WULS enrolls over 27.000 students, including undergraduate, graduate, postgraduate and doctoral studies students. The teaching staff is over 1.200 including 340 full professors. The number of foreign students is growing, which recently accounted for 420. Taking into consideration demographics of WULS's students, they come from all regions of Poland with the majority from Warsaw.

Students can choose from 28 major disciplines and 130 areas of specialization. Depending on the major, baccalaureate programs are 3 to 3.5 years in duration, and Master's programs are an additional 1.5 to 2 years. The University offers wide-ranging programs of study - from biological and technical, through medical, economics and humanities.

The research and education covers the entire field of agriculture related sciences, among 13 faculties (agriculture and biology, forestry, horticulture and landscape architecture, civil and environmental engineering, animal sciences, food sciences, wood technology, veterinary medicine, economic sciences, human nutrition and consumer sciences, production engineering, humanities, applied informatics and mathematics), 5 interfaculty studies (biotechnology, environmental protection, regional planning, commodity science, tourism and recreation), 1 MBA program in agribusiness management and several experiment stations around Warsaw.

WULS is well known and respected, both domestically and internationally. University is a member of many prestigious international organizations such as the European Universities Association (EUA), International Association of Universities (IAU), Association for European Life Science Universities (ICA), International Association of University Presidents (IAUP), Euroleague for Life Sciences (ELLS).

WULS has the most modern university campus in Poland with excellent conditions not only for learning but also for teaching and research. Because of the University´s research and educational potential, the level of its research, modernity and openness to the outside world, more and more research centers from around the world collaborate with WULS or declare their interest in establishing collaboration.

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BIOGRAPHICAL SKETCH

Malgorzata Szczupska was born in 1985 in Warsaw, Poland. She received her engineer's degree in planning and management from Warsaw University of Life Sciences in February of 2008. Upon completing her undergraduate degree, she continued her master studies in the same department of Interfaculty Study of Regional Planning and Management. During her final year, she moved to Belgium where she was enrolled in the framework of the Erasmus Program at the Faculty of Bioscience Engineering at Ghent University. After arriving in Poland she earned her MSc in planning and management from Warsaw University of Life Sciences in September 2009. Then she entered another international master's program, ATLANTIS. She pursued the joint academic degree of International Master of Science in rural development, awarded by the IMRD consortium consisting of the following partner universities: Ghent University (Belgium), Agrocampus Ouest (France), Humboldt University of Berlin (Germany), Slovak University of Agriculture in Nitra (Slovakia), University of Pisa (Italy), Wageningen University (The Netherlands), and the MSc in food and resource economics issued by the University of Florida (USA). The first semester, she studied at Ghent University, at the Department of Agricultural Economics. The second semester she attended the Humboldt University of Berlin at the Faculty of Agriculture and Horticulture. During July of 2010 she did a case study in Italy at the University of Pisa. In August 2010 she moved to Gainesville, Florida, in the United States for one academic year, where she began the Master of Science in food and resource economics program at the University of Florida. This master's thesis is the culmination of her EU-US program, which enabled her to gain theoretical and practical experience in the processes of rural development and food and resource economics.