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Biofuels Promotion Framework and Industry in Peru

Status and Challenges

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Abstract

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The share of global fuel consumption in the form of biofuels has experienced a dramatic growth in the last decade, and the participation of biofuels as an energy source is forecasted to increase. This growth is driven to a large extent by governmental support, in a context where many developing countries have become aware of the potential benefits of the production and use of this renewable source of energy. This global trend is also seen in Latin America, where besides Brazil, many latecomers such as Peru, have enacted specific legal frameworks to address the promotion of biofuels as a way to reduce dependence on fossil fuels while exploiting the potential climatic advantages of that region for the cultivation of energy crops. This research analyzes the basic characteristics of the biofuel promotion framework in Peru, as well as the status and main challenges faced by the biofuels industry in that country, with the aim of extracting conclusions and policy recommendations. The biofuel framework in Peru is mainly based on the creation of demand by means of establishing blending mandates for anhydrous ethanol and biodiesel with fossil gasoline and diesel, with dissimilar results in the industry. In the case of anhydrous ethanol, the comparatively advantageous climatic conditions of the Peruvian coast for growing sugarcane, and the use of efficient irrigation technology on mostly previously unproductive land, have provided the opportunity for investors to achieve a production that exceeds the domestic demand, opening the possibility for a further reduction in dependence on fossil fuels. On the other hand, in the case of biodiesel, production centered on palm oil in the jungle regions has not met domestic demand created by the blending mandates, thereby generating a dependence on foreign source biodiesel. The current production of palm oil also does not cover the domestic demand for oil and fats for human consumption. The future expansion of the ethanol industry on the coast is likely to be challenged by the availability of water resources, whereas the development of the biodiesel industry in the jungle faces a more complex scenario where the lack of adequate infrastructure, land titling, and zoning are among the problems confronted by investors.

Keywords: (Biofuels, Ethanol, Biodiesel, Renewables, Peru)
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Contents

List of Tables

List of Figures

Introduction

The use of biomass as a source of energy has shown a rapid increase in recent decades and now accounts for about 10% of the global energy supply. The share of biofuels, in particular, as part of the global liquid fuel consumption has grown at a rapid pace, and it is forecasted to increase due to support by governmental policies around the world, mainly as an alternative energy for the growing transport sector. This global trend is apparent even in Latin America, where countries such as Peru have enacted specific legislation aimed at promoting the use and production of biofuels in an attempt to reduce dependence on fossil fuels.

Most of the research effort in Latin America has been concentrated on the case of the oldest and most important producer of biofuels, namely Brazil, while comparatively little attention has been paid to latecomers such as Peru. The present research is therefore motivated to increase the knowledge of the basic characteristics of the biofuels promotion framework in Peru, as well as on the status of the biofuels industry and the main challenges it faces in its development.

With this perspective, we will address the following research questions: (i) What are the characteristics of the promotion framework for biofuels in

Peru? (ii) What is the status of the biofuel industry in Peru? and (iii) What are the main challenges faced by the biofuel industry in Peru for its development?

The answers to these research questions will not be derived by testing a specific theory. Instead, since a conceptual ordering will be construed from the available data, a qualitative methodology will be used to conduct the research (Corbin and Strauss, 2008).

The research is based on a case analysis of the Peruvian biofuel industry and framework. Basics from other Latin American biofuel frameworks and industries will also be considered in order to provide a better characterization of the Peruvian case, and to extract recommendations. Analysis of other legal frameworks will be conducted using De Cruz's basic blueprint for comparative law analysis as guidance (De Cruz, 2007). Descriptive statistics will also be used on the research to provide a better understanding of the available data.

The present research is divided into 6 chapters. Chapter 1 reviews basic knowledge on biofuels, including their classification. Chapter 2 describes the importance and development of biofuels and reviews the literature on the opportunities that biofuels bring to developing countries, their advantages, and their main challenges. Chapter 3 reviews the promotion frameworks for biofuels, with emphasis on Latin American countries. Chapter 4 includes an analysis of the Peruvian biofuel's framework, its background and characteristics. Chapter 5 analyzes the status, challenges, and proposed courses of action for the ethanol and biodiesel industries in Peru. Finally, Chapter 6 provides conclusions and policy implications that arise from the present research.

Chapter 1. Biofuels Overview

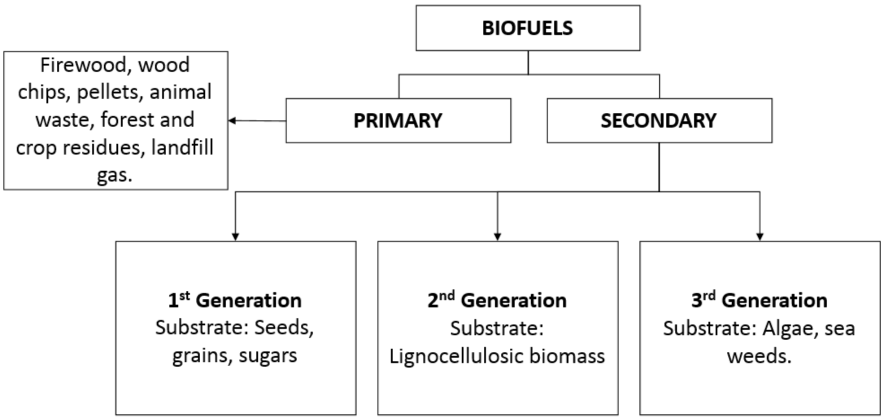
The simplest way to describe biofuels is to define them as liquid or gaseous fuels produced from organic matter derived from plants or animals (IEA, 2011), or, as expressed by Hazel, they are fuels of biological and renewable origin produced from biomass (Hazell et al., 2006). Despite these different ways to categorize biofuels, they may be broadly classified into primary and secondary biofuels (P Nigam et al., 2011).

Primary biofuels are those used in unprocessed and natural forms of biomass (e.g., fuel wood, pellets, and wood chips, etc.) that are directly combusted for cooking, heating, or even electricity generation. The use of primary biofuels may be traced to the early ages of human history, with the discovery of how to burn biological material to cook food or to produce heat. This allowed humans to migrate from tropical and subtropical climates to more temperate ones, by providing a way to heat caves and huts (Gressel, 2008).

Secondary biofuels, in turn, are based on processed biomass (e.g., ethanol, biogas, and biodiesel) and are used in industrial processes, and to a great extent, for powering vehicles. Due to the importance of biofuels as a source of energy for powering vehicles, the term biofuels is defined in parts of the literature as having a direct relationship to the transport sector, as "*liquid or* *gaseous fuels for the transport sector that are predominantly produced from biomass"* (Demirbas, 2007). In this research, we will focus on the liquid biofuels most commonly used for transportation – ethanol and biodiesel – in the Peruvian context.

Secondary biofuels are also commonly divided into three different generations, depending on the feedstock used and the technology applied to their production. Usually, the literature refers to second and third generation biofuels as advanced biofuels. (See Figure 1).

Figure 1. Classification of biofuels



Adapted from Nigam et al. 2011.

First generation biofuels include those whose primary feedstock is crops that may commonly be used for food (IEA Bioenergy, 2008). Thus, first generation biofuels include those that originate from sugarcane, oil seeds, palm, wheat, cassava, and other similar crops, but animal fats and used cooking oil are also included in this classification.

First generation biofuels are characterized by their ability to be blended with fuels based on petroleum, their combustion in existing internal combustion engines, by the fact that they may be distributed using existing infrastructure, and their use in already existing and commercially available vehicle technologies currently sold in the market, including Flex-Fuel Vehicles[1] (S.N. Naik et al., 2010).

Three main types of first generation biofuels are in commercial use: biogas, biodiesel, and ethanol.

Biodiesel, a substitute for diesel, may be used with no or very few engine modifications since most diesel engines can use 100% biodiesel (Jay J. Cheng et al., 2011). Ethanol, a substitute for gasoline, may be used either in blends or in pure form; however, the most common way to use it is in blends between E10 and E85, which contain a concentration from 10% to 85% ethanol, respectively. High blends, between 25% and 85%, can only be used by

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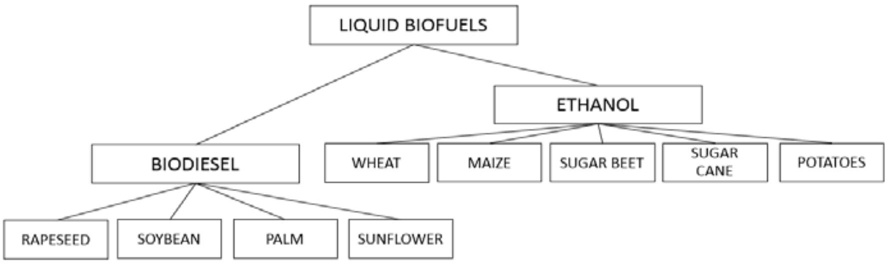
[1]Flex-fuel vehicles (FFVs) are designed to run on gasoline or a blend up to 85% ethanol (E85), and except for a few engine and fuel system modifications, they are identical to models that run on gasoline only. Source: U.S. Department of Energy. www.fueleconomy.gov.

specially adapted vehicles such as flex-fuel ones (FFv) (J.C. Escobar et al., 2009)[2].

Ethanol, the major biofuel on the market today, is produced from crops with high concentrations of sugar, or those with high concentrations of starch. Therefore, the ethanol produced today is mostly obtained using corn and sugarcane as the main feedstocks, but also it is produced from other crops such as beetroot, sorghum (DGCA, 2009), wheat and potatoes (See Figure 2 below). As highlighted by S.I. Mussatto (S.I. Mussatto et al., 2010), the ethanol production from sugar crops such as sugarcane and sugar beet accounts for nearly 40% of the world production, while the other 60% corresponds to ethanol derived from starch crops.

Figure 2. Main sources of liquid biofuels (first generation)



Adapted from Dermibas, 2007

[2]A study on the use of E10, E15 and E20 in non flex-fuel vehicles from different manufacturers and years, is found in "Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines, Report 1- Updated". (Knoll et al., 2009)

Climatic conditions are an important factor in determining the crop used for ethanol production. Countries in tropical areas (e.g., Brazil, Colombia, or Peru) use sugarcane as feedstock, whereas fuel ethanol is often produced from starchy materials such as corn in countries in more temperate areas (e.g., the United States, China and the European Union) (J.A. Quintero et al., 2008).

Ethanol is generally produced in three steps: (1) attainment of fermentable sugars, (2) fermentation of the sugars, and (3) ethanol separation and purification, usually by a distillation-rectification-dehydration process (S.I. Mussatto et al., 2010). The use of sugar crops is a relatively simple process that requires only milling for extraction of the fermentable sugars. On the other hand, the use of starch from grains requires a saccharification process[3] prior to fermentation. In turn, an even more complex process is required in the case of lignocellulosic materials, which require a pretreatment and an acid or enzymatic hydrolysis before fermentation[4] (S.I. Mussatto et al., 2010). (See Figure 3 below).

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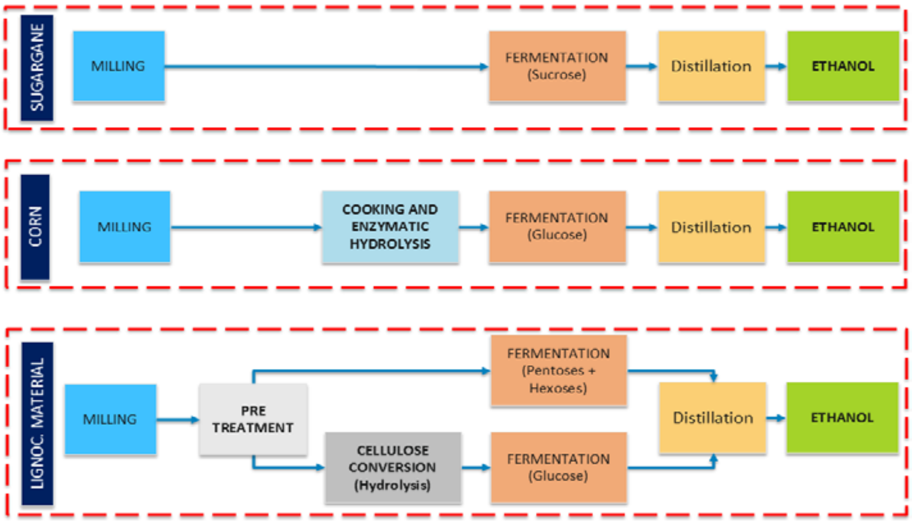
[3] In this step, the starch is gelatinized by cooking and subjected to enzymatic hydrolysis that converts the starch into glucose. Glucose, in turn, can be subjected to fermentation. (S.I. Mussatto et al., 2010).

[4] Pre-treatment, usually requires a mechanical step to reduce the particle size and chemical pre-treatment to make biomass more digestible. The acid or enzymatic hydrolysis breaks the polysaccharides to simple sugars for fermentation. (S.I. Mussatto et al., 2010)

Biodiesel, the other major biofuel in the market, is produced from vegetable oils, plant oils, and animal fats, but the main feedstock worldwide for its current production are oil seeds such as palm (*Elaeis guineensis*), sunflower, canola (rapeseed), and soybeans (Jay J. Cheng et al., 2011) (See Figure 2 above).

Figure 3. Ethanol: basic process flowchart



Adapted from S.I Mussato et al. 2010.

First generation biodiesel is produced by chemical transesterification of triglycerides from fats and oils with either ethanol or methanol, which in some cases requires a pretreatment[5]. The main products from the transesterification

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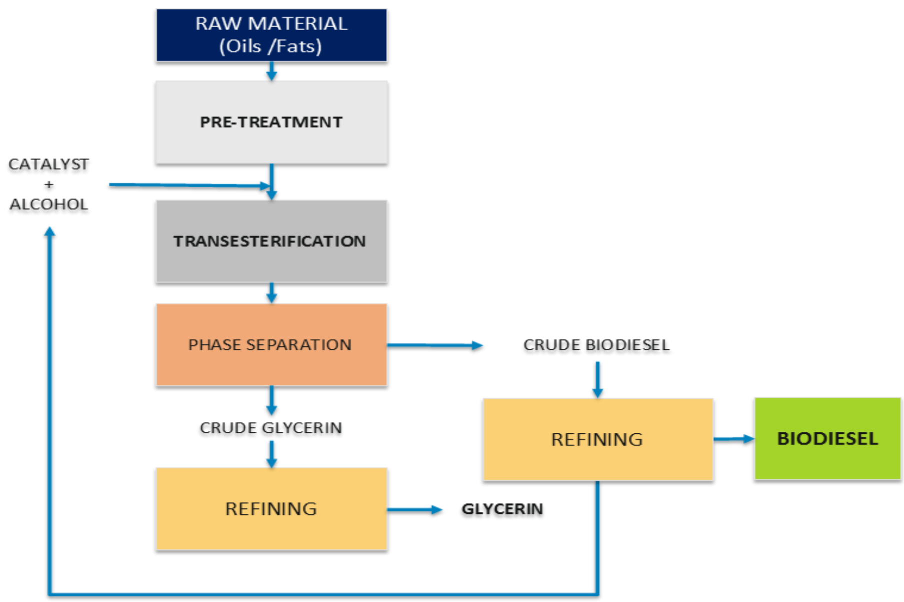
[5]Some oil and fats require pretreatment for degumming, de-acidification, bleaching, and dehydration, depending on their composition. Complete information on the process is found in Jay J. Cheng et al., 2011.

step are glycerin and biodiesel, which can be separated by settling, filtration, and decantation. Further refining of glycerin and biodiesel improves the quality of these products (Jay J. Cheng et al., 2011) (See Figure 4 below)

First generation biofuels are characterized as mature in technology. They are in widespread use in the world and have a well-established commercial production today. Therefore, policies for their use or production may often lie in facilitating their market entry, rather than focusing on R&D support (Weisenthal et al., 2008). This situation marks a key difference from the situation with second or third generation biofuels.

Figure 4. Biodiesel: basic process flowchart



Adapted from J. Jay Cheng et al. 2011

Despite their advantages, concerns about the sustainable production of first generation biofuels have been gaining attention in recent times in the academic literature. Discussions comprise a wide set of subjects, such as the alleged competition for land and water used to produce food, environmental impacts, and the expansion of cultivated energy crops that may lead to direct or indirect land use changes and deforestation.

Most feedstocks used for first generation biofuels may also be used for human consumption and for animal feeding, so concerns have been raised regarding the risk that biofuel production could lead to a food crisis (Heungjo An et al., 2011). Moreover, since the agricultural land of the world is limited, the suggestion has been made to define the portion of farmland that should be used for the production of biofuels (J.C. Escobar et al., 2009), as a way to reduce its potentially undesirable impacts.

On the other hand, the argument has also been made that the concerns raised regarding the use of biofuels (as in the case of ethanol from edible feedstocks, such as maize, wheat and sugar beets) have been grossly exaggerated, and may represent a very simplistic interpretation of the reality (Goldemberg et al., 2008). In a more practical fashion, some researchers contend that the potential of biofuels lies somewhere between the extreme points of view that they are useless or environmentally disastrous, on the one hand, and that they are already delivering significant benefits, on the other (Moore, 2008). The impacts will depend on the particular factors surrounding their production in each country where the production and use occur. In the case of sugarcane-produced ethanol, many countries, including Peru, are able to reach prosperous production today and to obtain benefits, while minimizing the risks that may come along with it.

Second generation biofuels are those produced from lignocellulosic materials such as forest residues, straws, bagasse, and vegetative grasses. As described by the World Energy Council, which stresses the differences with some of the risks associated with first generation biofuels, second generation biofuels are those based on the conversion of cellulosic resources, such as grasses, sawdust, and fast-growing trees, from non-food sources "*that can help to limit the direct competition between food and biofuel*" (World Energy Council, 2010). An additional advantage is stressed by the fact that these materials have a higher available volume (J.C. Escobar et al., 2009).

In that sense, in terms of competition with food production, the concerns raised by the first generation biofuels are in part reduced by coupling the use of second generation ones. The second generation biofuels are also presented as being more environmentally friendly because they produce lower amounts of greenhouse gases (GHG) than first generation ones do (M.B. Charles et al., 2007), and have higher yields with comparatively modest use of agro-chemicals (Ajanovic, 2011).

Nevertheless, a competition for land must still be taken into account, as this could still be present if the economic benefits surpass those from food cultivation, leading to a substitution of the latter in favor of feedstock for second generation biofuels, as pointed out by Timilsina (Timilsina, Govinda R., 2010). The second generation biofuels may then offer some hope, but they still might compete with the food supply through changes in land use. This panorama, notwithstanding, seems not to pose an immediate risk, since second generation biofuels are still immature (IEA Bioenergy, 2008), and their commercial production is not yet significant.

In contrast to the first generation, where the technology is mature and widely available, the production processes of second generation biofuels have a higher level of complexity, and effective deployment of these biofuels will require an intensive R&D for the next 10 to 15 years (OECD/IEA, 2010). One of the major obstacles for the development of second generation biofuel processes seems to be its high capital cost related to technical barriers. The price of establishing second generation biodiesel plants has been estimated, in some cases, at €500 million. (Theodoropoulos Dr., 2011). In that sense, at least on the short-term horizon, the production of second generation biofuels may not seem cost effective because of the technical barriers that need to be overcome before realizing their full potential (S.N. Naik et al., 2010). Therefore, large-scale production facilities have still not been established for the biotransformation of lignocellulose materials (P Nigam et al., 2011).

However, it is worth noting that the demand for this generation of biofuels will likely increase in the future. The incentive may come from the high biofuels mandates approved in developed countries and by the need to safeguard the sustainable supply of biofuels in the next decades, considering the fact that cellulosic biomass is the most abundant biological material on the earth (Timilsina, Govinda R., 2010).

In fact, it is worth considering that Directive 2009/28/EC of the European Union, related to the promotion of renewable source energy, set mandatory targets of 10% shares for renewable energy in the transportation sector by 2020 for member states. Within the scope of this Directive, second generation biofuels from waste, residues, non-food cellulosic material, and lignocellulosic material will be credited double for purposes of the 10% target, creating a future market for second generation biofuels in Europe[6].

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[6]In addition, on January 24, 2013 the European Council published the COM (2013) 17, Clean Power for Transport: A European Alternative Fuel Strategy. This document recommends no further support for first generation biofuels produced from food crops after 2020. In September 2013, a majority of members of the European Parliament voted that first generation biofuels should not exceed 6% of the energy consumption in transportation by 2020, and that advanced biofuels should represent at least 2.5% of the energy consumption in transportation by the same year.

In a parallel approach, the Energy Independence and Security Act of 2007 of the United States of America has set targets of 36 billion gallons of renewable fuels by 2022, including 21 billion gallons from advanced biofuels (Scarlat et al., 2011), defined as cellulosic ethanol and other biofuels derived from feedstocks other than corn starch (Congressional Research Service, 2007).

Underestimating the potential of advanced biofuels in the medium term would be naive, as would not taking steps to be prepared to use the advantages that this next generation might bring for countries such as Peru if they create the appropriate conditions to take part in that market. As predicted for the case of ethanol, lignocellulosic biomass will likely become one of its main feedstocks in the future (S.I. Mussatto et al., 2010)

Finally, third generation biofuels are usually defined as biofuels produced from algae or seaweeds, versatile feedstocks that can be used to produce either biodiesel or ethanol. Among their advantages, algae have high growth rates and high tolerance to varying environmental conditions, being able to survive and reproduce even in low quality and high saline water (S.N. Naik et al., 2010). Algae can be cultured using the abundant sea or wastewater, they are biodegradable, and they are comparatively harmless to the environment if an accidental spill occurs. Due the high productivity of algae, calculations predict that 1/7 of the area currently used to raise corn could produce enough algae to meet all the ground transportation needs of a large country like the United States (Heungjo An et al., 2011).

When compared with palm oil, which is one of the most productive first generation crops and in good climate and soil conditions can yield up to 5000 or 6000 liters of oil per hectare, algae may end up yielding an astonishing amount of around 58,700 liters per hectare (S.N. Naik et al., 2010).

Nevertheless, despite the versatility of algae, and despite the fact that algae may be grown in different water environments at higher yields than are achievable with first generation feedstock, most experts acknowledge that the use of algae for the production of biofuels may not be possible in the near future. In fact, Exxon Mobile, after investing over $100 million USD into R&D, admitted that algae-based biofuels will not be viable for at least 25 years due to economic factors (Bloomberg, 2013). As pointed out by Cheng, the key issues today for microalgae biofuels are the not only the cost effectiveness of algae harvesting, but also finding ways for protection of highly productive microalgae from their wild counterparts (Jay J. Cheng et al., 2011)

Chapter 2. Importance of Biofuels

2.1 The Growing Participation of Biofuels in the Globe

The use of biomass as a source of energy has shown a rapid increase in recent decades. In addition to its traditional role in providing food, fiber, and feed for livestock, biomass today accounts for 10% of the global primary energy supply, and it is considered the fourth largest source of energy after oil, coal, and natural gas (REN21, 2013).

In particular, the share of the global liquid fuel consumption contributed by biofuels has shown a dramatic growth, from 0.3% in 2000 to 1.4% in just one decade, and it is forecasted to further increase its participation at a slower pace, up to 2.7% in 2030, according to (BP, 2013).

In a similar way, the FAO forecasts that global ethanol and biodiesel production and use will also increase, and this increase will be mainly supported by promotional policies in several countries around the world (OECD-FAO, 2012). The world ethanol production is projected to increase by almost 70% compared to the average of 2010-2012 and may reach 168 Billion liters by 2022. In the case of biodiesel, the production is expected to reach 41 billion barrels in 2022 (OECD-FAO, 2013).

During most of the 20th century, the energy research emphasis was focused on the development of available and cheap fossil feedstocks such as petroleum, coal, and natural gas. In contrast, the sustainability of fossil resources is questioned today from economic, ecological, and environmental points of views. In fact, the effects of greenhouse gas emissions, and the decline in oil reserves, now drive the quest for sustainable and more environmentally benign sources of energy. This has created a renewed interest in the production and use of fuels derived from plants or organic waste (S.N. Naik et al., 2010), with biomass now being recognized as a world renewable energy source with the potential to supplement at least a part of the decline in fossil fuel resources.

Biofuels are not new fuels. Liquid biofuels have been used for transport since the early days of the automobile industry (Luque et al., 2008). The first prototypes of internal combustion engines, designed by Nicholas Otto in 1876, were able to use ethanol as fuel, and the first car produced by Henry Ford in 1896 was able to use pure ethanol as well. One of the most famous automobiles in history, the Ford Model T was able to use ethanol, gasoline, or any mixture of both (S.I. Mussatto et al., 2010).

Similarly, in 1900, the inventor of the diesel engine, Rudolf Diesel, forecasted the possibility of using vegetable oils, such as peanut oil, in his engines. Indeed, vegetable oil was used as fuel, either in pure or blended form, with some initial difficulties generated by the formation of residues. It was not until 1937 that the vegetable oil transesterification process was patented to separate the glycerin that caused the unwanted deposits in the engines (J.C. Escobar et al., 2009). This basic process is still used to prepare biofuels from energy crops such as oil seeds and palm oil trees.

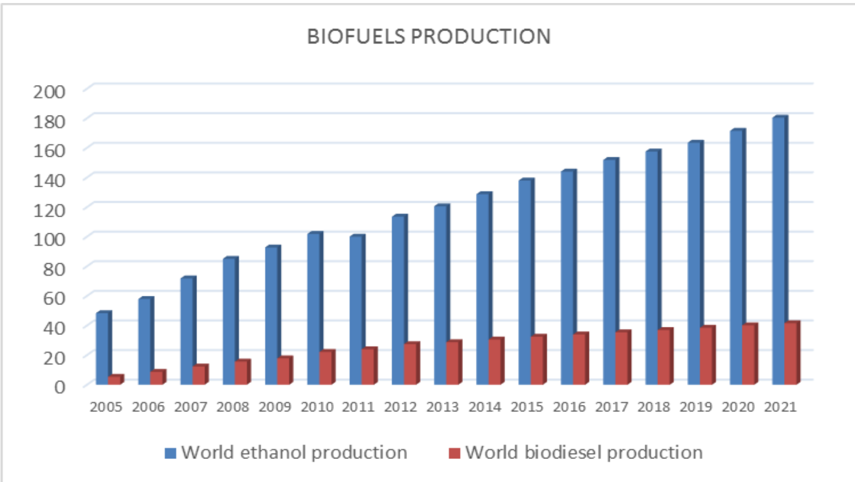
Nevertheless, after the substantial increase in the consumption of petroleum products during the 20th century, the use of biofuels declined to minimal quantities. The petrol crisis of the 70s sparked new interest in renewable sources, and biofuels in particular, and these gained even more attention after the 90s (Savvanidou et al., 2010).

The transport sector, a major consumer of fossil fuel sources such as diesel, gasoline, liquefied petroleum gas (LPG) and compressed natural gas (CNG), is faced with a series of challenges. These challenges include: (i) rising prices of petroleum in global markets; (ii) limitations of fossil fuel reserves and limited providers; and (ii) the increasing number of vehicles worldwide that are powered by the use fossil fuels (Demirbas, 2007). This combination of factors has prompted the quest for the use of alternative sources of energy, including the use of biofuels as one of the most attainable solutions.

The situation becomes of major importance given the calculation that 700 million light duty vehicles, automobiles, light trucks, SUVs, and minivans are already circulating in the world. A number that has been projected to increase further, up to 1.3 billion by 2030, and to over 2 billion vehicles by 2050, with most of the increase coming in developing countries (Balat et al., 2009). As the following chapter describes, developing countries such as Peru have experienced a high increase in the number of vehicles per inhabitant, leading to the corresponding escalation in the demand for refined fossil fuels.

Among biofuels, ethanol by far has been produced in the greatest amount in the world, a situation that will continue in the future. Biodiesel, in turn, has historically had lower participation than ethanol, but is similarly expected to grow in the next decade (OECD-FAO, 2012) (see Figure 5).

Figure 5. World biofuel production up to the year 2021



Data source: FAO

2.2 An Opportunity for Developing Countries

The fast growth of biofuels has taken place essentially supported by government policies around the globe, in a context where many developing countries have become aware of the potential economic and social benefits of biofuel production and use.

This trend and its future expected expansion has attracted the attention of countries from the developing world with comparative advantages for the production of biofuels. As explained by Mathews, the global south, where most of the developing countries are located, has better climatic and land resources that would likely make biofuel production more economically viable than in the north (Mathews, 2007). This advantageous production cost is also explained by lower labor cost and lower energy inputs in agriculture production in developing countries (Lamers et al., 2008).

Therefore, in the developed world, biofuels may be an expensive option, due to the intensive use of land, whereas in the developing world, which has larger land resources that can be used for raising energy crops, biofuels may be produced at lower costs by taking advantage of the already existing and mature advances in technology and management (Mathews et al., 2009). In fact, Latin America, the Caribbean, and Sub Saharan Africa have the largest expanses of available land surface (J.C. Escobar et al., 2009) that, with the help of well-designed policies, may be productively used for cultivating energy crops.

The particular case of ethanol production from sugarcane has been acknowledged to be cheaper in developing countries with warmer climates than the production from sugar beet or grain in developed countries, and is becoming an increasingly attractive alternative to supplement petroleum fuels (Dermibas, 2009). Hence, interest is growing in developing countries to take part in this global trend.

The world ethanol production is projected to increase by almost 70% compared to the average of 2010-2012 and may reach 180 billion liters by 2022, while its expected that the production in developing countries may increase from 42 Billion barrels in 2012 to 72 Billion barrels in 2022 (i.e. representing around 43% of the global production). Biodiesel production is expected to reach 42 billion barrels in 2022 and the production from developing countries is forecasted to increase from 10 Billion liters in 2012 to 14 Billion liters in 2022, or one third of the global production of that fuel (OECD-FAO, 2013).

2.3 Benefits and Challenges

One thing that can be said about biofuels is that they are not free from debate and controversy. They generate a widespread interest in academia, with publications that praise their potential benefits in terms of security reasons, environmental advantages, or economic rewards for the rural sector, mainly in terms of job creation. On the other hand, they also have raised concerns on their potential undesirable effects in terms of food security, land competition, or deforestation, and doubts have been casted on their alleged environmental benefits.

This part of the research does not pretend to include a complete and exhaustive compilation or analysis of all the benefits or concerns raised by biofuels; however, it presents some of the aspects that are of importance in the field. The aim is to highlight the multifaceted and multidimensional nature of biofuels, and to point out the existence of an ongoing debate around their production and use. As shown later, concerns relating to the availability of surface water resources and competition with food production may be some of the challenges faced by the biofuel industry in Peru.

Among the benefits attributed to biofuels, most literature cites energy security reasons, environmental advantages, foreign exchange savings for producing countries, and improvement of the conditions of the rural sector, including the capability for job generation. The next section will briefly cover some of the alleged benefits and criticisms of biofuels; most of these related to the use of first generation biofuels such as those produced by most developing countries, including Peru.

- Greenhouse gas (GHG) emissions reduction. The most common positive impact cited by the literature is the reduction of emissions of gases that produce the greenhouse effect, particularly CO_2 (Petrou et al., 2009). In this sense, biofuels are argued to help to minimize fossil fuel burning and CO_2 production. Because the plants they are made from use CO_2 as they grow, the CO_2 released in burning equals the CO_2 tied up by the plant during photosynthesis, so that no net increase occurs in CO_2 in the atmosphere (S.N. Naik et al., 2010) (Demirbas, 2007). Therefore, the whole process is meant to represent a CO_2 cycle in combustion (Balat et al., 2009).

  Today's biofuels remain the most immediate source of alternative energy for vehicular use, and the hope is that they might provide a partial solution to the current situation by displacing oil use in transport and by reducing emissions per liter of fuel consumed (M.B. Charles et al., 2007)

- Availability of resources. An advantage cited in the literature is the fact that biofuels are easily available from common biomass sources

(Demirbas, 2007) (Balat et al., 2009) that exist in almost every latitude. Therefore, biofuels may be locally produced in many countries in order to satisfy a portion of their internal needs for fuels.

- Improvement of the conditions of rural sectors. The literature highlights the advantages that biofuels might bring to the rural sector, having the potential to provide additional sources of income and additional employment opportunities in rural areas (S.N. Naik et al., 2010).

  This reasoning is supported, among other arguments, by the fact that biofuel production is more labor intensive than the production of equivalent fossil energies and, in addition, the latter is less capital intensive (Cadenas et al., 1998). As indicated by Goldemberg, the number of jobs per unit of energy produced may be up to 152 times higher in the ethanol industry than in the oil industry (Goldemberg et al., 2008).

  The expanded market opportunities for biofuel feedstock crops and their prices in the world market also raises the incomes of farmers and generates employment in agriculture and other related processing sectors (Ewig, Mandy, 2009). Countries with a better climatic condition and land potential for cultivating energy crops then have high possibilities for improving their life conditions by improving the income of the population in agricultural regions (J.C. Escobar et al., 2009).

An example of this advantage can be seen in Brazil, Indonesia, and Malaysia, where biofuels have contributed to income and employment generation in a significant way. In Indonesia, when the industry employs only 1,000 people, calculations show that in 2001 nearly 4.5 million people depended on the palm oil industry, including its use as a feedstock for biofuels (A. Gasparatos et al., 2011). In a similar way, biofuels may contribute to regional development (Demirbas, 2007).

Nevertheless, it is important to mention that these benefits are linked at present to the cultivation of biomass for first generation biofuels, and increased moves towards second generation ones probably will have adverse effects on the supply chains relying on corn, sugarcane wheat, sugar beets, and similar crops (M.B. Charles et al., 2007). This situation therefore, requires careful planning in the future by governments interested in becoming part of the next generation of biofuel production.

- Energy security and diversification. One argument widely repeated in the literature is that, in global terms, biofuels may help to reduce the world´s dependence on oil. At a national scope, the argument is made that biofuels may also help to improve domestic energy security (S.N. Naik et al., 2010) by reducing the dependence on imported petroleum with its associated political and economic vulnerability (Dermibas, 2009).

In this way, by using domestic sources, biofuels may produce foreign exchange savings (Demirbas, 2007) for biofuel-producing countries that are also net importers of fossil fuels. As noted by Pin Koh, the case of Brazil is a clear example. The development of its ethanol industry has allowed Brazil to reduce its oil import bill by around $33 billion from 1976 and 1996, and since ethanol use accounts for around 40% of the country's transport fuel, Brazil has reached what could be considered to be self-sufficiency in fuel consumption (Pin Koh et al., 2008).

- Biodegradability. Biofuels are indeed biodegradable materials (Dermibas, 2009) (Balat et al., 2009), which reduces the high risk of contamination that is present in almost every stage of the value chain of the fossil fuel industry.
- High adaptability to existing infrastructure. The literature highlights that biofuels may largely use already existing infrastructure and distribution systems in current use by fossil fuels counterparts (Foresight Vehicle 2004, cited by M.B. Charles et al., 2007). In this

sense, biofuels are integrated relatively easily into today's operating logistics systems, making their use the simplest way to increase the availability of the fuels in the transport sector (J.C. Escobar et al., 2009). Comparatively speaking, this advantage is not available for other alternatives for powering road transportation vehicles, such as liquid hydrogen, compressed air or electricity, which require higher investments for commercial deployment in terms of supporting infrastructure.

On the other hand, the literature also cites a series of concerns about biofuels, many of which are linked to the first generation forms, and broadly relate to environmental, social, and economic concerns, including limited area and water for production, undesired changes in land use, competition with food, and even questions on their alleged environmental advantages:

- In terms of land availability, arguments are presented the literature that increasing biofuel production may be impractical using corn, sugarcane, plant oils, and the like as feedstock (i.e., the first generation biofuel feedstocks), because of climate limitations and huge or impossible arable land requirements for feedstock production (Jay J. Cheng et al., 2011). Some literature provides hypothetical illustrations of land requirements; for example, if the United States of America, Canada, and the European Union were to replace 10% of their transport fuel with biofuels, this option it would require the use of 30 to 70% of their national crop areas, considering current production and crop yield levels (M.B. Charles et al., 2007). Other studies consider that replacement of 5% of fossil fuels would require at least 8% of the farmland in the United States of America and at least 5% of the farmland in the European Union for ethanol production. In the case of biodiesel, the Unites States of America would require an additional 13% of farmland and the European Union an additional 15% for the same purpose (J.C. Escobar et al., 2009)[7].

On the other hand, even with the calculation that by 2008 the land used for biofuels amounted to 20 million hectares worldwide, the contention is that this represents only around 1% of the total agricultural land (Scarlat et al., 2011) (J.C. Escobar et al., 2009). Similarly, the argument is raised that this represents a relatively small

[7]Nevertheless, competition for land, as noted by Gressel (Gressel, 2008) is not a privative problem of modern biofuels: “*A century ago, 20% of arable land in temperate Europe and North-America was dedicated to oats, the biofuel that powered the horses, mules, and farm laborers of agriculture, as well as much of urban transportation.*”

proportion of the 1.5 billion hectares of arable and permanent cropland worldwide (Pin Koh et al., 2008).

- Changes in land use. Part of the concern is also that demand for energy crops could result in major changes in current land use, which in turn could also lead to deforestation or erosion.

The change in land use could occur in direct and indirect ways. Direct land use changes will occur when nonagricultural land, such as a forest or peatland, is adapted for growing energy crops. Indirect land use changes will occur when the production of food crops is diverted to produce biofuels, and then the displaced production of food crops is in turn made possible by clearing and using nonagricultural land (Pin Koh et al., 2008).

This concern is especially important when linked to the risk of losing biodiversity, as in the case of native forests. Examples cited in the academic literature mention the already existing case of forests cleared in Indonesia and Malaysia for increasing palm oil crops[8]. Predictions are also made regarding the growing amounts of virgin

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[8]According to studies cited by Pin Koh, between 1990 and 2005, 55–59% of palm oil expansion in Malaysia, and at least 56% of that in Indonesia occurred at the expense of forests (Pin Koh et al., 2008).

rainforest cleared for farmland in the Amazon basin (e.g., see M.B. Charles et al., 2007).

Nevertheless, as in other situations that raise concerns, the magnitude of the land use changes and the impact on the loss of biodiversity will likely depend on the type of land that is being affected. The conversion of natural ecosystems like native forests will likely result in higher levels of biodiversity loss than if already cultivated land or previously unused land is the subject of conversion (A. Gasparatos et al., 2011). Moreover, as indicated by Fitzherbert on the contribution of oil palm to deforestation, quantitation of the extent to which oil palm has been the cause of deforestation is difficult due to the lack of reliable data and incomplete understanding of its complex causes (Fitzherbert et al., 2008). Finally, as Linares adds on the specific topic of indirect land use change (ILUC), the ILUC science is still uncertain and its methodologies debatable (Linares et al., 2013).

In this case, a system of checks and balances needs to be implemented in the legislation that addresses agriculture and biofuel production, in order to prevent and deter further deforestation, which may be decreased or eliminated if certain limitations are set in land use for biofuel production (Petrou et al., 2009).

- Competition with food. The competition with food production, and the effect on the increase on the cost of the food crops, also forms part of the academic literature discussion. This risk is explained to a large extent by the diversion of food crops to biofuel production (direct competition) or by the decrease in food production due to the increased substitution of cultivated land for planting of energy crops (indirect competition) (A. Gasparatos et al., 2011). Part of the blame lies with policies aimed at pushing the supply of biofuels, which create subsidies to favor their production in some countries. The existence of subsidies on biofuels may make the farmers prefer to produce goods with guaranteed prices, causing food prices to rise (Petrou et al., 2009).

  Some countries have taken preventive steps to avoid this conflict by adopting measures such as prohibiting the use of food crops for biofuel production, and instead promoting the use of inedible products such as molasses and *Jatropha*. In Mexico, where maize is an important part of the basic caloric intake of a large part of the population, the legal framework allows maize to be used as feedstock for biofuels only once it has been determined that the produced amount is able to satisfy the requirements for food[9]. Similarly, China allows only low quality corn to be used for biofuel production (A. Gasparatos et al., 2011).

On the other hand, the literature also points out that higher food prices may induce the agricultural sector to respond by increasing the production. In turn, this could be translated into higher employment rates and wages, especially in developing countries where agricultural labor is characterized as being labor intensive (Ajanovic, 2011). Therefore, the rural poor could become beneficiaries of greater biofuel use, while landless poor consumers may ultimately be the ones that suffer from higher food prices (Pin Koh et al., 2008).

Biofuels can therefore have both positive and negative impacts. While higher food prices could represent food insecurity for some, at the same time it could serve as a propeller of the agriculture sector in rural areas and provide new job opportunities. The extent of the impact will likely depend on the particular conditions and characteristics of each country, including its position as an importer or exporter of food, and its land availability.

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[9] Mexico´s Bioenergy Development and Promotion Law.

- Questions on the alleged carbon neutrality of biofuels. Concern has been raised that biofuels may not be truly carbon neutral when the stages of production, transportation, and processing are taken into account. As such, while different Life Cycle Assessment studies have been conducted showing that biofuels can emit less GHGs than fossil fuels considering the whole life cycle, but if the effects of land change were taken into account, the results may demonstrate that biofuels can be net GHG emitters (A. Gasparatos et al., 2011). Therefore, life cycle emissions generated by the whole process of producing biofuels should be considered, and the indirect land use changes (ILUC) should be part of the equation. Assessment of the GHGs continues to be debated in the literature.

As pointed out by Pin Koh, several studies shown that displacement of fossil fuels by biofuels may result in an average reduction in GHG emission of 31% for ethanol, 54% for biodiesel, and 71% for cellulosic ethanol. Specifically, if sugarcane is used as a feedstock, this may result in a larger GHG savings of up to 92%. Nevertheless, these studies did not take the land use change into account (Pin Koh et al., 2008). Some studies also consider that burning ethanol instead of gasoline reduces carbon emissions by more than 80% while eliminating the release of sulfur dioxide that causes acid rain (S.I. Mussatto et al., 2010).

Amid this ongoing discussion, one important note is that the measurement of the environmental impacts may be characterized by substantial differences and uncertainties. These may arise due to the lack of appropriate and integrated tools for the assessment of different biofuel practices during their full life cycle (A. Gasparatos et al., 2011), and by the existence of multiplicity of factors involved. These factors include: (i) the different ways the limits of each system are set, (ii) the different crops used for this purpose, (iii) the different cultivation techniques used for energy crops, (iv) the different production methods used, and (v) the differences in local climates. These factors complicate the determination and create great uncertainty (Petrou et al., 2009). Similarly, Scarlat points out that the diversity of feedstock, the large number of pathways, and their complexity lead to a high uncertainty over the greenhouse gas (GHG) emissions, in comparison with fossil fuels (Scarlat et al., 2011).

- Concerns about water availability. Warnings have been raised about the large volumes of water required to produce the biomass necessary for increasing biofuel production, especially in relation to some crops such as maize that are described as particularly “thirsty” (M.B.

Charles et al., 2007), as this could lead to a potential over-exploitation of this precious resource.

Nevertheless, as cited by Gasparatos, the current water requirement for first generation biofuel production, and particularly for irrigated feedstock, turns out to be modest if compared to the amounts of water appropriated for producing food, and in cases where the feedstocks are rain fed, the irrigation impact is even smaller (A. Gasparatos et al., 2011). The extent of the effects of biofuels on water availability will then depend on how much irrigation is required to grow the crops, which in turn will depend on the particular type and the particular location of the cultivated crop (Pin Koh et al., 2008). The technology used for irrigation may also vary from efficient droplet irrigation to less efficient systems of gravity irrigation, such as those used for cultivation of energy crops and in traditional agriculture in the northern coast of Peru, respectively.

Taking into consideration the multiplicity of aspects, it seems (as pointed out by Gasparatos) that whether biofuel production and use will have a negative or positive impact will depend on a multitude of factors (A. Gasparatos et al., 2011). Therefore, results will likely differ depending on the special circumstances of the producing country, so that generalizations could lead to erroneous preconceptions.

Chapter 3. Biofuels Promotion Framework in Latin America

3.1 Adoption of Promotion Legislation in Latin America

As indicated in Chapter 2, different literature, including official reports such as IEA (2011), OCDE/FAO, highlights the fact that the development of biofuels has arisen through support by policies imposed at the national or multinational level, as in the case of the European Union, which has implemented specific directives for its member states addressing the use of biofuels. The growth in demand, and the current increase in production, has been driven by governmental intervention (Sorda et al., 2010) shaped through the creation of specific legislation. In this regard, the vital importance of the relation between policies and the legal framework must be noted. As Tupy indicates, without the creation of a favorable legal and regulatory framework, renewable energy sources will likely be condemned to remain a small niche market (Tupy, 2009).

Estimates by the Renewable Energy Policy Network for the 21st Century (REN21, 2013) show that regulatory frameworks promoting the use of biofuels may be tracked to at least 49 countries, as of early 2013. Specifically, the adoption of blending mandates with fossil fuels exists at the national level in at least 27 countries and 27 states or provinces, amid the concern to address a set of different goals typically represented by tackling climate change and upholding energy security and agriculture development.

This trend of adoption of specific legislation to encourage the production or use of biofuels is also evident in Latin America, where most of the countries in the region have acknowledged the existence of regional advantages for its production. Currently, most of the Latin American countries have already implemented or are in process of implementing programs to incentivize biofuels (IICA, 2010). Besides Brazil – the country with the oldest and most developed biofuel program in the world – many latecomers such as Argentina, Colombia, and Peru have customized, enacted, and amended national frameworks to address the promotion of biofuels. This trend benefits from the combination of the comparative advantages of the region such as good soil, suitable climate, available land, and low labor costs (Janssen et al., 2011).

The common interest of the Latin American countries was a topic of discussion during the Fifth Summit of the Americas[10] held in 2009 in Port of

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[10] As outlined in the official website www.summit-americas.org, the Summits of the Americas are institutionalized gatherings of the heads of state and governments, where leaders discuss common policy issues, affirm shared values, and commit to concerted actions at the national and regional level to address challenges faced by the Americas.

Spain. The official Declaration, in its 49th paragraph, explicitly acknowledged the potential of biofuels as part of the new, emerging, and environmentally friendly technologies for diversifying the energy matrix and the creation of jobs.

In this regard, with the sole exception of Bolivia, countries participating in the Summit of Port of Spain stated in an explicit fashion their commitment to "*encourage, as appropriate, the sustainable development, production, and use of both current and next generation biofuels, with awareness of their social, economic, and environmental impact*".

This text mentioned is akin to the recent legislative history addressing renewable sources of energy in the region. In fact, apart from the well-known and ambitious National Alcohol Program, *ProAlcool*, that started in the mid-70s in Brazil with the enactment of the Decree 76.593 of 1974 as a response to the oil shock of 1973 and the decline in world sugar prices, the last decade witnessed a boom of new biofuel related legislation. This new legislation covers a considerable number of countries in South and Central America, as well as Mexico. Similarly, Brazil, that pioneered the use of ethanol four decades ago, passed legislation in 2005 to introduce biodiesel into the country energy matrix, expanding its reliance on biofuels in this way as a viable supplement of their requirements for fossil fuels.

As Tables 1 and 2 show, at least 17 countries in Latin America currently may be identified as having legislation in force for the promotion of biofuels. In most of these cases, the highest legislative authority (the National Congress or Assembly) has enacted specific legislation; Guatemala is a country with one of the oldest examples on this topic. In fact, in the case of Guatemala, the Law Decree Nº 17-85 or Fuel Alcohol Law (*Ley del Alcohol Carburante*) may be traced back as one the oldest in the region, as it was for decades the sole legal instrument of its kind in the Central American region. Nevertheless, even when this law is still considered as technically in force (due to the fact that it has not been formally repealed), it became inoperative because it was created for a regulated market that later ended up converted into a liberalized one (Lefèvre, 2010). Notwithstanding, as recently as February 2013, the Guatemalan Government announced the launch of its new Energy Policy 2013-2027. This policy includes as one of its strategic axes, the fuel supply security that comprises the approval of laws and regulations for the use and commercialization of biofuels, introducing them into the value chain of fuels in the country.

Similarly, in four other cases: Chile, Ecuador, Nicaragua and Costa Rica, absent a formal Law from the Legislative branch of the government, the Executive has led the implementation of a framework for the promotion of ethanol or biodiesel. In most cases, this involved a declaration of national interest in the development of biofuels or regulating their production and use, as shown in Table 2.

Table 1. Countries in Latin America with laws in Force for the Promotion of Biofuels

South America		
Argentina	Regulation and Promotion Regime for Production and Sustainable Use of Biofuels – Law 26.093	2006
Colombia	Law on the Use of Fuel Alcohols – Law 693 /	2001
Brazil* (biodiesel)	Introduction of Biodiesel into the Brazilian Energy Matrix – Law 11.097	2005
Bolivia	Law 3086 (2005) Anhydrous Ethanol / Incentives for Biofuels Law – Law 3207 (2005)	2005
Panama	Law that Establishes Guidelines for National Policy on Biofuels – Law 42-2011	2011
Paraguay	Promotion of Biofuels Law – Law 2.748-05 (2005)++	2005
Peru	Biofuels Market Promotion Law – Law 28054	2003
Uruguay	Agrofuels Law – Law 18.195	2007
Central & North America		
Guatemala	Fuel Alcohol Law – Law Decree 17-85	1985 (Inoperative)
Honduras	Law for the Production and Consumption of Biofuels – Decree 144-2007	2007
Mexico	Bioenergy Development and Promotion Law	2008

Author's own elaboration

The approval of biofuel promotion frameworks in Latin America includes countries that, at the time of adoption, were net fossil fuel importers (as in the case of most Latin American countries such as Peru, Panama, Paraguay, Guatemala, Nicaragua, Costa Rica, Chile, and Bolivia), encompassing a strategy for diversifying the sources of energy. Notwithstanding, the adoption of promotional frameworks for biofuels is also observed among countries with traditions as net exporters of fossil fuels, such as Mexico, Ecuador, and Colombia. In the case of Mexico, the driver could be traced to the use of ethanol in place of the oxygenating agent methyl tertiary butyl ether (MTBE), which Mexico imports (Schifer et al. 2010). In the case of Colombia, the enactment of legislation for promoting biofuels was made amid a trend of decreasing fossil fuel reserves in the last decade that raised the alarm of depletion by 2010 and the refining capacity limitations that made the country an importer of gasoline (J.A. Quintero et al., 2008).

Table 2. Countries in Latin America with Executive Decrees for the promotion of biofuels

South America		
Chile	Approves definitions and quality specifications for biofuels, authorizes blending – Decree 11-2008	2008
Ecuador	Declares of National Interest the Development of Biofuels as a means for the promotion of agricultural development. – Executive Decree 1303	2012
Central America		
Nicaragua	Declares of National Interest the production of biofuels and bioenergy – Decree 42-2006	2006
Costa Rica	Regulations of Biofuels – Executive Decree 35091-MAG-MINAET	2009

Own elaboration

Even though Latin America has about 13% of the proven oil reserves in the world, these reserves are highly concentrated in few countries: Venezuela, México, and Brazil, which together account for 84% of the total reserves and 81% of the production in the region (IICA, 2010).

3.2 Drivers of Promotion Legislation Adoption

As most of the literature highlights (e.g., Diop et al., 2013; Linares et al., 2013; Komor et al., 2005; Sorda et al., 2010; Weisenthal et al., 2008; M.B. Charles et al., 2007; Luque et al., 2008; Scarlat et al., 2011; Pin Koh et al., 2008), the preference for the adoption of biofuels is mainly motivated by one of the purposes listed below, or by a combination thereof. These purposes, in turn, are linked to the alleged advantages of biofuels, which we have explored in Chapter 2:

1) To reduce energy dependence on imported fossil fuels. The legislation usually states this as "*energy security*", or "*energy diversification*". In most cases, this has been the predominant concern (e.g., China, Brazil, India, USA, and the EU) (A. Gasparatos et al., 2011). The aim is also linked to worries about the fast approaching end of cheap oil or the reaching of peak oil (M.B. Charles et al., 2007), and thus, translates into a concern for future energy availability.

   As highlighted early on by the Directive 2003/30/EC of the European Union, the increase in biofuel production will reduce the reliance on external sources of energy. Local or national production of energy, such as that achieved by biofuels, may also circumvent the reliance on socially or politically unstable oil-rich suppliers of energy (Luque et al., 2008). In fact, the world´s oil reserves are distributed in an extremely irregular way, and only some areas have exceptional geological characteristics that allowed the formation and the accumulation of significant amounts of oil (J.C. Escobar et al., 2009)[11].

One of the most cited examples of achievement in energy security is Brazil. As noted by Pin Koh, by developing its ethanol industry, Brazil has been able to reduce its oil import bill by around $33 billion from 1976 and 1996, and since ethanol accounts for around 40% of the country's transport fuel use, Brazil has reached self-sufficiency in fuel consumption (Pin Koh et al., 2008).

In a similar fashion, by 2012, American ethanol use has helped to reduce oil imports by an estimated 462 million barrels. This represents a higher quantity than the oil imported by that country from Saudi Arabia per year (RFA, 32013).

2) To reduce greenhouse gas emissions (GHG) in the transport sector, usually stated as "*climate change mitigation.*"[12] Given the enormous

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[11]As indicated by Escobar, the Middle East holds around 65% of the world's reserves, Europe and Eurasia 11.7%, Africa 9.5%, Central and South America 8.6%, North America 5%, and Asia and the Pacific 3.4% (J.C. Escobar et al., 2009)

[12]The transportation sector, to which biofuels are mainly destined, currently accounts for about 25% of global energy linked CO_2 emissions and represents around 50% of

share of energy consumption by transportation, the rationale is that biofuels may contribute to reducing CO_2 emissions (Timilsina, Govinda R., 2010). Transport has shown the largest growth rates in GHG emissions than any other sector, with a predicted 80% higher energy use and carbon emissions by 2030 (Luque et al., 2008). Estimates of transport-related GHG predict an increase also as a consequence of the economic growth in populous and energy hungry countries such as China, India, Brazil or Mexico (M.B. Charles et al., 2007). Hence, the hope that biofuels may provide a partial solution by displacing oil use in transport and reducing GHG per liter of fuel consumed

3) To create a market demand for agricultural crops, and employment in the rural sector, usually stated in the legislation as "*rural development.*" A clear example of job creation could be the Brazilian ethanol industry, where most of the job expansion in productive areas such as Sao Paulo has a link to ethanol industry. Calculations show that for every 114 new jobs created in 2005, 89 were accounted for by the ethanol sector (i.e.,

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global oil consumption; use of biofuels is considered as a practicable way to reduce emissions in the sector (OECD/IEA, 2010).

The EU and the United States include ambitious targets in terms of reduction of GHGs. The EU´s Renewable Directive of 2009 requires at least a 35% reduction in GHG emissions from biofuels, and The Renewable Fuel Standard (RFS2) requires that advanced biofuels reduce GHG emissions by at least 50% and first generation biofuels by at least 20%, considering their life cycle emissions.

75% of total) (Goldemberg et al., 2008). Similarly, the ethanol industry has created 87,000 direct jobs and 295,000 indirect or induced jobs in the United States of America (RFA, 32013). As already mentioned before, in Indonesia, while the industry employed only 1,000 people in 2001, nearly 4.5 million people depended on the palm oil industry, including its use as a feedstock for biofuels (A. Gasparatos et al., 2011).

Nevertheless, aside from these common purposes that have served as main drivers for the enactment of promotional frameworks, a wide set of additional and different objectives may be identified at the country level, such as innovation relating, for example, to the development of advanced biofuel technology (Weisenthal et al., 2008).

The specific weights and strengths assigned to each objective vary among countries and regions. These may fluctuate from energy security as the main driver, as in the case of Brazil with the *ProAlcool* program that started with the Decree 76.593 of 1974), to the strong support of the agricultural sector, as in Argentina. However, it may also be aimed at deterring GHG emissions, as stated in the EU´s Renewable Directive of 2009, in which a 35% reduction in GHG emissions is required from biofuels. As Dermibas highlights, *"in the EU, climate change has been the principal policy driver for promoting the use of energy from renewable resources"* (Dermibas, 2009)

The objectives normally state the intention of the government on a determined topic, so they should, in turn, be the guidance for the design of the policies supporting its achievement and the selection of the specific way of implementing it. As Komor highlights when describing the policies for the support of renewable energy, a relationship should exist between the goal (the explicit objective, intention or purpose), the program (the government measure mechanism or effort or "policy instrument"), and the selected way a technology is employed (Komor et al., 2005). As such, depending on the prevailing objective, the focus of the policy should normally change in order to produce a necessary match.

Nevertheless, even when the objective seems clear, the identification of the appropriate policy may appear ambivalent, (Weisenthal et al., 2008). Then, if the objective is *supply security*, the policy may be intended to limit the share of imported biofuel, giving preference to the domestically produced one. However, if the biofuel can be imported from a wide number of different countries, it may be also argued that the result will be a reduction of the risks related to relying only on fossil fuels, and in this way lead to the fulfilment of the stated objective. The consumption, then, will not necessarily rely on domestic production, but on imports from those countries endowed with comparative advantages for generating biofuels that offer better prices.

In the case where the main goal is *reducing GHG*, the policy may then be focused on having the lower emissions generated by a particular biofuel in comparison to those generated by the proportion of fossil fuel that is being replaced. In that case, either domestic or imported products, depending on the higher or lower GHG of those products, may fulfill the objective. Nevertheless, as seen in Chapter 2, the way a particular crop is cultivated and its effects on the environment should also be taken into account.

In turn, when the objective is generating *agricultural income,* limiting import levels seems to appear as a default option (Weisenthal et al., 2008). In addition, using first generation biofuels may be an option since these heavily depend on agricultural crops, making these the likely choices selected for generating income for agriculture related activities.

In the particular case of the Latin American Region, most countries that have passed legislation for the promotion of biofuels have specifically stated in the text of these laws the objectives they are intending to pursue. The listed objectives include a wide array of combinations that range from environmental or human health protection and energy diversification to creating alternatives for the cultivation of illicit crops, as in the sole case of Peru. A chart that compiles the stated objectives of the main biofuel promotion legislation in Latin America is included in Table 3.

Despite the wide variety of stated purposes, we may find that most of them, following the global trend, include the issue of energy security in the way of diversification of sources of energy, and in the way of reducing the dependence on fossil fuels; as well as the reduction of environmental pollution, and the increase in employment opportunities or income.

Table 3. Latin America: Stated Objectives of Legislation Promoting Biofuels

OBJECTIVES		ARG	BOL	COL	BR	ECU	PER	UR	C.R	PAR	HND	MEX	PAN
Environmental Protection / Human health protection	Reducing environmennental pollution / Environmemental protection			X			X	X	X		X	X	X
	Human health protection								X				X
	Facilitating Implementation of MDL - contributing to sustainable development	X								X			
Reduction on oil dependence	Energy diversification						X					X	X
	Introducing biofuels in the Energy matrix				X								
	Reducing dependence of fossil fuels, increase energy self sufficiency	X	X	X				X	X		X		
Rural development Employment generation /Promotion of investments	Rural reactivation, rural development					X	X					X	X
	Generating employment opportunities or income			X	X		X				X	X	X
	Promoting investments							X					X
Others	Creating alternative markets to combat illicit crops (drugs feedstock)						X						
	Development of technology associated to raw materials and equipment of domestic origin							X					
	Local capacity building							X					

Data Sources: Legislation, (Hernandez, 2008), (Ajila et al., 2007), Author's own elaboration.

3.3 Promotion Mechanisms

A vast range of potential promotion measures exists, as well as ways to classify them, including demand versus supply, regulatory versus incentive-based, or the degree of market intervention among them (Komor et al., 2005).

In the case of first generation biofuels, such as those that are mostly included in the Latin American legislation, since these are already a mature technology, today's policy measures usually focus on facilitating their entry to the market, as opposed to a policy mostly based on R&D support (Weisenthal et al., 2008). Nevertheless, as mentioned before, when the use of second generation biofuels is included as part of the commitment of a particular country, the higher level of complexity of their production process means that the policy may include strong R&D support if an effective deployment is intended.

Normally, the entry of biofuels into the market is supported by subsidies, tax reductions, or exemptions that may reduce the price of the product or by mandatory blending that, once in force, creates a demand for the product. The literature acknowledges that even when the declining production costs are making biofuels a competitive alternative, aside from ethanol from sugarcane in Brazil – the country with probably the lowest cost of production of ethanol in the world – in almost all cases, biofuels may still require subsidies to compete effectively with gasoline and diesel today. Some studies estimate that ethanol becomes competitive in the EU when oil prices reach US $70 per barrel, while in the United States, it is competitive at oil prices between US $50-60 per barrel. In the case of Brazil, the same studies consider that ethanol becomes competitive at oil prices around US $25 and $30 per barrel, and other sugar producing countries such as Pakistan and Zimbabwe show similar results. (Dermibas, 2009)[13]

Most countries in Latin America have included blending mandates, or have set targets for blending in the future. Table 7 shows the blending included in the laws for the promotion of biofuels in each country, as well as information on the current mandate.

In the case of Brazil, Colombia, and Paraguay, the mandatory sale of flex-fuel vehicles, the creation of specific tax benefits for their purchase, or the preference for their use by governmental entities have been included as well in the legislation for promoting biofuels, as a way to increase the demand[14].

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[13]Other studies consider that, in the case of Brazil, the cost of ethanol is competitive with gasoline at an oil price of US $40 to $50 per barrel (Smeets et al., 2008)

[14]In Colombia, Decrees Nº 2629 (2007) and 1135 (2009) regulated the sale of flex-fuel vehicles in the country. According to the legislation, 100% of total vehicles with engines up to 2000 cm^3 sold in the country by 2012 should be flex-fuel; and 100% of vehicles with engines over 2000 cm^3 sold in the country by 2016 should be flex-fuel. Nevertheless, in 2011, the obligation was superseded by the enactment of Decree 4892 (2011). Importing flex-fuel vehicles is now done on a voluntary basis.

On the other hand, at the supply side, different measures, such as subsidies for energy crop cultivation feedstock or investment support for production facilities, are also part of the alternatives that have been considered by lawmakers.

Most of the countries in the region have included fiscal incentives for the promotion of biofuels in their legislation, including complex mechanisms in countries as Brazil, Colombia, and Argentina, the three main producers of biofuels in the region. Without the intention of including an exhaustive or complete list of incentives existing in the region, some of the benefits included in the current legislation are covered in the following.

In Bolivia, Law Nº 3207 - Law for Incentives of Biofuels of 2005, created benefits for investment projects that use feedstock from 100% domestic sources, granting tax stability for 10 years. Similarly, biodiesel producers are exempt from Tariffs and Value Added Tax (VAT) levied on capital assets during a period of 5 years. The production and commercialization of biofuels enjoy a reduction of 50% of the total existing

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In Brazil, flex-fuel vehicles have preferential regimes including reduced rates on different taxes: Tax on Industrialized Products (IPI), Contribution to the Social Integration Program/Contribution for Financing Social Security (PIS/COFINS) and ICMS (State Tax for Circulation of Goods and Services), reducing the final cost to the customer (USDA, 2012). Approximately 87% of total vehicles sold in Brazil are flex-fuel (IICA, 2007)
In Paraguay, Decree Nº 3.667, published December 17th, 2009, mandated a 0% custom tariff on imports of flex-fuel vehicles. It also determined that governmental entities should give preference to flex-fuel vehicles in public procurement.

tax burden in the country. Biofuels are equally exempted from the Specific Tax for Hydrocarbons (IEHD) and Direct Tax on Hydrocarbons (IDH).

In a similar way, in Honduras, investment projects enjoy incentives for the purchase of equipment, materials, and services used for production or processing of raw materials into biofuels. Investment projects on biofuels enjoy exemptions from Income Tax, Net Assets Tax, and other income related taxes for 12 years. In addition, the law includes tax exemptions from other taxes, state fees, and custom tariffs for goods used in the construction, equipment, and supplies related to the installation, maintenance, and operation of the biofuel plants. Similarly, the biofuel incorporated as part of fossil fuels is exempted from the Contribution to Social Care and Conservation of Road Assets for a period of 15 years.

In Panama, the legislation includes incentives equivalent to 20% of the purchase of domestic raw materials. Producers of raw materials for ethanol and biodiesel are exempt from import taxes, tariffs, contributions, and charges for the purchase of machinery, equipment, materials, and the like for a period of 10 years. Similarly, producers are exempt from payment of industrial licenses, commercial licenses, and municipal taxes for 10 years.

In Colombia, Laws Nº 788 and Nº 939 exempted fuel alcohol and domestic biodiesel destined for blending with fossil fuels from Global Tax, which is paid by the producer, and from the Sales Tax. The income generated by new farms of slow growing crops, including palm trees, is not subject to the Income Tax during a period of 10 years.

In Uruguay, the Law of Agrofuels, Law Nº 18.195 of 2007, created incentives for the producers of biodiesel and fuel alcohol, including tax exemptions on property taxes levied on fixed assets used as part of the production process. Similarly, an exemption is available for 100% of the Income Tax for the Industry and Commerce (IRIC) for a period of 10 years. The sale of domestic biodiesel is exempted from the Specific Internal Tax (IMESI) for a period of 10 years, and the fuel alcohol is levied with a 0% rate on the same tax.

In Argentina, Law Nº 26093 of 2006, which created the regulations and promotion regime for the production and sustainable use of biofuels, included a 15 year period with a set of complex incentives. Incentives include anticipated recovery of the value added tax (VAT) and accelerated depreciation on the Income Tax levied on capital assets or infrastructure. Similarly, projects in the industry of biofuels benefit from tax exemptions that are subject to budgetary quotas determined in the annual budget law, and distributed according to priorities determined by the law among medium and small enterprises, producers (including farmers as stockholders, owners, or partners) and regional economies. Similarly, the enforcement authority is empowered by the legislation to determine the minimum price paid to the biofuel producers by the blenders, as well as to determine distribution quotas for blenders to purchase at least 20% of the biofuels from small and medium producers. The biofuels produced are not subject to the Tax on Liquid Fuels and Natural Gas and the Tax on Transfers or Imports of Diesel.

In Brazil, during the ProAlcool program, ethanol production was supported through price guarantees and subsidies, as well as public loans and state guaranteed bank loans (Timilsina, Govinda R., 2010), blending mandates, and promotion of E-100 (pure ethanol) capable vehicles (Pin Koh et al., 2008). This promotional structure was later deregulated, eliminating the direct subsidies and using a less interventionist approach, based mainly on blending mandates, tax reductions of Flex-fuel vehicles, and one of the heaviest tariffs for importing gasoline in the world.

Therefore, whereas at the beginning of the industry Brazil strongly relied on support to the supply side, today, when the industry has reached maturity, direct governmental subsidies have been eliminated for ethanol. Nevertheless, due to the need to secure the supply of ethanol, which has been affected in recent years by climatic adversities, the Provisional Measure # 554 approved a R$2.5 billion credit line with subsidized interest rates for the implementation of ethanol storage facilities in Brazil. Similarly, credit lines of R$4 billion (approximately US$2 billion) are destined to finance the expansion of sugarcane fields. On the biodiesel side, the Brazilian tax system allows a deferment on tax obligation payments for biodiesel producers that use soybeans as feedstock. In that sense, the payment of taxes is due when selling the product, instead of when purchasing the raw material (USDA, 2012).

Differently from these countries, as we will cover in the following chapters, the biofuel promotion framework in Peru did not grant special subsidies or differentiated tax regimes for agricultural feedstock for ethanol or biodiesel, or for producers of biofuels, other than those that previously existed in the country. The main features of the promotion framework relied on the stimulus of the demand side, by creating blending mandates and a minimal reduction in excise taxes.

Table 4. Latin America: Blending Mandates for Biofuels

COUNTRY	PRODUCTS	AUTHORIZED %	STARTING PERIOD	CURRENT BLENDING
MEXICO	ETHANOL	Determined by Executive (SENER)	Determined by Executive (SENER)	Pilot blend 2% in Guadalajara (b)
HONDURAS	BIOCOMBUST.	Determined by a public-private Technical Unit (UTB)	Determined by a public-private Technical Unit (UTB)	N.A.
COSTA RICA	ETHANOL	0% to 8%	Determined by the national oil company RECOPE	7% (a) (b)
	BIODIESEL	0% to 5%		20% (a) (b)
PANAMA	ETHANOL	5% (Panama Province)	Sep. 2013	5% Panama capital (e)
		5% Nationwide	April. 2014	
		7% Nationwide	April. 2015	
		10% Nationwide	April. 2016	
COLOMBIA	ETHANOL	Determined by Executive (MME)	2005	Mandatory 8% to 10% (d) - Voluntary 25% to 85% (d) (f)
	BIODIESEL		2007	10% (d) (f)
BOLIVIA	ETHANOL	10% to 25%	Up to 2015	Target 10% (c)
	BIODIESEL	2.5% to 20%	Up to 2015	Target 2.5% (c)
PARAGUAY	ETHANOL	Determined by the Executive (MIC)	2007	24% (a) (b)
	BIODIESEL		2007	1% (a) (b)
URUGUAY	ETHANOL	Min. 5%	2015	Target 5%
	BIODIESEL	Min. 2%	2009	2% (a) (b)
		Min. 5%	2015	Target 5% (a)
ARGENTINA	ETHANOL	Min. 5%	2010	5% (a) (b)
	BIODIESEL	Min. 5%	2010	7% (a) (b)
ECUADOR	BIODIESEL	5% to 20%	Dec. 2013	Pilot blend: 5% in some provinces (b)
PERU	ETHANOL	7.8%	2010*	7.8%
	BIODIESEL	2%	2009*	2%
		5%	2011*	5%
BRAZIL	ETHANOL	18% to 25% (d) ***	1976 (4.5%) **	18% to 25%
	BIODIESEL	5% (d) ****	2008 (2%) ****	5% (a) (b) (c)

Data Sources: Legislation. Information on current blending mandates or targets: (a) Global Renewables Fuels Alliance – GRFA. (b) REN 21. (c) IEA, (d) USDA. (e) www.elnuevoherald.com (El Nuevo Herald, 2013), (f) Decree 4892 of 23.12.2011 MME. Author's own elaboration
* For more details, see Tables 5 and 6, below. ** Before the creation of ProAlcool program, Decree 19.717/31 (1931) implemented a voluntary blend of at least 5%; in 1938 Law 737/38 imposed a mandatory blend. *** Provisional Measure 532 of April 2011. **** Law 11.097/2005

Chapter 4. Biofuels Promotion Framework in Peru

4.1 Background

The introduction of biofuels and renewables in the Peruvian energy matrix may be better understood as part of the need to diversify the sources of energy amid the economic growth, the increase in energy demand, and the dependence on foreign source oil and refined products.

The following subchapters present a brief overview of the recent economic growth that followed the structural reforms of the Peruvian economy made during the 90s. Similarly, a brief description on the energy demand in Peru is given, highlighting the participation of foreign source oil and refined products for internal consumption, as well as the increase in the transport sector, the main consumer of gasoline and diesel fuels.

4.1.1 The Peruvian Economic Growth

During the first years of the 1990s, major structural reforms and macroeconomic stabilization programs were implemented in Peru, changing the legal framework for private investment in general as well as for the exploitation of the important revenue sources including the telecom industry and the mining, agriculture, and energy sectors. As a result, the long prevalent presence of state-owned monopolies that controlled different productive activities ended for the most relevant activities, opening the market to private domestic and foreign investors[15].

As part of this wide reform, a new Political Constitution, enacted in 1993, as well as a complete set of new legislation, was approved during the first half of the same decade. The aim was to promote private investment in Peru, thereby enabling a favorable framework for the development of some of the most significant economic activities for the Peruvian economy. Included in these reforms, Legislative Decrees Nº 662[16] and 775[17] set forth the general rules for the protection of private investment, removing the preference previously enjoyed by the state-owned companies to participate in economic activities at the expense of private initiative and reducing the participation of the state in economic activities to a subsidiary role.

Similarly, the Agricultural Reform carried out in the 70s by the military regime of president Velasco, which prohibited the sale of agricultural land, was overturned by laws such as Nº 26.505, which again provided an open

[15]These activities included hydrocarbons, mining, and telecommunications among the most important.

[16] Law for the Promotion of Foreign Investment, January 1991

[17]Framework Law for Private Investment Growth, November 1991

access to property consisting of agricultural land in the country. As a result, no legal limitations are currently placed on the size of the land (CEPAL, 2007), a fact that opened a dynamic in the market of land that had not existed during the previous decades following the Agricultural Reform by Velasco. Nevertheless, as we will see later, widespread lack of property certification, non-updated agricultural censuses, and lack of infrastructure in rural areas, among other factors, have turned out to be potential pitfalls for the wider development of the biofuels industry in Peru.

In addition, in 1991 and 1992, Peru ratified the Convention on the Settlement of Investment Disputes between the Sates and Nationals of Other Sates (ICSD), providing investors with a legal instrument for submitting investment disputes for international arbitration; and the Convention Establishing the Multilateral Investment Guaranty Agency (MIGA), as a measure to make the business environment more attractive and safe.

Similarly, complementing the openness of the domestic market, the following years witnessed the signing of various agreements to avoid double taxation or to promote cross-border trade. Thus, treaties for the avoidance of double taxation were signed with Chile[18], Canada[19], the Andean Community

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[18] Applicable since January 2004

[19] Applicable since January 2004

countries[20], and Brazil[21] (MEF, Ministry of Economics and Finance, 2013), and negotiations for similar agreements were initiated with Sweden, the United Kingdom, France, Italy, Spain, and Thailand (SUNAT, 2013). In a similar fashion, several regional, multilateral, and bilateral commercial agreements were signed. These included agreements with Chile, Mexico, USA, Canada, Turkey, China, South Korea, Thailand, Japan, Panama, Costa Rica, Venezuela, the EFTA (Switzerland, Norway, Iceland and Lichtenstein) the European Union, MERCOSUR, and the Andean Community (MINCETUR, 2013), with the purpose of increasing commerce from and into the country.

The improved framework paved the road for the economic upturn enjoyed by the Peruvian economy in the 2000s and following years. In fact, the Peruvian economy has shown a continuous growth, being among the top performers in Latin America & Caribe region. The Peruvian GDP[22] had a simple average growth of 5.6% between 2000 and 2012 (see Figure 6), surpassing the regional average (3.2%).

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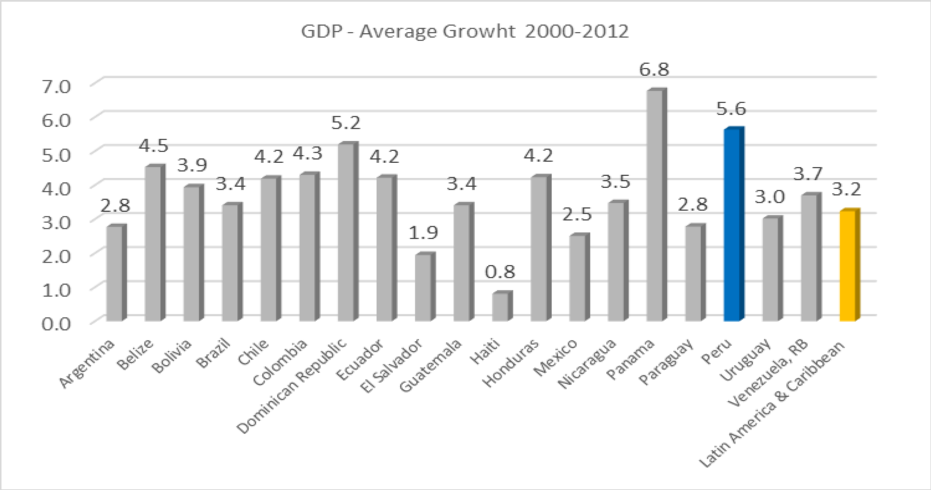
[20]Decision Nº 578, applicable since January 2005. This Decision actualized a Previous one (Decision Nº 40) approved in 1971.

[21]Applicable since January 2010

[22]In current US dollars. Data from World Bank Data Bank, http://data.worldbank.org

Figure 6. Peru: GDP – Average growth 2000 – 2012

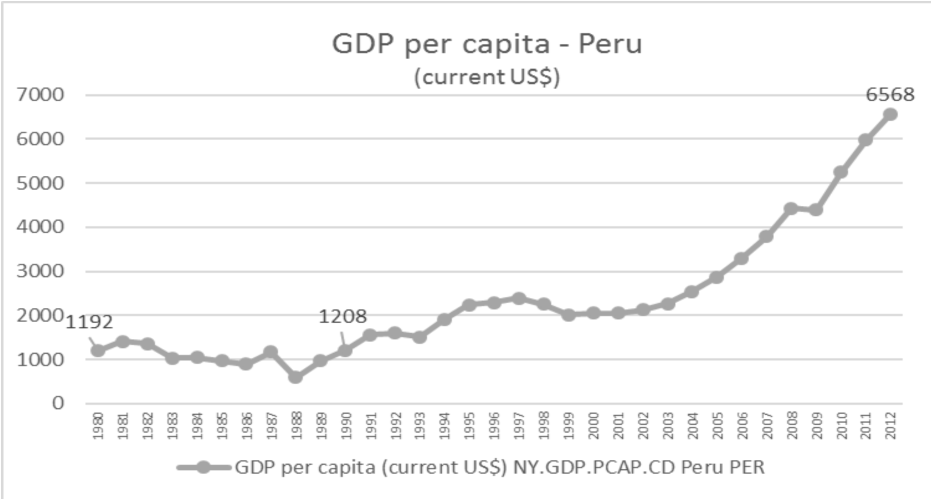


Data source: World Bank – Data Bank. Author's own elaboration.
Note: data available on Argentina: years 2001 to 2008

Because of this economic upturn, Peru became an Upper Middle Income economy. GDP per capita arose from $1208 USD at the beginning of the economic reform to $6568 USD in 2012 (see Figure 7).

Similarly, the last decade has witnessed an increase in energy consumption in Peru, in percentages than turn out to be higher than the average variation experienced among Central and South American countries. This led to a need for diversifying the energy matrix.

Figure 7. Peru: GDP per capita 1980 - 2012



Data source: World Bank Data Bank .Author's own elaboration

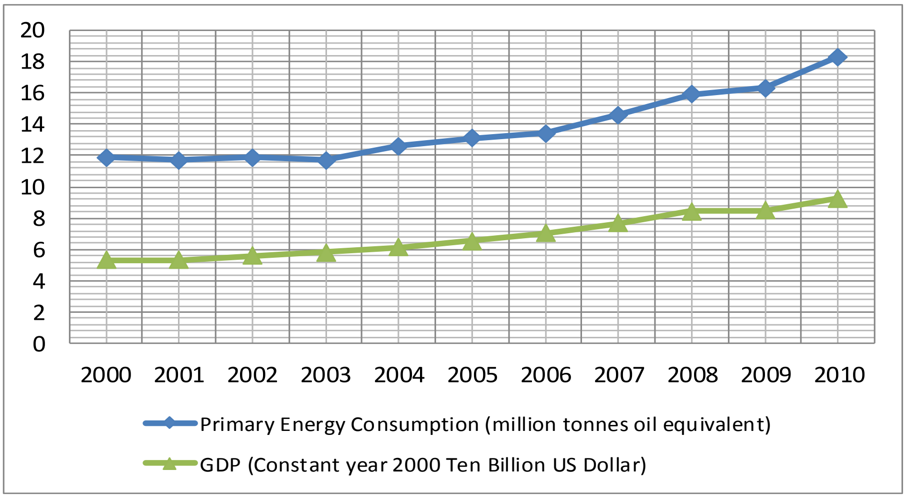
4.1.2 Energy Consumption

Encompassing the economic growth of the last decade, energy consumption in Peru has shown a considerable increase. In fact, comparing the consumption of primary energy for the years 2000 and 2010, the growth represented 53.8%. This figure turns out to be higher than the average growth experienced among Central and South American countries, which accounted for a variation of about 31.8% during the same period according to data from the BP Statistical Review of World Energy (BP, 2011).

Empirically, as Figure 8 shows, we may notice that a relation between the primary energy consumption and the GDP has existed during the last decade in Peru.

The increasing demand for energy in Peru is accompanied by a progressive migration from an internal supply based on oil and its derivatives to an important participation of natural gas, after the commercial exploitation of Camisea reserves started in the mid-2000s, and also with the introduction of renewables into the energy matrix in recent years. Indeed, the need to diversify the sources of energy led to legislation that approved targets for the participation of renewable sources of energy, including a five percent of the total electricity consumption.

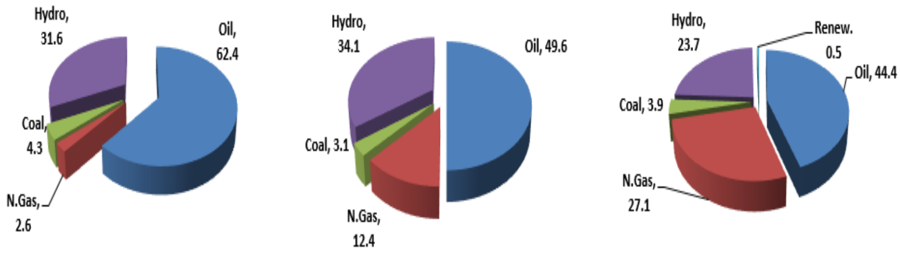
Figure 8. Peru: Energy consumption & GDP 2000 - 2010



Data sources: World Bank Databank / BP Statistical Review of World Energy, 2011 – Author's own elaboration

Figure 9 shows the evolution of the composition of primary energy consumption for years 2000, 2006, and 2010. The increasing participation of natural gas is mainly explained by the discovery and subsequent exploitation of large reserves in Camisea, at the southern region of Cusco[23]. In fact, natural gas production in the country rose from 0.3 Mtoes in 2000 to 1.4 in 2005 to 6.5 Mtoes in 2010, a noticeable increase of 2,000% in ten years, which transformed Peru into a net gas exporter.

Figure 9. Peru: composition of primary energy demand, years 2000, 2006, & 2011

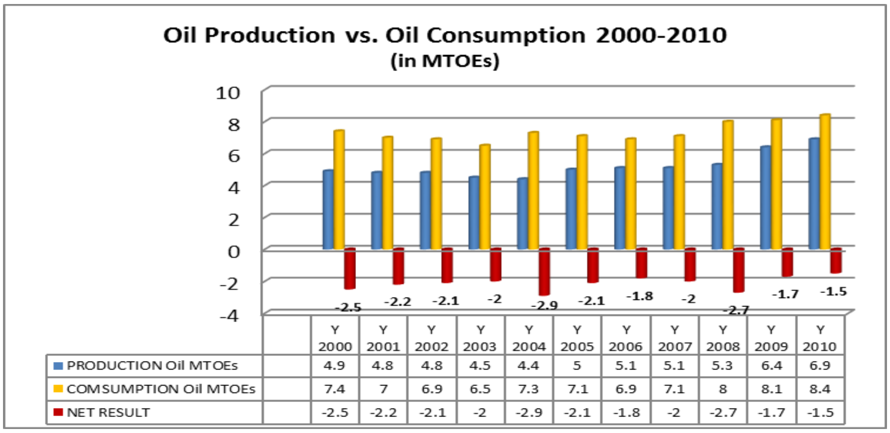


Data sources: BP Statistical Review of World Energy, 2002, 2008, 2012. Author's own elaboration

[23] According to statistics from the Ministry of Energy and Mining, proved reserves of commercial energy in Peru for the year 2009 were led by Natural Gas (45.1%), and followed by hydro-energy (22.55%), Liquids from Natural Gas (13.2%), Oil (11.7%), Coal (4.2%), and Uranium (3.3%). (MINEM, 2009)

In term of fossil fuels, Peru ranks 50th in the world in oil reserves and 37th in the world in natural gas (CIA FACTBOOK, s.f.), far below some of the countries in the region, such as Mexico, Venezuela, Colombia, and Ecuador, which are countries with important reserves of fossil fuels. Comparison of the oil production with consumption in the country shows that Peru has been a net importer of petroleum during the last decade (See Figure 10).

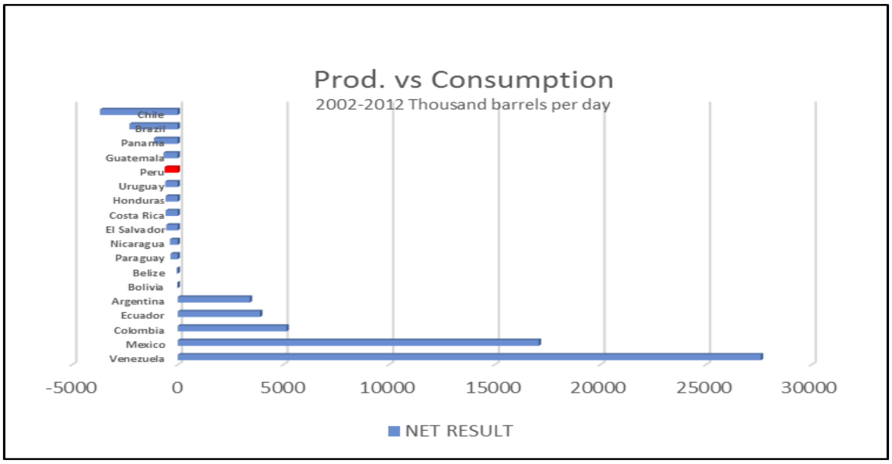
Figure 10. Peru: Oil production vs. oil consumption per day 2000 – 2010



Data sources: BP Statistical Review of World Energy. Author's own elaboration

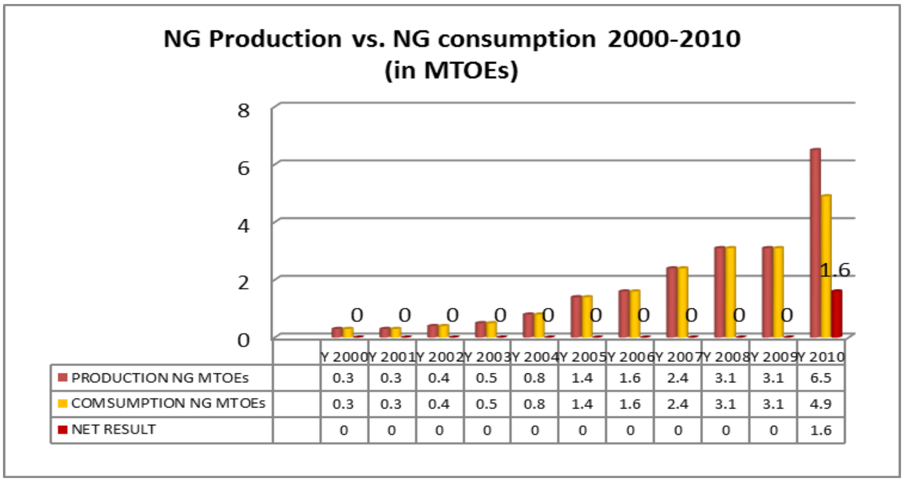
Moreover, during the period 2002–2012, Peru was among the five countries of the region with the highest negative differences between production and consumption of petroleum (See Figure 11). Only in recent times has the increase in the production of natural gas in the southern part of the country started to transform Peru into a net exporter of that product since the end of the last decade (See Figure 12).

Figure 11. Latin America & Peru: Production vs. consumption of oil 2002 –2012



Data sources: BP Statistical Review of World Energy. Author's own elaboration

Figure 12. Peru: Natural Gas production vs. consumption per day 2000 – 2010



Data sources: BP Statistical Review of World Energy. Author's own elaboration

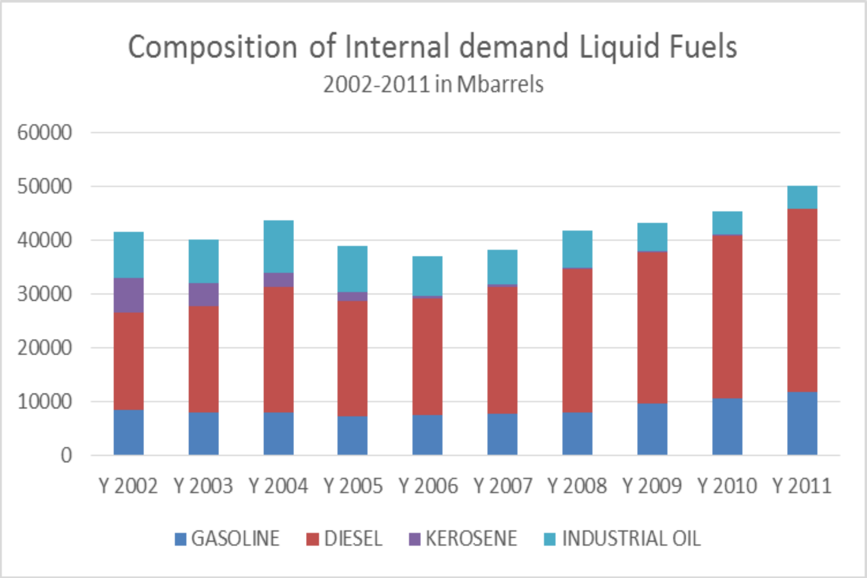
4.1.3 Consumption of Diesel and Gasoline

In terms of the internal consumption of refined liquid products derived either from natural gas liquids or from oil, diesel and gasoline account for most of the domestic demand (See Figure 13). Kerosene has disappeared from the market due to a governmental ban on its commercialization, and industrial oils are reducing its participation due to the substitution by natural gas, but gasoline and diesel have preserved their importance as the main energy providers for the increasing transport sector.

It is interesting to note that an important fraction of diesel consumed in the country is either produced from imported oil or directly imported (nearly 30% of the total). As highlighted by the ECLAC, of the total consumed diesel in 2006, only 25% was produced using domestic oil and around 48% was produced using imported oil (CEPAL, 2007). The total cost of the imported product for the same year was estimated as $454 US million dollars (MINEM, 2007). In other words, Peru depends on foreign oil as well as on foreign refined products (See Figures 13 and 15).

The high consumption of diesel may be linked to its historic comparatively low price, due to lower taxation compared to gasoline and to the boom in importation of second hand vehicles, many of them equipped with diesel engines (Castro et al., 2008). The introduction of these vehicles was subject to reduced tariffs over a considerable period, as a way to increase the supply of cheaper means of transportation and as a way to create job opportunities related to the mechanical conversion of right steering wheel vehicles from Japan. Today, diesel consumption by the transport sector accounts for 69% of total use of that product (GFHL, 2012)

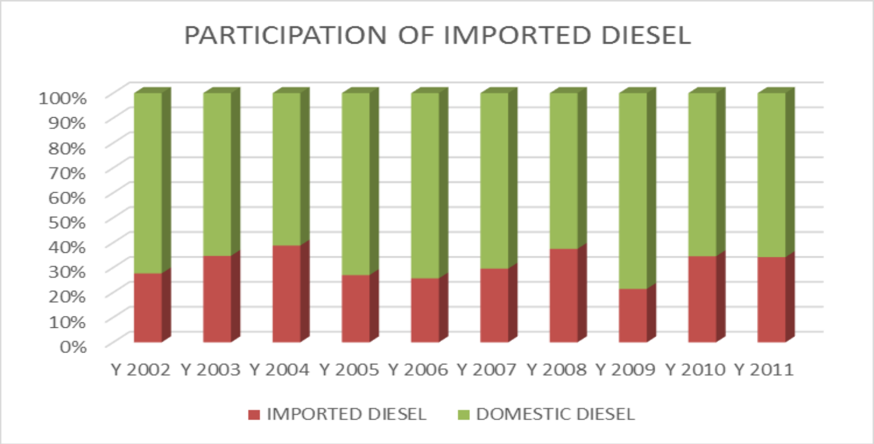
Figure 13. Peru: Refined liquid fuels – Composition of domestic demand 2002 - 2011



Data source: MINEM – Anuario de Hidrocarburos. Author's own elaboration

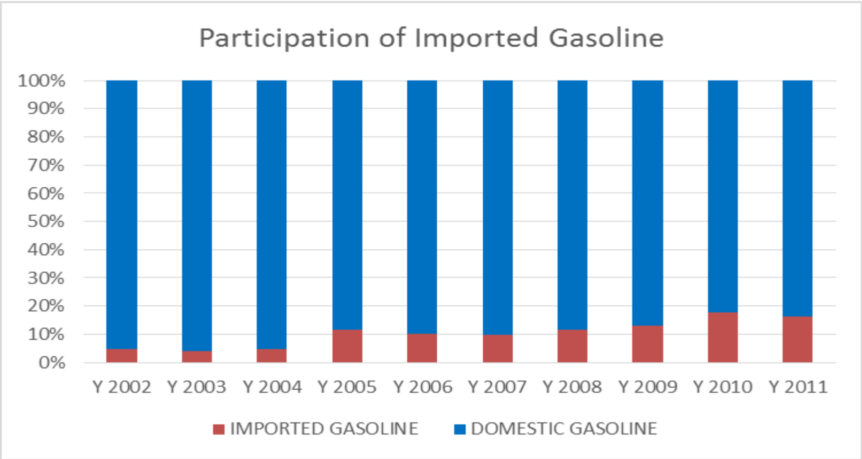
In the case of gasoline, the proportion of imported product represented an average of 10% in the period 2002 -2011 (See Figure 13), and it is worth mentioning that 98% of total consumption of that product is accounted by the transport sector (GFHL, 2012).

Figure 14. Peru: participation of imported diesel 2002 – 2011



Data source: MINEM – Anuario de Hidrocarburos / INEI – Compendio Estadístico
Author´s own elaboration

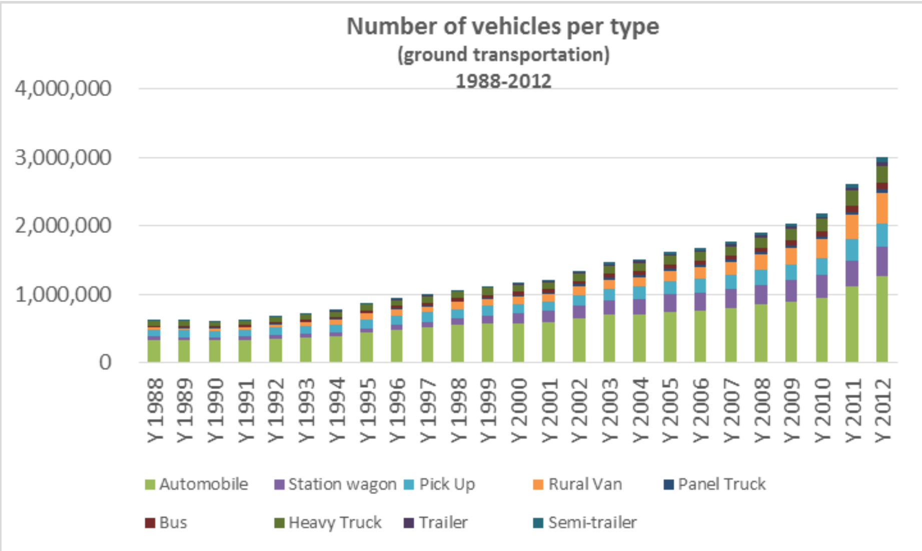
Figure 15. Peru: participation of imported gasoline in total consumption 2002 - 2011



Data source: MINEM – Anuario de Hidrocarburos / INEI – Compendio Estadístico.
Author´s own elaboration

In addition, the number of vehicles in the country has increased with a rapid pace during the last years. During the period 1992–2002, the increase was 99% in total vehicles, while during the period 2002–2012 the increase amounted to 123%, or a total of 3 million vehicles in the country, 56% of which were light vehicles such as automobiles and station wagons (See Figure 16).

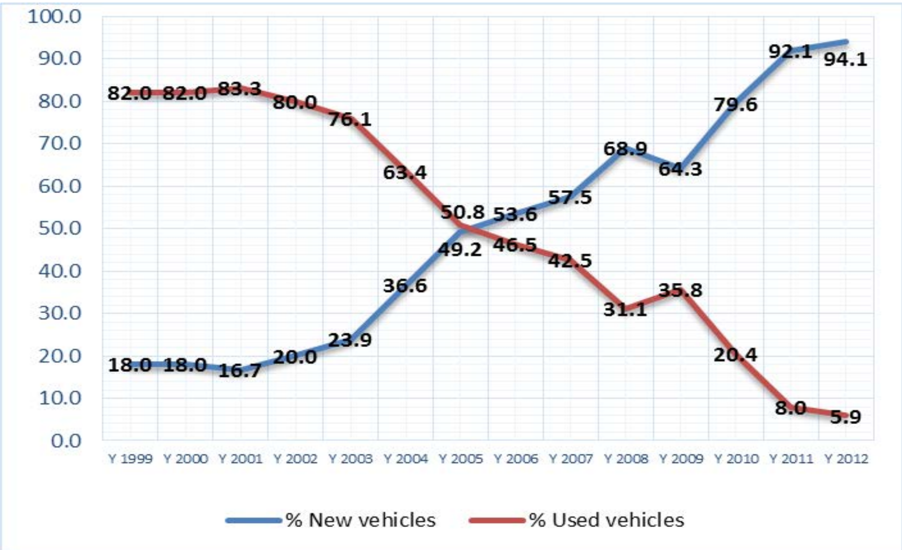
Figure 16. Peru: number of vehicles per type, evolution 1998-2012



Data source: INEI – Compendio Estadístico. Author´s own elaboration.

The number of vehicles is still expected to increase in the coming years, due to the dynamism of the Peruvian economy, the better acquisitive power, and the upsurge of the middle class. The number of new automobiles sold per year (as opposed to imported second hand vehicles) is also expected to grow to 500,000 in year 2023 from the 200,000 sold in 2012 (Peru 21, 2013). The statistics confirm that for the most part of the last decade, second hand vehicles dominated the market, but this tendency has changed in the most recent years. This may represent a decrease in the number of vehicles powered by diesel in the future, and an expected increase in gasoline powered ones (See Figure 17).

Figure 17. Peru: Imports of new vs. imports of used vehicles (in % of total) 1990-2012

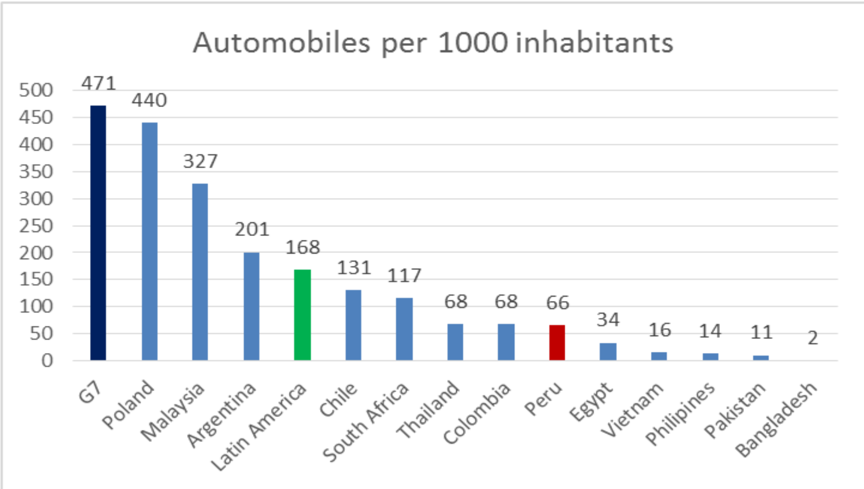


Data source: ARAPER / INEI – Compendios Estadísticos 2013, 2010, 2008, 2005, 2003 and 2001. Author's own elaboration.

It must be also noted that the number of vehicles per 1000 inhabitants in the country is still low (66) if compared to the average in South America

(117) and to the number of vehicles per 1000 inhabitants in other countries in the region.

Figure 18. Comparison of selected countries: Automobiles per 1000 inhabitants



Data source: BBVA..

This situation may represent an unsatisfied demand to be narrowed in the future (BBVA, 2012). Some estimates consider an average annual increase in that figure, at rates of 10% in upcoming years. This would probably increase the number of automobiles per thousand inhabitants to 140 in 2020, similar to the quantity that Chile records today; this increase would be higher than the expected average increase in Latin America, currently estimated at 4.1% (BBVA, 2012) (See Figure 18). As a natural result, the demand for fossil fuels would increase as well, highlighting the importance of biofuels as a feasible way to improve the energy supply.

4.2 Biofuel Promotion in Peru

Legislation addressing renewable energy in Peru can be classified into three different sets of legal bodies enacted during the period from 2003 to 2008: legislation on electricity generation from renewable sources,[24] legislation on geothermal energy,[25] and legislation on biofuels.

The legislation regarding electricity and geothermal energy created a set of advanced mechanisms for promoting the introduction of renewables into the energy matrix (such as granting priority in the daily supply to the national grid, guaranteeing tariffs during the contractual period, and granting accelerated depreciation of fixed assets for purposes of the Income Tax). In contrast, the law and regulations addressing the promotion of biofuels did not include any new concrete and specific incentives other than the creation of schedules for the mandatory use of blends of anhydrous ethanol and biodiesel

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[24]Promotion Law for Investments in Electricity Generation from Renewable Energy – Legislative Decree Nº 1002 of 2008; General Law of Rural Electrification - Law Nº 28749 of 2006 and Promotion Decree for Investments in Electricity from Renewable Energy - Legislative Decree Nº 105 of 2008.

[25]Organic Law of Geothermal Resources – Law Nº 26848 of 2003.

with fossil fuels, and minimal reductions on excise taxes imposed on the end products that were added later.

The new legislation did not gave farmers and biofuel producers a differentiated tax regime or subsidies for energy crops or for the implementation of facilities for the production of biofuels, such as those that existed in other countries in Latin America and mentioned in the Chapter 3. We can characterize the promotion regime for biofuels in Peru as one mainly focused on the creation of a market for the products, on the demand side, rather than one directed to granting incentives to producers or to providers of feedstock, on the supply side. This situation, in turn, has contributed to different outcomes in the two liquid biofuels addressed by the current legislation: anhydrous ethanol and biodiesel.

Ethanol, due to the comparative advantages for its production in the Peruvian coast region, has turned to be a successful experience that covers and exceeds the domestic demand. In contrast, biodiesel production in the Peruvian jungle region has only been able to cover a portion of the demand. So far, the adoption of biodiesel in the energy matrix has not reduced the dependence on products from foreign sources.

The cornerstone of the biofuel promotional framework was settled in 2003 by the Market Promotion Act of Biofuels – Law Nº 28054, published on August 9 of that year, and the regulations published two years later in 2005 and subsequently amended several times in 2007, 2008, 2009 and 2011. In fact, one of early problems for the development of the industry may be linked to this continuous variation in the regulations, especially regarding the changes in the schedules for the mandatory blending of biofuels. As expressed in the literature, one of these obstacles was "*the lack of political will to push through the proposed objectives of the law, as for example, it is mentioned the fact that the schedule for the implementation of ethanol has changed up to seven times*" (GAMIO, 2011).

The following subchapters cover the main features of the biofuel promotion framework of Peru regarding the stated purposes of the law, the biofuels covered by the law, the institutional framework, and the schedules for the blending of biofuels with fossil fuels.

4.2.1 Stated Objectives of the Promotion Framework

Law Nº 28054, published August 9, 2003, known as the Market Promotion Act of Biofuels, set forth the foundations for the use of biofuels in the country. The law created the basic framework for biofuels, stating the objectives for the activity and empowering the Executive to set up the opportunity and conditions for the use of these fuels.

Law Nº 28054 contained a set of different stated objectives, ambitiously expressed as[26]:

a) Diversifying the fuel market;

b) Strengthening agriculture and agroindustry development

c) Employment generation

d) Reducing pollution, and

e) Providing markets as alternatives to illegal drug production.

On this subject, the purposes were not further mentioned or developed in the law in the subsequent regulations, and they lacked any kind of indicators of performance to measure the law's effectiveness or impacts (Castro et al., 2008).

In fact, neither the law nor the regulations included any kind of indicator aimed at measuring the fulfillment of the stated objectives, an instrument that could have been used by policy makers to improve the existing framework.

Similarly, this wide array of objectives has been criticized as not necessarily being compatible (CEPAL, 2007) (Castro et al., 2008) (Ingenieria sin fronteras, Asociación para el Desarrollo, 2011), and not guiding, in real terms, the decisions of private entrepreneurs.

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[26] Article 1º, Law Nº 28054.

In fact, the lack of any specific incentive granted by the legislation usually causes private investment in the industry to be driven by its capacity to generate profit and not by the fulfillment of the purposes stated in the law. In order to achieve the goals of the biofuels legislation, the state could have influenced the type of projects and the actions of private investors, either through specific regulations or through incentives, which were not defined in Peru (SPDE, 2012).

On the specific objective of providing an alternative market to the illegal drug production, it is interesting to note that areas where the coca crops were cultivated might not necessarily have been the most suitable for competitive bioenergetics yields. The strict fulfillment of this objective may therefore have created a geographic limitation for selecting a location to place the crops without considering important aspects to guarantee the production of biofuels, such as the suitability of the soil, the availability of infrastructure, safety for collecting the raw material, and transporting and processing it (GAMIO, 2011).

On the specific objective of employment generation, this was criticized early on as a tautological declaration since, in general terms, all economic activities have the potential to generate jobs; the deficiency of the law was again in not determining the indicators of how many, what quality of jobs, and which level of income (CEPAL, 2007) the law was intended to reach.

Nevertheless, as we will see in the case of ethanol, the industry in fact has been able to create an important window for new job opportunities. On the other hand, the biodiesel industry still has potential for providing job opportunities if the proper conditions are set.

Similarly, in terms of the objective linked to strengthening the agro industry, the law did not address paths for the solution of structural problems faced by the agriculture in Peru. As highlighted by the literature, part of the structural problems included the highly divided property of the land, which would require establishing highly efficient systems of associativity. Other problems were the lack of property titles, and the lack of infrastructure for the development of the industry in areas that are appropriate for the production of biofuels, such as the jungle region. On the other hand, the lack of a limitation on the accumulation of land presented a risk in the sense that large enterprises could end up acquiring large expanses of land to produce feedstock for biofuels, with the potential of generating social conflicts (Ingenieria sin fronteras, Asociación para el Desarrollo, 2011).

Finally, it could be argued (as part of the literature on this topic does) that the law could be better interpreted as mainly intending to diversify the sources of energy, and that apart from that objective, no other concrete strategies had been considered for the achievement of the other purposes (RAA, Red de acción en agricultura alternativa, 2011). In fact, the diversification of energy sources, and the security of energy supply must be considered of high importance in the policy agenda. Diversification is needed to take into account the increasing demand for energy in the country, the rising number of transport vehicles (which is likely to continue in the next years), the current position of Peru as net importer of petroleum, and the dependence on foreign fuels.

On the other hand, if proper weight is given to objectives such as strengthening of agriculture and offering alternatives to illicit crops, the use of domestic products as feedstock for the production of biofuels should be given priority, since this use may likely be more helpful in fulfilling these objectives included in the law.

4.2.2 Biofuels Included in the Legislation

Law Nº 28054 included a general definition of biofuels, but only liquid biofuels, and particularly anhydrous ethanol and biodiesel, were specifically addressed in further regulations developed by the Executive.

Current regulations in force explicitly state that, for purposes of the law, the term biofuel shall be understood as meaning either alcohol fuel (defined in the regulations as referred only to denatured *anhydrous ethanol*) or *biodiesel*[27]. For practical purposes, this definition left out of legal coverage any other biofuel that could be seen as originally contained within Law Nº 28054.

Under the same scheme, the regulations mandated the approval of technical standards and quality specifications only for the two before mentioned biofuels: denatured *anhydrous ethanol* and *biodiesel*, as well as for the products that resulted from the blending of these biofuels with gasoline and diesel[28]. In fact, Peruvian Technical Standards Nº 321.126.2011 and 321.125.2008 set the quality specifications for anhydrous ethanol and biodiesel, respectively, and Supreme Decree Nº 092-2009-EM and Ministerial Resolution Nº 515-2009-MEM-DM sanctioned the quality specifications for the blending of anhydrous ethanol with gasoline, and biodiesel with diesel, respectively.

This limitation in the scope of the regulations and in the quality specifications caused the existing initiatives for the use of other products such as *hydrated ethanol* to face the barrier of lacking a legal framework that would allow these products to be commercialized. One of these initiatives, carried out by the enterprise *Riso Biocombustibles SAC* in the Department of

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[27] Article 4th of regulations approved by Supreme Decree Nº 021-2007-EM

[28] Articles 5th and 11th of regulations approved by Supreme Decree Nº 021-2007-EM

San Martin, allegedly ceased operations due to this problem of not having the regulatory framework that allowed them to offer the biofuel. Another initiative carried out by *Bioandes* in the department of Ucayali in the Jungle, aimed to supply the local market of “moto-taxis” (SNV, 2009), also was focused in producing *hydrated ethanol*. The potential for the use of this product, with a lower cost compared to anhydrous ethanol, is found among adapted motorcycles that are used for public transportation in the urban areas of the Peruvian jungle (SNV, 2009)[29]. Unfortunately, the lack of enabling legislation has possibly created an informal market for these products (García, 2013).

As Figures 19 and 20 show, the Peruvian jungle region encompasses a large percentage of registered motorcycles compared with the rest of provinces in Peru. As well, it has the largest number of motorcycles adapted for public transportation – the so-called and widespread “*Moto-taxi*”. According to the National Institute of Statistics (INEI), 35% of all motorcycles and Moto-taxis registered in the provinces during 2011 were accounted for by the departments located in the Peruvian jungle region, which

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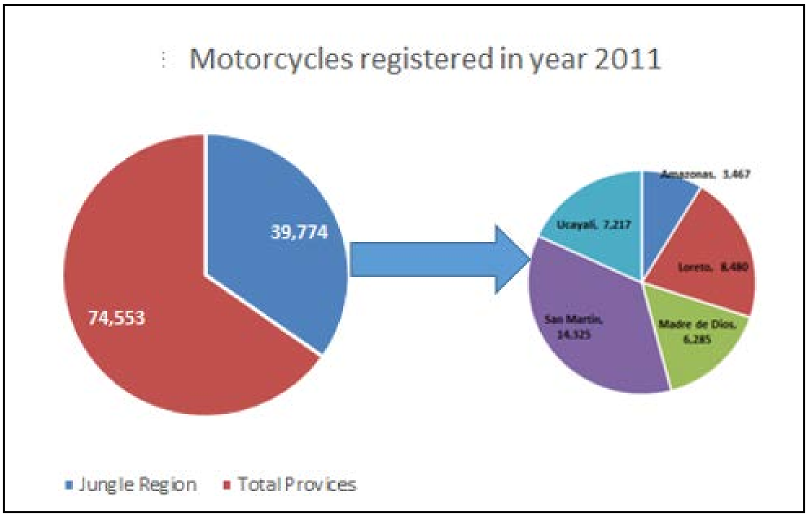
[29] It is worth taking into account, despite the obvious differences, that Brazil has a long tradition on the sale of hydrated ethanol as fuel for vehicles, and even lacking subsidies, the hydrated ethanol was sold at 60% to 80% the price of gasohol (a combination of anhydrous ethanol and gasoline) at the pump stations (Goldemberg et al., 2008). The production cost of hydrated ethanol is below that of any other liquid biofuel (Smeets et al., 2008)

gives an idea of the potential for the development of small or medium facilities for the production of biofuels aimed to supply that local market.

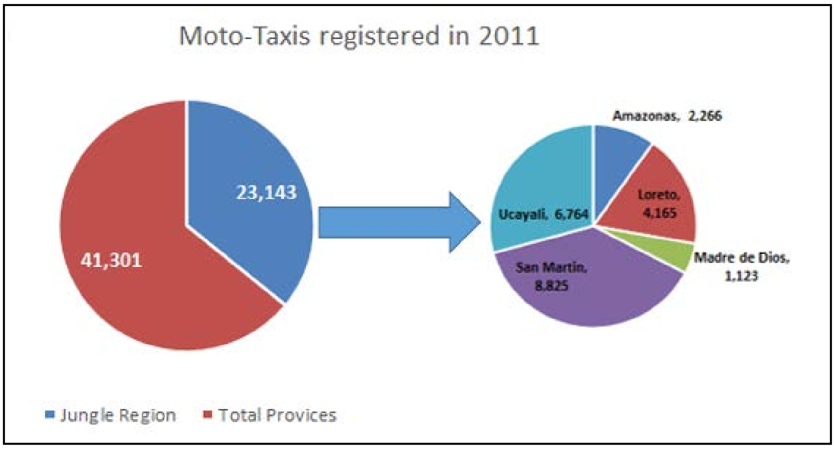
Figure 19. Peru: registered motorcycles in the jungle region 2011



Data source: INEI, Compendio Estadístico 2012. Author's own elaboration.

At this point is worth remembering that the literature on developing countries highlights the potential welfare benefits of the use of small-scale biofuel production models to convert feedstock locally in isolated or rural areas (e.g., Dermibas et al., 2007; Ewig, Mandy, 2009; A. Gasparatos et al., 2011). Similarly, in the case of Latin American countries, such as Colombia, it has been acknowledged that small producing facilities of biofuels could create attractive alternatives for small and rural communities (J.A. Quintero et al., 2008). The contribution of biofuels at the local level is especially beneficial when the costs of transport are high, such as in landlocked areas or when the road infrastructure is poor (A. Gasparatos et al., 2011), as in the case of the Peruvian jungle region.

Figure 20. Peru: registered Moto-Taxis in the jungle region 2011



Data source: INEI, Compendio Estadístico 2012. Author's own elaboration

In addition, it is worth noting that, according to the current legislation, the blending of biofuels is authorized only at oil refineries and oil storage facilities, which are mostly located along the coast region. In that sense, depending on the location, a product made in the jungle and destined for blending with fossil fuels could probably require transport to the coast and return as part of the blended fuel to the jungle in order to comply with the current legislation; this would have an impact on costs.

A review on the existing regulations is recommended in order to address the inclusion of products already existing in the market (such as hydrated ethanol), the approval of standards and quality specifications for these products, and the regulations on their commercialization in a way that accommodates the existing value chains.

According to the existing regulations, the term biodiesel has a broad definition in the regulations, without major limitations in terms of the feedstock for its production. Biodiesel is defined as a "*fuel consisting of mono-alkyl esters of long chain fatty acids derived from renewable resources such as vegetable oils or animal fats, to be used in diesel cycle engines, and could be obtained from palm oil, castor oil, pine nuts, soybeans, rapeseed, sunflower and other oleaginous vegetables, as well as from animal fats and used cooking oil*"[30].

In turn, regulations use the term *biodiesel B100* to describe the pure forms of biodiesel (before any blending), and the term *diesel BX* for the final product resulting from the blending of biodiesel B100 and diesel. Following an internationally accepted nomenclature, the letter "X" in the term "*diesel*

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[30] Article 5th of regulations approved by Supreme Decree Nº 021-2007-EM

BX" designates the percentage of pure biodiesel (*biodiesel B100*) in the final product. As such, the denomination used in Peru for the current blend of biodiesel with fossil fuel is *diesel B5.*

On the other hand**,** ethanol is defined as *"ethyl alcohol whose chemical formula is CH3-CH2-OH and is characterized by being a liquid compound, colorless, volatile, flammable, and soluble in water".* Specific reference to first generation sources is made, by adding that for purposes of the regulations ethanol is the alcohol "(…) *obtained from sugarcane, sorghum, maize, cassava, potato, rice and other agricultural crops"* [31]

In turn, when ethanol is blended with gasoline, it is named by the regulations as *gasohol.* Depending on the octane number of the gasoline that is blended with ethanol, the final commercial g*asohol* denomination changes[32]. Currently, the following denominations are used: *gasohol 98 plus* (a blend of ethanol and 98 octane gasoline), *gasohol 97 plus* (a blend of ethanol and 97 octane gasoline), *gasohol 95 plus* (a blend of ethanol and 95 octane gasoline), *gasohol 90 plus* (a blend of ethanol and 90 octane gasoline) and gasohol 84 plus (a blend of ethanol and 84 octane gasoline).

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[31] Idem.

[32] It is interesting to note that the original denomination in previous version of the regulations included the word "*ecological*" as part of the product name, but this designation was dropped in 2007 by the amendments carried out in that year.

Considering the role that advanced biofuels may play in the next decade, it is worthwhile to set up a path in the legislation for including them as an alternative in the country. We need to consider that the emphasis only on growing biomass for first generation biofuels is possibly misplaced, as this type of biomass may face a future demand that is drastically attenuated as better technology arises, especially as those relating to second-generation biofuels become available (M.B. Charles et al., 2007). If this occurs, significant opportunity costs may have been incurred. Therefore, a more balanced and long-term approach is needed for sustainability of the transport sector in the legislation.

4.2.3 Institutional Framework

The institutional framework assigned to deal with biofuels is quite complex and includes a wide platform of different governmental entities. In fact, competences have been split among four different ministries and five independent agencies of the executive. Regional governments and local authorities, as well as different coordinating programs or commissions such as PROBIOCOM and the Multi-sector Commission of Bioenergy, also participate, leading to criticism in the sense that it lacked a permanent institutional platform to articulate the contributions of the diverse public and private actors (GAMIO, 2011).

In comparison, it is interesting to note that in other Latin American countries, such as Argentina, the existence of a single body that draws together all the relevant ministries coordinating the national policy has been considered part of the elements or the life of biofuels production (Mathews et al., 2009).

Competences in the executive are divided among the following entities:

A. Ministry of Energy and Mining, in charge of setting technical specifications for products obtained from biofuel blending with fossil fuels (gasohol and *diesel BX*), determining schedules for the mandatory use of gasohol and *diesel BX*, approving regulations and amendments on commercialization of biofuels and their blending with fossil fuels;
B. Ministry of Production (PRODUCE), in charge of issuing permits for the putting in place and operation of production plants;
C. Ministry of Agriculture, in charge of identifying and promoting the development of agricultural areas that are suitable for biofuels production;
D. Ministry of Environment, in charge of regulating environmental aspects in Peru;

E. National Institute for the Defense of Free Competition and Intellectual Property (INDECOPI), in charge of approving technical specifications for ethanol and biodiesel;

F. National Agency for the Supervision of Investment in Energy and Mining (OSINERGMIN), in charge of supervising and controlling the compliance with regulations on biofuels and their blending with fossil fuels. Its competence begins at the physical point where the blend is made. It is also in charge of issuing permits for the different activities related to the blending of biofuels with fossil fuels, as well as for the commercialization and transport of final blends; controlling biofuels quality specifications, and approving the technical procedures for inspection, maintenance and cleaning of tanks, equipment and other facilities that are used for the commercialization of final blends;

G. Agency for Environmental Control and Evaluation – OEFA (Ministry of Environment)[33], in charge of supervising and controlling compliance with environmental regulations by the energy industry;

H. PROINVERSION, governmental agency in charge of promoting investments in the biofuels sector;

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[33]The Agency for the Environmental Control and Evaluation – OEFA was created after the enactment of the legal framework that regulates the biofuels industry; notwithstanding, its competence results clearly from its own regulations.

I. National Commission for Development and Life without Drugs – DEVIDA, in charge of promoting private investment aimed at producing biofuels in the high jungle area.

In addition, as mentioned above, the law also created PROBIOCOM, a program for the promotion and use of biofuels, ascribed to the PROINVERSION agency. PROBIOCOM, in real terms, had no permanence, and practically disappeared (RAA, Red de acción en agricultura alternativa, 2011); it no longer performs functions (SPDE, 2012). This program was originally integrated by different multi-sector working groups[34], which were also in charge of promoting investments for the production and commercialization of biofuels, and disseminating the advantages of their use. Notwithstanding, later regulations in 2009 created another body, the Multi-sector Commission of Bioenergy[35], to evaluate and recommend measures to promote a comprehensive management of national bioenergy.

This wide array of entities, to which we should add the participation of regional governments and local authorities, each one with its own procedures and competences, highlights the necessity of addressing the creation of

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[34]Article 2.3 of Directive Nº 004-2007-PROINVERSION

[35]Created by Supreme Decree Nº 075-2009-PCM

mechanisms to provide predictability to the investments in biofuels, and clarity on policy guidance.

In the case of the regional governments, Law Nº 27867 of 2002 mandated a progressive transfer of competences from the central government. This transfer included responsibilities to "*formulate, adopt, implement, evaluate, supervise, direct, control and manage plans and policies on energy, mining and hydrocarbons in the region, in accordance with national policies and sectorial plans"*[36], and to "*promote investments in the sector, with the limitations of law*"[37]. Later, in the year 2010, through Ministerial Resolution Nº 278-2010-MEM/DM, a plan for the progressive transfer of competences in energy and mining was finally approved.

Nevertheless, by 2012, the Regional Governments had not yet completed the process of adapting its structures to the new competences and had not modified its administrative procedures and regulations of organization and functions to incorporate the new responsibilities and tasks (SPDE, 2012). This was a reality that created a potential limitation for investments.

In addition, the regulations on biofuels required that the investment projects for biofuel production be primarily based on the "*Ecological and*

[36] Paragraph a) of article 59º, Law Nº 27867

[37] Paragraph b) of article 59º, Law Nº 27867

Economical Zoning (ZEE) of the region, watershed or locality (…)”,[38] and should be approved by the Regional authorities. Nevertheless, by 2012, this instrument had been approved by only three regions (SPDE, 2012). The lack of an instrument like the Ecological and Agroeconomic Zoning, which would allow determination of the best suitability for the use of the land, created another potential difficulty for making investment decisions.

Therefore, generating national legislation would be advisable that imposes on the decentralized governments the imperative compliance with those obligations that already exist in the law, as well as providing the technical assistance to fulfil the required tasks.

4.2.4 Blending Mandates and Schedules

As previously mentioned, legislation aimed to promote biofuels differed from legislation regarding electric power generation from renewable sources, as it did not include new concrete and specific incentives to this industry other than providing schedules for the mandatory use of blends with fossil fuels. Similarly, minimal reductions on rates of excise taxes levied on final

[38] Regulations of Law Nº 28054.

products[39] were added to the legal framework related to biofuels. To say the least, the main measures arising from the legislation on biofuels focused on the demand side, as its main feature was the use of blending mandates.

In the case of biodiesel, its use in a 5% blend with diesel (*diesel B5*) was originally scheduled to start in January 2008, covering some departments of the jungle region[40]. Nevertheless, before coming into effect, this schedule was postponed until January 2009, this time with a nationwide scope and with a reduced blend that included only 2% biodiesel (*diesel B2*), for a period of two years. Starting in January 2011, a higher blend of 5% (*diesel B5*) was programmed nationwide, and is currently in force.

It is interesting to note that a higher blend of 20% (B20) has also been included in the regulations, without a scheduled date for its mandatory use. Currently, the use of a 20% blend (B20) is allowed only on a voluntary basis for major consumers. Sale of this blend is not allowed through gas stations (See Table 5)[41].

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[39] Excise taxes, under the denomination of Selective Consumption Tax, are levied on imports and on sales by the producer of listed products and services in Peru, in addition to a common VAT. Fuels, as well as other products, are subject to excise taxes on a fixed amount per gallon imported or sold.

[41] As highlighted by Escobar, four main ways of using biodiesel may be identified in the fuel market: Pure (B100), Blends (B5, B20, B30) and Lubricity Additive (B2), with the blends between 5% and 20% being the most common (J.C. Escobar et al., 2009)

Table 5. Peru: Schedules for the mandatory blending of biodiesel with diesel

ORIGINAL SCHEDULE (Supreme Decree 013-2005-EM)		FINAL SCHEDULE (Supreme Decree 021-2007-EM)				
5% Blend (B5)		2% Blend (B2)		5% Blend (B5)		20% Blend (B20)
Loreto	01.01.2008	Nationwide	01.01.2009	Nationwide	01.01.2011	Date not determined yet. Currently allowed only on voluntary basis for authorized large consumers
Ucayali						
Amazonas						
San Martin						
Huanuco						
Nationwide	01.01.2010					

Data source: Supreme Decrees 013-2005-EM and 021-2007-EM.
Author´s own elaboration

Unlike the case of biodiesel, which varied on percentages of blending but finally adopted nationwide schedules, gasohol had only one allowed blending percentage, but contemplated different schedules for different regions. These schedules for gasohol were changed several times by the executive.

The mandatory blending of anhydrous ethanol into gasoline was determined as a fixed percentage of 7.8%[42]. This percentage is the only one among Latin American countries that was not set using an integer but a fraction.

The first schedule for the use of gasohol, approved in 2005, provided for the mandatory use of the blend in three consecutive stages with regional scope, beginning on June 30th 2006, January 1st 2008, and January 1st 2010. However,

[42] This percentage was approved by Supreme Decree Nº 013-2005-EM, and was maintained by the subsequent amendments made to the regulations.

due to the existence of various loopholes in the first regulations, these original schedules were not observed nor were they harshly enforced by the governmental entities. On the contrary, they were later replaced by new schedules approved in 2007.

After a series of modifications carried out in 2007, 2009, and 2011, the use of gasohol was mandated in consecutive stages with regional scope. The use of gasohol started in January 2010 and reached its largest coverage in December 2011, with the exception of only five departments located in the Peruvian jungle region that are still subject to specific schedules to be determined by the Ministry of Energy and Mining. At this time, the Ministry of Energy and Mining has not approved schedules for the use of the product in those regions of the Peruvian jungle.

In brief, northern regions (where ethanol is produced) were scheduled to use gasohol in 2010, and southern and central regions in 2011. Lima, the capital of Peru, and the neighboring city of Callao are the regions that account for the largest consumption of gasoline in Peru (about 41.7% of total consumption in the country); these regions started to use this biofuel in July 2011 (See Table 6 and Figure 21)

Thus, by the end of 2011, anhydrous ethanol was currently in use in most parts of the country. Regions where the use of this product is still pending (Departments of Amazonas, San Martín, Loreto, Madre de Dios and Ucayali) are all located in the jungle, and account for only about 6.3% of total consumption of gasoline (See Figure 21).

As we will observe in the following chapters, the demand created by these mandatory blendings has been covered mostly by domestic products in the case of anhydrous ethanol, due to the favorable conditions for the production of sugarcane in the northern coastal region of the country. On the other hand, in the case biodiesel, due to the lack of sufficient domestic production, the internal consumption has been covered mostly with imported products.

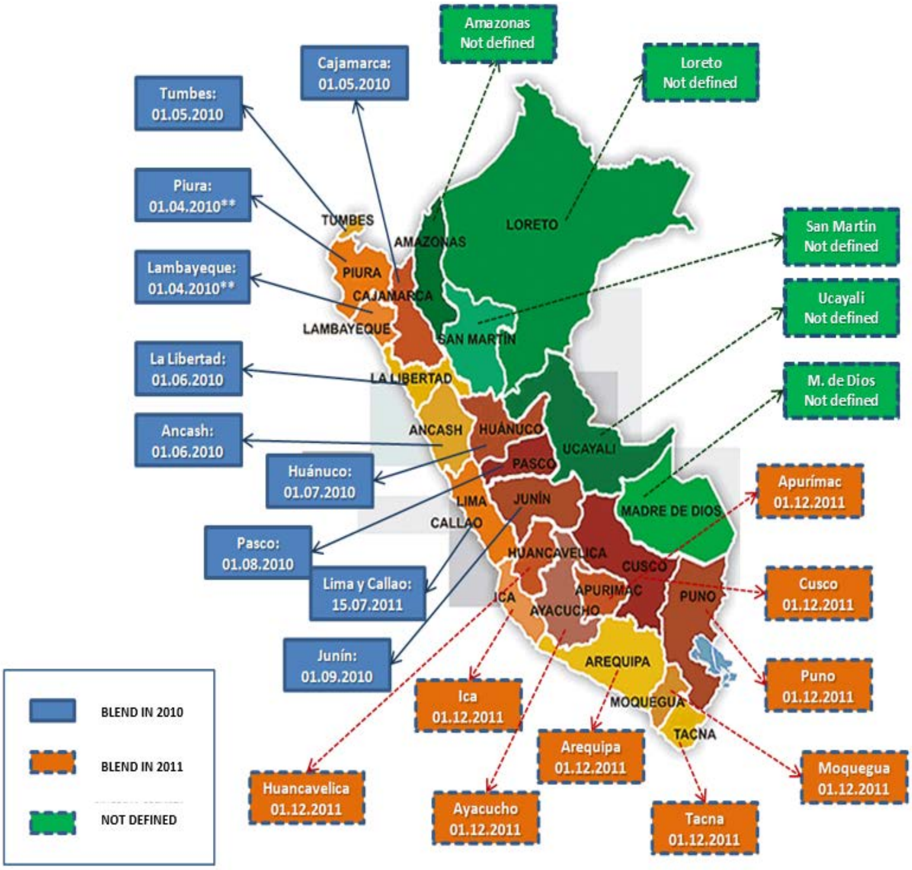
Table 6. Peru: Schedules for the mandatory blending of anhydrous ethanol with gasoline

<table>
<tr><th colspan="2" rowspan="2">REGIONS</th><th colspan="4">SCHEDULES AND MODIFICATIONS</th></tr>
<tr><th>Sup. Dec. 021-2007-EM
(Published 20.04.2007)</th><th>Modification by Sup. Dec. 091-2009-EM
(Published 29.12.2009)</th><th>Modification by Sup. Dec 061-2010-EM
(Published 28.09.2010)</th><th>Modification by Sup. Dec 024-2011-EM
(Published 13.05.2011)</th></tr>
<tr><td rowspan="2">Piura and Lambayeque</td><td>Districts of Piura and Chiclayo</td><td rowspan="19">01.01.2010</td><td colspan="3">01.01.2010</td></tr>
<tr><td>Rest of the region</td><td colspan="3">01.04.2010</td></tr>
<tr><td colspan="2">Tumbes and Cajamarca</td><td colspan="3">01.05.2010</td></tr>
<tr><td colspan="2">La Libertad and Ancash</td><td colspan="3">01.06.2010</td></tr>
<tr><td colspan="2">Huanuco</td><td colspan="3">01.07.2010</td></tr>
<tr><td colspan="2">Pasco</td><td colspan="3">01.08.2010</td></tr>
<tr><td colspan="2">Junin</td><td colspan="3">01.09.2010</td></tr>
<tr><td colspan="2">Lima and Callao</td><td>01.10.2010</td><td rowspan="11">01.06.2011</td><td>15.07.2011</td></tr>
<tr><td colspan="2">Ica</td><td>01.11.2010</td><td rowspan="10">01.12.2011</td></tr>
<tr><td colspan="2">Huancavelica</td><td>01.12.2010</td></tr>
<tr><td colspan="2">Ayacucho</td><td>10.01.2011</td></tr>
<tr><td colspan="2">Apurimac</td><td>01.02.2011</td></tr>
<tr><td colspan="2">Cusco</td><td>01.03.2011</td></tr>
<tr><td colspan="2">Arequipa</td><td>01.04.2011</td></tr>
<tr><td colspan="2">Puno</td><td>01.05.2011</td></tr>
<tr><td colspan="2">Moquegua</td><td>01.06.2011</td></tr>
<tr><td colspan="2">Tacna</td><td>01.07.2011</td></tr>
<tr><td colspan="2">Amazonas, San Martin, Loreto, Madre de Dios and Ucayali</td><td colspan="3">Schedule not determined yet by the Ministry of Energy and Mining</td></tr>
</table>

Source: Supreme Decrees 021-2007-EM, 091-2007-EM, 061-2007-EM, and 024-2007-EM
Author's own elaboration

Finally, it may be worthwhile to suggest again that a proper consideration should also be given to the use of hydrated ethanol in departments of the Jungle region where it is produced for local consumption, as an alternative to power modified light vehicles such as motorcycles and moto-taxis.

Figure 21. Peru: mandatory blending of anhydrous ethanol by regions



Source: Supreme Decrees Nº 021-2007-EM, Nº 091-2007-EM, Nº 061-2007-EM, and Nº 024-2007-EM. Author's own elaboration.

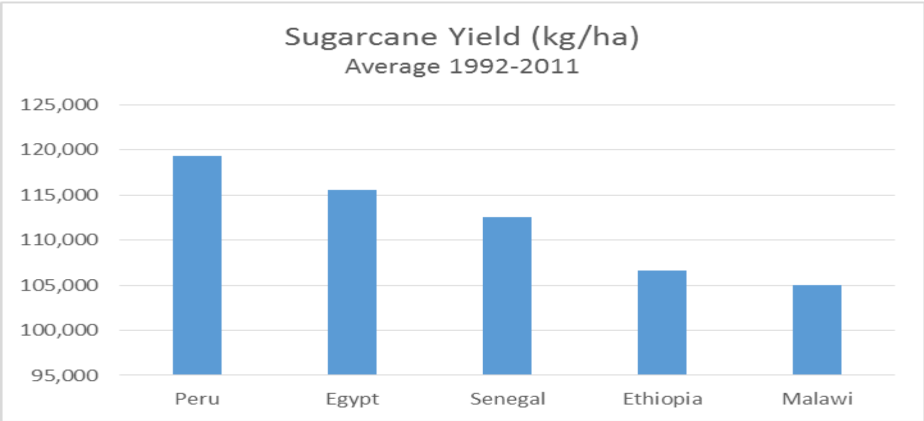
Chapter 5. Current Status and Challenges

5.1 Production of Ethanol

Lacking special tax incentives or subsidies acting on the supply side, the main driver for the introduction of ethanol into the energy matrix of Peru has been the creation of demand by means of enacting a mandatory blend with gasoline consumed in the country.

The most used crops in the world for the production of first generation ethanol are those with high concentration in sugars, or those with high concentration of starch. Thus, ethanol is mostly produced from maize, sugarcane, beetroot, and sorghum (DGCA, 2009). In Peru, initial studies (e.g., Ocrospoma, 2008) acknowledged the potential of different crops for the production of ethanol, such as sweet potatoes and sorghum, among others. However, favorable climatic conditions for the cultivation of sugarcane in the coast of Peru, a long tradition of sugarcane production in the country, and the correlated pre-existence of know-how, determined sugarcane as the preferred alternative for entrepreneurs, leading to a clustered and mono-source production of ethanol from sugarcane in the region of Piura. International evidence also suggests that sugarcane provides the lowest production cost. It has the highest productivity per hectare, needs simpler processing than comparative crops such as corn or sugar beet, and the bagasse may be used for energy generation in the plant that produces ethanol (S.I. Mussatto et al., 2010), as it is done in the case of projects in Peru.

Figure 22. Comparative sugarcane average yields per hectare 1992 – 2011



Data source: FAO

Due to its extraordinary climate and soil conditions in the coast, Peru has one of the world's highest sugar-cane productions yields per hectare. As reported by FAO for the period 1992 -2011, the productivity of the sugarcane in Peru reached and average of 119,369 Kg. per hectare, followed by Egypt with 115,553 Kg. per hectare, and Senegal with 112,522 Kg. per hectare (See Figure 22). Nevertheless, the productivity during the same period varies from region to region in the coast, from a lower 104,099 Kg. per hectare in the south to above 141,218 in La Libertad on the north coast of Peru (MINAG, 2013).

The literature also reports that production reaches 180 Tn. per hectare in well-managed fields (Schweizer, 2009). This high productivity is consistent with previous yields reached in the 70s in Peru (average of 170 Tn. per hectare) (CEPAL, 2007), before the imposition of the agricultural reform carried out by the socialist dictatorship of President Velasco, which contributed to a historic decline in the industry in terms of productivity. It is also important to mention that the projects aimed at producing ethanol on the north coast, using advanced techniques, are achieving production levels as high as 200 tons per hectare (RAA, Red de acción en agricultura alternativa, 2011), with an average of 160 tons per hectare (USDA, 2013).

Comparatively, in the case of Colombia, one of Peru's regional competitors, the average yield for sugarcane in the most productive zone of that country (the Cauca River valley) is only 123 tons per hectare, while the average yield in that country is only 92.7 (J.A. Quintero et al., 2008). Similarly, production in Brazil, the world's largest producer of ethanol from sugarcane, reached 76.4 tons per hectare as of 2011 *(Food and Agriculture Organization of the United Nations (FAO), 2013)*, in part due to the fact that the crops in Brazil can be harvested only 180 days per year (USDA, 2013).

Part of the advantages of the coastal region of Peru is that farmers have the capability to cultivate and harvest throughout the 12 months of the year *(PROINVERSION, 2008)*. In addition, the cane has a high sugar content of up to 16 % due to the differences in temperature between day and night, and the region has the advantage of closeness to markets and harbors (Schweizer T., 2009).

Production from sugarcane has again shown significant increases, due to better agronomic practices, more discipline in the workplace, and large private investments in equipment and research. As a result, with the current number of cultivated hectares of sugarcane, Peru is capable of satisfying its needs for sugar, for industrial and domestic alcohol, and for anhydrous ethanol for mixing with gasoline (Loebl Ari, 2011).

In terms of production costs, ethanol from sugarcane from the Peruvian coast has been estimated at between USD $0.25 and $0.34 per liter (FAO, 2010), depending on the origin of the raw material. The lower cost is reached when the raw material is supplied by commercial agriculture, and the higher coast is reached when 40% of raw material is supplied by small farmers. These costs are still competitive if compared with other ethanol producing countries (See Table 7)

Specifically, anhydrous ethanol is produced by two privately owned operations in Peru, each at different stages of productive activity. These are

Caña Brava and *Maple*, both located on the north coast of the country in the department of Piura, and one additional project is currently under development in the same region.

Table 7. Ethanol: cost per liter in USD cents

Ethanol cost per liter in USD Cents per liter (pre taxes)		
Ethanol from sugarcane Brazil	23-29	a
Ethanol from corn EEUU	53	a
Ethanol from sugar beet France	60-68	b
Ethanol from whey New Zealand	42-49	b
Ethanol from sugarcane Peru	25-34	c
Ethanol from wheat Europe	42	b

Data source: a: Balat et al. 2009, b: Mussatto et al. 2010, c: FAO, 2010
Author's own elaboration

These projects have been mainly developed on previously unproductive land[43] by utilizing advanced systems for droplet irrigation, which is 98% efficient compared to the 55% efficiency rate of gravity irrigation (FAO, 2010). Production is made using the diffusion method, which is broadly used in Brazil, and is more efficient than traditional milling, as it employs a

[43] According to the current legislation in Peru, article 3rd of Legislative Decree 994 defines as unproductive land, or "*Tierras Eriazas,*" those with agricultural suitability that have not been exploited due to the lack or excess of water. In the case of the Peruvian coast, they operate on land not exploited due to the lack of previous irrigation.

continuous flow that reduces idle time to a minimum (USDA, 2013). The existing projects may reach 35,000 hectares when completed.

In terms of job opportunities, these projects are calculated to provide around 5,200 direct jobs and more than 16,000 indirect ones. These numbers, in terms of employment, represent an increase of roughly 24% of the pre-existing direct jobs in the sugarcane industry, which were estimated at 21,450 at the ten sugar producing complexes of Peru (Castro et al., 2008). In that sense, the new ethanol industry has helped in real terms to fulfill some of the stated purposes of the legislation, namely contributing to employment generation and helping to improve the conditions of the rural sector in that region.

Caña Brava, which started operations in 2009 with an investment of $210 million US dollars, is currently the largest ethanol producer in Peru (USDA, 2013). With 3,540 hectares acquired from the Peruvian government and 2,617 acquired from private parties, a total of more than 6,000 hectares is available for sugarcane cultivation, with projections to expand crops to 8,000 hectares. (RAA, Red de acción en agricultura alternativa, 2011). Currently, this provides 2500 direct jobs and 800 indirect ones (Gomero Osorio, 2011). Processing of feedstock by Caña Brava is conducted internally in a processing plant with a capacity of around 350,000 liters per day.

Maple, through its subsidiaries Maple Ethanol and Maple Biocombustibles, with investments of $280 million (USDA, 2013), has acquired 10,676 hectares from the government and around 4,637 hectares from other parties, for a total of more than 15,000 hectares for sugarcane cultivation. Under the contract signed with the Peruvian government for the sale of the land, a condition was included for the generation of direct jobs for 1,000 people and indirect jobs for other 7,000 people (Gomero Osorio, 2011). The project includes its own industrial plant for processing ethanol, with a capacity of around 415,000 liters per day (RAA, Red de acción en agricultura alternativa, 2011)

The third player is COMISA – Corporación Miraflores S.A, a project also located in the same area. The project includes plans to develop sugarcane cultivation in three different stages, beginning with an initial cultivation of 6,000 hectares, and growing to a total cultivated area of sugarcane of 20,000 hectares (Corporación Miraflores S.A, 2012). This project would give 1700 direct jobs and 8,000 to 9,000 indirect ones (Gomero Osorio, 2011)

In terms of future expansion in the region, the potential for sugarcane cultivation has been estimated at 200,000 hectares (USDA, 2012) (FAO, 2010), as very suitable under the current conditions of water infrastructure, using droplet irrigation techniques at unused land in the coast of Peru.

Another 70,000 hectares qualifies as suitable and an additional 59,000 as moderately suitable[44].

Since the main development of these crops utilizes mostly previously unused land, major conflicts derived from land competition, addressed as a concern by the academic literature, are minimized in the case of ethanol in Peru.

The possibility also exists for expansion of the agricultural frontier into the Amazon basin, in the jungle region, using deforested land, where around 4,7 million hectares are considered as very suitable, and around 400,000 as suitable for farming sugarcane to obtain anhydrous ethanol in large farms or by small and medium producers (FAO, 2010). Notwithstanding, as in the case of cultivation of palm oil for the production of biodiesel, it must be acknowledged that investors in sugarcane in the jungle would likely face the same difficulties associated with the lack of road infrastructure and land tenure confronted by palm oil producers. In that sense, the involvement of regional governments and the required support of the central government are needed to improve the current conditions for investment in the jungle region.

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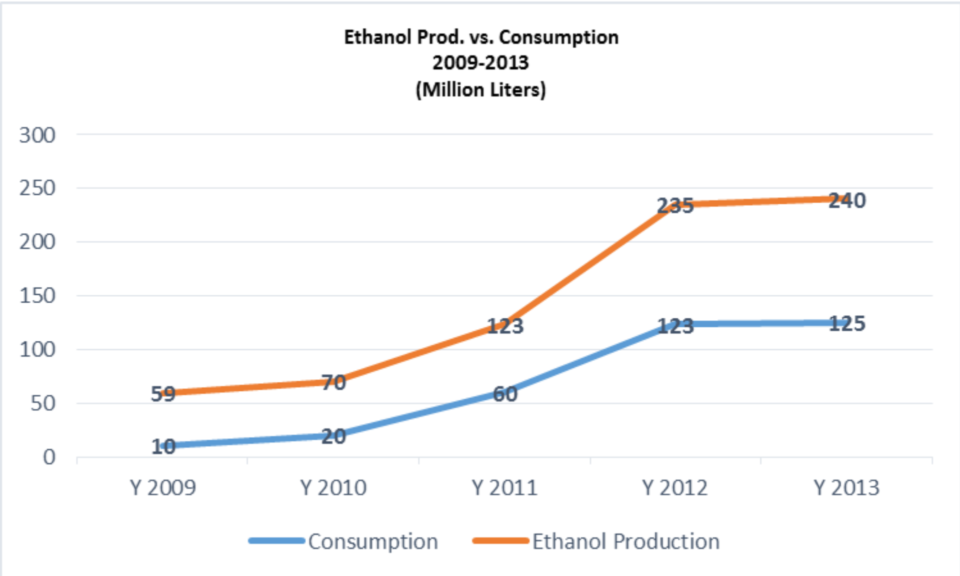
[44] A very suitable land has yields ranging from 80% to 100%, a suitable land from 60% to 80% , and moderately suitable land from 40% to 60%.

Since the introduction of the blending mandates, production of ethanol has been higher than the domestic demand, making Peru a net exporter of ethanol, with European countries as the main destination.

Currently, while the ethanol consumption is forecasted at 125 million liters for the year 2013, the production for the same year is estimated at 235 million liters (USDA, 2013), surpassing 84% of the internal demand, a difference that will be further increased when the existing projects reach their maturity (See Figure 23)

Figure 23. Peru: Anhydrous ethanol production vs. consumption 2009 – 2013



Data Source: USDA. Peru Biofuels Annual (07/08/2013)

Similarly, as observed from Table 8, the participation of the domestic ethanol as percentage of the domestic consumption has gradually been increasing from a minimal participation in 2009 to a production that is able to cover, in excess, the domestic demand.

Concerning the projected demand of ethanol, even in the very unlikely case that the domestic production would not increase from the currently estimated 240 million liters, current production still would be sufficient to cover, and exceed, the domestic demand for the next decade.

Table 8. Peru: Balance of anhydrous ethanol 2009 – 2013

YEAR	2009	2010	2011	2012	2013
Ethanol Production	59	70	123	235	240
Ethanol Import	14	12	13	15	20
Ethanol Exports	58	64	51	126	135
Consumption	10	20	60	123	125

Data source USDA. Peru Biofuels Annual (07/08/2013)

Taking into account the scope of the existing projects, and considering an average yield of 110 liters of ethanol per ton of sugarcane, and the average production of 160 tons per hectare in the region, the domestic demand for the next decade could be covered by a fraction of the existing projects. Similarly, the required production may be covered by an even smaller fraction of the total potential land presently available for sugarcane cultivation on the coast (See Table 9).

As a result, an increases in the existing blend could be addressed by the Peruvian government, in order to reach percentages of 10% or even above. The increase, if high blends such as those in Brazil, Colombia (voluntary blend) and Paraguay are adopted, would require the introduction of flex-fuel vehicles, as in the case of these countries, by means of granting incentives on the purchase of these means of transportation.

Table 9. Peru: Gasoline demand, required cultivated land for a 7.8% blend and comparison with cultivated land of existing projects and potential, up to year 2023

Year	Gasoline Demand	Ethanol Demand (7.8%)	Required Cultivated Land	Existing Projects	Potential
	(Million Liters)	Million Liters	Has.	Has.	Has.
Y 2015	2,110	165	9,351	43,000	200,000
Y 2016	2,152	168	9,537	43,000	200,000
Y 2017	2,217	173	9,825	43,000	200,000
Y 2018	2,283	178	10,118	43,000	200,000
Y 2019	2,352	183	10,424	43,000	200,000
Y 2020	2,422	189	10,734	43,000	200,000
Y 2021	2,495	195	11,057	43,000	200,000
Y 2022	2,570	200	11,390	43,000	200,000
Y 2023	2,647	206	11,731	43,000	200,000

Data Source on Gasoline demand: USDA. Peru Biofuels Annual (07/08/2013)
Estimates on cultivated land, considering average yield per hectare. Author's own elaboration

It is worth noting that Brazil has a adopted a flexible blend that ranges between 18–25%, which is set by the authorities in charge, reducing to a great extent its dependence on fossil fuel. Since 2003 and until June 2010, because of the promotion policies existing in Brazil, more than 11 million flex-fuel vehicles have been sold in that country, amounting to 37% of the total fleet of light vehicles (Scarlat et al., 2011). As the literature acknowledges, flex-fuel vehicles have been a key element in the success of the ethanol industry in Brazil, since these vehicles are able to run on almost any blend of gasoline and ethanol. This brings about a great flexibility at the moment of refueling (Pin Koh et al., 2008), and allows the authorities a great flexibility for setting and adapting the authorized blends to the variable conditions of the market.

Nevertheless, it should also be noted that that the main limitation for further expansion of sugarcane cultivation on the coast of Peru is the future availability of water resources. Measures for the use of alternative sources of water must be evaluated, as well as incentives for changing obsolete practices of irrigation in use in traditional agriculture.

5.2 Challenges for Ethanol Development

Currently, the production of ethanol from sugarcane does not compete with the manufacture of sugar, and its expansion has been based mostly on previously unused land ("*tierras eriazas*"), which reduces the problems of biofuel/food competition and the competition for land. Nevertheless, one of the problems for the future expansion of crops in the coast may be assuring the sufficient provision of water for irrigation.

Regarding environmental impacts, the literature acknowledges that ethanol produced from sugarcane is more efficient for the decrease of GHG in terms of reduced CO_2 emissions, when expressed per unit of land and when compared with other bioenergy options, such as bagasse, corn, or sugar beet or with fossil-based fuels. Soil erosion is also limited and the use of mineral fertilizers is not identified as an area of concern (Smeets et al., 2008)[45]; therefore, from an environmental point of view, an argument could be made that the ethanol industry in Peru may not currently represent a major risk. Nevertheless, it is advisable that the environmental authorities should carry out an on-site assessment to evaluate the impacts of the industry.

As mentioned, no conflicts are currently in evidence between the sugar production in Peru and the use of sugarcane for the production of anhydrous ethanol (Loebl Ari, 2011). In fact, projects carried out on the north coast of Peru are specifically aimed to produce anhydrous ethanol, while the

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[45] As indicated before, some studies indicates that burning ethanol instead of gasoline reduces carbon emissions by more than 80% while eliminating entirely the release of acid rain causing sulfur dioxide (S.I. Mussatto et al., 2010)

preexistent agro industry of sugarcane, on the rest of the coast, is focused on the production of sugar and other types of alcohol.

One of the reasons for this outcome is that the preexistent sugar agroindustry is favored by the Agriculture Promotion Law (Law Nº 27360) that grants the sugar companies located outside the capital city of Lima a reduction in the Income Tax from 30% to only 15%, as long as they utilize at least 90% domestic feedstock. Since anhydrous ethanol is not included among the agricultural products, this benefit would be lost if these sugar producers opted to shift to ethanol production. Consequently, these companies have not ventured into ethanol production activity (García, 2013).

Table 10. Peru: Sugarcane – cultivated area, years 2005 - 2012

Region	YEARS							
	2005	2006	2007	2008	2009	2010	2011	2012
Ancash	5,879	5,591	5,588	5,955	5,105	5,174	5,132	5,684
Arequipa	670	664	769	903	690	638	539	599
La Libertad	24,760	27,056	29,135	28,731	32,367	34,235	37,454	37,067
Lambayeque	18,061	20,047	20,002	21,609	25,927	26,773	25,317	25,710
Lima	12,179	12,488	12,459	11,928	11,260	10,163	11,627	12,089
TOTAL Has.	**61,549**	**65,846**	**67,953**	**69,126**	**75,349**	**76,983**	**80,069**	**81,149**
Var %		7.00%	3.20%	1.70%	9.00%	2.20%	4.00%	1.30%

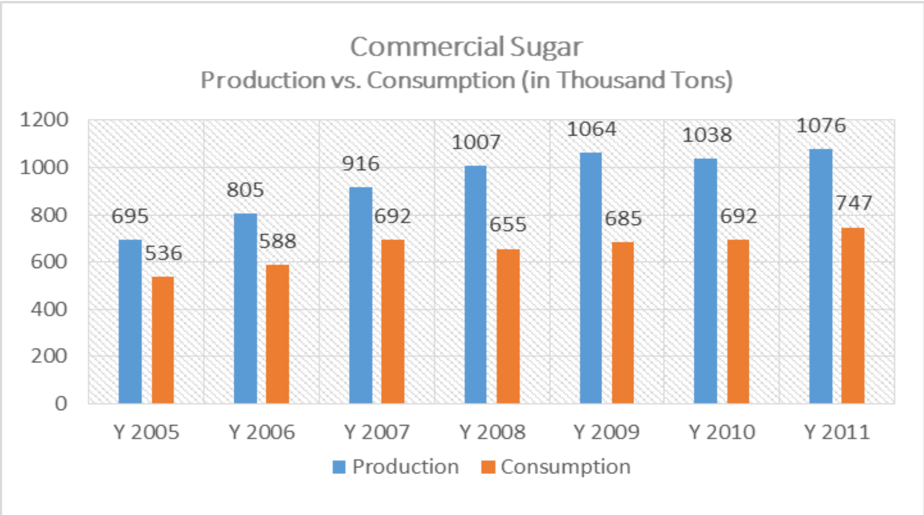
Source: MINAG –Ministry of Agriculture

In fact, during the past few years, the total area cultivated with sugarcane in other departments has increased from 61,549 hectares in 2005 to 81,49 hectares in 2012, representing a growth of 31% in six years (See Table 10).

Peru is now self-sufficient in sugar, as it was until the late sixties (Loebl Ari, 2011).

Because of this constant increase, the production of commercial sugar has been higher than the domestic consumption, despite the fact that the latter also increased from 535,991 tons in 2005 to 746,506 in 2011. Specifically, the commercial balance of imports and exports of the product "*sugar from cane*"[46] represented a positive balance for the Peruvian production (MINAG, 2013), surpassing the domestic demand of the same product (See Figure 24).

Figure 24. Peru: Commercial sugar – production vs. consumption 2005 - 2011



Source: MINAG –Ministry of Agriculture

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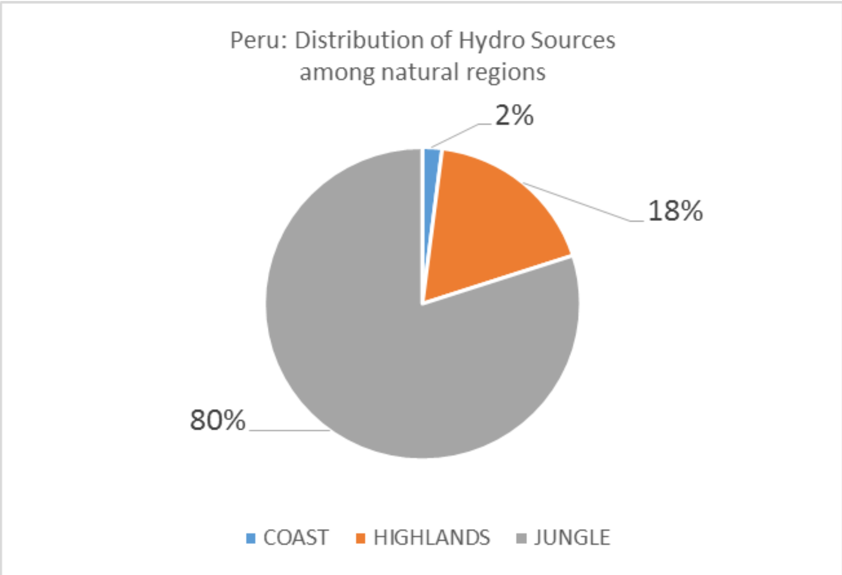
[46] Product classified by the tariff system under the code : 1701119000

Therefore, no competition of ethanol with the production of sugar as a source of food currently occurs on the Peruvian scene. Nevertheless, the real threat to the expansion of ethanol production is the future availability of water resources. The Peruvian coast is warm and dry because of the Humboldt Current and because of the influence of the Andes mountains over the flow of hot and wet air of the Amazon region (Ingenieria sin fronteras, Asociacion para el desarrollo, 2011); both phenomena have an impact on the lack of rain and water availability in the coast.

Peru ranks 17th among 180 countries in terms of surface water availability (CEPAL, 2007), but the distribution of these sources among the three different natural regions (coast, highlands, and jungle) is far from uniform. The coast is the region with the lowest availability of surface water, representing only 2% of total. In comparison, the other two natural regions (highlands and jungle) account for 98% of total surface water sources in the country (See Figure 23 below).

Likewise, the geographic conditions of the Peruvian coast limit the availability of rain, which is scarce compared with the other natural regions, and is not sufficient to sustain crops without the help of additional (surface or subterranean) water resources.

Figure 25. Peru: Distribution of surface water sources among natural regions



Data source: IICA. Author's own elaboration

While precipitation in the jungle reaches an annual volume of 3,000 to 4,000 mm, precipitation on the coast reaches only 40 mm, which is not sufficient to allow proper cultivation of sugarcane (See Table 11). If rainfall is used for sugarcane cultivation, as in the case of Brazil, where that crop is mainly rain-fed in its most productive area (Sao Paulo), the estimated rainfall requirement is 1,500 to 2,500 mm per year (Goldemberg et al., 2008), a situation not feasible on the Peruvian coast. As a result, the production of sugarcane crops in non-irrigated lands on the Peruvian coast is practically nonexistent.

Table 11. Peru: Characteristics and annual average of rain per climatic area

Region	Altitude (M. above sea level)	Annual Average Temperature (Celcius)	Rain: Annual Average (mm)
Coast	0 - 500	18 - 20	40
Highlands	500 - 6,780	8 - 11	600
Jungle	400 - 1,000	24	3,000 - 4,000

Data source: FAO

In addition, despite this uneven distribution of hydro sources, the Peruvian coast is the region with the largest consumption of water, due to the concentration of population and economic activities in that region. This situation may limit the future expansion of the biofuels industry in Peru, unless an improved use of the scarce water resource is achieved (See Table 12).

Consequently, careful planning for the use of the scarce water resources in the coast is needed, as well as reorienting the actual use of inefficient techniques of traditional agriculture that are used on 40% of the cultivated land of the coast. So far, all the projects for the production of ethanol have incorporated advanced systems for droplet irrigation, which is 98% efficient compared to the 55% efficiency rate of gravity irrigation (FAO, 2010) used in traditional agriculture.

Table 12. Peru: Availability and use of surface water per climatic area

Region	Area Km2	Population (Millions)	Water availability (in Million m3)	Water availability per person (in m3)	Used water * (in Million m3)
Coast	141,373.65	14,249,411	**43,596.79**	3,059.55	**15,557.80**
Highlands	332,155.90	9,116,029	367,716.60	40,337.37	3,035.67
Jungle	809,685.45	3,782,631	1,634,296.00	432,052.72	379.46

* Including use by population, agriculture, mining, industry and livestock

Source: IICA

As highlighted by the FAO, the inefficiency may by be due to a combination of factors including the absence of an effective measure of consumption and poor payment control systems, factors that have weakened – and in some cases eliminated – incentives for maintenance and repair of water distribution systems. This situation has not encouraged the replacement of outdated methods of gravity irrigation by the incorporation of more efficient irrigation techniques.

5.2.1 Suggested Courses of Action

The improvement of the current situation would require the implementation of a series of mechanisms in the management of the resources, as well as governmental intervention.

As indicated by the literature, the benefits of moving away from hydrocarbon-based fuels to biofuels are tied closely to a nation´s capacity to provide the infrastructural resources to support a biofuel industry (M.B. Charles et al., 2007).

Attention should be paid to the following activities:

- Improvement of control and payment systems for the use of water in agriculture. In this sense, a review of the existing use of water for productive activities should be addressed. Water resources must be considered as a resource with economic value. At this point, it is worth taking the legislation for water resources use in Sao Paulo, Brazil as an example. The Sao Paulo state Law Nº Nº 7,633 provided the basis for the legislation that promotes the efficiency in water use, based on the "*user-payer*" and "*pollutant-payer*" principles. According to these principles, the amount used, as well as dumping of pollutants into the water, is considered to determine the price of the resource (Smeets et al., 2008). Therefore, since the payment depends on the amount and quality of water that is collected and later released, it has in fact incentivized an efficient use of the resource, as well as the development of an environmentally friendly activity. A technical committee sets the price in the Brazilian case.

- Providing technical assistance and financial support or subsidies for the conversion of customary and inefficient gravity irrigation systems used in traditional agriculture into more efficient methods. Even when the initial cost for the deployment of advanced systems of irrigation is high, the benefits of reduced use in the next years should bring an overall benefit, and compensate the investment on the basis of the reduced payment for the resources.
- Consumption of underground water, which is currently not used or sub-utilized on the coast. According to the Ministry of Agriculture, underground water has not been sufficiently studied and is scarcely exploited, presenting a potential for adding 7,618 Million m^3 for the expansion of the agricultural land (MINAG, 2007). This may represent an additional 50% to the currently used surface water resources.

  This may require analyzing the possibility that future projects be asked to invest in the study and use of underground water as a requirement for obtaining the permits for carrying out the activity.
- Development of additional water reservoirs, as well as proper maintenance of existing ones. Currently, a large portion of surface

water from rivers is lost into the Pacific Ocean, and some of the most important existing reservoirs are working with a reduced storage capacity. The Poechos reservoir, an important source of water on the north coast, has 50% of its capacity covered with sediment, reducing its water volume.

- As an additional step, the government should take an active role in pushing for financing R&D aimed at exploring a diversification of feedstock crops that the scientific literature considers to require lower quantity of water, such as sorghum, as alternatives for the production of biofuels.

5.3 Production of Biodiesel

The most commonly used crops for the production of biodiesel in the world are rapeseed, sunflower, soybeans, and palm oil (Jay J. Cheng et al., 2011). In fact, rapeseed (canola) is the dominant feedstock for biodiesel in Europe, while soybean is the basis for the production of biodiesel in the United States and Argentina. Warmer countries, such as Malaysia, Indonesia, Thailand, and Colombia, rely on the production of biodiesel from palm oil, due to the productivity of that crop in their climatic environments.

In Peru, most domestic production of biodiesel is currently made from a single feedstock: palm oil, which is cultivated in the jungle region, with a concentrated production in the department of San Martin. Even when the climatic conditions of the country were considered, by early academic studies, as suitable for the production of different crops such as canola, soy, jatropha, and palm oil, investors opted for the crop that produces the highest yields of feedstock per hectare under the existing conditions in the country: palm oil. In fact, palm oil has a higher production per hectare, if compared with the rest of oleaginous products (Ocrospoma, 2008), (Corley, 2009)[47], and was the only crop that had a consolidated technological package (García, 2013).

Palm oil has a cheaper production costs when compared to other vegetable oil sources. It is praised by part of the literature as the crop with the potential to be the source of fats and vegetable oil to feed the people around the globe, as well as it is considered as the most suitable candidate among all vegetable oils as source of biodiesel production (K.T Tan et al., 2009)

While other crops, such as jatropha, were considered in Peru as an alternative for degraded soils, it is still required to conclude investigations to

[47] An interesting example on the yields per hectare is made by Corley (Corley, 2009). Corley calculates the required additional land for supplying the world´s need of edible oil. In that case, palm oil would require only additional 19 million hectares, while soybeans would require additional 95 million hectares.
The average yield of palm oil, according to K.T. Tan is 4.2 tons per hectare, while rapeseed produces only 1.2, and soybeans 0.4 tons per hectare (K.T. Tan et al., 2009).

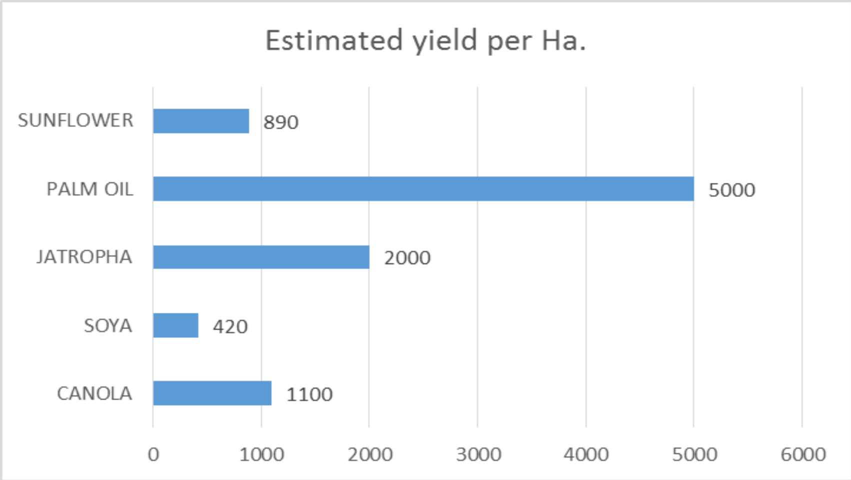
determine the adequate technological package for their production at large scale (RAA, Red de acción en agricultura alternativa, 2011). Currently it has been estimated that around 400 hectares of demonstrative crops of jatropha are developed in the San Martín region with assistance of the international cooperation, but there is not yet major commercial production.

According to the literature, palm oils has an estimated production ranging from 4,000 to 5,000 liters of raw material for biofuels per hectare, compared to jatropha that yields from 1,590 to 2,000 liters of raw material per hectare and canola with around only 1,100 liter per hectare (See Figure 26).

In the case of palm oil, the final production of biodiesel from the raw material has also been estimated at around 87.16% (Ocrospoma, 2008)

As result, domestic biodiesel in Peru today is based on palm oil cultivated in the jungle region. The largest biodiesel producer in Peru is Palmas Del Espino, with 7,357 hectares of palm oil in the San Martin Region, and currently establishing new sites, just under 10,000 hectares, in the same region to increase its palm production. Another producer is Heaven Petroleum, and together these account for more than 90% of biodiesel production in Peru (USDA, 2013).

Figure 26. Estimated yields per hectare – different crops (in liters)



Sources: Sunflower, Soy and Canola: Ocrospoma. Palm Oil, Jatropha: Calle.

Nevertheless, the current production of biodiesel falls below the domestic demand, not meeting the needs for the 5% blending mandate that has been in force since 2011, or even contributing a considerable percentage of that blending. In practical terms, this situation has shifted the dependence on foreign oil to a new dependence on foreign biodiesel to meet the blend rules, raising questions about the fulfilment of the objectives of the law for the promotion of biofuels, mainly in terms of energy independence.

As shown in Table 13, even when the domestic production of biodiesel has increased in the last years, it was only able to cover less than 20% of the total demand.

Table 13. Peru: Balance of biodiesel (Million Liters) 2009-2013

YEAR	2009	2010	2011	2012	2013
Biodiesel Production	10	32	32	56	56
Biodiesel Import	166	162	178	238	228
Biodiesel Exports	0	0	0	0	0
Consumption	175	195	210	271	283

Data Source: USDA. Peru Biofuels Annual (07/08/2013)

Moreover, considering that the demand for biodiesel is expected to increase over the next years, while the existing projects are still limited in scope, the dependence on foreign products will likely be higher than today. This situation requires a review of policies, and improvement of the existing conditions of the productive regions.

Table 14. Peru: Biodiesel demand. Estimation of required cultivated land for different blends

Year	Forecasted Diesel Demand	Current blend 5%		Blend 2%		Blend 20%	
		Biodiesel Demand (5%)	Required Cultivated Land	Biodiesel Demand (2%)	Required Cultivated Land	Biodiesel Demand (20%)	Required Cultivated Land
	(Million Liters)	Million Liters	Has.	Million Liters	Has.	Million Liters	Has.
Y 2015	6,035	302	69,240	121	27,696	1207	276,962
Y 2016	6,216	311	71,317	124	28,527	1243	285,268
Y 2017	6,340	317	72,740	127	29,096	1268	290,959
Y 2018	6,467	323	74,197	129	29,679	1293	296,788
Y 2019	6,597	330	75,688	132	30,275	1319	302,754
Y 2020	6,728	336	77,191	135	30,877	1346	308,765
Y 2021	6,863	343	78,740	137	31,496	1373	314,961
Y 2022	7,000	350	80,312	140	32,125	1400	321,248
Y 2023	7,140	357	81,918	143	32,767	1428	327,673

Data Source on Diesel demand: USDA. Peru Biofuels Annual (07/08/2013)
Estimates on cultivated land, considering average yield per hectare. Author's own elaboration.

To cope with the internal demand, a massive increase in land cultivated for palm oil would be required, as shown in Table 14. Alternative scenarios with blending at 5%, 2%, and 20% are included, considering average yields per hectare of palm oil. The scenario of increasing the blending mandate to 20%, one of the alternatives currently present in the text of the Law, would require almost quadrupling the total cultivated area of palm oil in the country (presently around 57,752 hectares). Similarly, maintaining the status quo of a 5% blending mandate would also require an important growth of the total area cultivated for palm oil, leaving the production for human consumption practically out of the scene. Compared to those scenarios, a blending mandate of 2% may represent a more reasonable option, even when it would also require a growth of the cultivated area dedicated to the production of biodiesel feedstock.

Therefore, the main task to be addressed is the increase in cultivated land, whereas at the same time a careful review is required of the blending mandates in force.

5.4 Challenges for Biodiesel Development

The ethanol industry has been able to cover, in excess, the domestic demand, with the future availability of water on the coast as its main challenge. In contrast, the biodiesel industry is faced with a more complex scenario. Current production is not able to meet the existing demand, and a potential competition with the supply of oil and fat for human consumption may develop.

The cultivated land required to produce biodiesel from palm oil is higher than that existing now. In fact, according to the Ministry of Agriculture, by 2012, the total area cultivated with this crop was only 57,752 hectares, with around 56% of that total (32,567 hectares) in production while the other 44% is still in process of growing and expected to produce in coming years (MINAG, 2012). At this point, we must take into account that the production of palm oil starts from the third year, reaching higher productivity later, as it is a perennial crop, unlike soy or other crops that have a shorter cycle and require an annual renewal (MINAG, 2012). In fact, as the Colombian legislation correctly acknowledges in its promotion framework, palm oil trees are "*slow growing crops*", and therefore, incentives may be required to compensate for the time that elapses between when the initial investments are made and when the productive period starts.

Due to the need for a tropical climate with warm temperatures and regular rainfalls of more than 1,800 mm. per year, production is only possible in the rainforest region (Schweizer, 2009). In the case of Peru, these conditions exist in the jungle region, such as in the departments of San Martin, Ucayali, Loreto and Huánuco, where most of the palm oil crops are located (See Table 15). However, despite the increase in the cultivated land in those areas over the past six years, a difference still exists with the number of hectares that would be required to produce enough biodiesel to cover the domestic demand for the existing 5% blending mandate (above 60,000 hectares). Therefore, as easily becomes evident, a large deficit exists.

The case is worsened when considering that Peru is currently a country with a deficit in the production of oils and fats for human consumption. Thus, in order to meet the current demand, Peru must import these products from other countries. Currently, Peru is a net importer of oils and fats for domestic consumption (MINAG, 2012), and as it has been warned of a potential risk that the production of oil for bioenergy purposes may end up competing with use for human feeding (Schweizer, 2009).

Table 15. Peru: total cultivated land with palm oil 2006 – 2012

Region	Y 2006	Y 2007	Y 2008	Y 2009	Y 2010	Y 2011	Y 2012
San Martin	15,880	21,680	25,051	25,611	28,657	28,657	28,657
Ucayali	6,641	10,341	13,102	13,741	12,699	13,741	14,741
Loreto	1,250	1,250	1,610	5,900	7,844	11,613	13,354
Huanuco		232	732	1,000	1,000	1,000	1,000
TOTAL	**23,771**	**33,503**	**40,495**	**46,252**	**50,200**	**55,011**	**57,752**

Data Source: Ministry of Agriculture.

One way to analyze the current situation is shown in Table 16, which compares the volumes of palm oil imports, which vary between 24,000 and 37,000 tons per year, with the local production of the same product. The results are clear: considering only this product as a source of oil and fats, the domestic production represents, on average, around 65% of the total domestic demand, with the difference covered by imports. The risk, then, is that part of the production, usually destined for human consumption, may end up transformed into biodiesel if prices for that product are more attractive for farmers, since the current legislation has not set any prohibition to that practice.

Table 16. Peru: Oil from palm: imports, local production and local demand 2007 - 2012

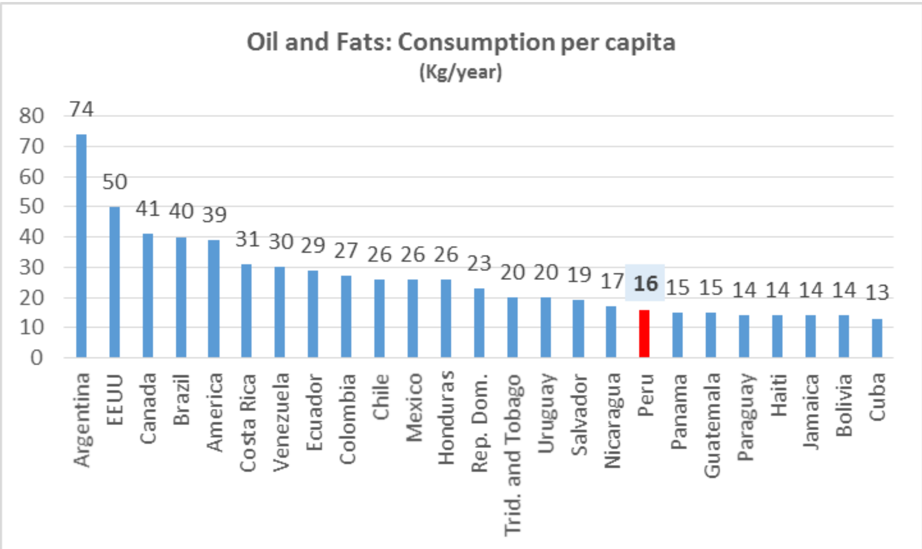
YEAR	Imports	Local Production	Local Demand	% Imports
Y 2007	23,667	47,680	71,347	33.17
Y 2008	37,294	49,280	86,574	43.08
Y 2009	34,553	53,660	88,214	39.17
Y 2010	31,088	58,360	89,449	34.76
Y 2011	40,851	71,957	112,808	36.21
Y 2012 *	24,694	79,926	104,620	23.60

* Up to october 2012

Data Source: Garcia 2013

In addition, total consumption of oil and fats is in Peru is higher than the portion covered by the sum of palm oil and the production from other sources , such as cottonseeds and fish, which accounts for an average of around 32,000 tons per year, as we observe from statistics of the Ministry of Agriculture (MINAG, 2012). According to official data from the Ministry of Agriculture, human consumption of oil and fats in Peru represents around 16 kg per year, one of the lowest in the continent, and below the world average of 25.2 kg in the same year (See Figure 27). Therefore, it is naturally expected that an improvement in the economic conditions of the population could lead, in the near future, to an increase in the consumption of oil and fats per capita, a situation that could in turn push the competition with biofuel production even further.

Figure 27. Comparative: oil and fats – consumption per capita



Data Source: MINAG 2012. Average years 2010-2011

As forecasted by the Ministry of Agriculture, consumption of oil and fats is expected to grow from 465,000 tons in 2,012 to 624,032 in 2,020, which would also require an increase in the domestic provision of oil from palm oil, in addition to that required by the biodiesel industry.

Table 17. Peru: Oil for human consumption: forecasted demand, production from other sources and required hectares of palm oil crops 2013 - 2021

YEAR	Y 2013	Y 2014	Y 2015	Y 2016	Y 2017	Y 2018	Y 2019	Y 2020	Y 2021
Human Consumption: Forecasted Oil demand (in Tns.)	465,000	488,250	512,663	538,296	554,444	571,078	588,210	605,856	624,032
Prod. other sources of oil (in Tns.)	32,000	33,280	34,611	35,996	37,435	38,933	40,490	42,110	43,794
Difference	433,000	454,970	478,052	502,300	517,009	532,145	547,720	563,746	580,238
Palm 60%	259,800	272,982	286,831	301,380	310,205	319,287	328,632	338,248	348,143
Required Has.	51,960	54,596	57,366	60,276	62,041	63,857	65,726	67,650	69,629
Palm 100%	433,000	454,970	478,052	502,300	517,009	532,145	547,720	563,746	580,238
Required Has.	86,600	90,994	95,610	100,460	103,402	106,429	109,544	112,749	116,048

Data: MINAG. Considering optimum yields per hectare, and constant increase in production of other sources.

Now, to cover the forecasted domestic consumption, we may calculate that even with coverage of only 60% of total demand, the required land cultivated for palm oil would need to be increased. In fact, as shown in Table 17, considering the forecasted demand for oil and fats, and using the optimal average yields of oil from palm, the required cultivated land greatly exceeds that covered by existing crops. Moreover, if we wanted to consider covering

100% of the oil and fat demand, the cultivated hectares required would need to increase substantially.

Then, in order to cover both human needs and biodiesel, around 189,940 hectares of palm oil would be required by 2020, considering a blending mandate of 5%, and around 143,626 hectares if we consider a blending mandate of 2%. In both cases, the increase in cultivated land would be higher than that achieved in previous years.

On the other hand, the existence of land does not seem to be the main obstacle. Instead, the current conditions of the existing framework, as mentioned in the previous chapter – and the poor infrastructure that hinders the spread of growth to Peru's non-coastal areas (Index Mundi, 2013) – represent barriers for further development.

In terms of land availability, we may consider that according to reports from the Ministry of Agriculture, the Peruvian jungle has around 77,535,384 hectares, with a potential for cultivation of palm oil of around 1,135,000 hectares, of which only 57,752 hectares have been used (See Table 18). This represents 0.07% of the total land of the region, and only a tiny 5% of the potential area that is suitable for cultivating palm oil.

Therefore, at least from a theoretical point of view, the required expansion of the cultivated area for complying with a 5% blending mandate, and for covering all the demand for oil and fats, would require the use of only around 16% of this potential.

Table 18. Peru: Potential area for cultivation of palm oil.

Region	Hectares	%
Peruvian Jungle	77,535,384	100%
Potential Area	1,135,000	1.46%
Used area	57,752	0.07%

Data Source: MINAG 2012.

Moreover, studies carried out by the FAO have considered that, at a macro level, the Peruvian jungle have up to 10,231,240 hectares of very adequate land for palm oil, and up to 1,011,420 hectares of adequate land for the same crop. This may present a more optimistic perspective; nevertheless, as acknowledged in the literature, this evaluation has not considered economic, social, or environmental restrictions (García, 2013), and should be taken only as merely referential.

On the other hand, in terms of potential for job generation, we may take into account that the Economic Commission for Latin America and the Caribbean - ECLAC estimate that one direct employment and two indirect employments are generated for every 9 hectares cultivated with palm oil trees (Castro et al., 2008). The expansion of the existing cultivated land to the extension required by year 2020 would then have a potential beneficial impact on job creation. If we follow the ECLAC estimates, 189,940 hectares of palm oil, considering a blending mandate of 5%, would open up the possibility of creating an additional 14,687 direct jobs and 29,375 indirect ones. In turn, 143,626 hectares of palm oil, considering a blending mandate of 2%, would offer 9,541 direct employments and 19,083 indirect ones. These scenarios look attractive in terms of employment generation and in terms of the spillover effect on the rural economy.

Finally, it is also interesting to note that while canola and soy are used in other countries in their transgenic forms, in Peru the current legislation, approved by Law Nº 28811 of 2011, has imposed a ban on the use or production of genetically modified organisms in the country without restricting its scope to food products. Therefore, the prohibition also applies in the case of crops used for the manufacture of biofuels. In that regard, it may represent a disadvantage when compared with countries without this limitation. To cite some examples, the United States has increased almost twofold the biofuel yields from cornstarch because of biotechnological developments and genetic manipulation (M.B. Charles et al., 2007)[48].

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[48]A comprehensive analysis of the potential advantages of transgenic in biofuel crops is found in Gressel's "Transgenic are imperative for biofuel crops," Plant Science 174 (2008) 246 -263.

Similarly, Argentina has tripled its soy production in 15 years after the introduction of genetically modified soy in 1996/1997 (Lamers et al., 2008). That country has reached nearly 100% genetically modified soy crops by 2001, improving yields, reducing herbicide and insecticide inputs, and producing savings of nearly $20 billion (Mathews et al., 2009). Despite the controversy around the use of genetically modified organisms, it is interesting to consider, as Gressel does, that *"plants have not been domesticated for modern biofuel production, and the quickest, most efficient, and often, the only way to convert plants to biofuel feedstock is biotechnologically"* (Gressel, 2008). Further research and discussion on this topic are required.

So far, we may indicate that the main challenges faced by the expansion of cultivated land include:

- Difficulty of identifying land suitable for energy crops:
    - The lack of updated information on the current distribution of the land is a present problem. The last agricultural census in Peru was carried out in 1994; therefore, to some extent, it means that investment decisions may rely on data from a country that existed decades ago. Therefore, a priority task should be to carry out an update on the information on the current use, property, and distribution of the land.
    - The uncompleted Ecological and Economical Zoning (ZEE) that according to the law, should be approved by the regional authorities.

The availability of this instrument would determine the best use of the land for energy crops. Its lack creates a difficulty in making investment decisions, and represents a risk to the assignment of land use.

- Problems associated with land tenure. This problem arises for several reasons, including the fact that the expansion of agriculture is relatively new in the jungle, the presence of the state is still lower, and the territory is broad and sometimes hardly accessible; then, land tenure is perceived as a more serious problem in the jungle than in the coast (DGCA, 2009). In the same sense, an unresolved problem is the instability of the acquisition of property, due to the lack of proper title to the land (SNV, 2009), which creates a serious constraint to attracting investors. The problem is also present in the case of deforested land, which may be subject to claims on previous rights of property. At least one case was reported by the media where land for cultivating palm oil was allegedly granted over an area within the possession of 60 families of a Quechua-Lamita community (SERVINDI, 2013).

At this point, it is worth remembering, as highlighted by Corley (Corley, 2009), that palm oil development is clearly preferable to leaving the land fallow, and decisions need to be made to ensure that development of this land proceeds.

- Problems associated with financial resources to grow and access to credit. The funding of small producers is limited, in part because there are no appropriate financial mechanisms to meet their needs, and partly because, to the extent that small farmers have no formal ownership of land, banks cannot use it as collateral to give credits (DGCA, 2009). As previously indicated, it is worth considering the example of the nearest competitor, Colombia, where the legislation has addressed the fact that palm oil trees are "*slow growing crops*", and therefore assistance is needed during the period elapsing between the initial investment and the productive stage.
- Major problems are the difficulties and high costs of transportation, due to the lack of adequate routes. Those problems are mentioned by investors in the region (e.g., Romero, www.palmas.com.pe, 2012) but also by researches on the topic (e.g., FAO, 2010; SNV, 2009).

  In fact, one of the main problems is the high cost of physical distribution of the product from the farmers to the producers, and in turn to wholesalers and retailers (Binda et al., 2007). According to producers, the lack of adequate routes for transportation and bringing the products from San Martin region to the capital city may represent a similar cost of importing it from Colombia or Ecuador (Palmas, 2011). The last Regional Competitiveness Index, published by the National Council of Competitiveness of Peru in 2013 (CNC, 2013) shows that all the four palm oil producing departments (San Martin, Ucayali, Huánuco and Loreto) are considered below the median of the country. This Index considers, among other factors, the institutional development[49], the infrastructure[50] (including easy access to roads) and the innovation. (See Table 19).

Similarly, the International Development Bank has highlighted the lack of proper road infrastructure in its study on transport in Peru. That study, while considering the routes for exporting products from the different regions, acknowledged that the road density is ten times lower per square kilometer in departments such as Loreto and Ucayali, compared to Lima, and with a low percentage of paved segments. Consequently, according to the same research, improvement of the road conditions would reduce the cost of transportation to a large extent in departments that produce palm oil. Reductions in costs may reach 30% in the case of Loreto, and more than 20% in the case of San Martín and Ucayali (Moreira et al., 2013).

[49] It measures the quality of the regional public management (investment efficiency, tax collection, use of management tools, etc.).

[50] It measures the ease of road and aerial access, and telecommunications.

Table 19. Peru: Regional Competitiveness Index

Regional Competitiveness Index			
Region	Department	Ranking	Index
Coast	Lima	1	0.78
	Moquegua	2	0.72
	Arequipa	3	0.72
	Ica	4	0.71
	Tacna	5	0.64
	Tumbes	6	0.52
	La Libertad	7	0.51
	Lambayeque	8	0.50
	Piura	9	0.48
Highlands	Junin	10	0.47
Coast	Ancash	11	0.46
Jungle	Madre de Dios	12	0.43
Highlands	Cusco	13	0.42
	Pasco	14	0.40
Jungle	San Martin	15	0.36
	Ucayali	16	0.36
Highlands	Ayacucho	17	0.34
	Puno	18	0.34
	Cajamarca	19	0.33
	Apurimac	20	0.31
Jungle	Huanuco	21	0.30
	Amazonas	22	0.30
	Loreto	23	0.29
Highlands	Huancavelica	24	0.26

Data Source: CNC 2013. Author´s own elaboration.

5.4.1 Suggested courses of action

As in the case of ethanol industry, the improvement in the current situation for palm oil cultivation requires governmental participation, in this case mainly by providing infrastructure and an enabling framework.

Attention is required for the following activities:

- Improvement of infrastructure in the jungle region. Improvements in infrastructure, and specifically improvements in the road infrastructure, are required to allow producers to compete with imported oil and fats, as well as imported biodiesel. As mentioned before, the improvement of road conditions may allow a reduction of up to 30% of the costs of transportation for some of the departments with the largest palm oil potential. This could be achieved by means of concessions or by direct investment.
- Addressing the problems of identifying the land suitable for energy crops. This requires updating the agricultural census, which would provide information on property and distribution of the land. Similarly, the Ecological and Economical Zoning (ZEE) requires completion at the regional level and provision of technical support to the regional governments should be considered, including the possibility of assistance from NGOs. In the same sense, a need exists to take action for improving the conditions of land tenure, for which titling procedures should be reviewed and improved.
- Provision of specially designed financial resources for palm oil cultivation should be analyzed, considering the period that elapses between the initial investment and the productive stage, and taking

into account that the lack of proper titling on the land may limit access of small producers to credit from the private financing system.

- Further analysis is required to reduce the risk of competition between the cultivation of palm oil as an energy crop and palm oil as source of oil and fat for human consumption.

Chapter 6. Conclusions and Policy Implications

6.1 Conclusions

It is clear that cultivation of sugarcane on the coast of Peru has proven so far to be a good choice for addressing ethanol production under the current conditions. In this case, advantageous climatic conditions, the existing experience with its cultivation, the utilization of previously unused land that reduces impact on land rivalry, the lack of conflict with sugar production, its proven effect on rural employment, and minimal environmental impacts are among its advantages. Nevertheless, future expansion of sugarcane crops will require efforts from the government to improve the conditions for a better utilization of water resources on the Peruvian coast.

In the case of the biodiesel industry, domestic production based on feedstock from palm oil cultivated in the jungle region has not been able to meet the domestic demand of biodiesel set up by the existing blending mandates. Moreover, the consumption of oil and fats is also not covered by the domestic production, a situation that combined with the blending mandates in force could result in creation of undesirable conditions for competition between the cultivation of palm oil for energy purposes and cultivation of the same crop for human consumption. In this case, further analysis is needed to evaluate the risk and provide solutions to mitigate its possible impacts, including a revision of the current blending mandates.

While the availability of suitable land for palm oil cultivation does not seems to represent a major problem, the development of the biodiesel industry is faced with challenges that are present in the jungle region, including the lack of appropriate road infrastructure, land tenure problems, a non-updated agricultural census, and uncompleted regional Ecological and Economic Zoning required by the current framework.

In terms of the existing promotional framework, we may conclude that it is currently limited in scope. It hinders the development of products already existing in the market with potential for a regional supply, such as the case of the hydrated ethanol, which – lacking the legal support – is condemned to act through an informal supply chain. In the same sense, the current framework does not include an adequate basis for the development of advanced biofuels, which will likely have an important presence in the future driven by the targets set up by the European Union and the United States of America. The current emphasis on first generation biofuels may end up being confronted with a future limited demand when better technology for second-generation biofuels becomes available at reduced costs.

Similarly, the complex institutional framework includes a wide array of institutions that each act on aspects related to the biofuel industry. This requires implementation of an improved platform that articulates the diverse actors.

6.2 Policy Implications

The analysis conducted throughout the present research allows us to provide suggestions that we believe may serve as basis for discussion and implementation of policies related to biofuels in Peru. In that sense, we provide the following proposals for discussion:

- An increase in the current blending mandate for ethanol should be considered on the basis of the domestic production. The increase would help to displace the average 10% of currently imported gasoline and would promote higher levels of energy independence.
- Further increases in the blending of ethanol are also possible and are required given the provision on incentives for the introduction of flex-fuel vehicles to the Peruvian market, as in the cases of Brazil, Colombia, and Paraguay. The introduction of these vehicles would allow the use of higher and more flexible blending that could be periodically adjusted according to domestic production.

- Improvement of the conditions for an efficient use of water resources should be addressed with priority by the Peruvian government. In that sense, suggested courses of action have been included in section 5.2.1.
- A revision for reducing the blending mandate of biodiesel is suggested, considering a more attainable percentage that takes into account the domestic production, and considers the possible conflict with the provision of oil and fats for human consumption. Further analysis on the latter subject is required.
- Improvement of the conditions for the development of the palm oil industry in the Peruvian jungle, including the creation of the adequate road infrastructure, is required. Suggested courses of action have been included in section 5.4.1
- A revision of the current legal framework is suggested, integrating the overall institutional framework, avoiding overlapping of responsibilities, and including mandatory dates and technical assistance for the adoption of ZEE, and updating of the agriculture census in all regions, as a condition to generate an adequate environment for investments. Similarly, the legislation must include those products already existing in the informal market, by creating regulations for their commercialization and quality standards. Finally, legislation should be updated in order to provide a basis for the future development of advanced biofuels. In this

regard, our recommendation is entry into cooperative agreements with countries that are already developing pilot projects for the production of advanced biofuels.

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페루의 바이오 연료 진흥법 및 산업에 관하여

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바이오 연료의 비중이 세계연료소비에 있어 지난 수십 년간 눈부신 성장을 보여온 가운데, 에너지 자원의 주축으로 자리할 것으로 예상하는 목소리가 높아지고 있다. 정부의 강력한 지지가 이러한 성장에 큰 역할을 한 점은, 실제 많은 개발도상국들이 바이오 연료 생산의 잠재적 수익성 및 신재생에너지원으로서의 유용성을 주시하는 현상과 함께 이해될 수 있다. 세계적 트렌드와 마찬가지로 라틴아메리카 역시, 브라질과 그 뒤를 따르는 여러 국가 중 하나인 페루 등지에서는 특별 진흥법을 세워 바이오 연료를 장려함으로써 화석연료의 의존도를 감소시키는 동시에 기후적 혜택을 최대한 살려 에너지 작물 경작에 박차를 가하고 있다. 이 연구는 페루

바이오 연료 진흥법의 특성을 분석하며 그 현상과 핵심 문제를 짚어, 결론을 도출하고 정책적 개선 방향을 제시한다. 페루의 바이오 연료 진흥법은 무수 에탄올, 바이오 디젤을 화석 연료 가솔린, 디젤과 배합하는 하는 것을 의무화함으로써 수요 창출하는 데에 기반하며, 이는 기존산업에 상이적인 결과를 가져왔다. 무수 에탄올의 경우, 비교우위적인 기후조건으로 사탕수수 경작이 수월한 페루의 해안가와 효율적 관개기술을 통해 개선이 가능한 불모지라는 두 가지 요건으로 투자자들에게 국내수요를 뛰어넘는 생산을 가져다 주었는데, 이는 화석 연료 의존율을 크게 낮추는 데에 기여했다. 반면 팜유를 중심으로 정글 지역에서 생산된 바이오 디젤의 경우, 의무배합규정으로 증가된 국내 수요를 채우지 못한 바, 수입 바이오 디젤에 의존해야 하는 상황이 이어졌다. 더욱이, 현재의 팜유 생산량은 국내 식용 팜유 및 지방팜유의 수요조차 채우지 못하고 있는 실정이다. 향후 해안지역의 에탄올 산업확대가 다양한 수자원의 가용 여부에 달린 점과, 정글지역의 바이오 디젤 산업개발이 인프라부재, 토지 소유권, 토지이용규제법 등이라는 복합적 시나리오를 앞에 두고 있는 상황이라는 양대 산맥의 난제가 투자자들을 가로막고 있다.

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