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Emerging liquid biofuel markets

¿A dónde va la Argentina?

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Abstract

High oil prices, news about limited oil resources and the increasing demand from fast growing economies like India and China have fuelled the global discussion for a security of energy supply, as well as a diversification and decentralisation of energy sources. At current oil prices, liquid biofuels become a cost-competitive alternative to traditional transport fuels. This option seems to be of special interest to developing countries with favourable climatic and environmental conditions for plant growth and low production costs for bioenergy crops. Not only the satisfaction of domestic demand, hence a security of energy supply, but also to take part in an international trade with liquid biofuels is interesting for these countries to ensure their development. If quality and labour standards are put in place, liquid biofuel trade offers developing countries and especially their rural areas heavily needed economic incentives and a possibility for development and poverty reduction.

Argentina is one of the countries currently looking into the option of liquid biofuel production. An investigation of the current emerging market setting for biodiesel and bioethanol has lead to the conclusion that a biodiesel production for international supply is likely to emerge in the short-run (up to 2010) and could also be switched-back to local supply in the medium-run (post 2010). A bioethanol market (demand and supply) does neither seem to be likely in the short- nor in the medium-run as the most influential actors seem to oppose its development. The current constellations of the emerging biodiesel market appear to leave many uncertainties regarding its sustainability, especially in regards to a limited role of small and medium sized enterprises (SMEs) and a suitable and diversified biodiesel feedstock. Currently, the focus lies solely on big scale production of biodiesel derived from soybean oil.

Executive Summary

The production of liquid biofuels seems cost-competitive at current oil prices and an increasing amount of countries are looking strongly into a development of a local market i.e. a production and demand for liquid biofuels. One of these countries is Argentina. As the second biggest country in South America and the 8th biggest country in the world, Argentina has a significant amount of bioenergy potential. It already hosts a well-equipped and efficient agricultural industry that ranks among the most important producers for several agricultural products in the world. The Argentinean Senate has approved a liquid biofuel law in May 2006 which outlines an incentive mechanism (tax exemptions) for liquid biofuel producers and legal blending requirements from the beginning of 2010 at a minimum of 5% in volume content for diesel and petrol.

The three main objectives of the investigation are to identify and analyse the probable future value chains of biodiesel and bioethanol in Argentina; to derive the most likely directions of their development in the short- (until 2010) and medium-term (post 2010); to discuss the 'sustainability' of this development.

The **key findings of the analysis** of the value chains in the current emerging market setting for biodiesel and bioethanol are that a biodiesel production for international supply is likely to emerge in the short-run. A bioethanol market on the other hand neither seems to be likely in the short- nor in the medium-run as the most influential actors, the vegetable oil and the petrol companies seem to oppose its development. Their leverage appears to be stronger than the one of other potentially interested parties in bioethanol production.

The interest of the petrol companies in a local biodiesel and no local bioethanol market can also be observed by looking at the local transport fuel consumption matrix. Around 55% the total vehicle consumption is diesel while only 20% is petrol. Although refineries in Argentina currently operate at full capacity, trying to maximise the diesel output, around 3% of the annual consumption had to be imported in 2005. As petrol and diesel are co-products in the refining process, the intense refining leaves the petrol companies with an excess amount of petrol – which is currently exported. Hence, they have no interest in developing a market for a petrol substitute product such as bioethanol. What's more, petrol engines are increasingly converted to compressed natural gas (CNG) usage. CNG has already substituted a significant part of petrol powered engines in recent years and this rate is expected to increase further. On the other hand, the diesel market remains strong as the country's traffic network relies heavily on diesel powered long distance truck transport, passenger transport, and also agricultural farming equipment. Another important reason in favour of biodiesel production is the domination of oil crops in the agricultural production and infrastructure in Argentina. Argentina ranks among the top three producers and exporters for vegetable oil, and the strong industry networks linked to this production obviously favour a biodiesel production.

It is most likely that the biodiesel production will primarily consist of large-scale facilities with a domination of the vegetable oil and petrol industry. The destination market in the short-run will most likely be solely overseas. This is mainly due to the fact that the local market is still only emerging and current diesel prices are lower than current biodiesel production costs. A local demand until 2010 without legal blending requirements does not seem possible. Overseas markets such as the EU on the other hand already now offer a secure demand at higher prices. Also, the agricultural sector in Argentina – in particular the vegetable oil industry, as well as many activities of the petrol companies are already now export oriented.

A local bioethanol production for petrol blending is relatively unlikely even in the medium-term (post 2010) with legal blending requirements. In the short-run, the sugar industry in

Argentina is not powerful enough to promote a production of bioethanol for petrol blending and feedstock is currently also only available in low quantity. Furthermore, as stated, the local market is not secure and on overseas markets Argentina would have to compete with highly efficient producers such as Brazil. But also in the medium-run, current incentive mechanisms as described in the new law do not seem sufficient to compensate for the high investment costs for a bioethanol plant. As it seems currently, bioethanol production could be strengthened with net crude oil imports in 2-3 years and depleting oil resources in Argentina in general – which are supposed to last only another 9-12 years. Liquid biofuels have however not yet been integrated into an overall Argentinean energy strategy. It also remains unclear from which feedstock bioethanol would be produced. Current options include maize, sugar cane, and sorghum.

The current constellations of the emerging biodiesel market however also leave **uncertainties regarding its 'sustainable' development**. The two main issues of concern are a limited role of small and medium sized enterprises (SMEs) and a suitable and diversified biodiesel feedstock. Currently, the focus lies solely on big scale production of biodiesel derived from soybean oil. It seems desirable however to ensure a development with a more balanced production scale i.e. a market access to all interested parties, and a diversification of biodiesel production feedstock.

The new law on liquid biofuels and its incentive mechanisms will have a great influence in designing the market and hence framing the role of SMEs. Currently, the incentive mechanism appears too weak to strengthen their role. High investment costs and perceived risk prevail in Argentina, people also still have a significant mistrust and disbelief in politics. The law lacks transparency and does not clearly outline the ranking criteria for the tax exemptions. Also, the law is not yet integrated into the overall legal framework. There is a significant risk of overlapping between state and provincial law, and unclear responsibilities resulting in enforcement problems. The major part of the design of the new law as well as its enforcement will lie with the Secretary of Energy and the National Biofuels Commission. The Commission (headed by the Secretary of Energy) should take these points into consideration for the further development of the law and its regulatory decree.

Moreover, the Secretary of Energy should soon state what role liquid biofuels will be playing in the future for the Argentinean energy matrix in order to outline a clear level playing field for investors. This includes a statement on the local market price development for petrol and diesel as well as a statement on the liquid biofuel production for export or local usage. Argentina is an important exporter for vegetable oil products but will become a net importer of crude oil within 2-3 years. Hence opportunity costs for biodiesel production will soon play an important role. The local price development in the short- and medium-run for diesel and petrol will be an important stimulation mechanism for liquid biofuel production in Argentina for the local market. So far, prices are kept artificially low due to a government strategy which aims at supplying electricity and fuel at low costs as the country suffered only recently from a severe economic crisis and the purchasing power of society remains low. With net oil imports, prices at the pump however automatically have to increase. So far, production costs for biodiesel are low in Argentina and can almost compete even at current local diesel prices at the pump. The current prevailing industry strategy however is to supply solely the export market. No energy policy has yet outlined which market should be satisfied in the medium-run (post 2010) and which prices will apply for diesel or petrol respectively. This should be integrated in an overall energy strategy for Argentina from the Secretary of Energy. In this regard it seems desirable to develop a production of liquid biofuels with an internal or external demand in the short-run and to 'switch-back' to a supply of the local market in the medium-run.

The design of a biodiesel market will also depend on the definition of a suitable quality standard. As it seems currently, the quality standard will be oriented along the European one which is considered to be strict in its requirements. While a quality standard should be introduced and enforced, its design will strongly influence the ability of SMEs to enter the market. This should be taken into consideration by the issuing Secretary, the Secretary of Energy.

The second major point of concern for a 'sustainable' development of the biodiesel market in Argentina is the exclusive usage of soy beans as vegetable oil feedstock. It seems desirable to push for a diversification of biodiesel feedstock, as well as a revision of the environmental and social impact of soy bean cropping in Argentina. Currently, there is still a lack of evidence that the soybean biodiesel energy balance is positive in the Argentinean setting. Its GHG balance on the other hand seems favourable compared to conventional diesel.

Competition for land use seems to be only an issue in the northern part of Argentina – the country's poorest region. Nevertheless, there are still regions in Argentina where people suffer from hunger and thirst while the country produces around three times the amount it would need to feed its population. In 2003, around 50% of the society still lived below the poverty line. One of the main contentious issues for soy bean production in this regard is that while land competition with food production seems to exist, soy cropping is also an important income for the northern part of the country.

The main problem arising from soy bean farming seems to be that the majority is produced through monocropping which has negative effects on soil (nutrient depletion), biodiversity, and also puts farmers in a dependence on soy bean/oil market prices. The oil content of soy is very low (around 18%) and a significant amount of the economic benefit is generated through the soy's proteins (soy flour). While a biodiesel market would require a lot of soy bean cultivation for soy oil, there is a risk of a protein overproduction and a falling international market price for soy flour. This would significantly affect the cost structure for soy bean cultivation with a major impact on small- and medium-sized farmers. Due to the nutrient depletion of soy monocropping, a switch to other crops is not directly feasible without significant investments. The low oil content of soy beans also affects the net biodiesel yield per ha which is the lowest compared to other oil crops. This is problematic as a 5% blend of biodiesel in the transport fuel matrix in Argentina, would require around 13% of the current land surface devoted to soy bean cultivation to ensure a biodiesel production in 2010 and 15% in 2015. This means that Argentina could not become diesel self-sufficient through soy bean derived biodiesel if the soy bean cultivation area is not extended significantly. This however does not seem to be a desirable option.

Hence, the National Biofuels Commission, and in this regard especially the Secretary of Agriculture, Livestock, Fishery and Food should promote the diversification of feedstock for liquid biofuel production, push for more efficient oil crops than soy, and a crop rotation pattern in order to reduce monocropping. In order to ensure this, an overall liquid biofuel strategy for Argentina seems desirable which outlines liquid biofuel production and feedstock objectives, integrates all major actors along the value chains, and defines the interlinkages between the activities from different secretaries. The National Biofuels Commission has the potential to become a central player in this regard. To achieve this position, its activities and objectives however would have to be more transparent and streamlined.

Table of Contents

List of Figures

List of Tables

1 Problem definition

With a global economy still heavily linked and dependent on traditional energy carriers, news about limited oil reserves and predictions for a peak in oil production within the next years from well-known geologists as e.g. Colin Campbell (Guardian, 2005) have shocked international investors, politicians and citizens worldwide. The remaining known larger oil reserves can only be found in a small number of countries – mainly in the Middle East, leaving the majority of countries world wide in a competition for oil imports. The continuing strong economic growth of India and China and the increase in transport worldwide have only fuelled this global political race for the remaining crude oil fields in order to ensure a (national) **security of energy supply**.

Within this race, increasing attention has been given to the research, development, and diffusion of alternative transport fuels, such as biodiesel, bioethanol or biogas in order to **diversify fuel supply sources**. The high demand for oil and its limited availability have pushed the oil price which remains on a high level and is not expected to decrease mainly due to its limited availability and the continuing political instability in the middle-east, the world's biggest oil producing region. Taking the high oil price, technology and learning improvements into consideration the production of liquid biofuels has become **cost-competitive** to petroleum based transport fuels.[1]

Also, there is increasing evidence for **adverse environmental and social impacts** from the usage of traditional transport fuels such as acidification and climate change. Greenhouse gas (GHG) emissions from transport alone account for around 21% in the EU – and the percentage is expected to rise (EU, 2006, p. 3). In order to meet the reduction of GHG emissions under the Kyoto Protocol, the reduction of these emissions becomes a key criterion. Liquid biofuels have the potential to reduce these impacts if produced and handled properly.

Many countries worldwide have therefore already embraced **national support schemes** for the demand and production of liquid biofuels.[2] These schemes have in general lead to an increase in the global production of liquid biofuels which is currently estimated to be over 35 billion litres annually (EU, 2006, p. 3). The production and demand patterns are although not equally (geographically) distributed. As shown in the following figure, the biggest theoretical bioenergy potentials lie in developing countries with favourable climatic and environmental conditions for plant growth and **low**(er) **production costs for bioenergy crops** whereas recent policy incentives have been mainly put in place in developed countries where the current domestic demand cannot be solely fulfilled by local supply.[3] This **international trade with biomass and liquid biofuels** however offers developing countries and especially their

[1] According to estimates of the International Energy Agency (IEA) biofuels become cost-competitive between US$ 60 and 100 (PlanetARk, 2005). This is supported by Faaij and Domac (2006, p. 7) who believe that bioethanol production from sugar cane becomes a feasible alternative at an oil level price of more than US$ 60 per barrel.

[2] Within the European Union (EU) e.g., a directive for the promotion of biofuels which set blending requirements (measured in energy content) of 2% in 2005 and 5.75% in 2010 (see EU, 2003) has strongly promoted the local demand for liquid biofuels. Its main objectives for the support of biofuels are the reduction of GHG emissions, the promotion of the decarbonisation of transport fuels, the diversification of fuel supply sources and the development of long-term replacements for fossil oil (EU, 2006, p. 3).

[3] Regarding lower production costs in developing countries, it is acknowledged that while they could lead in the beginning to an earlier cost-competitiveness of liquid biofuels with traditional transport fuels, their prices should not be transferred to the consumers or policy parties in developed countries, but rather benefit those producing them. Finally, prices for liquid biofuels should be put in relation to the fuel that they substitute – eventually even including a carbon tax.

rural areas heavily needed economic incentives and a possibility for development and poverty reduction if quality and labour standards are put in place.[4]

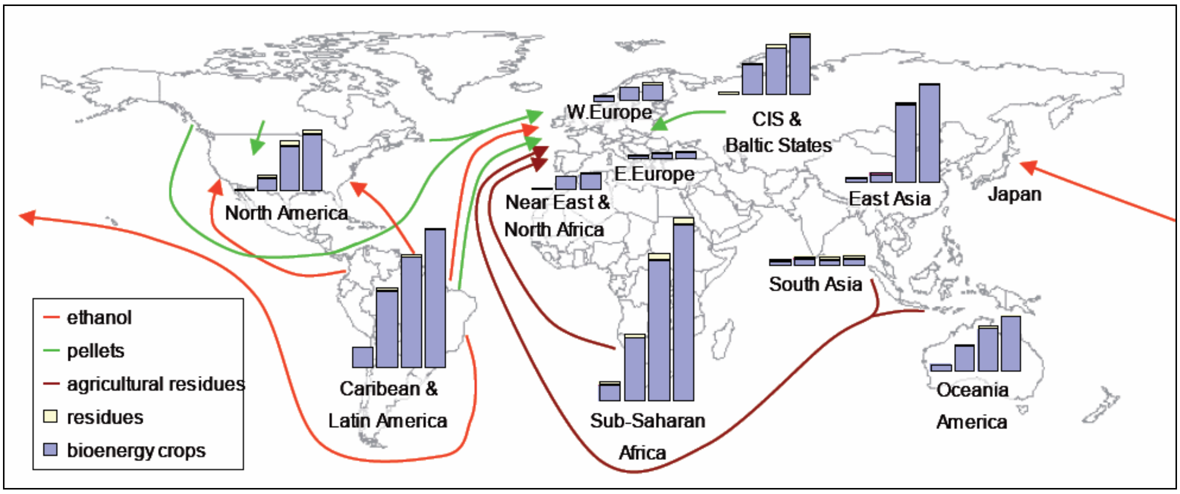

Figure 1-1 Theoretical bioenergy potentials (for 2050) and examples of current trade routes.

Source: IEA, 2005, p. 2

As Figure 1-1 indicates, the potential for bioenergy crops is enormous in **South America**. It has already been stated in international press that the region could become a world power in energy sources in the near future (Osava, 2006). One of its countries, Brazil, is easily the biggest success story worldwide for the local promotion of liquid biofuels and international trade.[5] The second largest country within South America after Brazil is **Argentina**. Bordering with Brazil in the north, Argentina has significant potential for biomass and bioenergy crops. The country hosts vast areas of arable land and a very good agricultural infrastructure making it already today one of the world's most important export countries for several agricultural products[6] as e.g. vegetable oil (DENA, 2005, p. 21).[7]

Currently, Argentina still bears the burden of a high external debt inherited from the significant economic problems in the 1990's which peaked after the currency equality of the US$ to the Argentinean Peso (AR$) in state bankruptcy in December 2001.[8] The economic

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[4] The International Energy Agency (IEA) has set up a team of experts to develop and research the sustainability of international biofuel trade. The results of this group, IEA Task 40, are available online under http://www.fairbiotrade.org [May 18th, 2006].

[5] The national alcohol programme Proalcool, launched in the 1970's involved all major players along the whole value chain of ethanol production from farmers to vehicle producers and customers (IEA, 2004, p. 159; Oliveira, 2002). Brazil has successfully proved the technical feasibility of large-scale, cost-efficient production of bioethanol from sugar cane as a transport fuel its use in high-level petrol blends as well as in dedicated vehicles (IEA, 2004, p. 159; Oliveira, 2002). Nowadays, around one fifth of the current vehicle fleet in Brazil runs on bioethanol (Oliveira, 2002, p. 130) and Brazil has become the most powerful international trader of bioethanol in the world with a current annual production of 10 million tons (Spiegel, 2006, p. 127).

[6] And according to the US and World Agricultural Outlook from the Food and Agricultural Policy Research Institute (FAPRI), this role is expected to increase in the future even further (FAPRI, 2006).

[7] Due to its geographic location and climatic conditions, various oil crops like sunflowers, soy, peanuts etc. can be grown all year round leading to a constant vegetable oil production which enhances Argentina's opportunity for biodiesel production. What's more, vegetable oil presses are strategically located in coastal areas, making the country destined for vegetable oil and also biodiesel export (DENA, 2005, p. 21).

[8] The average rate in July 2006 was AR$ 1 = US$ 0.32477. This rate is used throughout the thesis.

downturn has shrunk the middle class in Argentina significantly with more people of it now belonging to the lower class. Since 2003 the political stability has regained strength and the gross-domestic product grew has grown steadily, but the country is still heavily dependent on foreign capital (DENA, 2005, p. 6).[9] Within the country there are also strong regional differences in terms of living standards. The rate of people living on less than US$ 2 per day (between 1990 and 2003) was still 14.3% (UNDP, 2005, p. 227).

In the past there have already been scattered, regional, small-scale initiatives for the production of liquid biofuels, mainly biodiesel for autoconsumption (see e.g. DENA, 2005; Valente, 2006; FB, 2005b). A large-scale, national programme has however not yet been followed. This might be mainly due to the strong oil lobby in the country (DENA, 2005; EIA, 2006). Although international estimations expect Argentina's oil reserves to be depleted in 10-15 years at current extraction, consumption and efficiency rates (DENA, 2005, p. 14), the country is still almost energy independent[10] and also a net exporter of crude oil (EIA, 2006, p. 2).

The country has however suffered from frequent energy crises, the most recent one in 2004 when state caps on energy prices kept those artificially low and the soaring energy demand could not be met. The energy sector suffers from a significant lack of investments since 1998, and the country is expected to further face energy supply crises within the coming years if no structural measures are implemented. Also, recent national statistics claim that Argentina could become a net importer of crude oil already within 2-3 years (El Clarín, 2006).

As global demand for crude oil is expected to stay high respectively increase even more, and the country's agricultural sector is highly competitive on a global scale, opportunity costs for liquid biofuels play an important role. As Argentinean oil and gas resources are expected to be depleted within foreseeable time, the development of a domestic supply industry for liquid biofuels becomes an issue of security of energy supply and a driver towards a diversification of energy sources. The development of biofuels has also the possibility of increasing rural employment leading to poverty reduction and in terms of export become another important source for foreign capital.

Liquid biofuels are evidently becoming of increasing national interest and the Argentinean Senate recently approved a new law providing liquid biofuel producers of biodiesel, bioethanol and biogas with tax incentives if they meet certain criteria and produce for the local market (SCDA, 2006). Furthermore, the law is directed towards a legal blending requirement of 5% in volume for diesel with biodiesel and petrol with bioethanol respectively. At the end of 2005, the major oil producing and refining company of Argentina, Repsol-YPF already announced that it will invest US$ 30 million into a new liquid biofuel refinery in the state of Buenos Aires in the year 2006 which is supposed to produce 100,000 tons of biofuels annually as of 2007 (Valente, 2006).

Current evolvements as the ones stated indicate that it is very likely that the Argentinean liquid biofuel market is heading towards a strong development within the coming years. This thesis is directed to answer the question 'where is Argentina going' or 'a dónde va la Argentina'. It identifies and analyses the probable future value chains of biodiesel and bioethanol in Argentina, derives the most likely directions of their development in the short- and medium-run, and discusses the 'sustainability' of this development.

[9] The real GDP of Argentina grew 9.0% in 2004, 8.7% in 2005 and is estimated to grow 5.0% in 2006 (EIA, 2006, p. 1).

[10] The share of energy imports from net primary energy sources accounted for 0.7% in 2003 (DENA, 2005, p. 11).

2 Research framework

2.1 Objectives and structure

The three **objectives** of the research are to

- Identify and analyse the probable future value chains of biodiesel and bioethanol in Argentina,
- To derive the most likely directions of their development in the short- and medium-run,[11]
- And to discuss the 'sustainability' of this development.

In order to identify and analyse the Argentinean liquid biofuel setting, three **background** sections will be provided.[12] The first background will provide a general overview on liquid biofuels and their feedstock options. Whether liquid biofuels resemble a 'sustainable' option for a more secure and diversified energy matrix depends on a number of factors which are illustrated here. Furthermore, the sustainability of these emerging products should be a major policy constraint. There are also signs for future requirements (sustainability standards) for liquid biofuels in order to become part of a global alternative transport fuel trade.

Based on this, the second background section will describe the energy and agricultural sector in Argentina in regards to agricultural activities and transport fuels. In both sectors, the focus of the illustration lies on the market structure (i.e. actors, networks, demand) as well as the institutional, political and legal framework. The chapter serves as the main base for the following analysis of the market and its possible directions. It finishes with a short overview of previous experience with bioethanol and biodiesel in Argentina.

Although the international trade with liquid biofuels is still in its infancy (Faaij, 2006, p. 3), its trends influence the development of new markets such as the Argentinean one. Therefore, international trade patterns for biodiesel and bioethanol, the development of an international liquid biofuel market and demand will be looked at (briefly) in the third background section.

For the **analysis** of the Argentinean setting, i.e. the formation of a liquid biofuel market, the three background sections are brought together. Based on an innovation system approach (see Bergek et al., 2005; Jacobsson, 2005; Jacobsson & Bergek, 2004; Jacobsson & Johnson, 2000), the value chains for the desired liquid biofuels are investigated. The essence of this section is to identify the main factors (i.e. actors, networks, and institutions) and their leverage that influence the development of a liquid biofuel production and demand (market) in Argentina. The chapter finishes with a short preliminary conclusion upon the most likely liquid biofuel market development in order to provide a basis for discussion on the 'sustainability' of this development.

[11] While short-run looks at the development up to 2010 which marks the date for a local blending requirement, medium-run goes beyond this time looking at the development that could arise due to the change in oil imports to Argentina. As stated before, Argentina is expected to become a net importer of crude oil in 2-3 years i.e. certainly post 2010 (El Clarín, 2006).

[12] Throughout the thesis, the terms 'liquid biofuels' and 'biofuels' are used in coherence. 'Liquid biofuels' or 'biofuels' respectively refer always to biodiesel and bioethanol if not stated otherwise.

The **discussion** section is divided into four parts, covering socio-political, market, technical, and 'sustainability' issues. Following, the **main drivers** for a liquid biofuels market development in Argentina are derived and the most likely **market development scenario** laid out. The discussion serves as the basis for the **final conclusions and recommendations**. The policy recommendations will focus on the production i.e. supply side as well as the demand side strengthening. The structure of the thesis is also illustrated in the following figure.

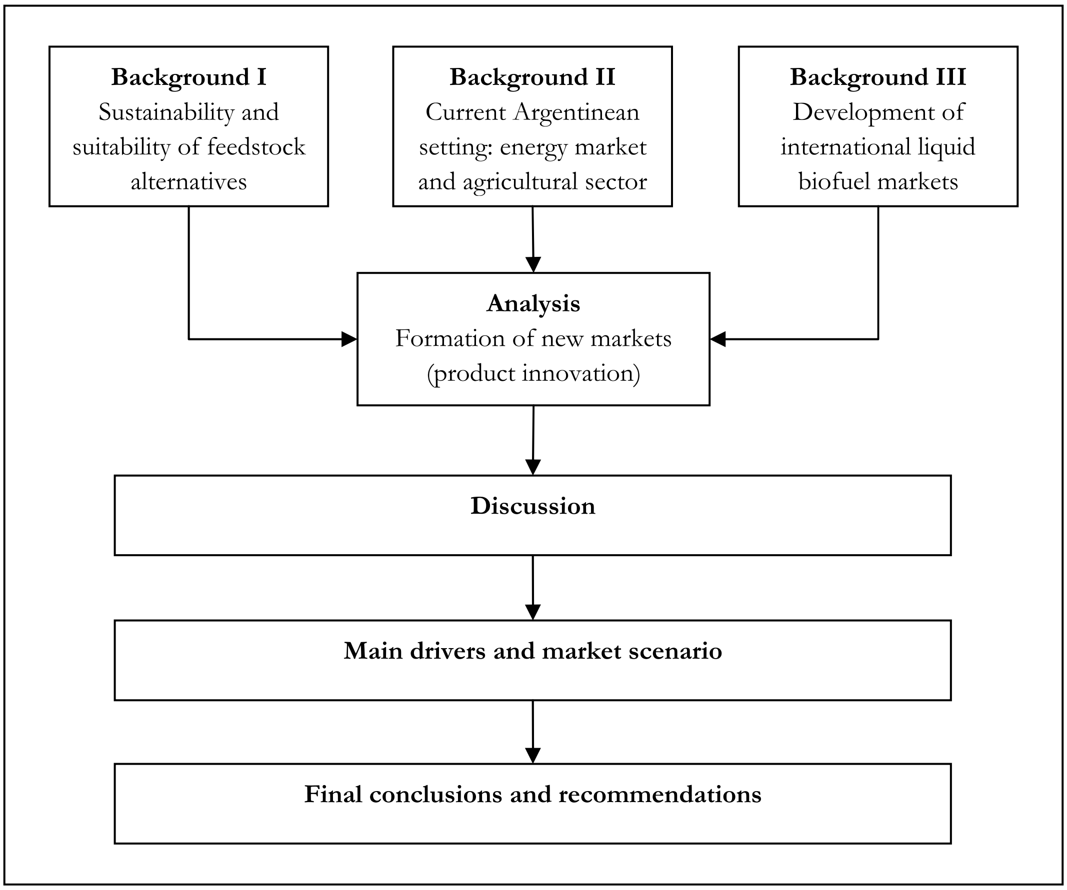

Figure 2-1 Research structure and paper outline.

2.2 Research questions

Based on the objectives and the paper structure, there are three main research questions (analysis, discussion, and conclusion). Under these, a number of sub-questions also seem relevant. They are supposed to guide my research in the first stages. It is obvious that the whole range is too broad for the thesis. Therefore, they will be limited and adjusted after the early stages of the research and especially after the first interviews.

1. What is the most likely liquid biofuel market development in Argentina in the short- and medium-term?

- What are the current country characteristics regarding agricultural production and energy consumption in Argentina? How could they influence a liquid biofuel market development

- Who are the main actors, networks, and institutions that can promote/strengthen the diffusion of biodiesel and bioethanol in Argentina? What are their opinions and how do they influence the market development i.e. in which direction?

- What are the most likely developments in terms of feedstock, applied technology, blending, supply and demand (including import/export) for biodiesel respectively bioethanol in Argentina? How does this change from the short- to the medium-term?

- What are the main international trends in liquid biofuel trade and which factors will most likely effect the emerging market in Argentina, and how?

2. Is this development certain and 'sustainable'? What are the uncertainties regarding this market development in regards to likeliness and sustainability concerns?

3. How can the market development be influenced? What are the recommendations?

2.3 Methodology and analytical framework

The **data** for the first and the third background section were mainly collected from literature. Both have been investigated thoroughly in the past and as the sections serve as the theoretical background (introduction) for the research, interviews have not been directed towards their investigation. This is however different for the second background section.

Whereas basis data on the agricultural industry and the energy sector could be collected from the designated ministries and secretaries i.e. mainly the Secretary of Energy (Secretaría de Energía – SE) and the Secretary of Agriculture, Livestock, Fishery and Food (Secretaría de Agricultura, Ganadería, Pesca y Alimentos – SAGPyA), main insights into the market, its actors, institutions and networks had to be collected through local interviews in Argentina. This is mainly due to the fact that the liquid biofuel market still in its infancy and just about to evolve. The setting has not yet been investigated upon its main stakeholders and development although a recent research by Asal et al. (2006) has tried to investigate the barriers for a sustainable biodiesel market in Argentina.

The interviewees were chosen with the help of the local supervision and advisor team at the Fundación Bariloche in Buenos Aires, Argentina, as well as with the help of the first interviewees themselves and the attendance lists of international bioenergy conferences with speakers from Argentina. This way it was tried to ensure the selection of 'experts' on the topic which has not yet been investigated thoroughly. The selection of interviewees also took into account to generate a perspective on the market from four different directions. The first two distinctions made were between top-down political decision making and bottom-up implementation on industry level. The second two were more general in terms of supposed support or resistance towards the development of a liquid biofuel market in Argentina. A full list of interviewees as well as a desription of the interview strategy and structure can be found in the Appendix.

The **analytical framework** is mainly based on the innovation system approach as described by Bergek et al. (2005), Jacobsson (2005), Jacobsson and Bergek (2004) as well as Jacobsson and Johnson (2000). The approach can be applied on different levels. In this research the focus is on technology innovation, more specific product innovation. The *unit of analysis*, i.e. the focus of the study are the two products biodiesel and bioethanol. The *level of aggregation*, i.e.

the breadth/specificity of the research focuses solely on the two products and their vegetable i.e. crop feedstock options in Argentina (spatial focus).[13]

The development of a new product and its diffusion affects the whole value chain. In order to differentiate between the stages, I have divided the value chain for the two liquid biofuels in focus into the three sections of production, supply and consumption (as shown in the following illustration).

Jacobsson and Johnson (2000) developed the bare bones of the analytical framework mentioned before by applying it to the diffusion of renewable energy technology. They claim that the alteration in the energy system is a slow, painful, and highly uncertain process and that is why in the analysis of this process the innovation system perspective needs to be applied where the focus is on actors (firms' perceptions, competencies and strategies), networks, and institutions (Jacobsson & Johnson, 2000). These three structural components are investigated upon along the two value chains in focus.

- *Actors*: Include actors directly situated along the value chain such as liquid biofuel producers, suppliers, oil companies, car and equipment manufacturers, as well as universities and other influential organisations such as the associated trade associations.

- *Networks*: Include *formal* networks as liquid biofuel producers' trade associations, public-private-partnerships, and other umbrella organisations under which the identified actors collaborate with each other as well as *informal* networks such as supplier groups, buyer-seller-links, university-industry collaborations, etc.

- *Institutions*: Socio-political perspective: regulatory framework (rules and laws) and public perception (norms and beliefs)

Within the institution level, the innovation system approach (as described by Bergek et al., 2005; Jacobsson, 2005; Jacobsson & Bergek, 2004; Jacobsson & Johnson, 2000) looks at the socio-political framework including social acceptance and legal requirements/incentives. In the analysis, only the influencing institutions, their power and leverage for a liquid biofuel market development are looked into. The social acceptance was not regarded to be homogeneous and was therefore covered in the discussion part.

The importance and leverage of the actors, networks, and institutions and their interests is based on the interviews and observations made. It allows to derive a **preliminary conclusion** about the most likely market development for liquid biofuels in terms of biofuel, feedstock type, production scale, and demand pattern. In the following **discussion** the uncertainties about the preliminary conclusion will be laid out into detail regarding issues on four levels. Socio-political issues have to be discussed as they form the framework conditions for the production of liquid biofuels on state level. Similarly, market issues have to be looked into in order to evaluate the industrial framework. Technical issues seem important in order to assess the feasibility of a local production, and the transition from traditional to alternative transport fuels. Finally, the potential market development is evaluated upon its 'sustainability' regarding the main issues of concern for alternative liquid transport fuels.

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[13] It is acknowledged that the feedstock options for biodiesel and bioethanol include others than the ones investigated. The scope of the investigation however had to be limited.

Following the discussion, the preliminary market development will be turned into a robust **market scenario** for liquid biofuels in Argentina. The section starts by identifying the main drivers for biodiesel and bioethanol in Argentina, followed by a demand and a production side scenario. Based on this, the **final conclusions and recommendations** are made. They analytical framework is also illustrated in Figure 2-2.

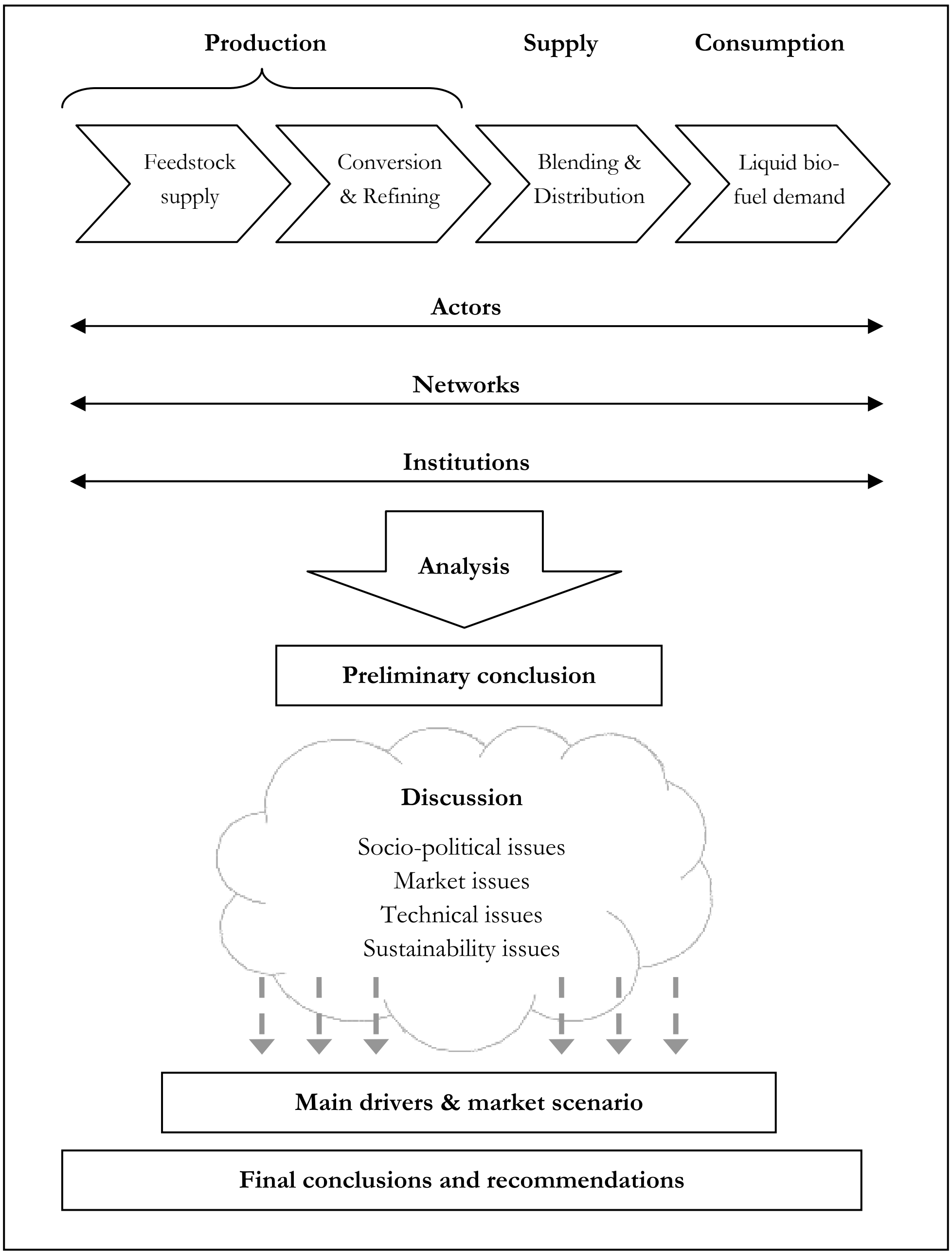

Figure 2-2 The analytical framework.

2.4 Scope and limitations

Concerning the biofuel options the scope is reduced to biodiesel and bioethanol. While biogas is also considered a biofuel, it is not investigated within this study for the following reasons. First, biogas is in general mainly used in domestic (production and) supply patterns and not traded internationally. A significant driver for the development of a biofuel market in Argentina however, seems to be the possibility to export biofuels (see e.g. Hilbert, 2006).

Second, compressed natural gas (CNG) is used for road transport in Argentina but the blend with biogas is not required within the new law on biofuels. As the production of biogas is not price competitive with CNG, experts do not consider the role of biogas to be of significance within the next two to three decades (Almada, 2006; Leone, 2006). Finally, as the biofuel market in Argentina is just emerging, a smooth transition from traditional to alternative transport fuels is necessary, including low investment costs for the distribution and usage of the new fuels. These requirements are also not fulfilled in the case of biogas.

Second generation biofuels and conversion technologies such as biomass gasification to produce biofuels such as methanol, synthetic diesel, dimethyl-ether, methane or hydrogen are very advanced and expensive and do not seem suitable for a country with limited scientific and financial capacities and are therefore also neglected.

The feedstock options for biodiesel and bioethanol include a range of different materials (see Chapter 3.1). In this thesis however, only feedstock derived from direct agricultural crop production were taken into account i.e. for example in regards to biodiesel that neither animal fat nor used frying oil were taken into consideration. This focus is mainly due to the size of the Argentinean crop production and the time constraints for the research.

Concerning the research framework, the (sectoral) innovation system approach identifies seven distinct functional patterns that contribute to the overall goal of establishing a new system (see Bergek et al., 2005). The potential to investigate these functions is acknowledged, it seems however not within the scope of this research to include and investigate them into detail. Whenever used as guiding points during the research they will be acknowledged and referred to.

The Argentinean market development could be studied in a comparison approach with other, already developed liquid biofuel markets e.g. in Brazil. This possibility was not followed however as the external setting on the world market, e.g. for energy have changed significantly and the investigation of trends and possibilities seem to be country specific (Johansson, 2006).

Being of German origin, I face a language and cultural barrier, investigating the Argentinean setting. Therefore, I might not be able to 'read between the lines' during my interviews and might also miss important cultural characteristics. This might influence my perception of the local conditions which then might be reflected in my findings and conclusions in regards to feasibility (policies, social acceptance, mentality, etc.). The results should therefore be treated carefully.

3 Background

This descriptive chapter provides information on three main areas that are necessary to look into before a thorough analysis of the liquid biofuel market setting in Argentina can take place. First, a general introduction on liquid biofuels and their feedstock options provides an overview of the current possibilities to produce liquid biofuels. As they are seen as an option to reduce the dependency of fossil fuels, their 'sustainability' is crucial, especially as the production facilities and applications reach a larger scale and diffusion. Therefore, several sustainability criteria are developed in regards to the different liquid biofuel-feedstock-combinations.

The two main sectors that are affected by the development of a liquid biofuel market in a country seem to be the agricultural as well as the energy sector. Their current settings in Argentina are investigated. In this section, a short description of experiences in Argentina with biofuel production is also given.

Liquid biofuels have become major trade goods for many countries, e.g. Brazil, and the international market seems to be just emerging. The momentum of this market and the dynamics that come with it are seen to be major influences on new, emerging markets. Moreover, Argentina has been struck by much economic turbulence and is regarded to be an economy in transition. It is certainly looking into this international market as it offers needed foreign currency. Therefore, in the third and final background section, the international market development for liquid biofuel trade, i.e. production and demand, is described.

3.1 Liquid biofuels and their feedstock options

3.1.1 General overview

Liquid biofuels are considered bioenergy carriers. Bioenergy can be described as stored solar energy in plants (through photosynthesis) and subsequently also animal matter. Biofuels are energy carriers which are processed from this stored energy in biomass, i.e. they are bio(mass)fuels. Biofuels can occur in all different phases: solid, liquid, and gaseous. The two latter ones are those of interest as alternative transport fuels.[14] As e.g. Article 2 of the European Biofuels Directive suggests, biofuels should be considered any "liquid or gaseous fuels for transport produced from biomass" (EU, 2003, p. 44). However, for several reasons – as stated in the introductory chapter, gaseous fuels are neglected in this research. Among the liquid biofuels, the most commonly produced are (first generation) biodiesel and bioethanol.

3.1.1.1 Biodiesel

Biodiesel is based on fatty acid methyl ester molecules.[15] Feedstock options are not abundant compared to other biofuels such as bioethanol but include vegetable oil (from various plants and seeds), used frying oil and also animal fat. The production process for biodiesel is relatively simple and does not consist of many production steps. After the extraction, the oil is usually filtered in a pre-treatment step to remove water and other contaminants. In the actual biodiesel production process step, the transesterification step, the oils are blended with an

[14] Solid biofuels include e.g. charcoal or briquette/densified biomass.

[15] This is why biodiesel from canola/rape seeds in the EU is also referred to rapeseed oil-methyl-ester (RME).

alcohol (usually methanol) and a catalyst. This leads to the breaking apart of the oil molecules which reform into esters (biodiesel) and glycerol (a valuable by-product).

Currently, the ratio for Argentinean biodiesel producers is 100kg of oil and 10kg of methanol to extract 100kg of biodiesel and 10kg of glycerol (SE, 2006a). Other biodiesel by-products come from the crushing of the oil seeds, e.g. soy flour. The technologies to produce biodiesel are well-established and it is not expected that they change significantly within the coming years (IEA, 2004, p. 33). This is different to the production of bioethanol where so-called second generation technologies are currently under development.

According to the IEA (2004), biodiesel can be used in any blend with regular diesel up to pure biodiesel (B100) without making engine modifications necessary. There are however other statements which set the level without modifications at 20-30% (volume content) (see e.g. Asal et al., 2006, p. 49). Also, several vehicle manufacturers allow biodiesel blends of up to 5% in their warrants for new cars.[16] It appears that one of the main concerns is that biodiesel – a good solvent, dissolves flexibilisers in the car's pipe and tube systems. Nevertheless, it can generally be said that not more than small modifications seem to be necessary for a biodiesel use as a neat fuel.

An important point regarding biodiesel as well as alternative transport fuels in general is that their energy contents vary to their traditional substitutes. Generally their energy contents appear to be lower per litre than those of their traditional counter parts. Biodiesel has an energy content of around 90% of that of regular petrol diesel (IEA, 2004, p. 81; Spiegel, 2006, p. 125; see Table 3-1).

3.1.1.2 Bioethanol

Bioethanol is produced from feedstock containing sugar or other materials that can be converted into sugar with reasonable effort. This means that a variety of inputs can be used including sugar crops, grain crops, cellulosic crops, and waste biomass such as crop residues.[17] The harvest ratio of bioethanol is highly dependent on the sugar/starch/cellulose content of the feedstock and the energy necessary to extract/convert it.

To produce **ethanol from sugar**, the sugar is extracted from the plant (e.g. sugar cane in country with tropical climate or sugar beet in moderate climate zones) by crushing, soaking or chemical treatment. Afterwards, in the fermentation process, the sugar is converted into alcohol with the help of yeasts and other microbes. Finally, in the distillation process step, the ethanol is purified to the desired concentration and (most often) water is removed to get 'anhydrous-ethanol' which is directly blendable in petrol. Co-products are the bagasse (left-over cellulose and lignin after the crushing/sugar extraction) which is often used for heat and electricity production to power the ethanol facility. Over 60% of the world's ethanol production (for all uses) today comes from sugar crops (Rosillo-Calle & Walter, 2006, p. 21). The leading technology in this production method certainly comes from Brazil. Its sugar cane ethanol is the best performer in regards to the overall GHG reductions on a well-to-wheel basis and has also the highest cost-efficiency per ton of GHG absorbed (IEA, 2004).

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[16] See http://www.iwr.de/biodiesel/auto.html [July 18th, 2006] for a list.

[17] Ethanol can also be derived synthetically from crude oil, coal, or biomass. This is however not discussed and taken into further. This is justified through estimates from Berg (2004) in Rosillo-Calle and Walter (2006) after which less than 5% of the overall global ethanol production was synthetic.

To produce **ethanol from grain crops** (such as wheat, barley, or maize) involves more process steps and is thus more energy intensive to produce. Before the fermentation and distillation process steps, the grains have to be separated, cleaned and milled. Then the starch is converted to sugar using a high temperature enzyme process. As shown in Figure 3-1, co-products include protein-rich animal feed and also sweeteners in some cases (IEA, 2004, p. 37). The range of useful co-products however varies greatly depending on the feedstock used. Nevertheless, this way of producing bioethanol is more energy intensive than directly from sugar crops and more common in countries that have (apart from a more moderate climate) agricultural subsidies and import tariffs such as the EU and the USA. Also the energy used in the planting, harvesting, and conversion steps comes mainly from fossil fuel sources which has a major negative impact on the bioethanol's GHG balance on a life-cycle basis (IEA, 2004).

Another production possibility is to derive **ethanol from cellulosic biomass**. A couple of RD&D plants exist, e.g. Sweden, Canada and the US, but this technique is still under development and has not yet been applied to produce ethanol on a large scale for the petrol market. The process involves the separation of the plant materials similar to the pulping process, i.e. in a combination of physical and chemical treatment cellulose is separated from hemi-cellulose and the lignin. While some of the hemi-cellulose can also be used to produce sugar, the focus lays on the cellulose output which is converted into sugars through hydrolysis. Due to its technological complexity bioethanol from cellulose is also referred to as a *'second generation biofuel'*. It is assumed that this development will lead considerably to a higher diffusion of bioethanol as a transport fuel as the main parts of plants are cellulose, hemi-cellulose and lignin and not kernels or other. I.e. the feedstock supply is abundant and the competition for land use is reduced as mostly agricultural residues can be used. There are also great hopes that once established the GHG emissions on a well-to-wheel basis are significantly lower than those of current starch-to-ethanol production technologies as most of the energy required for the process can be derived from the feedstock itself (IEA, 2004).

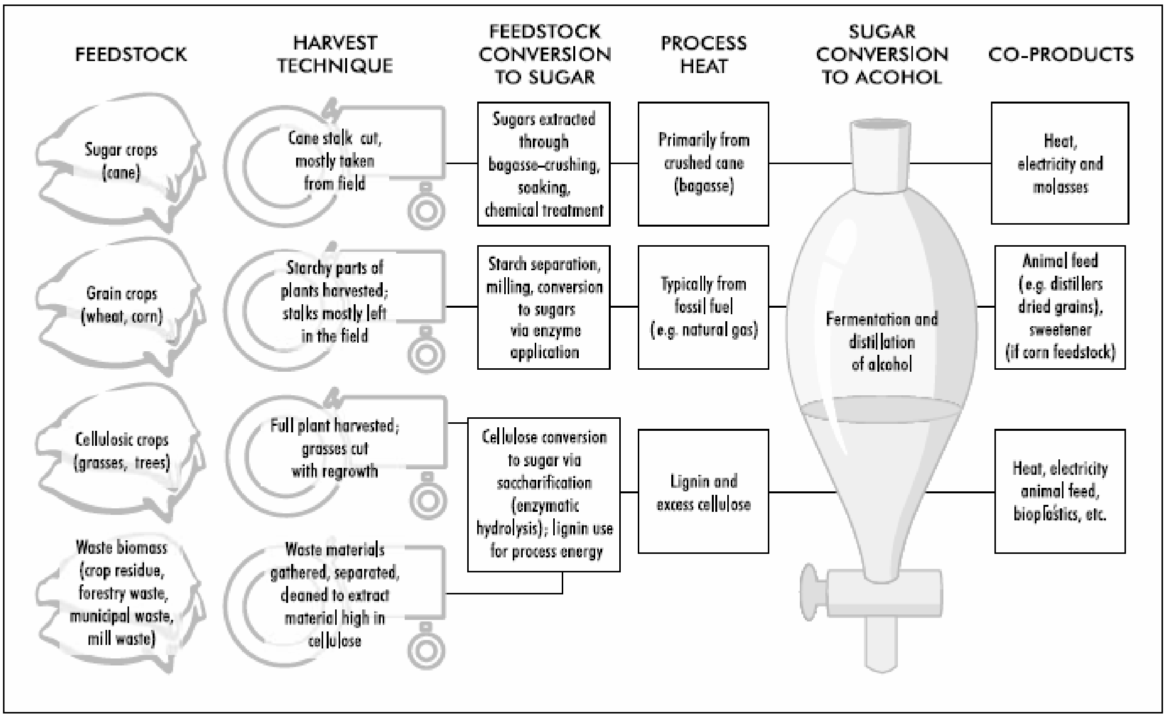


Figure 3-1 Bioethanol production options

Source: IEA, 2004, p. 35

Recently in Europe there has also been a trend to produce bioethanol for transport from wine excess production (Svebio, 2004; IEA, 2004). This has mainly occurred in Spain, Italy and France and was made cost-efficient due to higher import tariffs on non-denatured bioethanol from e.g. Brazil.[18] Figure 3-1 gives an overview of the mentioned bioethanol production possibilities.

Bioethanol can be used in blends of up to 10% (in volume) with regular petrol without making engine modifications necessary (IEA, 2004). Higher blends require modifications mainly due to the ethanol's corrosiveness. However, vehicle manufacturers nowadays also offer so-called 'flexi-fuel' cars which can run on either petrol or ethanol, i.e. also any blend between them. In Brazil these cars are already a common sight in everyday traffic for a decade. In other countries like Sweden, tax exemptions for bioethanol petrol blends and the resultingly lower prices have lead to a boost in the demand for flexi-fuel vehicles in recent years.

The energy content ratio between bioethanol and its traditional counter part petrol is around 67% (see Table 3-1). This is lower than the ratio for biodiesel to diesel (90%). Table 3-1 provides an overview of energy contents, density and energy equivalency for biodiesel and bioethanol.

Table 3-1 Diesel-biodiesel, petrol-bioethanol comparison in energy contents and density.

	Energy content (MJ/kg)	**Energy content (MJ/l)**	**Density (kg/l)**	**Energy equivalence (per litre)**
Diesel	42.324	35.501	0.839	100%
Biodiesel	36.728	32.728	0.892	92.19%
Petrol	42.210	31.546	0.747	100%
Bioethanol	26.710	21.164	0.792	67.09%

Source: Bomb, 2005, p. 14

3.1.2 Criteria for sustainable liquid biofuels

In general, the substitution of traditional transport fuels with liquid biofuels offers a number of advantages such as a diversification of energy sources and a higher security of energy supply. However, there are a number of criteria that should be kept in mind when diffusing these new products and when designing markets for them. The most stringent are the energy and GHG balance of the liquid biofuels as well as the competition for land of their feedstock options with food production (Johansson, 2006). Moreover, a number of environmental and social standards during their production have to be assessed. The most important criteria upon which liquid biofuels and their feedstock options as well as the production process should be assessed upon will be developed in this chapter.

3.1.2.1 Energy input-output ratio

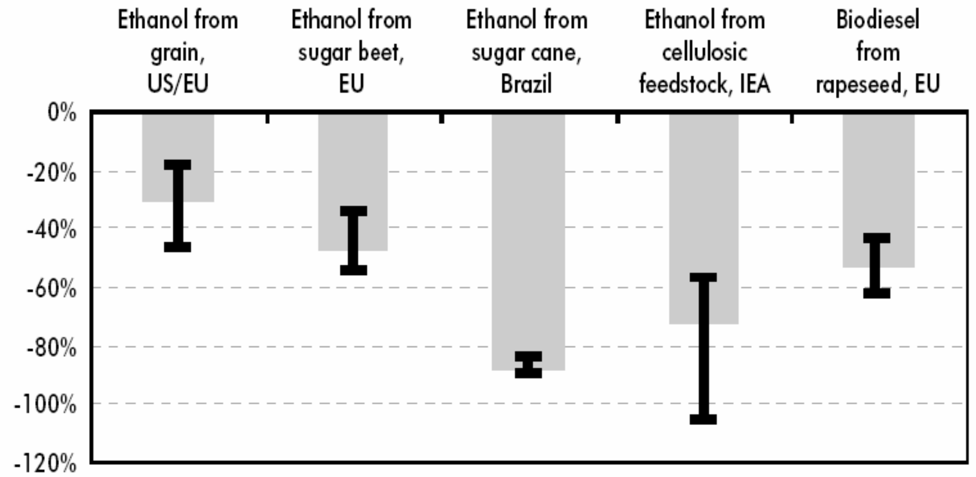
From an energy perspective, a main criterion is the **energy input/output ratio**. In order to support national energy resources, the production of biofuels should not take up more energy

[18] Rosillo-Calle and Walter (2006, p. 24) provide an overview of the current bioethanol production capacities in different countries.

than it generates. Important to consider in the energy input/output calculation are the benefits of potential by-products. When producing ethanol from sugar cane e.g. the bagasse (left-over cellulosic material and lignin after the sugar extraction) can be used to generate heat and electricity for the production process. This energy self-sufficiency also strongly affects the cost-efficiency and the carbon balance of the biofuel.

3.1.2.2 GHG balance on a life-cycle basis

The usage of biofuels also aims at reducing the main environmental aspects that derive from the combustion of traditional transport fuels among which GHG emission reductions and air quality benefits are the main components. It is therefore necessary to calculate the **GHG emissions on a life-cycle basis** (from well-to-wheel) for the certain biofuel-feedstock crops and only support those with the best ratio. It cannot be assumed that biofuels are CO_2-neutral as the conversion and refining takes up energy which is mostly still fossil fuel based. Figure 3-2 gives an indication how GHG emission reductions vary depending on the feedstock, the country and the biofuel.



Note: This figure shows reductions in well-to-wheels CO_2-equivalent GHG emissions per kilometre from various biofuel/feedstock combinations, compared to conventional-fuelled vehicles. Ethanol is compared to gasoline vehicles and biodiesel to diesel vehicles. Blends provide proportional reductions; *e.g.* a 10% ethanol blend would provide reductions one-tenth those shown here. Vertical black lines indicate range of estimates; see Chapter 3 for discussion.

Figure 3-2 Range of estimated GHG reductions from biofuels.

Source: IEA, 2004, p. 13

3.1.2.3 Competition for land use

A third key point for the sustainability of the biofuel is the **competition for land**. Within a sustainability assessment by Smeets et al. (2005) for the production of biomass for energy it is claimed that land should always primarily serve for the production and security of food supply. While the efficiency of food production should be increased, biomass for energy generation should only be planted on surplus land (Smeets et al., 2005). Competition for land includes the issue of deforestation. Clear cutting forest is still a common practice in developing countries for the extension of farm land. The prevention of an uncontrolled extension of farm land for crop plantations is a major concern in the development of a sustainable liquid biofuel trade. The current, first generation liquid biofuels are produced from energy crops i.e. that the feedstock is the actual crop and not a by-product (like e.g. straw).

This is certainly the case for biodiesel and for the currently marketed bioethanol options. It may change significantly with the market maturity of second generation biofuels such as bioethanol from cellulosic feedstock which offers the possibility of using agricultural residues. Whether or not liquid biofuel production siginificantly interfers with food production is still a heavily debated issue (see e.g. REFD, 2005). Nevertheless, with global phenomena such as a continuously growing population, increasing living standards in economies of transition like India and China, increasingly mobile societies, and increasing global transport, i.e. transport fuel consumption, there is reason to assume that land will always be scarce and the competition between new crops for energy purposes and food will remain.

3.1.2.4 Other environmental and social impacts

The list for sustainability criteria could be extended further. A number of criteria has been listed e.g. by Smeets et al. (2005) and also by Fritsche et al. (2005). A summary of the most important ones is given in the following table.

Table 3-2 Additional sustainability criteria for the production of liquid biofuels.

Criteria	**Requirements**
Environmental	Decrease soil erosion
	No fresh water depletion, good water management
	No nutrient leaching or depletion
	Pollution prevention regarding pollutants from chemicals
	No negative impact on biodiversity
Social	Increase of direct employment
	Minimum wages and no child labour
	General societal responsibility regarding education and health care

Source: Smeets et al., 2005; Fritsche et al., 2005

A lot of research has been and is still spent on identifying the most-suitable and sustainable biofuel and its feedstock option(s). As crop growing methods as well as climatic and soil conditions vary significantly, this assessment is not easy to do and it will still take years to provide a clear answer. Many liquid biofuel markets – such as the one in Argentina, are currently only emerging and have not attracted sufficient research interest in the past. This is also true because many of the new markets for liquid biofuel crops will evolve in developing countries, as stated in the introduction chapter.[19] It seems that among the current production methods, sugar cane ethanol from Brazil is the best performer in regards to the overall GHG reductions on a well-to-wheel basis and has also the highest cost-efficiency per ton of GHG absorbed (IEA, 2004). In fact, the Brazilian sugar cane ethanol is price-competitive with petrol at current crude oil prices per barrel. A description of the Brazilian case of biofuel development is given in Chapter 3.5.4.

[19] Sub-saharan Africa e.g. is considered to have very suitable conditions for energy crop growing and hence the potential to become a significant player in liquid biofuel trade in the future (see e.g. Johnson & Matsika, 2006; Batidzirai et al., 2006).

3.2 The Argentinean agriculture sector

Argentina is the second largest country of South America and the 8th largest in the world. It has vast areas of arable land and it stretches significantly from north to south. Within its 2.8 million km² it hosts different climatic zones from the hot and dry provinces of Jujuy and Salta, and the tropical ones of Misiones and Corientes in the north, further south to the fertile lands and moderate temperatures of the La Pampa and the Buenos Aires province. Argentina only ends at the very artic south of the continent.[20] Needless to say its possibilities to produce energy crops are immense and diverse. What's more, the country has a strong agricultural industry and ranks among the world's most important exporters for several agricultural products, e.g. vegetable oil. The agricultural sector is a significant income of foreign exchange for the country which underlines its importance even more as Argentina still bears a high international debt. In 2004, 54.4% of all exports of the country were of agricultural origin (IEE & BC, 2006, p. 7; SAGPyA, 2006b).

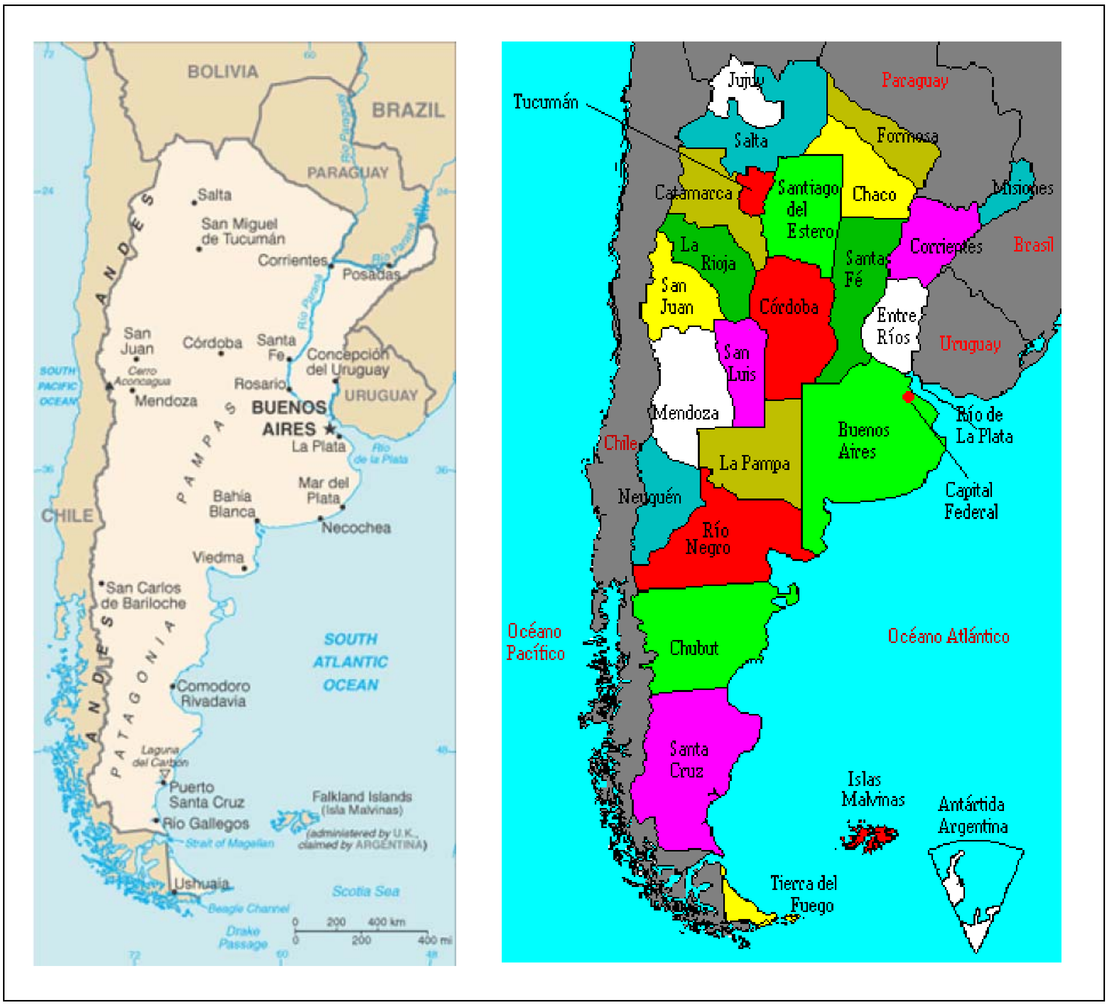


Figure 3-3 Map of Argentina and its regions.

Sources: http://www.eia.doe.gov/emeu/cabs/argentna.pdf [July 3rd, 2006]; http://www.rit.edu/~andpph/photofile-c/argentina.gif [June 27th, 2006]

[20] It is common practice to group Argentinean provinces into regions. In this regard, if not other defined, the following terms apply: The *centre region* includes the provinces of Buenos Aires, Córdoba, Entre Ríos, La Pampa, San Luis, Santa Fe; the *northeast* includes the provinces of Chaco, Corrientes, Formosa, Misiones; the *northwest* includes the provinces of Catamarca, Jujuy, La Rioja, Salta, Santiago del Estero, Tucumán; *Cuyo* includes the Mendoza, and the San Juan province; *Patagonia* includes the provinces of Chubut, Neuquén, Río Negro, Santa Cruz, and Tierra del Fuego.

3.2.1 Land ownership and production structure

The land ownership structure of the Argentinean agricultural sector varies from region to region. In general, the land itself is still mainly Argentinean owned, although international companies have heavily invested in the Argentinean agriculture sector in the 1990's (Hilbert, 2006; Lattuada & Neiman, 2005). The main trends in recent decades have been an intensification and extension of large-scale agriculture mainly in the Pampa region, which hosts the country's most fertile soils (Lattuada & Neiman, 2005). However this does not mean that necessarily the ownership of the land has always changed. Nevertheless, it has become a common practice that big (national and international) companies own or rent land and produce with high capital and technology input. This trend was again most intense in the centre region and here mainly in the Pampa region (Lattuada & Neiman, 2005). Figure 3-4 shows this on the basis of four different regions within the Pampa.

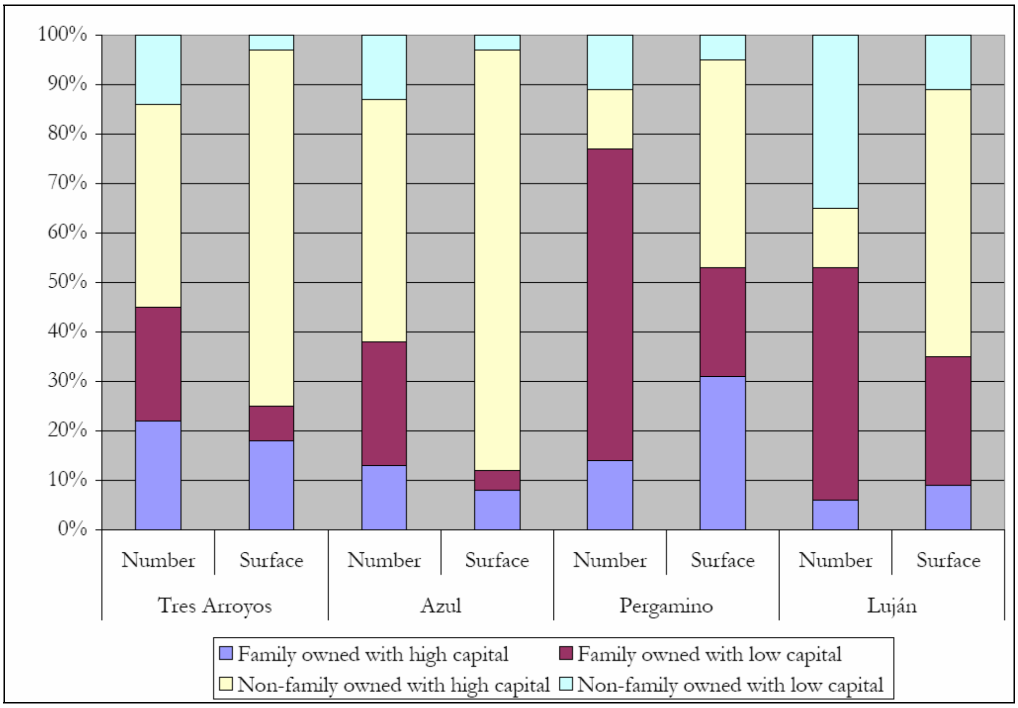


Figure 3-4 Number of agricultural producers and surface area cultivated in selected regions of the Buenos Aires province.

Source: González et al., 2005, p. 75.

The increasingly large-scale agricultural production has lead to a significant increase of agricultural output in Argentina with its highest increase throughout the 1990's (Lattuada & Neiman, 2005). Nowadays, the agricultural sector contributes 30% to the gross domestic product (GDP) of Argentina (Lattuada & Neiman, 2005, p. 28). According to Lattuada and Neiman (2005) the increase in production size and volume has however resulted in an exclusion of small and medium sized producers, again with most effect within the centre/Pampa region. This change can be observed from Table 3-3.

The intensification of large scale agriculture in the centre region was apparently one of the reasons for an increasing migration of rural populations into urban areas in the centre region (Taboada, 2006; Girardin, 2003, p. 10). While the total Argentinean population increased by 13% within the period of 1991-2001, the share of the population living in rural areas decreased by 8% (Lattuada & Neiman, 2005, p. 26).

Table 3-3 Quantify and surface areas per producers in Argentina, comparison between 1998 and 2002.

Region	1998			2002		
	Producers		Average surface area (ha)	Producers		Average surface area (ha)
	No.	%		No.	%	
Total	**421,221**	**100**	**421.2**	**317,816**	**100**	**539.1**
Pampa	196,254	46.6	391.3	136,345	42.9	530.7
North-east	85,249	20.2	222.0	68,332	21.5	284.3
North-west	72,183	17.1	268.6	63,848	20.1	257.5
Cuyo	46,222	11.0	140.2	32,541	10.2	137.9
Patagonia	21,313	5.1	2,619.8	16,750	5.3	3,499.6

Source: Lattuada & Neiman, 2005, p. 41

The share and distribution of the rural population throughout Argentina is relatively unbalanced. The provinces which host the main agricultural activity are also the provinces with the highest urban population. This means that while only 7% of the local population in the centre region – the main agricultural region in Argentina – live in rural areas, they make up to 40% of the total rural population in Argentina (Lattuada & Neiman, 2005, p. 26). The share of people living in rural areas is significantly higher in Northern provinces like Misiones and Santiago del Estero where it reaches around 30% (Lattuada & Neiman, 2005, p. 27).

Also, in the northern part of the country, a significant part of the rural population still depends heavily on their own micro and small scale agricultural production. Argentina is still regarded to be a developing country (e.g. by the UNFCCC) and hosts a significant amount of poor and indigenous population – which lives mainly in the northern part of the country. Poverty as well as water and food supply issues are mainly prevalent in this part of the country and in the shanty towns around the main cities (e.g. Buenos Aires, Rosario, etc.). In a recent report on renewable energy potential in Argentina, it was pointed out that these parts of the Argentinean society have been excluded from recent modernization processes within the country (FB, 2005b, p. 3).

The very critical point in recent Argentinean history seems to be the state bankruptcy in December 2001 which was followed by an economic crisis in 2002. The personal implications for many Argentineans remain prevalent as this was only 4.5 years ago. Since the state bankcruptcy, the income structure within Argentina has undergone a change which seems to have mainly thinned out the once prevailing middle-class, leaving the majority of it now in the lower income segment (Mendoza, 2006). In general, most people are left with fewer money and purchasing power than before the economic downturn (Mendoza, 2006). People's perceptions towards policy are nowadays characterised by resistance, disbelief and mistrust.

The average rate of people living on less than US$ 2 per day (between 1990 and 2003) in Argentina was still 14.3% (UNDP, 2005a, p. 227). The percentage of the population living below the poverty line has sharply risen (again) due to the ecomonic crisis and levels currently at over 50% (see Figure 3-5). The unemployment rate has not suffered sustainably from the economic crisis and also the GDP has continuously risen again since 2002 (UNDP, 2005b).

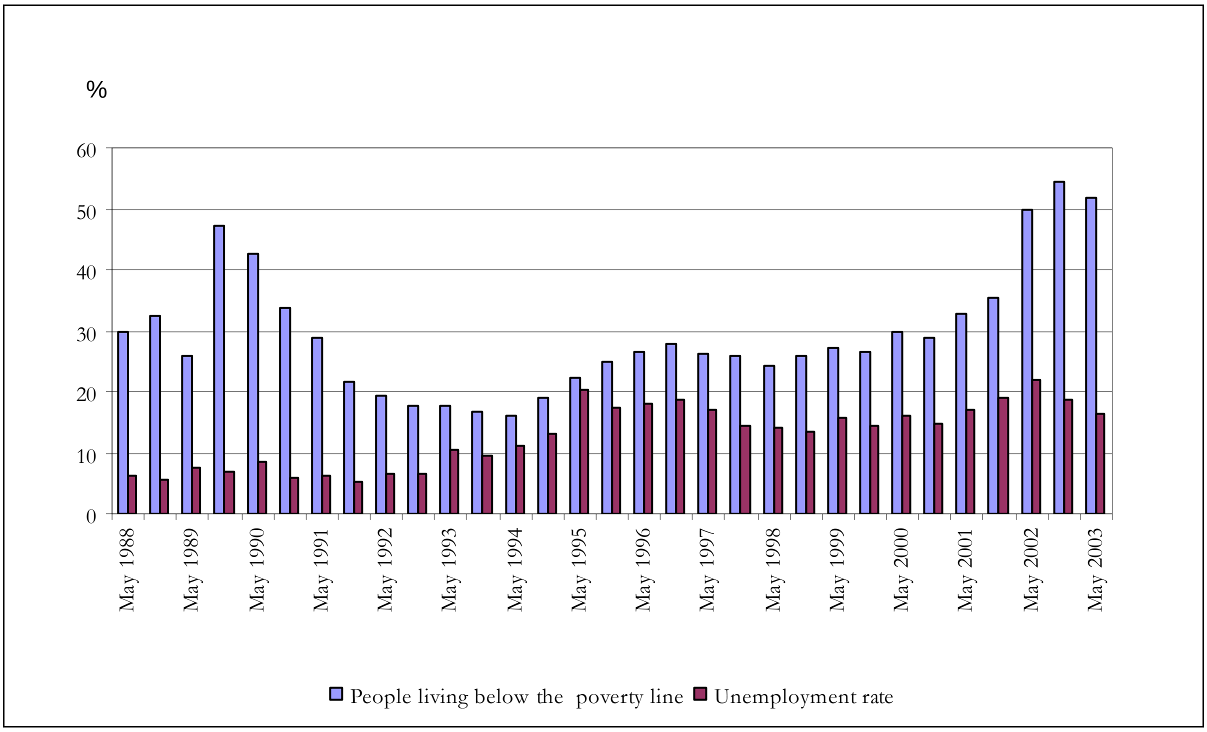


Figure 3-5 Percentage of the Argentinean population living below the poverty line and unemployment rate between 1998 and 2003.

Source: http://www.indec.mecon.ar/nuevaweb/cuadros/74/grafpobreza2.xls [September 1st, 2006]

3.2.2 Crop production

Due to the various climatic conditions, the theoretical **feedstock opportunities** for biodiesel and bioethanol in Argentina are diverse (see Appendix I for a dynamic graph of the major crops produced in Argentina). Based on the produced quantities, current local biodiesel feedstock options include vegetable oil from soy beans, sunflower seeds, rape seeds, safflower, and to a lesser extent also peanuts (INDEC, 2002; SAGPyA & IICA, 2005).[21] Local bioethanol feedstock crops include foremost sugar cane and sugar molasses, but also grain crops such as maize and wheat and to a smaller extent also sorghum, oats, rye, and millet (INDEC, 2002; SAGPyA & IICA, 2005).

3.2.2.1 Oil crops

The crop production in Argentina has steadily increased in the past, with a significant rise during the last decade (SAGPyA & IICA, 2005, p. 28). A major part of this was the increase in land devoted for soy bean production. Soy beans are by far the main crop produced in Argentina. They cover 53% of the entire land surface devoted to agriculture and this share is rising (SAGPyA & IICA, 2005, p. 28). During the last 15 years, the amount of produced soy has almost tripled with a sharp increase after the introduction of genetically modified soy in the 1996/1997 season (see Figure 3-5).

[21] This section only covers energy crop feedstock options. Animal fat and used (frying) vegetable oil are not considered.

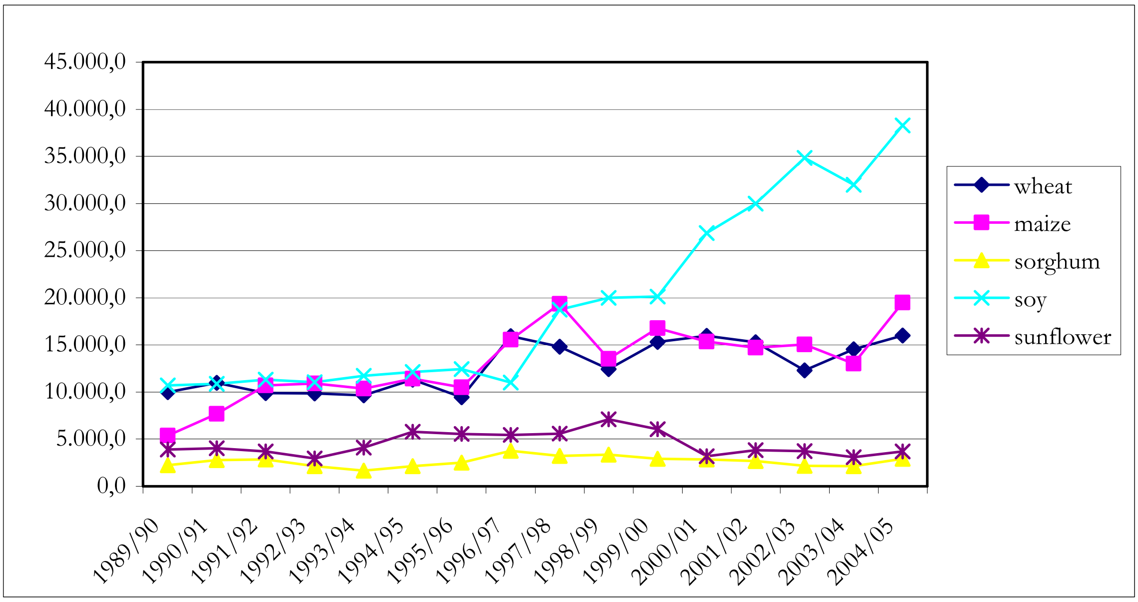


Figure 3-6 Argentinean crop production (in thousand tons).

Source: Taboada, 2006; SAGPyA 2006a & 2006b; SAGPyA & IICA, 2005

Today, Argentina is the third largest producer in the world for soy beans (after Brazil and the USA) and the world's biggest exporter of soy bean oil (Valente, 2006; SAGPyA & IICA, 2005, p. 28).[22] The main market for the soy oil is China, whose demand has steadily increased in recent years (BBC, 2005).[23] This strong demand of China (a secure market), the relatively easy cultivation of the herbicide resistant genetically modified soy, combined with low herbicide prices, and the introduction of no tillage farming equipment in Argentina are considered to be the main drivers for the strong increase in the production of soy (Taboada, 2006; Hilbert, 2006; SAGPyA & IICA, 2005, p. 28). Moreover, the Argentinean climate is very suitable for soy allowing two harvests per year (first and secondary soy). Around 67% of the first soy and 100% of the secondary soy is grown through no tillage farming which has lower machinery i.e. energy input than tillage farming (Asal et al., 2006, p. 54).

In 2005/2006, the land devoted to soy bean production increased again and is now around 15.2 million ha of land (from 14.4 million ha in 2004/2005, see Table 3-4). The harvest is expected to reach another record high of over 40 million tons (SAGPyA, 2006c). The second most important oil crop in Argentina is sunflower. The share of sunflower and soy oil in the total vegetable oil production in Argentina has mainly risen due to the increase in soy oil production. In 2005, the two oil crops account for more than 98% of the total vegetable oil production in Argentina (CIARA, 2006). Their relation in production sizes are shown in Figure 3-5 and Table 3-4.

[22] Another main product from soy beans apart from the beans themselves and the soy oil is the meal which is rich in proteins and therefore highly desired animal fodder, e.g. for poultry.

[23] Detailed information on the export destinations for Argentinean crops is available on the website of the Grain Stock Exchange (Bolsa Cereales) in Buenos Aires (http://www.bolcereales.com.ar/ [July 20th, 2006]).

3.2.2.2 Sugar and starch crops

Other important crops for Argentina are maize and wheat (see Figure 3-5, Table 3-4). Usually grown in rotation patterns with soy, these crops grow in similar climatic conditions as soy (Taboada, 2006). Their production has also reached record highs for Argentina in the 2004/2005 planting season. Nowadays, Argentina is the world's sixth largest maize producer and the second largest exporter of maize (SAGPyA & IICA, 2005, p. 11).

Sugar cane, a very suitable feedstock for bioethanol production only has a marginal share in the agricultural crop matrix in Argentina currently. In 2004, 1.72 million tons of sugar cane were produced in total in Argentina (SAGPyA & IICA, 2005, p. 11).[24] It is estimated however that the current production range of sugar cane growing cannot be further extended as the regions with suitable climatic conditions are already fully used (Almada, 2006; Molina, 2006). The province Tucumán is the country's main sugar cane producing region.

Table 3-4 Crop production in Argentina 2004/2005.

Grain	Sown area	Harvested area	Production	Production share
	Mill. ha	Mill. Ha	Mill. tons	%
Soy	14.4	14.0	38.3	46%
Maize	3.3	2.7	19.5	23%
Wheat	6.3	6.1	16.0	19%
Sunflower	2.0	1.9	3.7	4%
Sorghum	0.6	0.6	2.9	3%
Others	1.2	1.2	3.7	4%
TOTAL	**27.8**	**26.5**	**84.0**	**100%**

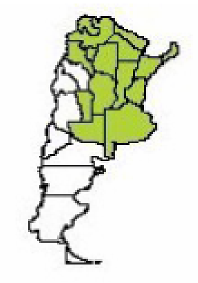
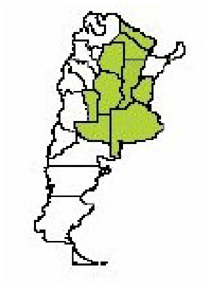
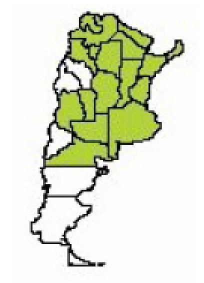
Source: SAGPyA (2006a & 2006b)

3.2.2.3 Geographic distribution

The main geographic location of the crop production is the centre region, the country's 'grain and meat basket' (see Table 3-5; SAGPyA & IICA, 2005; DENA, 2005). The flat land with fertile soil and moderate temperatures all year round offers ideal conditions for the farming of several crops. In the farming season 2003/2004 around 89% of all soy beans, 82% of all sunflower as well as 98% of all rape seeds, and 92% of all maize (in tons of production) were produced in the centre region (SAGPyA & IICA, 2005, p. 29-45). The northern region also has agricultural industries (such as e.g. tea and yerba growing in Misiones and sugar cane industries in the provinces of Tucumán, Jujuy, and Salta) but the scale of production is significantly smaller than the large-scale farming methods in the centre region.

[24] As a comparison, Brazil, the world's largest producer of sugar cane grew 450 million tons of sugar cane in 2004 (SAGPyA & IICA, 2005, p. 13).

Table 3-5 Regional distribution of major crop plantations.

Soy	Sunflower	Rape	Maize
			

Source: SAGPyA & IICA, 2005, p. 28-44

The centre region also hosts the country's main harbours, situated along the Río Paraná which flows from Paraguay down to the Río de la Plata between the borders of the three provinces of Formosa, Chaco, Santa Fé and the provinces of Corrientes and Entre Ríos. As said, the agricultural sector is strongly export oriented, and almost all export is handled and shipped overseas at these harbours. The main port in Rosario (Santa Fé province) alone accounts for almost 70% of all export handling (Hilbert, 2006).

3.2.3 Vegetable oil production

Argentina ranks among the world's most important vegetable oil producers (first for soy bean oil, second for sunflower oil), and is supposed to have one of the most efficient and technologically advanced milling equipment for vegetable oil in the world (Hilbert, 2006; Almada, 2006; Leone, 2006). Its current milling capacity reaches 154,174 tons *per day* (SAGPyA & IICA, 2005, p. 30) and 95% of the vegetable oil is devoted to export (SAGPyA, 2006a). The vegetable oil industry is characterised by an oligopoly structure. 85% of the installed milling capacity is divided among six major companies (see Table 3-6). Their locations are concentrated in the provinces of Santa Fe, Buenos Aires and Córdoba (see Appendix I for a map). Often the milling facilities are situated at or close to important harbours (SE, 2006). In the harvesting season of 2003/2004 the centre region accounted for almost 90% of the total vegetable oil production in Argentina (SAGPyA & IICA, 2005, p. 30).

Table 3-6 Most important vegetable oil milling companies as of 2006.

Company	**Provinces**	**Production capacity (tons/day)**	**Share**
Bunge Argentina SA	Santa Fe, Córdoba, Buenos Aires	26,800	17.4%
Cargill SACI	Santa Fe, Buenos Aires	25,600	16.6%
Molinos Río S.A.	Santa Fe	21,700	14.1%
SACEIF Luis Dreyfus	Santa Fe	20,000	13.0%
Vicentín SAIC	Santa Fe	19,300	12.5%
Gral. Deheza SAICA	Santa Fe, Córdoba	17,800	11.5%
		TOTAL	**85.1%**

Source: SAGPyA & IICA, 2005, p. 30

Around three quarters of the vegetable oil production is from soy beans. In 2005, they accounted for 76% of the total amount produced, i.e. more than 5.0 million tons of vegetable oil (CIARA, 2006; SAGPyA & IICA, 2005). The other important oil crops are sunflowers. They accounted for 22% of the vegetable oil production in 2005 (see Figure 3-6). The remaining vegetable oil production is shared among the following crops (with decreasing importance) as of data from 2005: peanuts, safflower, cotton, rape/canola, flax/linen (CIARA, 2006). The development of the crop utilisation and the increase in vegetable oil production in Argentina is shown in Figure 3-6.

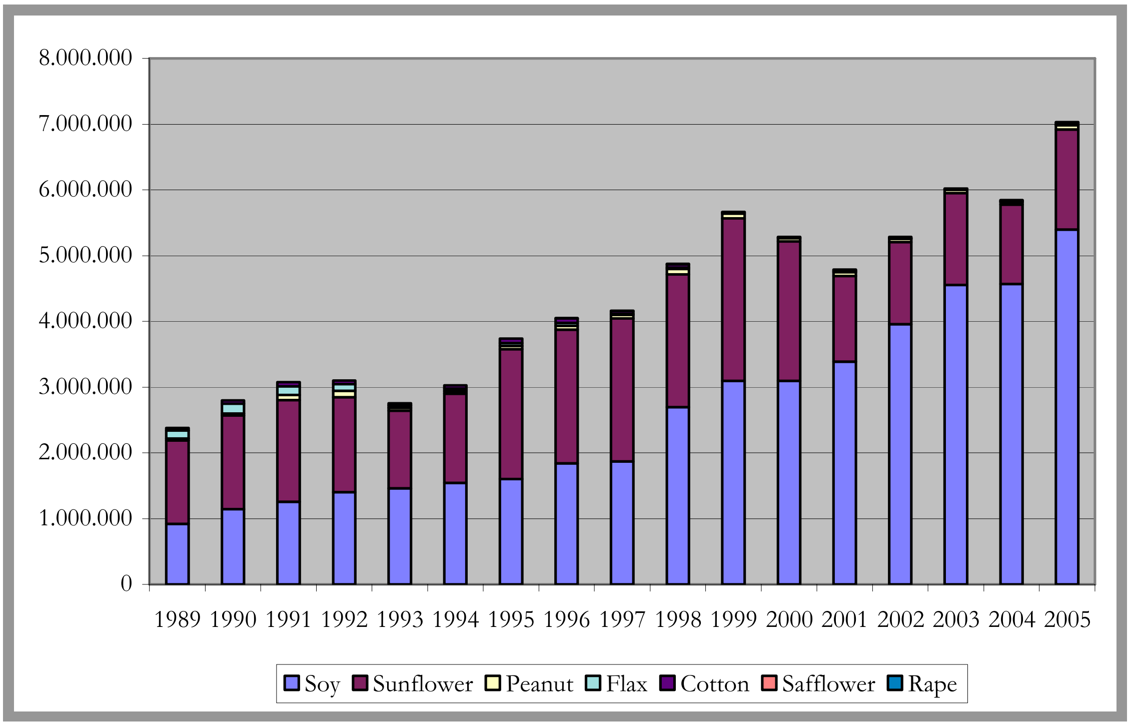


Figure 3-7 Development of the Argentinean vegetable oil production (in litres).

Source: CIARA, 2006.

3.2.4 Policies and legal aspects

It is framed in the National Constitution of Argentina (Art. 124, §2) that natural resources are the property of the provinces which means that agricultural policy is foremost dealt with at the local government level. However, all provinces are combined under a general national law – which results in overlapping. According to the SAGPyA there is currently no general national agricultural policy in terms of support for certain crops in certain provinces or regions (Almada, 2006; Leone, 2006; Hilbert, 2006). There is however a current research focus of the SAGPyA on different crop options for the arid and semi-arid regions in the northern part of the country (Leone, 2006). Here, depending on the development of the Argentinean biofuel market, potential feedstock crops for biofuels like ricinus (for biodiesel) or sugar cane (for bioethanol) could play an important role (Leone, 2006).

Currently, there are no agricultural subsidies, neither at the national nor the local level (Almada, 2006; Leone, 2006). The state takes taxes on revenues (national level) and export goods. While the revenue tax is a general value-added tax (VAT)[25] of 21%, the export tax varies from product to product. The export tax for agricultural products is on average around 20% of the export value (Moltoni, 2006; Hilbert, 2006). This tax is supposed to ensure the local food supply and keep food prices on a stable and low level (Almada, 2006; Leone, 2006). It is feared that otherwise, due to the low production costs in Argentina, the export of agricultural products will soar, leaving the country in a local (price) competition for food (Almada, 2006; Leone, 2006).

Table 3-7 Important export taxes for selected agricultural products in 2006.

Product	Soy beans, sunflower seeds	Soy & sunflower oil	Grains	Biodiesel
Tax (in % of export value)	23.5%	23.5%	20%	5%

Source: http://www.agroparlamento.com/agroparlamento/desarrollada.asp?id=6 [July 5th, 2006]; Bakovich (2006); Almada (2006); Leone (2006).

Together with Brazil, Paraguay, Uruguay, and since July 2006 also Venezuela, Argentina forms the Mercado Común del Sur (Mercosur), a consolidation for an internal free trade and a common external trade policy. Export taxes to these countries are therefore lower than to those not in the Mercosur. Noteworthy in regard to biofuels is the dispute between Argentina and Brazil over sugar (and its co-products) which is a product, currently not included in the Mercosur treaty (Osava, 2006). The main reason for this seems to be the efficiency of the Brazilian sugar industry and their low prices. Argentina fears to be exposed to cheap Brazilian imports leaving its own (less efficient) sugar industry without revenues. Apparently, Brazil has recently offered to transfer its technology for the conversion of sugar into bioethanol to Argentina in order to solve this issue (Osava, 2006). Regarding taxes, another important issue is that small and medium-sized enterprises (SMEs) face different i.e. lower tax rates in Argentina.

3.3 The Argentinean oil and transport fuel sector

Although Argentina is almost energy independent[26], energy security issues play an important role as the last severe energy crisis was only in 2004. Due to the economic downturn in late 2001, caps were put on energy prices to keep those artificially low. As the demand for energy in the following years increased again they were however not adjusted which lead to an under-supply of energy. To ensure local demand, Argentina had to buy natural gas from Bolivia and also partially cut off its natural gas supply to Chile. Since then Argentina has preserved itself the right to cut off this supply during times of national shortage worsening the two countries' foreign relations as Argentina is the main natural gas importer for Chile.

Concerning natural gas and crude oil, Argentina is today still a net primary energy exporter. Nevertheless, Argentina's proven oil reserves will at current extraction, consumption, and efficiency rates most likely only last for another 10-15 years according to the German Energy Agency (see DENA, 2005, p. 14). The production of oil however has declined in recent years (see Appendix II for a dynamic graph), and the expected increase in fuel consumption could

[25] The term in Argentina is 'Impuesto sobre la Valor Agregada' (IVA).

[26] The share of energy imports from net primary energy sources accounted for 0.7% in 2003 (DENA, 2005, p. 11).

shrink the timeline down to 9 years until the country will become a net importer for crude oil (SAGPyA & IICA, 2005, p. 1). Recent national statictics even stated that net oil imports could only be 2-3 years away (El Clarín, 2006). In any case, Argentina is currently already now importing oil from Venezuela (DENA, 2005; Bakovich, 2006).

As the primary energy matrix of 2004 shows (see Figure 3-7), Argentina still heavily relies on conventional energy carriers. In the period between 1970 and 2003, oil, its by-products and natural gas contributed on average to more than 80% of the Total Gross Domestic Supply[27] of energy (FB, 2005a, p. 68) (see Appendix II for a dynamic graph). In 2004, the total primary energy production in 2004 was 71,415 million toe (SE, 2006b), an all time record high.[28] This mainly arose through an increase in the use of crude oil and natural gas (SE, 2006b).

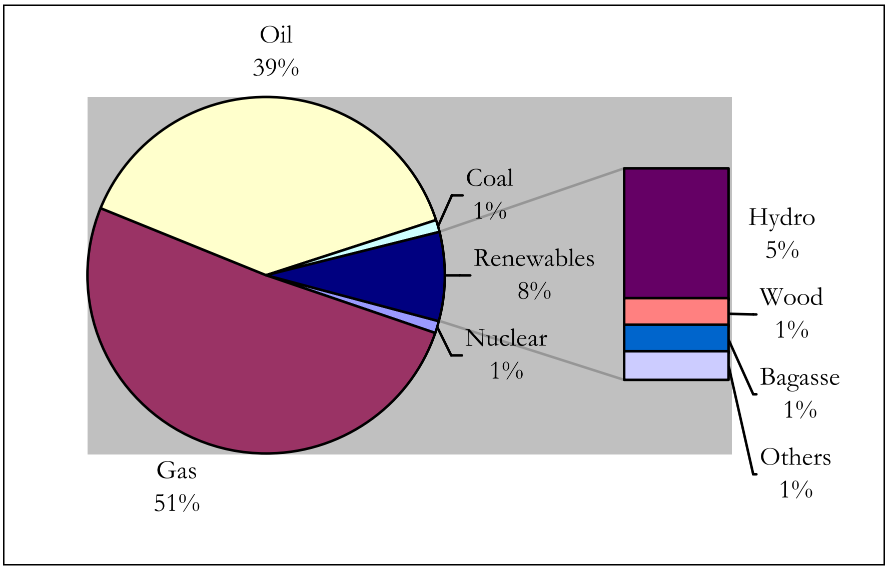


Figure 3-8 Argentina's primary energy matrix in 2004.

Source: SE (2006b)

3.3.1 Transport fuel production

Until the late 1990's the Argentinean oil sector (up-stream and down-stream part) was a state owned monopoly under Yacimientos Petroliferos Fiscales (YPF). In 1999, YPF merged with the Spanish state owned oil company Repsol to form Repsol-YPF. The sector was also opened up to private investors and today it resembles an oligopoly structure in both, the up-, mid- and down-stream part.

In the oil **exploration and exploitation (up-stream)** part there are Repsol-YPF, Petrobrás (Brazilian), Chevron-Texaco (USA), and Pan American Energy (controlled by British Petroleum, UK) (EIA, 2006).[29] In 2004, the Argentinean government formed a new, state

[27] It is defined as "the total amount of energy contributed annually, coming from national production and exchange with foreign countries, for its transformation and/or final consumption in the country, including all types of losses" (FB, 2005a, p. 68).

[28] Until 1997 the primary energy production was below 60,000 million toe and until 2004 below 70,000 million toe (SE, 2006b). See Appendix for more information.

[29] Other companies include Pioneer, Pluspetrol, Sipetrol, Tecpetrol, Total, and Vintage (SE, 2006a).[30] Whereas its expenses in 2005 arose to US$500,000 (EIA, 2006, p. 2).

owned oil company called Enarsa (Energía Argentina S.A.). As regulated in its formation law (Law 25.943), the permits for off-shore oil exploration and exploitation belong to Enarsa. Most of the left oil reserves in Argentina are found off-shore but their exploitation requires significant investments. At the moment, Enarsa however has no production sites and revenues[30] and so far plays no significant role in the market. To ensure a national oil supply, there are currently also government plans to buy back the YPF-shares from Repsol. The privatisation of the industry has lead to a decrease of investment in Argentina and a decline in oil production in recent years (Bakovich, 2006; EIA, 2006).

In the **refining step (mid-stream)**, more than 90% of the market volume is concentrated among the oligopoly of Repsol-YPF, Esso, Shell, and Petrobrás (Bakovich, 2006; ADI, 2005, p. 6).[31] In total, Argentina's oil refineries have an overall crude oil refining capacity of 625,000 barrels a day (EIA, 2006, p. 2). The main geographic locations of the refineries are the province of Buenos Aires, along the Río Paraná and Río de la Plata (SE, 2006a). The refineries are expected to run at full capacity in order to satisfy the fuel demand in Argentina (SE, 2006; Bakovich, 2006).

The **distribution (down-stream)** of transport fuels part is also dominated by Repsol-YPF which runs about 45% of all gas stations (ADI, 2005, p. 6). The other main players with which Repsol-YPF covers around 92% of the market are Shell (17.3%), Esso (16.6%), and former EG[3] (now Petrobras) (13%) (ADI, 2005, p. 6). The number of gas stations has significantly declined since the economic collapse of the country – mainly to the dissatisfaction of rural communities and geographically isolated areas.

3.3.2 Transport fuel demand

The road transport fuels used in Argentina are diesel, petrol and compressed natural gas (CNG). The latter has seen a steady increase since its market introduction in the mid-90's and has substituted a significant amount of petrol powered cars (see Figure 3-8). It is (still) the cheapest at the pump and vehicle conversion costs in Argentina for CNG cars are around US$ 500 (Bakovich, 2006). Although the diesel demand has varied and followed the economic trend within the country (downturn in December 2001 and the following year), it always was the main transport fuel (see Figure 3-8). Today is accounts for about 55% of the annual road transport fuel consumption (Bakovich, 2006; SE, 2006c).[32]

[31] Others include Refinor, Rhasa, and Dapsa (SE, 2006a).

[32] Even including all other common, conventional transport modes (train, ship, airborne, etc.), its share of the total amount of transport fuel consumed accounts for over 48% (in toe) (Bakovich, 2006; SE, 2006a & 2006b; AABH, 2006; SAGPyA & IICA, 2005, p. 26).

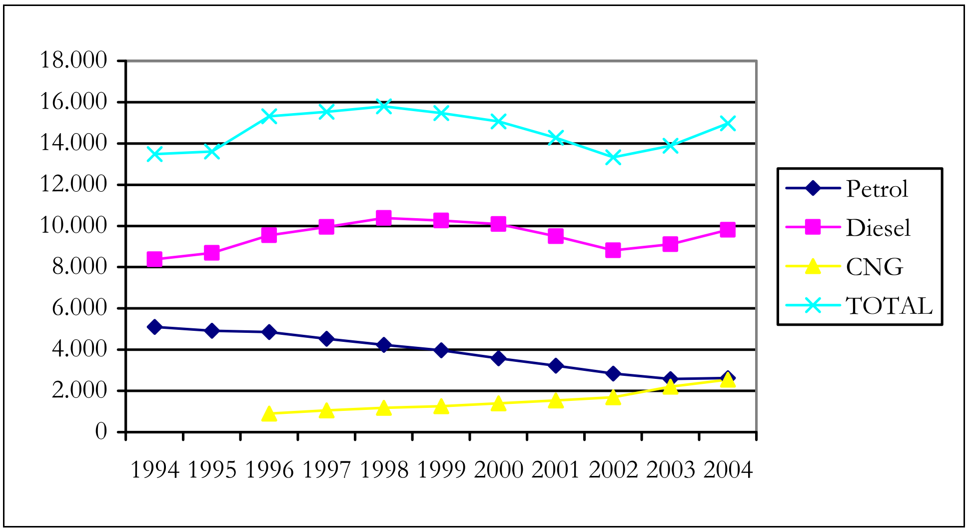


Figure 3-9 Consumption of road transport fuels in thousand toe between 1994-2004.

Source: SE (2006b)

The total diesel consumption has increased from 11.38 million m³ in 2004 to about 12.24 million m³ in 2005 and is estimated to rise even further with an average annual increase of 3.0-3.5% (SAGPyA & IICA, 2005, p. 26; ADI, 2005, p. 5; Acosta et al., 2006; AABH, 2006). Even though Argentinean refineries currently operate at maximum capacity, their supply of diesel cannot fulfil the high demand. Argentina is already now a net importer of diesel (SE, 2006; Bakovich, 2006; Acosta et al., 2006). In 2005, 3.1% of the annual diesel consumption was imported (SE, 2006d; Bakovich, 2006).

The country's dependence on diesel can be explained by three main issues. Firstly, the country's railway system is old and not maintained. Train services do not exist for most parts of the country. Therefore most cargo is transported by lorrys and passengers by buses. Moreover, diesel for use in public passenger transport is subsidised (Acosta et al., 2006). Secondly, as the agricultural sector contributes significantly to the country's GDP, naturally its energy consumption which arises mostly from farming machinery and equipment contributes significantly to the overall diesel consumption. Finally, the private car fleet still consists of a significant amount of diesel powered vehicles. The consumption ratios from 2005 are shown in Figure 3-9.

Diesel supply shortages in Argentina have become more frequent, especially during times of intensive agricultural activity such as sowing and harvesting (Hilbert, 2006). The country's remote areas also face regular supply shortages due to the low density of gas stations and their geographic distance from the refineries which are concentrated in the centre region (see e.g. Infobae, 2006). The consumption of fuel is however highest in the centre region, which hosts the country's highest farming activity (SE, 2006a).

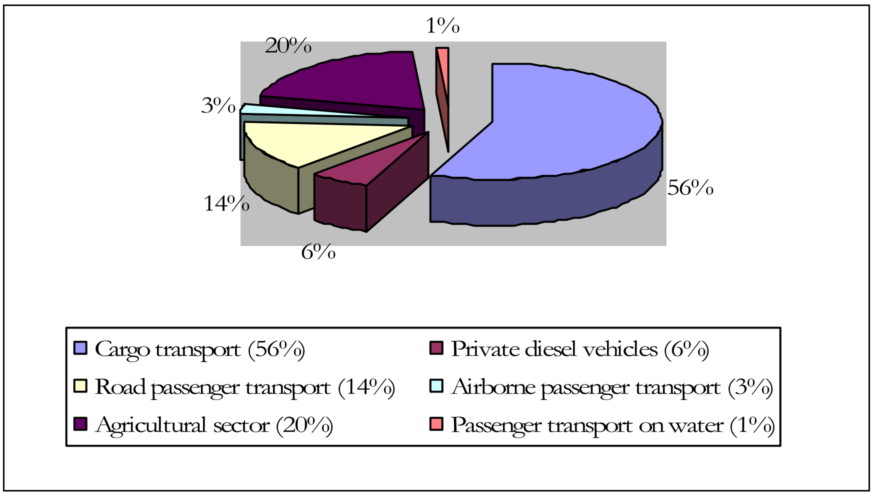


Figure 3-10 Share of diesel consumption per service in 2005.

Source: AABH, 2006; SAGPyA, 2005, p. 26

3.3.3 Policies and legal aspects

The regulatory framework for energy includes different state secretaries depending on the aspect involved. The Secretary of Energy plays the central role. It sets the norms and checks the enforcement for the standards of production, refining and distribution of fuels as well as for the quality of the fuels themselves.

The energy market in Argentina is still distorted as state caps on electricity and fuel prices prevail. It is assumed that these price caps have already artificially stimulated the demand for energy in Argentina. Combined with a significant lack of investments in the energy sector since 1998, these price caps could have contributed partially to the energy crisis in 2004. As a consequence of the crisis, the government has launched the '**2004-2008 Energy Plan**' in order to prevent future (short-term) energy shortages. It addresses both the production as well as the energy demand side. On the production side it is aimed to 'correct' investments which include mainly the increase of fossil fuel export taxes in order to keep resources in the country and the set-up of the state owned energy company Enarsa which will become the owner of any new crude oil exploration in Argentina that has not yet been awarded. On the demand side, it is aiming at the liberalisation of fossil fuel prices in Argentina.[33] Although so far this liberalisation has not yet taken place.

The government's resistance for a liberalisation of fuel prices at the moment is the assumed low purchasing power on behalf of the consumers since the economic downturn in 2001/2002. In order to give people access to electricity and fuel, prices are kept under international market prices. This is however only part of a short-term strategy. As soon as Argentina will become a net importer of crude oil, and current estimations say that this could already be in 2-3 years at current production, consumption, and efficiency rates, it will have no other choice but to raise petrol prices closer to the international level. The purchasing power

[33] The current price per barrel of crude oil on the Argentinean market however is still between US$ 33-42 (Bakovich, 2006; Acosta et al., 2006), around half of the international price at the moment (over US$ 72). Petrol and diesel leave the refining plants at around the same price (~ AR$ 0.80 per litre) but different taxes apply to them (see Table 3-8). Nevertheless, after taxes, current fuel prices at the pump in Argentina are very low (see Table 3-8) compared to Europe, North as well as South America.

of consumers cannot be expected to increase significantly within the coming years. However there is currently still no medium-term strategy (post 2008/2010) of the Secretary of Energy how this issue should be dealt with. It is also unclear which role liquid biofuels will have in Argentina's future energy matrix. Currently, they are still not mentioned in any overall strategic energy plan for Argentina on behalf on the Secretary of Energy.

Noteworthy in terms of legal aspects and laws in general is that the tax setting is controlled by the president. In Argentina, the president has the right to change taxes on his/her own behalf without the approval of the senate or the Chamber of Deputies (Cámara de los Diputados). The enforcement is controlled by the assigned ministries i.e. their secretaries.

Table 3-8 Taxes and prices for diesel and petrol in Argentina.[34]

Tax	**Diesel**	**Petrol**	
Fuel Transfer Tax	19%	Común: 70%; Super: 62%	
Diesel tax	20.2%	(does not apply)	
Tax for hydric infrastructure	(does not apply)	0.05 AR$/litre	
Tax on profits for crude fuels	3.5%	3.5%	
Value added tax	21%	21%	
Price per litre (as of 31.01.2006) at the pump	AR$ 1.44 (US$ 0.48)	Común	AR$ 1.69 (US$ 0.55)
		Súper	AR$ 1.88 (US$ 0.61)
		Ultra	AR$ 2.00 (US$ 0.65)

Source: Bakovich, 2006; http://energia.mecon.gov.ar/home_pet/home_pet.asp [July 6th, 2006]

3.4 Experiences with biofuels in Argentina

Argentina has experience in the production and promotion of bioethanol and biodiesel. The government i.e. the secretaries have been involved in different activities concerning the two biofuels. While there was a national programme for bioethanol already at around the same time as the Brazilian Proalcool programme (late 1970's and 1980's), the strong interest in biodiesel is more recent (late 1990's).

3.4.1 Bioethanol

The national interest in a bioethanol industry that produces anhydrous ethanol for transport dates back to 1922 (SAGPyA & IICA, 2005, p. 41). The further development of this interest peaked in the 1970's when high crude oil prices lead to the set up of the '**Alconafta**'[35] programme. It envisaged the production of anhydrous ethanol from sugar cane in the northern region (mainly the province of Tucumán) of the country, consisted of five steps, and was started in 1979 (Almada, 2006; Leone, 2006). The idea of the plan was to increase the

[34] The law on the taxation of liquid fuels and natural gas as well as the modifications of the law can be found under http://www.infoleg.gov.ar/infolegInternet/anexos/45000-49999/48772/texact.htm [July 17th, 2006].

[35] The term is a combination of Alcohol (for ethanol) and Nafta (name for petrol in Argentina). For a detailed description of the historical development see SAGPyA and IICA (2005, p. 41ff).

capacity of sugar production, the elimination of sugar exports, and the expansion of potential feedstock crops. It was also planned to increase the capacity for distillation and dehydration.

Throughout the 1980's however, only the first two steps of the programme could be realised (Almada, 2006; Leone, 2006). After a decade of government expenditure, it became obvious that the local production of ethanol was still not cost-competitive with the (distorted) local petrol prices and the increase of the international sugar prices lead to a switch back from the sugar cane industry in Argentina to produce solely sugar. Since then the interest in bioethanol production has been low and although raw material is available in different forms in Argentina, there is currently no commercial production of anhydrous bioethanol for petrol blending (SAGPyA & IICA, 2005, p. 41&42). The commercial ethanol production currently is only directed towards the food, beverage, and pharmaceutical industry (SAGPyA & IICA, 2005, p. 11). Mainly sugar cane molasses are used as raw material (Almada, 2006). But the current ethanol producers – the Secretary of Energy estimates that there are 15-16 small-scale ethanol production facilities in Argentina (Bakovich, 2006), do not all form part in the sugar cane production chain (SAGPyA & IICA, 2005, p. 11).

3.4.2 Biodiesel

Since the increasing interest in the late 1990's, several secretaries of the state have formulated different resolutions (see section 3.4.3 for more details). Most are not specifically designed for biodiesel but for biofuels in general. In 2001 however, the Secretary of Energy formulated the **'Competitiveness Plan for Biodiesel'** which gives tax exemptions for 10 years from the fuel transfer tax (see Table 3-8) on the national level and for hallmarks, brutto revenues, and property on the provincial level to biodiesel producers (SAGPyA & IICA, 2005, p. 39). Although it did not have the desired effect so far, a number of small-scale biodiesel production projects of entrepreneurs, enthusiasts, and mainly farmers are running (for a list see SAGPyA & IICA, 2005, p. 24f). It is estimated that the current production capacity of biodiesel in Argentina reaches around 50,000 tons of biodiesel per annum and is of medium quality (Hilbert, 2006). The biodiesel produced is usually used as a neat fuel (B100), designated for autoconsumption and local distribution (Hilbert, 2006; SAGPyA & IICA, 2005; Almada, 2006; Bakovich, 2006).

Recently, there have been increasing news about plans for high investments in big scale biodiesel production facilities from several players along the biodiesel value chain including vegetable oil producers, refinery companies, and even ports (see Appendix for a full list).[36] But only few are actually under development.

[36] Repsol-YPF has announced that it will invest US$ 30 million into a new liquid biofuel refinery in the state of Buenos Aires in the year 2006 which is supposed to produce 100,000 tons of biofuels annually as of 2007 (Valente, 2006; Acosta et al., 2006).[36] Petrobrás and Cargill have also shown interest in investing in the production of biodiesel (Rosarinos, 2006; SAGPyA & IICA, 2005, p. 5). The port of Rosario has announced that it will invest US$ 40 million in the construction of a plant which should also produce 100,000 tons annually in its first phase (Rosarinos, 2006). Vicentín, one of the main vegetable oil producing companies in Argentina has plans to invest US$ 40 million into a plant to produce 200,000 tons of biodiesel (Rosarinos, 2006). Another biodiesel production company, Oilfox S.A. which already has a biodiesel plant in San Luis in is apparently planning to build another one in Santa Fe in order to produce biodiesel for export to Europe (Rosarinos, 2006; Valente, 2006). It even seems that Oilfox S.A. has already signed a five year contract with a German buyer of biodiesel which request 10,000 tons of biodiesel per month (Valente, 2006). The investment rumours also reach provincial level: the province of Santiago del Estero and the company Villucco have apparently set-up plans to invest US$ 38 million in order to build five biodiesel plants (La Nacion, 2006b).

3.4.3 Current policy and legal framework for the support of biofuels

Recently, the Argentinean Senate has approved a new law on the promotion of biofuels. It seems so far the most overarching promotion mechanism for biofuels in Argentina and will therefore be looked at into detail in this section. However, there have been several other legislative efforts since 2001 which can be seen as part of the development of this law. In chronological order, the main ones until 2006 are (SAGPyA & IICA, 2005, p. 23&39):

- July 2001 – Secretary of Energy and Mining: *Resolution 129/2001 which defines the quality requirements for neat biodiesel (B100).*

- August 2001 – Secretary for Sustainable Development and Environmental Policy: *Resolution 1076/2001 launches the 'National Programme for Biofuels' related to climate change.*[37]

- November 2001 – Secretary of Energy and Mining: *Launch of the competitiveness plan for biodiesel as of Decree 1396/2001.*

- November 2004 – SAGPyA: *As of Resolution 1156/2004, the National Programme for Biofuels is further defined in its principal aims, missions, and functions. These are (SAGPyA, 2006b; SAGPyA & IICA, 2005, p. 39f):*

  - To promote the sustainable production and consumption of biofuels as a renewable source of energy, especially the use of biodiesel from vegetable oil or animal fat and bioethanol from sugar cane, maize, or sorghum.

  - Support and advise rural sectors in the development and set-up of biodiesel and bioethanol production facilities as an alternative local development.

  - Collaborate with and support institutions, organisations and other public entities in the investigation and diffusion of biofuels.

  - Promote public and private investments in biofuels.

Furthermore, the SAGPyA is working on the development of a framework for the promotion, control, and financing of energy crops (SAGPyA & IICA, 2005, p. 40). Another important legal frame for the development of the biofuel industry in Argentina could become the law 25.924/2004 which promotes investments into new industrial infrastructure and equipment through tax incentives.

The new law on the promotion of biofuels, **'Ley 26.093/2006: Regimen de Regulación y Promoción para la Producción y Uso Sustentables de Biocombustibles'**[38] (see SCDA, 2006) was finalised in April 2006 and approved by the Argentinean Senate in May 2006. For the design of the law, a National Commission for Biofuels[39] was created which is now – as framed in the current form of the law an advisor commission to the National Application Authority (the enforcement body of the law). The commission is currently working on a regulatory decree ('decreto reglamentario') i.e. a more technical description and specification

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[37] The resolution can be found under http://www2.medioambiente.gov.ar/mlegal/clima/res1076_01.htm [July 11th, 2006].

[38] Law 26.093/2006: regulatory and promotion regime for the sustainable production and consumption of biofuels.

[39] Headed by the Secretary of Energy it consisted of member from the following Secretaries: SAGPyA, SAyDS, SIP, SCI, SECyT (SAGPyA & IICA, 2005, p. 3). Its functions as during the development of the law are described by SAGPyA and IICA (2005, p. 4).

of the law (SAGPyA & IICA, 2005, p. 3; Almada, 2006; Bakovich, 2006). The most important contents of the law are listed here. The law itself, its strength and potential to stimulate the production and consumption for biofuels in Argentina will be analysed and discussed later.

- *The description of the governmental support framework:* If the production of the defined biofuels fulfils a set of criteria, they are given tax incentives, i.e. a tax exemption for 15 years from the fuel transfer tax, the diesel respectively the tax for hydric infrastructure and the tax on profits for crude fuels. Eventually all fuel taxes apart from the VAT.

- *The set-up and definition of a national application authority for biofuels and its functions.* Represented in the Secretary of Energy, it will set as well as control the requirements for the biofuel production and grant the tax exemptions to the producers (see Art. 2, 4).

- *The set-up of a national advisor commission to the national application authority.* Headed by the Secretary of Energy, it consists of members from different secretaries, and other public and private institutions. It was this commission that already helped design the current form of the law (see Art. 3).

- *The definition of what are considered to be biofuels* (biodiesel, bioethanol, and biogas) as well as the assignment for the national application authority to define and control their quality requirements (for selling as well as autoconsumption) (see Art. 5, 10).

- *The definition of a (minimum) 5%-blending requirement (on volume basis)* for petrol with anhydrous bioethanol respectively diesel with biodiesel as of the first day of the 4th year after the approval of the law, i.e. from the beginning of 2010 (see Art. 7-11).

- *The criteria to be granted the tax exemptions.* They most important are (see Art. 13):

    - At least 50% of the plant has to be owned either by the state, any province or municipality, or any physical and juristical person that is active in the agricultural sector. The detailed requirements for this are set by the national application authority.

    - The facilities have to comply with the quality and efficiency requirements as set by the national application authority.

    - Acceptance of the ranking criteria for tax exemptions.

- *The ranking criteria for recipients of tax exemptions:* SMEs, agricultural producers, and regional economies will be prioritised (see Art. 14).

- *The potential infringements and sanctions (see Art. 16ff).*

While the law promotes the production and consumption of biofuels, there is currently still no specific political framework promoting R&D in biofuels. Although other financial instruments exist through which biofuel R&D activities could be established (SAGPyA & IICA, 2005, p. 4).

The quality standards for the biofuels are oriented along international standards (Bakovich, 2006).[40] According to the Secretary of Energy (Bakovich, 2006), the current quality standard for biodiesel e.g. will in the short-run be adjusted to match the European Union (EU) quality standard. This adjustment already shows the importance of the emerging international trade with biofuels and the interest and potential for Argentinean producers to supply a local or/and an international market. As Argentina's agriculture sector is export oriented, this interest in the biofuel production comes as no surprise. The following chapter will give a brief introduction to the current international trends in liquid biofuel markets and trade in order to enhance the picture for a future development of the Argentinean biofuel market.

3.5 International experience and trends in biofuel markets and trade

As stated in Chapter 1, the theoretical production capacities and the current demand patterns for liquid biofuels worldwide are not overlapping. As shown in Figure 1-1, the biggest theoretical bioenergy potentials lie in currently still developing countries with favourable climatic and environmental conditions for plant growth. Recent policy incentives however have been mainly put in place in developed countries where the current domestic demand cannot be solely fulfilled by local supply. The main regions that will rely on import of biofuels in the near future are the EU and Japan. The EU is already today the main importer for biodiesel (mainly from Malaysia) and for bioethanol (mainly from Brazil and Pakistan). An international trade with these products is therefore inevitable in the short-run, and a number of reasons indicate that it will also consolidate itself in the medium- to long-run (see e.g. Johnson, 2002). Other countries that have shown interest in importing biofuels in the long-run are e.g. the US and China.

The potential drivers and barriers, as well as the requirements for the further development of an international trade with biofuels are laid out here as they can be found in academic literature. Based on this, the trends in the market are illustrated before the chapter ends with the Brazilian experience in liquid biofuels – commonly referred to as an international role model for a liquid biofuel market development. Argentina as a neighbouring country to Brazil, has been watching this development carefully and there is a number of people involved in the development of the Argentinean biofuel market that would like to see a similar development in their home country.

3.5.1 Potential drivers

Experts worldwide estimate that within the short-run, the volumes of biofuel trade are likely to double each year (Faaij, 2006, p. 3). Over this century, the biofuel market could develop to reach 400 EJ with an estimated value of US$ 1.6 trillion per annum (Faaij & Domac, 2006, p. 17).[41] According to Faaij et al. (2003, p. 3f) the **key arguments for the development of a sustainable international trade** with biofuels are:

1. Cost-effective GHG emission reductions

[40] The standards and norms for petrol, diesel, gas, and biofuels can be found on the webpage of the Argentinean Standardisation Institut (Instituti Argentino de Normalización – IRAM). They are available under: http://www.iram.com.ar/Normalizacion/Departamentos/oe.asp?mOrg=-2147483287&nOrg=SubComit%C3%A9%20Calidad%20de%20Combustibles [July 11th, 2006].

[41] I.e. 400 EJ in 2100 at US$ 4/GJ. Of the 400 EJ, 100 EJ would come from residues and wastes, 100 EJ would be from biomass from degraded land, and 200 EJ would be derived from agriculture and pasture land representing around one fifth of the current land devoted to agriculture (Faaij, 2006, p. 4; Faaij & Domac, 2006).

2. Socio-economic development
3. Fuel supply security
4. Sustainable management of natural resources.

Although the international biofuel market is still considered to be in its infancy (Faaij, 2006), recent developments have lead to increasing interest in insights to the market. To map these developments and to create an information platform for experience in biofuel trade, the International Energy Agency (IEA Task 40) has set up a task group of researchers to investigate the biofuel trade market.[42] The IEA Task 40 tries to highlight barriers and opportunities for sustainable international bioenergy trade and to give policy advice on how sustainable international bioenergy markets can be developed further (Faaij, 2006, p. 3). Current research findings of this group suggest that all four aspects mentioned above will play an important role in the international liquid biofuel trade in the long-run (see e.g. Faaij et al., 2005; Faaij & Domac, 2006).

Additional drivers that could facilitate the development of a (liquid) biofuel market can be found in Faaij et al. (2005) as well as Faaij and Domac (2006). Thus the market could be either stimulated through a *raw material/biomass push* – which is more likely in countries with an overcapacity of e.g. agricultural production or other available bioenergy sources at low costs (e.g. wood in Sweden), or a *demand/market pull*. The latter has been witnessed e.g. in countries with biofuel blending requirements for transport fuels. In general, *political incentives and support mechanisms* for the production and/or demand for biofuels can be considered a separate driver. Another driver could be a *favourable infrastructure* where already established logistical networks and industries reduce the costs. This was e.g. a major driver for Brazilian bioethanol from sugar cane (sugar industry) and wood pellets in Sweden (forestry sector). As stated already in the analytical framework, actors, networks, and institutions play an important role for the development of a new market. *Prime movers* such as enthusiastic entrepreneurs and innovators could drive the market development through research, development, and demonstration (RD&D).

3.5.2 Potential barriers

On the other hand, significant negative influences (here described as barriers) can hinder the development of a biofuel market. According to Faaij et al. (2005) as well as Faaij and Domac (2006) they can be listed under different categories as shown in Table 3-9.

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[42] The IEA Task 40 webpage can be found under http://www.fairbiotrade.org [July 11th, 2006].

Table 3-9 Potential barriers for the development of bioenergy markets and trade.

Economic barriers	Production costs, risky long-term investment in infrastructure and conversion capacity, immature and unstable markets
Technical barriers	Physical and chemical properties of the (bio)energy carrier: difficult and expensive to transport, unsuitable for direct use, old equipment often needs to be replaced (e.g. boilers); restricted availability of biomass fuels
Logistical barriers	Lack of technically mature pre-treatment technologies on compacting biomass at low costs, (low) availability of suitable vessels, local transportation by truck is a high cost factor, lack of significant volumes of biomass
International trade barriers	Lack of clear technical specifications for biomass and specific biomass import regulations, transport tariffs, possible contamination of imported biomass with pathogens or pests
Land availability	Competition for land, biomass production costs are generally higher due to lower yields and accessibility difficulties, competition with food and fodder production, deforestation and potential conflicts with wood production
Sustainability issues	Ecological and environmental issues, social implications
Methodological barriers	Problems with the allocation of GHG credits, indirect import of biomass
Legal (national) barriers	Conflicts between international and national legislation (e.g. in regards to emission permits)

Source: Faaij et al., 2005; Faaij & Domac, 2006

3.5.3 Requirements and trends

It seems that there are several **requirements** for an increasing importance of biofuels and the development of local as well as international markets. It is not that all above listed barriers would have to be overcome, but certainly some should be addressed. One of the main ones seems to be that the security of energy supply requires a *minimisation of risks of supply disruptions* in terms of volume, quality, and price (Faaij et al., 2005). Furthermore, the development of truly international markets would require the *elimination of trade barriers* and the liberalisation of environmental goods and services. The liberalisation offers the opportunity that only the most efficient producers of bioenergy carriers will prevail, and those that maximise GHG mititgation. In this regard, the IEA Task 40 advises to *focus on resources and bioenergy chains that maximise GHG mitigation* (Faaij et al., 2005, p. 4).

In regards to the **trends**, it seems most likely that *technical quality standards* will soon become a major requirement in international trade with biofuels. Also, the development of *sustainability criteria* and labelling of biofuels has made significant progress and there are interests in an international classification and certification of biofuels in the medium- to long-run.[43] The sustainability of the feedstock production is a crucial issue and the competition for land use should not be neglected (neither should other sustainability criteria as mentioned under Chapter 3.1.2).

[43] In its recent preliminary advice, the IEA Task 40 suggests the investigation whether an international certification body for sustainable biomass is feasible (see Faaij et al., 2005, p. 4).

No requirements or trends can currently be observed towards the issue of biofuel production for export or domestic use. The IEA Task 40 however suggests that it is more rational to use the biofuels primarily locally while only the (certified) excess should be exported (Faaij et al., 2005, p. 4). In this regard it emphasises however that producers for a (liberalised) international market will face strong competition (Faaij et al., 2005, p. 4), forcing them to be more efficient in production and eventually also in GHG mitigation.

While bioenergy trade has usually been conducted among neighbouring regions and countries, an increasing amount is now transferred over long distances, e.g. bioethanol from Brazil to Japan (Faaij & Domac, 2006, p. 8). Also, an increasing amount is of greater bulk and lower calorific value (Faaij & Domac, 2006, p. 8). Reasons for this can be found in a bioenergy supply chain cost assessment by Hamelinck et al. (2005). According to the authors' calculations, the main transportation cost factor within the supply chain appears to be the first local truck transport (Hamelinck et al., 2005). Once freighted on ships, transportation over long distances should not be considered an obstacle (Hamelinck et al., 2005). This indicates that an additional cost reduction could be realised when the bioenergy conversion facility is constructed at or close to the export harbour (Hamelinck et al., 2005).

3.5.4 Brazil – a biofuel success story

When it comes to the development of a domestic liquid biofuel production and demand, Brazil and its Proalcool programme which was launched in the 1970's is often referred to as a role model. While it is acknowledged that the success of the programme itself in terms of cost-efficiency and environmental costs is debatable (see Oliveira, 2002), it is clear that Brazil has successfully proved the technical feasibility of large-scale, cost-competitive production of bioethanol from sugar cane as an alternative transport fuel and its use in high-level petrol blends and dedicated vehicles (IEA, 2004, p. 159; Oliveira, 2002). Today, around one fifth of the current vehicle fleet in Brazil runs on bioethanol (Oliveira, 2002, p. 130), Brazil's bioethanol has become cost-competitive to petrol, and Brazil is the largest international trader of bioethanol in the world with a current annual production of 16 billion litres (Coelho & Goldemberg, 2005).

One of the major success factors seems to be that **Proalcool** *addressed and involved all major players along the whole value chain of ethanol production.* It reshaped the agricultural as well as industrial policies, and stimulated investments and research in both sectors through cheap credit possibilities. The local ethanol industry was protected against cheap imports through tariffs and public research on alcohol related activities was supported. A price control for ethanol on the pump eventually gave an important incentive to car owners to shift to alcohol fuelled cars, thus increasing the demand for alcohol (IEA, 2004, p. 159; Oliveira, 2002). The policies of the Federal Government were elementary to induce a leapfrog alcohol technology and increase alcohol efficiency and competitiveness (Oliveira, 2002).

Another success factor was the *timing*. The oil price peak in the 1970's and the resulting fuel supply shortages coincided with a crisis of the Brazilian sugar cane industry.[44] Proalcool should address both issues. The alcohol production would ultimately reduce the sugar surplus and the petroleum imports, and eventually safeguarding national sovereignty (a major concern of the military). Moreover, current account deficits and inflation were high and income growth was slow. A reduction in petroleum imports would help Brazil to adjust to the OPEC oil

[44] I.e. low international sugar prices and sugar surplus production in Brazil.

shock by saving foreign exchange, reducing inflation, and enhancing income growth. The market creation would generate further employment.

Furthermore, Proalcool had a strong *lobbying power* from the sugar cane industry, connected with downstream industries, state governments, military (fuel security), research, media and also a strong acceptance within the population. Other parties, mainly oil companies and car manufacturers however could not present suitable alternatives.

Another success factor can be seen in second phase of the programme. The first phase, from 1975 to 1979, which was characterised through high oil prices, low sugar prices, and a sugar surplus production, the distilleries – subsidised from the government – were still focusing on both, sugar and ethanol production in order to be able to adjust to changing price patterns for oil and sugar on the international market. In the second phase of the programme however, post 1980, with the introduction of alcohol-fuelled cars many distilleries focused solely on the production of ethanol as the local market seemed to be secured (Oliveira, 2002, p. 134). From that moment onwards, there was *no turning point back to sugar production* any more and the stable development of the local market become crucial for the further activities of the ethanol production industry in Brazil. In this regard, the significant success factor was also the *development and diffusion of alcohol-powered engine technology*.

Other major success factors as stated e.g. by Oliveira (2002, p. 135f) include the *large dimensions of agricultural land* in Brazil and the *suitable climate for sugar cane production*, the *long tradition i.e. existing infrastructure in Brazil concerning sugar cane and alcohol related industry activities*. Brazil has made significant *efficiency improvements* in sugar cane production and ethanol conversion (Coelho & Goldemberg, 2005). These improvements are joined by the development of *by-product use* above all sugar bagasse for heat and electricity production (nowadays most Brazilian sugar cane factories are self-sufficient in energy terms). In total, this has lead to a *significant price reduction* of Brazilian ethanol on the international market which is at current oil prices per barrel highly cost-competitive.[45]

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[45] According to Faaij and Domac (2006, p. 7), the bioethanol production from sugar cane became cost-competitive at an oil level price of US$ 60 per barrel. Other estimates e.g. from Brazilian Embassador Sergio Silva do Amaral see Brazilian bioethanol already price-competitive withiout subsidy at US$ 35 a barrel (PlanetArk, 2005).

See Coelho et al. (2006) for a recent publication of the 'lessons-learned' in Brazil concerning bioethanol.

4 Analysis: status quo – the main parties, their interests and leverage

As the methodology framework in Chapter 2.3 explains, there are several dynamics that should be looked into when the development of a new product and its market takes place. For the development of the biofuel (i.e. biodiesel and bioethanol) market in Argentina, the value chain (production, supply, and consumption) is investigated upon actors, networks, and institutions. For the creation of a scenario of the most likely biofuel market development in Argentina, it seems crucial to look at their interests and leverage.

While the interests of the different parties are relatively easy to investigate, their power, i.e. leverage for a policy and market steering is not that obvious. To decide upon the **leverage**, interviewees (i.e. experts in the field of biofuel related areas in Argentina) were asked for *rankings and evaluations*. As in any other country, political power and influence in Argentina is often linked to *economic and financial power*, i.e. the size of the company, its share of the market, etc. For networks in this regard it seems important to look at their *coverage of the industry* (i.e. percentage of the industry as registered members). The *industry structure* in itself is also an indicator for the power of the various actors, i.e. the fewer actors in an industry the more likely is a combined effort in a certain direction. Along the value chain, oligopoly structures can represent *'bottlenecks'* for the development of a product. Actors, networks, or institutions situated along these bottlenecks have significant leverage for the steering of the whole value chain.

One of the important points that the investigation of the market setting in Argentina revealed is that the value chain as described in Chapter 2.3 has to be further detailed as the production includes more process steps and important 'players'. These phases are shown in the following figures. The structure of the analysis is oriented to serve understanding, and an easy overall view of the situation. Hence, the actors' analysis is undertaken sequentially for biodiesel and bioethanol. The actors appear to be the main influential parties in the development of the new market and should therefore be distinguished. The networks' analysis is undertaken step by step along the value chain due to a significant amount of overlapping interests of certain networks regarding biodiesel and bioethanol. The institution analysis is undertaken in general for both value chains as no further insight could be gathered from a distinction along certain steps in the two value chains and because of a significant amount of overlapping between the two liquid biofuels.

The analysis serves the examination of a potential market direction for biodiesel and/or bioethanol. In a final chapter, the analysis sections are shortly summarised. Here, the most significant, preliminary findings are laid out and the most important issues for discussion in the following chapter are pointed out.

4.1 Main actors

4.1.1 The biodiesel value chain

According to all experts interviewed and asked for a ranking (e.g. Hilbert, 2006; Martinez Justo, 2006; Molina, 2006), the main actors along the biodiesel value chain (see Figure 4-1) seem to be the ones located at the vegetable milling and oil refining step. Both arise mainly from the oligopoly industry structure (bottleneck situation) (see Chapter 3.2.2 and 3.3.1). No company was observed to have an integrated position along the whole biodiesel value chain.

The **vegetable milling facilities** certainly have a strong link along the value chain as they are directly linked to the agricultural sector.[46] Their lobbying power can be derived from the high amount of crops grown for vegetable oil extraction in Argentina (the mills are key buyers for farmers) and the high industries annual contribution to the GDP. 54.5% of the total annual exports are of agricultural origin, of which 60% are solely vegetable oil and its by-products (mainly soy oil and protein) (SAGPyA, 2006). The vegetable oil industry also has seen a steady increase in milling capacity and vegetable oil production (see Figure 3-6, Chapter 3.2.3).[47] As the raw material is readily available and cheap (Almada, 2006) and milling capacities are sufficient, the vegetable oil companies have a strong interest in the big scale production of biodiesel. Their current activities are already export oriented, e.g. strategically located milling facilities at big harbours, and it seems that their main interest lies in exporting biodiesel (mainly to Europe). Furthermore, the export tax for biodiesel is around 18.5% lower than the one for vegetable oil (see Chapter 3.2.3) and export prices for biodiesel (~ US$ 600-680/ton) are higher than for vegetable oil (~ US$ 480) (La Nacion, 2006; Martinez Justo, 2006; Molina, 2006). An export orientation would also allow the vegetable oil companies to preserve a strategic position in the value chain because biodiesel could be exported as a neat fuel for blending in other countries. This way they would not have to pass the second bottleneck of the biodiesel value chain, the blending and distribution process i.e. the oligopoly of the petrol companies.

In general, the big **petrol companies** have been more hesitant towards the interest in the transesterification of biodiesel apart from Repsol-YPF and Petrobras. Repsol-YPF shows certainly the main interest. It has its own biofuel research lab and announced to invest US$ 30 million into a new liquid biofuel refinery in the state of Buenos Aires in the year 2006 which is supposed to produce 100,000 tons of biofuels annually as of 2007 (Valente, 2006; Acosta et al., 2006).[48] The company has strong links to the agricultural sector as co-operations also include the production of farming products like fertilizers, lubricates, etc. This however can be seen as an exception within the sector and is related to the activities on behalf of the formerly state owned part of the company: YPF. Generally, it seems that petrol companies show interest in the production of biodiesel due to two main reasons. Firstly due to the arising opportunity costs from the import necessity of diesel at 3% of the annual internal consumption and the country's strategic positioning and export of vegetable oil. Secondly, transport fuel prices in Argentina are 'adjusted' (Acosta et al., 2006) i.e. artificially low. The barrel of crude oil has an internal market value of US$ 33-42. Hence, profit margins for petrol companies are thin and their interest in biofuels is therefore based on new evolving international markets for biodiesel – mainly Europe.

A group of actors of medium importance on another step of the biodiesel value chain are the **farmers**. Their leverage power as individual companies or families is although not significant compared to the vegetable oil and petrol companies. First, they produce different feedstock. In this regard, the main source of vegetable oil in Argentina is still soy (see Chapter 3.2.2) and those producers would have the biggest leverage. Second, the supply pattern for soy milling reaches from big scale to small scale farming (Taboada, 2006). Therefore, their leverage is too dispersed as individuals, and might only arise through networks (see following chapter).

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[46] Vicentín e.g. also has agricultural activities.

[47] Their investments in 2005 accounted for a quarter of the total investments which passed under the new law 25.924/2004 (which promotes investments into new industrial infrastructure and equipment through tax incentives, see Chapter 3.4.3) (Almada, 2006).

[48] See also http://www.empresaexterior.com/conte/3089.asp [July 14th, 2006].

For the **transesterification step**, no commercial producers of biodiesel yet exist (see e.g. Carlstein, 2006). Small scale production facilities are devoted to autoconsumption and big scale projects for the production of biodiesel are yet only announced. Through the annunciation process however, the leverage of the petrol as well as vegetable oil milling companies can be observed. The investments range for big scale biodiesel projects is significant and only these companies (together with other players such as the state and major harbours) can afford to do so.

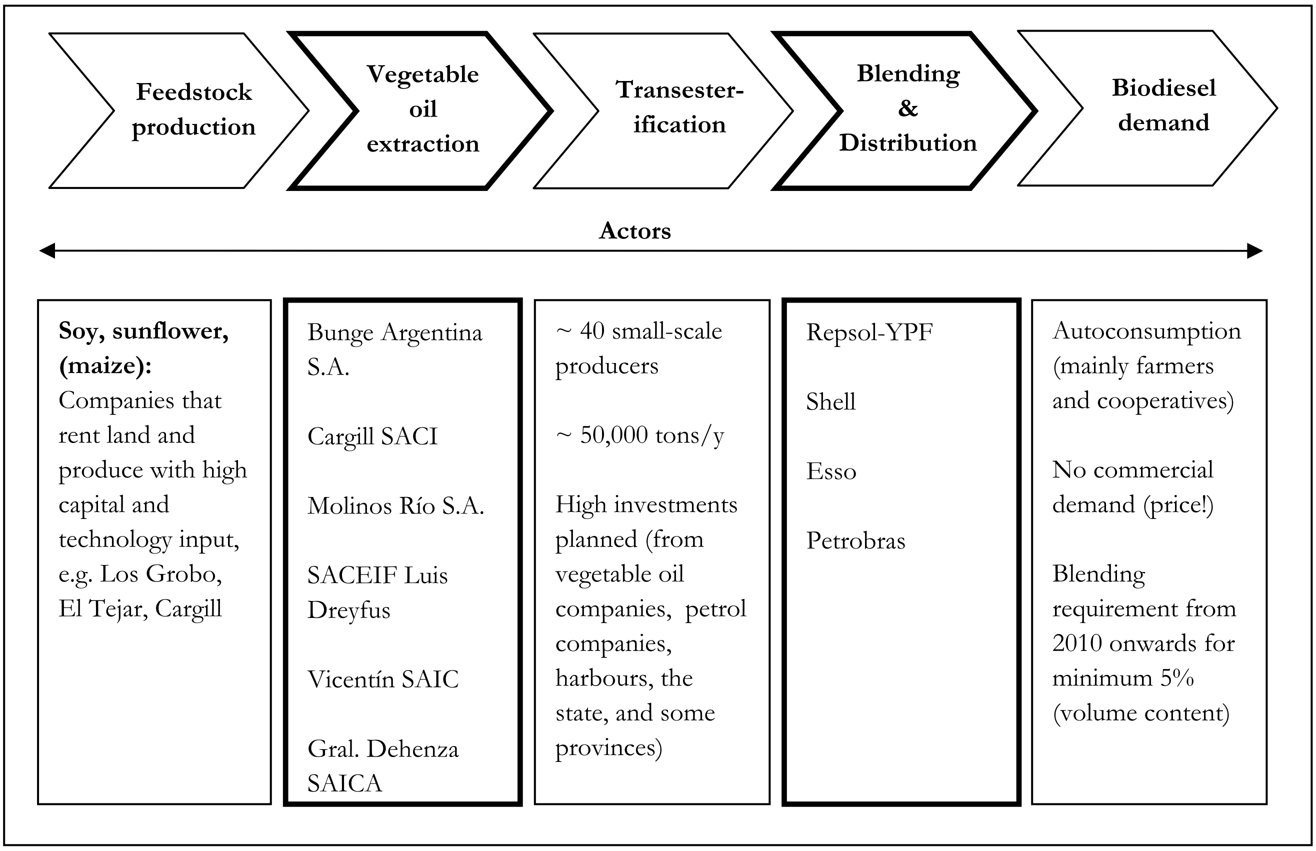

Figure 4-1 The main actors along the biodiesel value chain in Argentina.

4.1.2 The bioethanol value chain

Regarding bioethanol, the main feedstock that is currently used is sugar molasses (Almada, 2006). Although other feedstock options are produced in Argentina, e.g. maize and other grains as well as sorghum, they are currently not converted into bioethanol. The **sugar cane production** is controlled by 23 companies which are located in the northern part of the country.[49] Apart from being individual companies, the low amount of sugar cane production (1.72 million tons in 2004) shows their small leverage for the development of a bioethanol market. What's more, according to SAGPyA and IICA (2005, p. 11) they are not all integrated into the value chain of bioethanol. It is estimated that around 15-16 rather small-scale producers of bioethanol exist which serve the beverage, food, and pharmaceutical industry (Bakovich, 2006; Molina, 2006). As the *Alconafta* programme (see Chapter 3.4.1) has shown there are not enough incentives for the mentioned actors to produce bioethanol for large scale fuel blending. An increase in capacity would mean significant investments and the sugar

[49] For an overview see http://www.centroazucarero.com.ar/mapagrande.htm [July 20th, 2006].

market within Argentina and for export is more secure than the developing internal biofuel market in a country with such low petrol prices as Argentina. Furthermore, the amount of sugar cane production would have to increase significantly in order to be sufficient for the development of large scale bioethanol production. It is estimated however, that the land that could possibly be devoted to sugar cane production in Argentina is almost completely farmed (e.g. Molina, 2006; Almada, 2006).

Maize and grain crops on the other hand are produced on a large scale, and their production area could be extended e.g. through substitution of soy with maize (Taboada, 2006). The leverage of the individual farmers however also only reaches significance through networking. A diversification of customers for their grains would be appreciated of course, i.e. a demand for grains to produce bioethanol. Their political leverage can be seen as higher than the one from sugar cane producers due to the production capacities and high their share of export (see Chapter 3.2.1).

Just as in the biodiesel value chain, one of the main actors seem to be the **petrol companies**. Their refineries operate at maximum capacity and try to maximise the output of diesel per barrel of crude oil due to the unbalanced transport fuel demand matrix (>50% diesel) (Bakovich, 2006). As petrol and diesel are co-products (together with others) in the refining process, this leads to an access amount of petrol which is exported. Now, it has to be taken into account that bioethanol is a substitute for petrol. With already a net excess of petrol on the local market, the interest of the petrol companies to produce bioethanol or to blend their petrol with bioethanol is practically non-existent. What's more, it is assumed that the current trend of petrol substitution through CNG powered engines is going to continue (e.g. Acosta et al., 2006) which decreases the amount of petrol in the transport matrix continuously. The resistance of the petrol companies to a bioethanol market development and blending requirement for Argentina can be assumed to be very high.

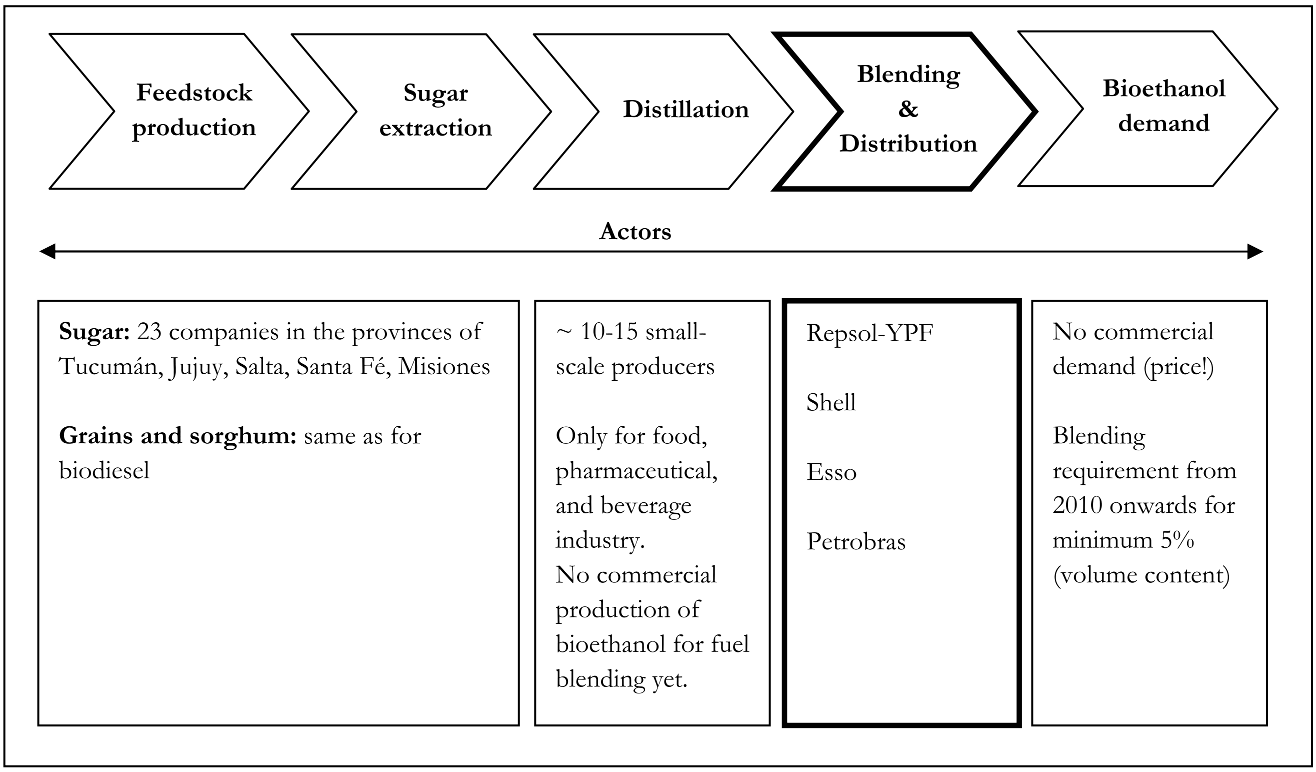

Figure 4-2 The main actors along the bioethanol value chain in Argentina.

4.2 Main networks

The value chains of biodiesel and bioethanol will not be regarded separately in this section as a distinction does not appear to add to the findings. On the first level of the value chain, the agricultural sector, four levels of networks can be identified. There are farmer cooperatives, farmer associations, and associations for certain farming methods as well as for certain crops.

4.2.1 Farming networks

Among the **farmer cooperatives** are two main ones: the 'Asociación Cooperativo Argentino' (ACA) and the 'Federal Asociación Cooperativo por la Agricultura' (FACA). The cooperatives traditionally had a strong position in the farming sector, but this is currently weakened through the conglomeration of farmers in other, more specified associations (as listed above), as well as through the increasing power of large scale farming companies. The interest of the cooperatives most likely lies in the field of liquid biofuel production for autoconsumption and in this regard mainly biodiesel due to the high consumption in the agricultural sector. Their leverage power on policy level for this possibility in the law is somewhat weak however. There are stronger players throughout the value chain. Moreover, it is not clear whether the interest in autoconsumption is homogeneous among the cooperatives.

This is more or less also true for the second group of networks on the farming level, the **farmer associations**. The two main ones are the 'Sociedad Rural de Argentina' (SRA), a lobby of large-scale farming (mainly livestock), and the 'Federación Agraria Argentina' (FAA), a lobby for small-scale farming (Lattuada & Neiman, 2005; Almada, 2006; Leone, 2006). In terms of lobby power, the stronger one seems to be the SRA (Almada, 2006; Leone, 2006). The development of a liquid biofuel market seems to be in the interest of both, the SRA and the FAA. Due to the large share of the agricultural sector within the diesel consumption in Argentina, they will most likely support the development of a biodiesel market. Not only from a demand-side point of view (e.g. security of energy supply) but also from a production perspective (diversification of products).

The two main network groups regarding **farming methods** are the 'Asociación Argentina de Productores en Siembra Directa' (AAPRESID), and the 'Asociación Argentina de Consorcios Regionales de Experimentación Agrícola' (AACREA) (Hilbert, 2006; Almada, 2006; Molina, 2006). The AAPRESID is an association for farmers using direct sowing, a technique which has gotten strong headway in Argentina throughout the last decade. Currently, around 66% of the agricultural area is cultivated through direct-sowing i.e. no-tillage practices in Argentina (see Table 4-1). The shares per crop are illustrated in the Table 4-1.

This amount of land devoted to direct sowing technique makes the AAPRESID a powerful association and also shows the leverage and influence it already had in the past. According to many interviewees the power of the farming sector in regards to liquid biofuels is dominated by the AAPRESID (Hilbert, 2006; Almada, 2006; Molina, 2006). The interest of the AAPRESID lies certainly in the extension of the market for the crops cultivated through direct sowing, i.e. a large-scale agricultural sector mostly devoted to the production of soy, sunflower, maize, wheat and sorghum (Taboada, 2006; see Table 4-1). The domination of direct sowing for soy and the domination of soy bean cultivation in general can also be seen in Table 4-1. For the AACREA no specific interest could yet be identified. Its leverage compared to the AAPRESID is however somewhat weaker and can therefore be neglected.

Table 4-1 Distribution of no-tillage farming practices in Argentina.

Crop	**Cultivated area in 2003/2004 (thousand ha)**			
	Total	**Conventional**	**No-tillage (NT)**	**% NT**
Soy bean 1st sowing	11,710.119	3,887.759	7,822.359	66.8
Soy bean 2nd sowing	2,816.487	0	2,816.487	100.0
Corn	2,988.400	1,147.546	1,840.854	61.6
Sunflower	1,847.963	1,395.212	452.751	24.5
Sorghum	545.125	265.476	279.649	51.3
Total	19,908.094	6,695.993	13,212.101	66.4

Source: Asal et al., 2006, p. 54.

In regards to the **crop associations** in Argentina, the most important ones for oil crops (biodiesel) are the 'Asociación de la Cadena de la Soja Argentina' (ACSOJA) for soy and the 'Asociación Argentina de Girasol' (ASAGIR) for sunflower. Here ACSOJA clearly dominated due to the high share of soy in production and exportation. As an example, while sunflower and soy account for more than 98% of the vegetable oil production in 2005, 76% of this share was derived from soy beans (CIARA, 2006). The interest of ACSOJA is certainly the diversification of markets for soy i.e. a biodiesel market development – local or for export. Its strong role and its biodiesel interest could be observed in its lobby activities at the soy congress for soy within the Mercosur, 'Mercosoja', June this year in Rosario, Argentina. Apart from growing soy for protein production (hence livestock feeding), the diversification of the soy oil markets was strongly encouraged (see La Nacion, 2006c).

In regards to bioethanol, the crop associations include Centro Azucaero Argentino (CAA) for sugar cane, 'Maíz Argentina' (MAIZAR) for maize, and the 'Asociación Argentina Pro Trigo' (AAPROTRIGO) for wheat. Due to the production scale, maize and therefore MAIZAR dominates this section. Also, lobbyist speakers of MAIZAR were present at recent liquid biofuels conferences, speaking of the possibilities to use maize for bioethanol production. The CAA does not seem to be interested in a bioethanol production, nor the AAPROTRIGO. Both have relatively secure export markets. A back-up of MAIZAR's interest comes from the SAGPyA which is also inclined to promote bioethanol production from maize in Argentina.

The main force on this level is certainly combined in the hands of AAPRESID, ACSOJA, and to some extent also MAIZAR. In their interests they vary mainly between ACSOJA and MAIZAR i.e. the development of a biodiesel and/or a bioethanol industry. Due to the strong position of the vegetable oil industry within the country, and the importance of soy for the production of vegetable oil, this conflict of interests has an imbalance of power towards to ACSOJA. Consequently, the step of the farming networks is strongly directed towards a biodiesel market. The farmers of the bioethanol value chain cannot provide sufficient leverage to compensate for the power of the soy and vegetable oil industry on this level.

4.2.2 Networks for oil/sugar extraction

On the crop extraction level, the most powerful political lobbying networks are clearly CIARA, the 'Cámara de la Industria Aceitera de la República Argentina', the Argentinean vegetable oil industry chamber, and FAIM, the 'Federación Argentina de Industría Molinera', the Federation of the Argentinean Milling Industry (Hilbert, 2006; Martinez Justo, 2006; Acosta et al., 2006). The reasons for this are mainly the oligolopoly vegetable milling industry structure hence the homogeneous interests within the chamber and the federation, and the export orientation of the sector hence its significant contribution to the country's GDP.

The interests here are the same as the one of the vegetable oil companies themselves: the development of a biodiesel market for export. They have an interest in the production of biodiesel due to the fact that they have access to readily available and cheap feedstock as well as equipment storage and handling of vegetable oil or biodiesel. Their export oriented industry structure and their locations along export harbour make them destined for biodiesel export. Their interest in exportation could have also another reason. If they do not have to supply a local market, they would be able to 'skip' the second bottleneck situation in the biodiesel value chain in Argentina: the blending through petrol companies.

In the shadow of these powerful lobby groups stands FIAA, the 'Federación de las Industrias del Azúcar y del Alcohol', the Federation of the Sugar and Alcohol Industry in Argentina. Its interest is not so much directed towards a liquid biofuel focus. Companies under the FIAA are mainly sugar cane producers. Under the current production capacity restrictions these companies still have a secure market for their sugar and alcohol and are not interested in a diversification of their products. This has been clearly shown by the Alconafta programme. Since sugar and its co-products are still not part of the Mercosur, they will also be able to retain this position. A strong lobbying towards bioethanol cannot be expected from this network. Since maize and wheat are currently not used as feedstocks for sugar or alcohol production, the FIAA has no link towards this industry, which has certainly a stronger position on the farming level and also an interest in the diversification of its product range.

4.2.3 Distillation/Transesterification

So far no biodiesel industry exists that is organised as networks. The bioethanol production is not directed towards the transport fuel market but has an industry chamber, the 'Cámara de Alcoholes' (CDA). The chamber has – similar to the industry it represents, no specific interest in bioethanol production for transport fuel and also not significant leverage or political power compared to its counterparts e.g. CIARA.

4.2.4 Blending and distribution

Among the petrol companies there are two industry chambers, one for downstream and one for upstream activities. *Upstream* there is the 'Cámara de las Empresas Petroleras Argentinas' (CEPA), the chamber of the petrol companies. The chamber is although not of significant interest within this analysis as the main activities for the blending and distribution of liquid biofuels with traditional transport fuel occurs in the downstream part. *Downstream* activities are represented in the 'Cámara de la Industria del Petróleo' (CIP), the chamber for the petrol industry. Within the chamber there is however no homogenous interest in the production for liquid biofuels (Acosta et al., 2006). Repsol-YPF is clearly the leader in this regard. According to the transport fuel consumption matrix i.e. the domination of diesel and the necessity to import diesel and export the excess amount of petrol, the industry chambers interest is certainly not in the set-up of a bioethanol but rather for a biodiesel market – if at all.

One of the important informal networks on the blending and distribution step is the link between Repsol-YPF and the activities located in the upstream part of the biodiesel value chain. Repsol-YPF has subsidiary companies which supply the agricultural sector with fertilizers, lubricants, etc. Its market share in this regard is considered to be around 60% (Acosta et al., 2006). The company has therefore strong industry contacts within the agricultural sector – dominated by the vegetable oil production, and certainly an interest in the development of a biodiesel market.

4.2.5 Demand side

On the demand side there are a number of networks and industry chambers. Examples include CETAP, the 'Cámara de Empresarios del Transporte Automotor de Personas' and CEAP, 'Cámara Empresaria del Autotransporte de Pasajeros'[50]. Their positions towards a liquid biofuel market are most likely resistant due to the current low prices for petrol and diesel. They might have a positive opinion in regards to the security of transport fuel supply, the diversification of energy carriers, and the decentralisation of fuel supply. The latter one might be an important point especially in remote areas in Argentina where there are already nowadays frequent shortages of transport fuel supply (Hilbert, 2006). The transport fuel prices in general were already expected to increase but did not so far. The legal blending requirement in 2010 will certainly mark a price increase (Bakovich, 2006) and could therefore be regarded as a point of major concern. Another issue could arise through the acceptance of liquid biofuels in general and quality as well as energy content concerns.

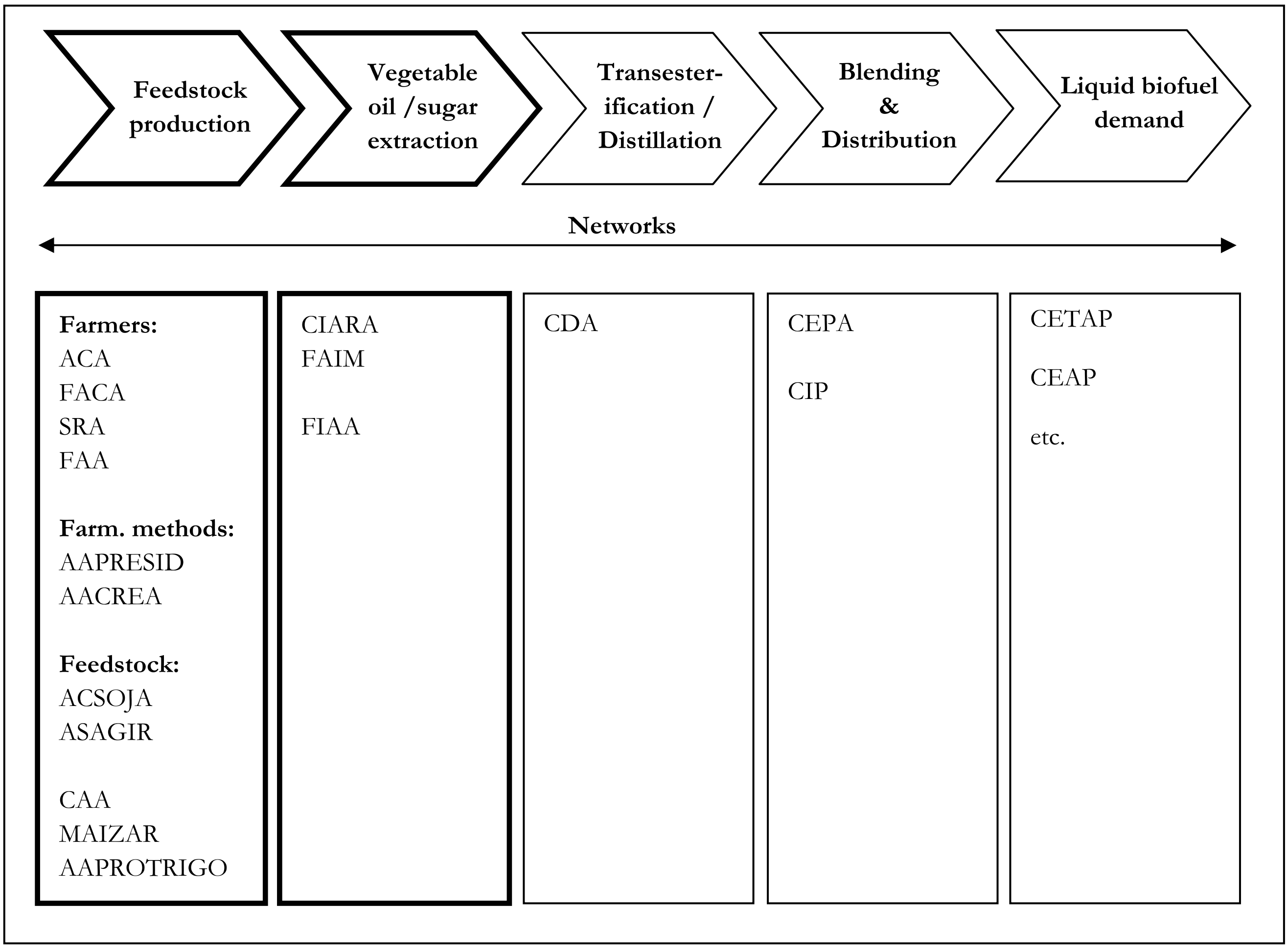

Figure 4-3 The main networks along the combined biodiesel-bioethanol value chain in Argentina.

[50] See http://www.transporte.gov.ar/html/cam_pasa.htm for a full list [August 4th, 2006].

The leverage of this network segment is relatively weak as the interests are spread out between different groups and none has so far taken the lead in either direction (support or opposition). Their role throughout the whole chain (as illustrated in Figure 4-3) can therefore be regarded as insignificant. The major networks arise on the feedstock production (SRA, AAPRESID, ACSOJA, ASAGIR, MAIZAR) as well as the vegetable oil extraction step (CIARA, FAIM).

4.3 Main institutions

4.3.1 National Biofuel Commission

There are many institutions to consider. The most important ones that steer and lobby for a biofuel market development in general are certainly those present in the **National Biofuel Commission** (see SCDA, 2006). They include several state agencies and secretaries: the Secretary of Energy (Secretaría de Energía – SE), the Secretary of Agriculture, Livestock, Fishery and Food (Secretaría de Agricultura, Ganadería, Pesca y Alimentos – SAGPyA), the departments under the former Secretary for Environment and Sustainable Development (Secretaría de Ambiente y Desarrollo Sustentable – SAyDS), also the Secretary of Finance (Secretaría de Hacienda), the Secretary of Political Economics (Secretaría de Política Económica), the Secretary of Commerce, Industry and SME (Secretaría de Comercio, Industria y de la Pequeña y Mediana Empresa), the Secretary of Science, Technology, and Production Innovation (Secretaría de Ciencia, Tecnología e Innovación Productiva - SECyT), and the Federal Administration for Public Revenues (Administración Federal de Ingresos Públicos – AFIP).

Obviously the parties have a shared interest in developing a biofuel market in Argentina. The composition of the commission however hosts controversial viewpoints. I.e. while the leverage of the commission is not challenged, the streamlining of its actions might become an issue. The SAGPyA e.g. is interested in a diversified feedstock base for biofuels (Almada, 2006) others e.g. the SE are mainly looking into the most efficient, reliable and appropriate one(s) (Bakovich, 2006). This can be explained by the following example. While sugar cane, sugar molasses, and sorghum are potential feedstock options for bioethanol in Argentina, the SAGPyA is interested in promoting also other crops, mainly maize and wheat as the main potential source for anhydrous bioethanol in the future (Almada, 2006; Leone, 2006; SAGPyA & IICA, 2005, p. 39). This is most likely due to the fact that maize and partly also wheat are competitors for land use with soy beans in Argentina (Taboada, 2006) i.e. could lead to a reduction of soy monoculture cropping. The SE however is trying to promote only the most efficient bioethanol technologies and has a specific interest in the development of second generation bioethanol from cellulose production (Bakovich, 2006).

How homogeneous the commission's work will be in the future seems to be a critical factor for the development of the market (Nadal, 2006). So far, the work of its parties can be characterised by promotion and lobbying events for the development of a biofuel production in Argentina. Content wise, the events have followed similar directions, especially in regards to the biodiesel market development. In general, the current institutional framework and the diverse interests within the commission have also lead to confusion among biodiesel producers (Martinez Justo, 2006; Mancini, 2006).

4.3.2 Public and private research organisations

Other institutions include public as well as private research organisations, e.g. the University of Buenos Aires (Universidad de Buenos Aires – UBA), the National Technological University

(Universidad Tecnológica Nacional – UTN), National University of the Litoral (Universidad Nacional de Litoral – UNL) and Cuyo (Universidad Nacional de Cuyo – UNCU), the National Institute for Farming Technologies (Instituto Nacional de Tecnología Agropecuaria – INTA), and the National Council for Scientific and Technical Investigation (Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET). The interests of these institutions can be summarised under the 'sustainable' development of a biofuel market in Argentina. The universities certainly have a more general interest in the research for the suitability of certain crops in certain regions, also with the aspect of regional development (esp. the regional universities such as UNCU and UNL). The INTA has direct link towards the agricultural sector and might be biased in this regard. A certain lobbying interest for a certain direction has so far not been revealed for any party. It is believed that their lobbying power in general and esp. the one of CONICET and INTA could become crucial in the steering of national policies and especially the general public interest.

4.3.3 Non-governmental organisations

Finally, there are also non-governmental organisations (NGOs) such as Greenpeace Argentina or the Rural Reflection Group (RRG) which are of interest in this section of the analysis. Their lobbying interest goes into the same direction as the one of the public and private research organisations whereas not much lobbying could yet been observed. Greenpeace Argentina e.g. has not yet joined the general discussion about biofuels in Argentina (Villalonga, 2006). In an interview with Greenpeace Argentina however, it was pointed out that a biofuel market development should take mainly two things into account: to not support soy bean monoculture cultivation and to look into the opportunity costs for the market development in regards to other renewable energies (Villalonga, 2006). This is supported by a recent statement of the RRG which also points out that bioenergy crop development should not be a competitor for land use and that agricultural activities should mainly focus on the production of food (RRG, 2006). Also, energy efficiency measures should be looked into as well as more feedstock options other than primary crops (RRG, 2006). The political influence and power of NGOs in Argentina regarding the steering of a biofuel market development can be considered to be rather weak. The power of NGOs seems to lie mainly in the steering of public opinions and movements. The broader public interest however has not yet picked up on the biofuel market development. The discussion is still taking place on political as well as industrial level. Here the NGO influence in Argentina seems to be marginal.

4.4 Short conclusion

In this section, the analysis is shortly summarised and the main points for the discussion are pointed out. Regarding the biodiesel value chain, the main actors, networks, and institutions in regards to leverage in favour of the development of a biodiesel market seem to be located at the vegetable oil extraction step as well as the refining and distribution step. The power of these two positions derives mainly from the oligopoly industry structure and the resulting bottleneck situation along the biodiesel value chain. No transesterification industry exists at the moment in Argentina and these two sides show the main interest in its set-up. In regards to a transesterification and biodiesel industry, the vegetable oil industry and its chambers have even more power than the petrol companies as they have the possibility to avoid the second bottleneck i.e. the blending for a local market, by exporting the biodiesel directly.

The direction the biodiesel market development is taking in Argentina seems to be dominated by the vegetable oil extraction companies and the petrol companies. As it seems both have an interest in the large scale production of biodiesel primarily for an international market. Vegetable oil companies are in this regard looking for an extension of their product range and have direct access to the main raw material. Petrol companies seem to have an interest as their profit margin in Argentina are low due to the low crude oil prices within the country, and also due to the imbalanced transport fuel consumption matrix and the necessity to import diesel. The feedstock used will certainly be soy oil as it is the cheapest, readily available and most secure and also due to the strong lobbying power of the soy industry in Argentina and ACSOJA. The main players within the biodiesel value chain are again illustrated in Figure 4-4.

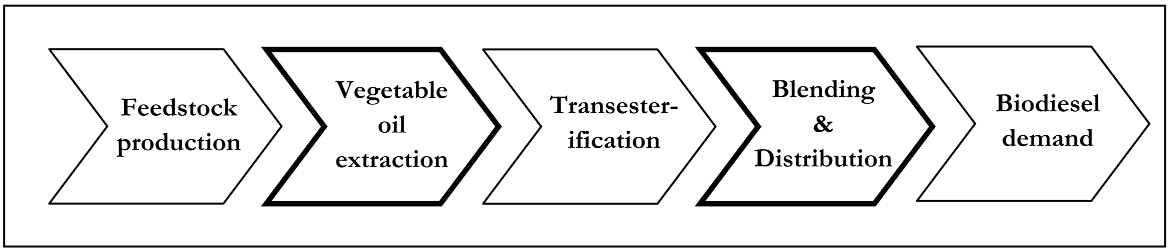

Figure 4-4 The main interests and powers along the Argentinean biodiesel value chain.

Looking at the bioethanol value chain (see Figure 4-5), the petrol industry seems to be also a main player. In fact it appears that their current bottleneck situation allows them to become *the* main player. The lack of homogeneous action among feedstock producers and the lack of a large scale sugar milling and/or distillation industry for bioethanol creates this position.

Their interest in this regard is however not at all to develop a bioethanol industry in Argentina – neither for local consumption nor for export. Bioethanol would be a substitute for petrol, a transport fuel which is available in excess in Argentina. The heavily unbalanced transport fuel consumption leads to the maximisation of diesel production per barrel of oil and as petrol and diesel are co-products during the refining step, to an excess amount of petrol. The development of a bioethanol market seems therefore more than unlikely.

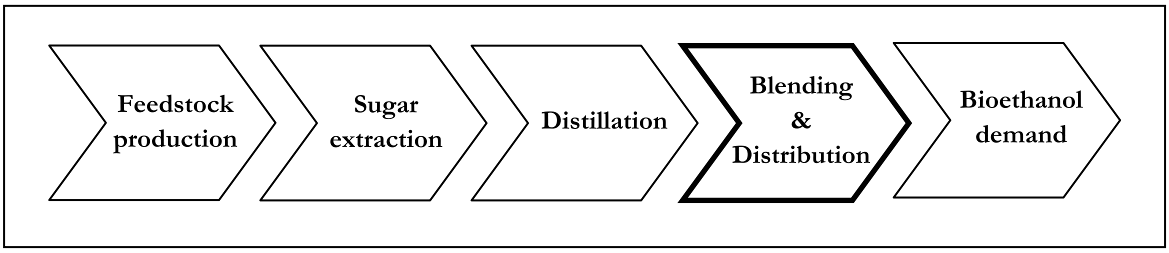

Figure 4-5 The main interests and powers along the Argentinean bioethanol value chain.

The discussion will be primarily directed towards the development of the biodiesel market in Argentina as it has the highest potential for development. As stated, it appears that the current direction of the biodiesel market is primarily oriented towards a large scale production by vegetable oil and petrol companies for export. The vegetable oil used will most likely solely be derived from soy beans. This however bears several points worth discussing. There is a significant uncertainty for the sustainable direction of the biodiesel market in Argentina. The main points are the large-scale production and the chances for small-scale producers to enter the market, the direction of the market towards export rather than local supply, and finally the sustainability of soy as the only feedstock. These points are evaluated into detail, while discussion points regarding bioethanol in Argentina will be also taken into consideration wherever appropriate.

5 Discussion: the framework for liquid biofuels in Argentina

5.1 Socio-political issues

5.1.1 Legal framework

Concerning the legal framework, **the development of the biofuel law** and its regulatory decree (decreto reglamentario) will be the most critical influence. The biofuel law is supposed to support the production side of biodiesel and bioethanol in Argentina and it has to provide enough incentives to overcome several barriers, among which the low transport fuel prices i.e. the distorted transport fuel market (discussed under Chapter 5.2.1) are probably the most strongest. This could already be seen in the failing of the Alconafta programme (see Chapter 3.4.1) where bioethanol prices could not compete with local petrol prices even through heavy subsidies and state support.

The main problem with the current version of the law seems to be its lack of transparency which does not seem to allow secure investments into transesterification and/or distillation plants (Mendoza, 2006; Villalonga, 2006; Mancini, 2006). The regulatory decree is yet to come and its content will have a significant influence on the further liquid biofuel market development. A clear outline of the financial incentives, i.e. the tax exemptions, the timeline for which they can be gotten, and the requirements under which they will be given is a minimum necessity for the decree. The main issue will be to clearly state how the ranking for the requirements to get tax exemptions will be undertaken by the regulatory authority, the Secretary of Energy (Bakovich, 2006; Acosta et al., 2006). If these ranking criteria will not be laid out clearly the law (and with it the liquid biofuel market development) runs the risk of contributing to an unfair market development (Mancini, 2006).

In the current version, the law states the preference of SMEs and farmer respectively state owned enterprises (at a minimum of 50% ownership). In order to actually support these, it has to fit into the overall policy framework and the investment climate which apply to these actors. Otherwise it is not going to lead to sufficient investments to reach the quantity required for a 5% biodiesel/bioethanol blend in 2010.

Also, it is necessary that liquid biofuels will be considered in a medium- to long-term overall energy strategy for Argentina from the Secretary of Energy. It is not clear which role they are intended to play in the longer run for Argentina. This clarification is necessary as the market is only emerging and producers of biodiesel or bioethanol need a **clear-cut level playing field** in order to make decisions.

Critical points in the regard of an integration of the law in an overall political and financial framework are the already currently existing problems within the legal framework. **Overlapping requirements, responsibilities, and enforcement problems** between different secretaries and the provincial or the national level respectively are not infrequent (Mancini, 2006). The main problem in regards to biofuels will be that oil exploration and exploitation, as regulated under Law 17.319, fall under energy and mining operations with jurisdiction on state level. Biofuels as regulated under the Law 26.093 however will fall under the agricultural activities with jurisdiction on both national and provincial level. I.e. provinces can decide whether or not they live up to the law or enforce it. This makes the current framework for biofuel support untransparent, insecure, and uncertain.

5.1.2 Institutional framework

The institutional framework in Argentina regarding biofuels (and renewable energies in general) has not been clearly coordinated in the past. The country lacks one strong institutional entity that coordinates activities, formulates policies as well as objectives (FB, 2005b, p. 3). In this regard, Argentina's state apparatus in general might present a critical factor. It is considered to be relatively big with a significant amount of bureaucracy slowing down transition and communication processes (Pigretti, 2006). This leads not only to problems on the support but also on the enforcement side. It seems that one can say that the overlapping legal framework is reflected in the policy framework and vice versa.

With the set-up of the new law, the **National Biofuels Commission** (see Chapter 4.1.3) has the potential to get the role of this missing entity. It is not easy to assess its potential in this regard as it has not been very active in the past. So far, its only major contribution has been the set-up of the current law whose development took 6 years (Acosta et al., 2006). The current version of the law is not satisfiable in many regards (see above). Also, the constitution of the Commission in general hosts many conflicting viewpoints and might hinder its efficiency and streamlined action. A homogeneous approach and a clear-cut policy framework with defined objectives is a critical factor for the development of a liquid biofuel market in Argentina. Otherwise, biofuels will face the same problem as bioethanol from sugar cane during the Alconafta programme.

As the Brazilian Proalcool programme has shown (see Chapter 3.5.4) it is necessary to harmonise and streamline not only the political actions but also the interests and leverage of other actors along the liquid biofuel value chain. The National Biofuel Commission will have to face the challenge to engage with local actors along the value chains and to interact in a dynamic and ongoing process in order to define the right mechanisms and approaches. The Alconafta programme has – in contrast to the Proalcool programme – shown that without this integration of a top-down *and* bottom-up approach *and* an interaction along the value chain from production to demand, the set-up of a liquid biofuel market will not prove to be successful.

Within the National Biofuel Commission, a central role will have to be played by the **Secretary of Energy**. Firstly, it serves as the central institution for the set-up of the ranking criteria and as the enforcement unit of the biofuels directive in general. Secondly, there is a need for a clear-cut role of liquid biofuels in Argentina's future energy matrix/strategy. This has also to be defined in a new energy plan by the secretary. It is obvious that Argentina will already in the short-run become a net importer for crude oil and that it will have to increase its prices for petrol in the country. In order to further assure not only a national supply with combustibles but also with affordable combustibles to society, the role of liquid biofuels has to be defined. Especially as production prices for biodiesel are low in Argentina and current interests lie mainly in the orientation of biofuel production for export and not for local consumption.

5.1.3 Socio-economic framework

Within the socio-economic framework, perceptions of society as well as the economic conditions and opportunities of the country and its inhabitants will matter. The most influential point in this regard seems to be the state bankruptcy in 2001 followed by an economic crisis in 2002. This was only 4.5 years ago and the personal implications for many Argentineans remain prevalent. The income structure within Argentina has undergone a change which seems to have mainly thinned out the middle-class, leaving the majority of it now in the lower income segment.

Most people are left with fewer money and purchasing power than before the economic downturn. Their perceptions towards policy can be characterised by **resistance, disbelief and mistrust**. This of course affects the investment climate. People have become risk averse and the perceived unstable and not trustworthy political framework only fosters their investment resistance.

Argentina is still regarded a developing country (e.g. in the UNFCCC) and hosts a significant amount of poor and indigenous population – which lives mainly in the northern part of the country. In a recent report on renewable energy potential in Argentina, it was pointed out that these parts of society have been excluded from the modernization processes within the country (FB, 2005b, p. 3). It seems that the country **lacks an adequate perception of poor and indigenous needs**. In this regard it is not clear if the possibility to cultivate energy crops in poor areas will become a major influence in the development of the liquid biofuel market. In Brazil e.g. the social development is seen as a major component of the development of a liquid biofuel industry (Almada, 2006).

While there are initiatives e.g. from the SAGPyA to support regional economic development through the cultivation of labour intensive crops such as ricinus and/or jatropha,[51] the successful development of a larger production scale to supply a liquid biofuel production that is oriented towards local or international demand remains yet to be seen. An optimistic estimate of Senator Roberto Urquía states that liquid biofuels could lead to a total of 25,000 direct and indirect employment generations in Argentina.[52] How this would be divided however is not sure. There is significant scepsis among researchers if the liquid biofuel market development will benefit lower income regions and SMEs (Hilbert, 2006). Most people believe that the development will favour established market players, mainly of the vegetable oil extraction and petrol sector (Hilbert, 2006; Molina, 2006; Martinez Justo, 2006).

A final word should be said towards the general perception of the public for alternative transport fuels. In a country with a low average income and a distorted transport fuel market, the incentives to demand (under current market conditions) uncompetitive liquid biofuels such as biodiesel and bioethanol are non-existent. Furthermore, the Argentinean culture is regarded not to be significantly environmentally aware (Bakovich, 2006). It is assumed therefore that only through lower prices than traditional transport fuels or legal blending requirements will a demand for liquid biofuels be created. The price incentive or legal requirement also seems to be necessary as there is significant concern about **consumer acceptance** of the alternative transport fuels according to Acosta et al. (2006).

5.2 Market issues

5.2.1 Production and demand of traditional transport fuels

Argentina has a very low internal **market price for crude oil** which lies between US$ 33 and 42 (Acosta et al., 2006; Molina, 2006). The revenue margin for oil companies is therefore

[51] Example: In the region of Tartagal (Salta Province), a branch of YPF was closed after its privatization and the unemployment rate rose up to 70% in the region (Leone, 2006). The conditions to grow ricinus are excellent and the SAGPyA runs a project which aims at the creation of work through ricinus biodiesel production (Leone, 2006).

[52] See http://www.infobae.com/notas/nota.php?Idx=255494&IdxSeccion=0 [July 31st, 2006].

relatively low compared to other countries and production sites in the world. In recent years, petrol companies active in Argentina have decreased their investments in the exploration and exploitation of oil fields which lead to a decline in production (EIA, 2006). The economic crisis in 2001/2002 has also added to the decline in extraction (DENA, 2005, p. 21).

Nevertheless, the refineries in Argentina are running on full capacity (Bakovich, 2006), trying to **maximise the diesel production** per barrel of oil due to the unbalanced transport fuel market demand. As this production of diesel is currently not sufficient, 3% of the diesel consumption in 2005 had to be imported. As diesel and petrol are co-products in the refining process (together with others) and the demand for petrol is relatively low in the country compared to diesel, the resulting **excess amount of petrol** is exported currently.

Therefore, there is currently no incentive for petrol companies to support or invest in the production of bioethanol for petrol blending. Bioethanol would be a direct competitor to the already existing excess amount of petrol and the production would require significant investments. Moreover, there has been a trend in recent years to substitute petrol with CNG in cars in Argentina. Since the petrol companies are the main forces along the bioethanol value chain (see Chapter 4), the development of a bioethanol market in Argentina is more than unlikely. Doubts about a development have also already been expressed by members of the National Biofuels Commission – e.g. the SAGPyA (see SAGPyA & IICA, 2005, p. 2). The potential feedstock industry seems too scattered and not powerful enough to overcome this barrier.

The 3% import of diesel per annum however is, together with the significant role of diesel within the country's transport fuel matrix, an incentive to produce biodiesel. And it is very likely that diesel will remain the main transport fuel in Argentina. The list of potential incentives for its consumption is long. Apart from the necessity to use trucks and lorrys for long distance cargo due to the lack of a sophisticated train network, and the necessity to use diesel in agricultural machinery, buses for local passenger transport get diesel subsidies and private consumers face lower taxes for diesel than for petrol. Transport fuel prices at the pump for diesel per litre are currently AR$ 1.44 whereas for petrol AR$ 1.69-2.00 per litre. The two fuels leave the refinery however at more or less the same level price of AR$ 0.80 per litre (Molina, 2006; Acosta et al., 2006). Higher octane fuels are slightly more expensive at around AR$ 0.90.

In regards to other transport fuels, there are state plans for the increase in CNG usage, especially in buses and taxis (Acosta et al., 2006). As the buses are currently all diesel powered, the transition would require new engines. Due to the high costs this market development is therefore unlikely in the near future. Diesel will remain the main transport fuel.

The caped or 'adjusted' fuel prices lead to a **distorted fuel market situation**, favouring the demand for diesel and giving no incentives to the production of alternative transport fuels. The market entry barriers are significantly high. It seems unlikely that the prices will be raised significantly in the short-run due to the reluctance of the government. Their change seems however to be likely in the medium-run (post 2010) when Argentina is supposed to become a net importer of crude oil. The price changes could become one of the main influencing factors for the development of a liquid biofuel market for local supply.

5.2.2 Production and demand of liquid biofuels

For bioethanol, the current production is solely addressed towards the food, beverage, and pharmaceutical industry. Distillation plants exist, but their production capacity would not be enough to supply a 5%-blending requirement in 2010. For this blend, an increase in production capacity would be necessary. For the production of biodiesel, a similar scenario exists at the moment. Current production is solely addressing autoconsumption and small-scale regional marketing. For the 5%-blending requirement in 2010, an expansion would be unavoidable and require high investments into production equipment.

The investment costs for a distillation plant are around three times higher than those for a biodiesel plant of similar capacity (Bakovich, 2006) due to the more complex process. The conversion of sugar into bioethanol is in this regard slightly less expensive (and complicated) than the conversion of starch crops into bioethanol – as the starch has first to be transformed into sugar. But since the production of sugar cane in Argentina has almost reached its maximum production capacity (Almada, 2006; Molina, 2006), which is still below the amount of sugar required for a 5%-blending, starch crops would have to be taken in order to supply sufficient bioethanol. In fact the main part of the bioethanol for the local market in Argentina would have to be derived from starch containing crops. The set-up of such a plant seems unlikely under current circumstances. Compared to this, biodiesel production is a relatively easy process. The main part of the biodiesel, around 90%, is vegetable oil, which comes directly into the processing as feedstock. The mixing with a catalyst and the methanol does not require complex equipment and is currently already made worldwide in small-scale home appliances for autoconsumption (Carlstein, 2006). Ultimately, the investment costs for a transesterification plant are a third of those for a distillation plant (Bakovich, 2006).

Obviously, investment costs for production units depend also on the scale of production and their origin. Small-scale, Argentinean produced biodiesel equipment e.g. sells at around US$ 11,600 and has the annual capacity to produce 445 tons (500,000 litres) of biodiesel (Carlstein, 2006). Large-scale equipment is not produced in Argentina and would have to be imported. Investment costs are therefore significantly higher. The estimation for the construction of large scale plants vary, but lie in general around US$ 10-13 million for 40,000 tons/year, US$ 12-16 million for 60,000 tons/year, and US$ 16-25 million for 100,000 tons/year (see also Chapter 3.4.2) (Punto Biz, 2006). Distillation equipment is not produced in Argentina and would have to be imported which increases the investment costs even more.

The problem arising in this regard now is that for Argentina in general **high investment costs and perceived risk** prevail (FB, 2005b, p. 3). The significant investments become even more of a concern regarding a not yet enforced legal blending requirement (only from the beginning of 2010), and the lack of transparency (see Chapter 5.1) in the new liquid biofuel law (i.e. will someone and if who will get the tax exemptions). It appears that short-term investments seem much more likely for an export market than for the local one. No company can really be assured to get the tax exemptions for liquid biofuel production in 2010 at the moment. That's why most of them are currently hesitating to invest (Acosta et al., 2006). Also, it is questionable if the liquid biofuel production even with the tax exemptions will provide a sufficient margin to become an attractive investment. This will be calculated and discussed in the following for biodiesel.

5.2.3 Biodiesel production costs

The general perception in industry and politics at the moment is that biodiesel production costs in Argentina e.g. are currently above diesel prices at the pump (AR$ 1.44 or US$ 0.47 respectively) (Acosta et al., 2006; Martinez Justo, 2006; Almada, 2006). When biodiesel is going to be blended with diesel, the state is supposed to pay the margin between the liquid biofuel production costs and the local market prices (Bakovich, 2006). This contains a number of problems however.

The new liquid biofuel law states that SME liquid biofuel production and farmer as well as state owned enterprises will be preferred, but what if their production capacity is not enough in 2010? What if the prices for their production will be higher than from producers who can benefit from economies of scale or direct links to feedstock like vegetable oil companies? Certainly, the state will be interested in getting the cheapest available liquid biofuel in order to reduce the margin it would have to pay. The future production structure as it seems, remains uncertain and highly dependent on the transparency of the **regulatory decree** and its enforcement.

With the supposed minimum blending requirement of 5% in 2010, it is assumed that in order to reduce the costs for the state, the diesel prices will rise around AR$ 0.02-0.05 (US$ 0.007-0.016) (Bakovich, 2006). A critical point in this regard could only become the **social acceptance of the raised prices** and the biodiesel in general (Acosta et al., 2006). This is combined with a general lack of payment capacity on the part of consumers (FB, 2005b, p. 3). The demand for biodiesel will certainly only be based on price (Bakovich, 2006). Other factors e.g. environmental benefits are not likely to become drivers for alternative transport fuels in Argentina for the local population.

There is the possibility to acquire **foreign (direct) investments** for the production of biodiesel. Although no Clean Development Mechanism (CDM) methodology for GHG emission reductions through biodiesel is yet accepted under the UNFCCC, this is still an option for the future. Applications for such projects exist already.[53] As stated before, an option for foreign investment is the set-up of a production for export. In this regard, the Argentinean company Oilfox S.A. has made significant headlines. Not only has acquired two contracts with biodiesel importers in Europe, but also it has recently established a contact to the combined German-Swiss owned biodiesel company Neckermann-Gate GmbH. The company is now investing around € 21 million (US$ 26.8 million) in a big scale biodiesel production facility in the province of Buenos Aires which is supposed to produce 20,000 tons of biodiesel per month and will be run in cooperation with Oilfox.[54] Should the companies be looking at the proposed tax exemptions in 2010 for liquid biofuel production, this co-joint operation is necessary as the law prescribes at least a 50% ownership by local actors involved in the agricultural sector or the state.

The most recent **biodiesel production cost assessment** for Argentina was published in June 2006. Asal et al. (2006) calculate that biodiesel can compete with diesel sold at the pump in Argentina even after taxes. For a production facility of 2 tons/day, they calculate the net production costs[55] at US$ 0.347 (AR$ 1.07) per litre before taxes and at US$ 0.517 (AR$ 1.59) per litre after taxes including VAT (Asal et al., 2006, p. 51). This would mean that the current biodiesel production in Argentina is competitive under the assumption that the supposed tax exemptions with be enforced. Asal et al. (2006) compare their biodiesel production price however to an internal diesel price of US$ 0.517 per litre which is significantly higher than the current US$ 0.47 at gas stations in Argentina (Asal et al., 2006, p. 51). Also, their calculations indicate the lowest biodiesel production costs per litre compared with other calculations undertaken in previous years by Adreani et al. (2000) and Ugolini (2003).[56] According to

[53] For example the BIOFAA project which plans the production of biodiesel production from canola seeds. Available under: http://aplicaciones.medioambiente.gov.ar/archivos/web/OAMDL/File/fip%20BIOFAA.pdf [August 31st, 2006].

[54] Available online: http://prensa.oceba.gov.ar/modules.php?name=News&file=article&sid=9456 [July 31st, 2006].

[55] I.e. including the selling of the process by-product glycerol at an estimated US$ 100/ton.

[56] In both calculations the selling of glycerol as a by-product was taken into consideration. It should be stressed that the calculations were undertaken for a scenario before the economic crisis of the country in 2001/2002. After which the purchasing power for Argentineans has dropped dramatically.

Adreani et al. (2000), production costs lie between US$ 0.372 (AR$ 1.15) and US$ 0.406 (AR$ 1.25) depending on the production scale. Ugolini (2003) calculated biodiesel production costs assuming lower soy oil prices which resulted in production costs of around US$ 0.35 (AR$ 1.08) per litre. This shows which effect the assumed vegetable oil price has on the calculated biodiesel production price. Asal et al. (2006, p. 51) estimate the raw material costs for biodiesel to be around 64% of the total costs for production and marketing including labour, administrative and commercial costs as well as transport. If only the production costs are taken into consideration the share of vegetable oil rises over 75% (see Table 5-1). It appears however, that Asal et al. (2006, p. 51) have assumed a very low vegetable oil price (US$ 240.87 per ton). As most potential biodiesel producers do not produce vegetable oil, hence, would have to buy the vegetable oil on the internal market and taken the important share of the vegetable oil in the price of the end product into consideration, this has to be reviewed. As Figure 5-1 shows, the cheapest available vegetable oil is soy and its international market price in 2005 was around US$ 480. Now on the Argentinean market, i.e. the country's internal price for soy oil is around US$ 370 (La Nacion, 2006a).[57]

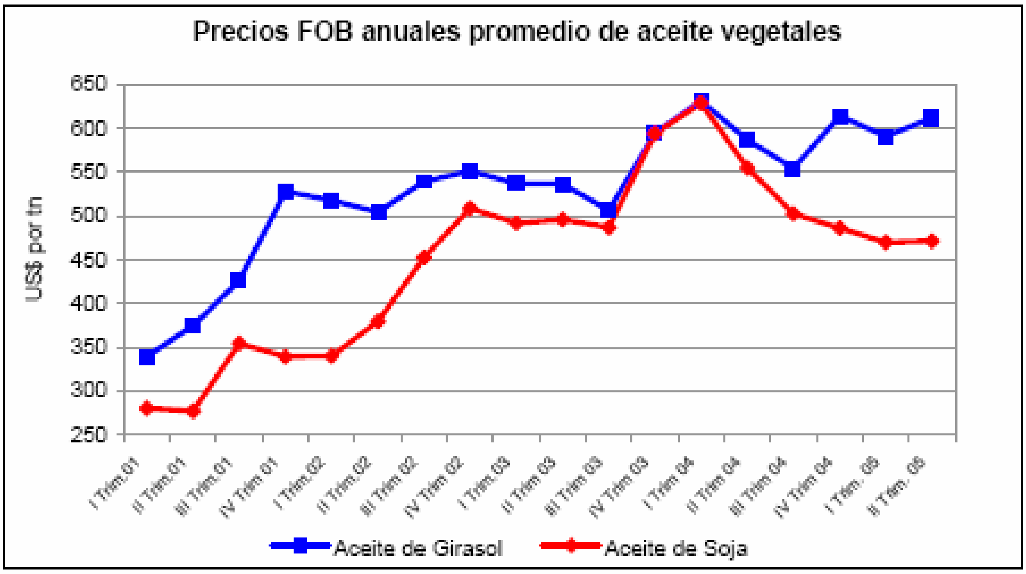

Figure 5-1 Annual FOB prices for vegetable oil between 2001 and 2005.

Source: SAGPyA & IICA, 2005, p. 37

It seems reasonable to take the internal market selling price for vegetable oil into the calculation costs for biodiesel as the transesterification industry does not exist yet, and most of the biodiesel producers would have to buy the vegetable oil on the internal market. This means however that vegetable oil companies which have direct access to the vegetable oil can reduce that margin i.e. produce at lower costs. With an internal market price of US$ 370 per ton of vegetable oil, the production costs for biodiesel are now as shown in Table 5-1.

[57] This can also be calculated through the exportation tax (23.5%) that applies to soy oil in Argentina. Assuming an internal price of US$ 480, the internal market price (less 23.5%) is US$ 367.2.

Table 5-1 Biodiesel production costs for a plant size of 2 tons of biodiesel per day.

Input	Cost per unit product (US$)	Production cost (US$/ton biodiesel)	Percentage of total production costs
Vegetable oil (970 kg)	370/ton	358.9	79.0%
Methanol (117 kg)	0.6/kg	70.2	15.5%
Catalyst (1.5 kg)	0.5/kg	0.75	0.2%
Steam @ 4 kg/cm² (600 kg)	0.003/kg	1.8	0.4%
Electricity (9 kWh)	0.067/kWh	0.6	0.1%
Labour (1 unit)	16.67	16.67	3.7%
Amortisation (1 unit)	4	4	0.9%
Laboratory/maintenance/ supervision (1 unit)		1.34	0.3%
Total production costs (US$/ton)		**454.26**	**100%**
Total production costs (US$/litre)		0.397	
Sale of glycerol per ton (@ US$ 100/t)		7.14	
Net production costs (US$/ton)		**447.12**	
Net production costs (US$/litre)		0.391	
Net production costs per diesel equivalent litre (US$)		0.434	

Source: Own calculations based on Asal et al., 2006, p. 51

The biodiesel production price per litre in Argentina without taxes now appears to be slightly higher than US$ 0.347 (AR$ 1.07) per litre before taxes and reach US$ 0.391 (AR$ 1.20). As supposed in the new biofuel law, 'accepted' biofuel producer will be able to sell into the market with an exemption from taxes. For diesel or biodiesel respectively this would mean an exemption from the fuel transfer tax and from the diesel tax. The calculation for the biodiesel price (after taxes) is shown in Table 5-2.

Table 5-2 Biodiesel production price per litre after taxes and tax exemptions.

	Tax	Biodiesel (AR$)	Biodiesel (US$)
Net production costs		1.20	0.391
Fuel Transfer Tax	19%	Tax exemption	Tax exemption
Diesel tax	20.2%	Tax exemption	Tax exemption
Tax on profits for crude fuels	3.5%	0.042	0.013
Value added tax	21%	0.252	0.081
Total price per litre		1.494	0.485
Price per diesel-equivalent litre		1.66	0.54
Price per litre of diesel (pump)		1.44	0.47

Taking into account that biodiesel only has an energy content of around 90% of that of regular diesel (IEA, 2004), this means that the net costs for the consumer will increase. The actual cost of biodiesel after taxes will rise up to AR$ 1.66 (or US$ 0.54 respectively). This would mean that the diesel price in Argentina would actually have to increase by more than the stated AR$ 0.02-0.05. It would mean a net increase of AR$ 0.22 (US$ 0.07) per litre. But all these calculations should not neglect that the transport fuel market in Argentina is currently still distorted i.e. the biodiesel production has to cope with artificially low prices and the calculated biodiesel production is small-size (2 tons per day). As stated before, both factors are however supposed to change: petrol prices will have to increase in the country as more and more crude oil will have to be imported, and current production sizes aimed at by potential investors are of large scale.

Compared to **international biodiesel production** prices, it seems that Argentinean biodiesel costs are low compared to other countries like the USA or the EU. While in Argentina, the current biodiesel production price (per diesel equivalent litre) is around US$ 0.434 for small-scale operation (see Table 5-1), biodiesel production costs in the USA – also based on soy oil and in small-scale, range between US$ 0.48 and US$ 0.73 per diesel-equivalent litre (Coltrain, 2002; IEA, 2004, p. 81).[58] Production facilities in the EU are of large-scale and can produce biodiesel from rapeseed oil at around US$ 0.35 to US$ 0.65 per diesel equivalent litre (IEA, 2004, p. 81).[59] Potential Argentinean biodiesel production is therefore strongly price competitive and the set-up of a local industry to sell biodiesel in an international market seems therefore highly attractive.

Current international prices for a ton of biodiesel range between US$ 600 and 680 (La Nacion, 2006a) excluding export taxes. Export taxes for biodiesel in Argentina are 5% at the moment which leads to a net export price of US$ 570-646. Net production costs were calculated at US$ 447 per ton (see Table 5-1) and could be decreased by selling the by-products to other markets.[60] This leads to a net margin of around US$ 123-200 per tons of biodiesel.[61] Selling to a European market would have to take freight and shipping costs into account. According to a cost assessment for biofuel transport by Hamelink et al. (2005), shipping costs are however neglectable. According to the authors' calculations, the main transportation cost factor within the supply chain appears to be the first local truck transport (Hamelinck et al., 2005). Once freighted on ships, transportation over long distances should not be considered an obstacle (Hamelinck et al., 2005). This indicates that an additional cost reduction could be realised when the bioenergy conversion facility is constructed at or close to the export harbour (Hamelinck et al., 2005) which would be the case for biodiesel production from Argentinean vegetable oil or petrol companies.

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[58] Per litre of biodiesel produced, the range is based on soy oil costs of US$ 0.38 to US$ 0.55, production costs between US$ 0.20 and US$ 0.28, and a glycerol credit of about US$ 0.10 (IEA, 2004, p. 81).

[59] All figures are subject to increase by an additional US$ 0.10 under large-scale production, as an increase in biodiesel production would also lead to an excess amount of glycerine as a by-product which would most likely cause its market price to fall and hence the biodiesel net production price to rise (IEA, 2004, p. 81).

[60] Glycerol prices for Argentina were assumed to be US$ 100 per ton. Glycerine prices in the EU however vary at the moment between US$ 500 and US$ 1000 per ton (IEA, 2004, p. 81). A significant increase of biodiesel production and hence also its by-product could affect this price however negatively.

[61] In a recent ranking for the most profitable current business investments, biodiesel production in Argentina ranked number two (available under http://money.cnn.com/2006/07/31/magazines/business2/Soybeans_gas.biz2/index.htm [August 10th, 2006]).

5.3 Technical issues for biodiesel in Argentina

Within the technical issues, the following play a significant role for the development of a local production industry. The availability of locally produced biodiesel production equipment, which reduces the set-up costs of a biodiesel production. Also, the technical requirements for producing, handling, transporting, storing, blending, and consuming biodiesel play a role i.e. potential investments into infrastructure and for consumer. Finally, the quality standards will be looked into in this section.

5.3.1 Production

International equipment e.g. from Austria is relatively expensive for Argentinean producers due to their reduced purchasing power after the economic downturn and the decoupling of the Argentinean Peso from the US$. In general, Argentina has seen a rather scarce local development of a renewable energy equipment-production industry (FB, 2005b, p. 3). Until recently, equipment imports have prevented the growth of a national renewable energy equipment industry – a situation which has improved to some extend in the past years (FB, 2005b, p. 3). In regards to biodiesel, one biodiesel equipment producer for small-scale application exists. Biofuels S.A. produces equipment facilities for 'High Temperature Pressurised' biodiesel (batch process) with an annual production capacity of 445 tons or 500,000 litres of biodiesel respectively (Biofuels, 2006, p. 1).[62] These facilities are mostly suitable for autoconsumption or at best small-scale regional markets e.g. under farming cooperatives. Large-scale biodiesel production plants like e.g. those from Lurgi are not produced in Argentina.

5.3.2 Storage, blending, and distribution

After the production, the biodiesel can in general be handled, stored, and transported in existing infrastructure for diesel. This is mainly due to the biodiesel's higher ignition/flash point compared to diesel. While diesel ignites at around 50°C, biodiesel flash-points are generally more than twice as high (Carlstein, 2006).

The blending of diesel with biodiesel is certainly the most complicated part of the production and consumption chain of biodiesel. In the current legal framework under the liquid biofuel law in Argentina, this step is only allowed at the refineries. It is not clear yet, how this step could be managed properly by small-scale producers on-site (Acosta et al., 2006), but the option for such blending would enhance the possibility for a decentralised autoproduction and -consumption of biodiesel. Currently, the biodiesel produced through small-scale plants is used as a neat fuel (Hilbert, 2006; Carlstein, 2006).

5.3.3 Consumption

On the consumption side, biodiesel can apparently be used in any blend with regular petrol diesel without making modifications necessary (according to IEA, 2004). Other statements indicate that only blends of up to 20-30% (volume content) are feasible without engine modifications (see e.g. Asal et al., 2006). Moreover vehicle manufacturers allow only biodiesel blends of up to 5% (in volume) in their warrants for new cars – if at all.[63] Consequently, it can be said that if biodiesel is used as a neat fuel, small modifications seem to be advisable. One of

[62] They sell at around 9,100 € per facility (Biofuels, 2006, p. 1).

[63] See http://www.iwr.de/biodiesel/auto.html [July 18th, 2006] for a list.

the greatest concerns is that biodiesel – a good solvent, dissolves flexibilisers in the car's pipe and tube systems. On the demand side, it should also be kept in mind that biodiesel has only an energy efficiency of about 90% of that of regular petrol diesel (IEA, 2004, p. 81; Spiegel, 2006, p. 125). This means that with the introduction of biodiesel in a mandatory 5%-blend, the consumption of diesel will increase in order to keep the net energy balance of the consumption stable.

5.3.4 Quality standards

The current quality standard in Argentina that applies to biodiesel, Norm IRAM 6515-1[64], is designed for neat consumption (B100) and apparently not enforced. The Secretary of Energy – the enforcement authority for the new liquid biofuels law in Argentina, is however working on the modification of this requirement and will apparently soon release a biodiesel norm which resembles more or less the European EN 14214 (Bakovich, 2006).[65] Whether or not this is useful or necessary respectively is a point of discussion.

Small-scale biodiesel producers fear that they could lose the license for autoconsumption as the EN 14214 requirements are among the highest for the industry (Carlstein, 2006; Bakovich, 2006). On the other hand, it seems that this is one of the objectives of the implementation, as neither the SE nor other parties within the National Biofuels Commission seem to want to support autoconsumption. Biodiesel producers argue that many of the requirements formulated in the EN 14214 are not necessary to comply with, e.g. a flash-point requirements over 110°C as biodiesel will be handled and stored in the same equipment as diesel i.e. has to allow an ignition point of around 50°C (Carlstein, 2006). They see these requirements as market entry barriers opposed and controlled by petrol industry advocates and claim that many European producers do in fact not comply with the EN 14214 but nevertheless are allowed to sell to the transport fuel market (Carlstein, 2006).

5.4 Sustainability issues of soy production in Argentina

In this section, the sustainability of the most likely transport fuel for Argentina, biodiesel, will be assessed upon its sustainability. This means its suitability as an alternative transport fuel and more specific the sustainability of its feedstock production i.e. soy for the case of biodiesel in Argentina. Issues of main concern, as shown in Chapter 3.1.2 will be the energy input-output ratio, the GHG balance on a life-cycle basis, and the competition for land use.

5.4.1 Energy balance

The energy balance for certain crops has to be made country specific as the results may vary depending on climate and cultivation technology applied. For Argentina, so far, no country study for the energy balance of soy production has yet been finished. One is currently carried out on behalf on the SAGPyA together with research institutions like the University of Buenos Aires for soy bean, sunflower and corn for liquid biofuel production. Preliminary findings in the Argentinean assessment show similar results to studies made in the USA

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[64] The norm can be found under http://www.iram.com.ar/Normalizacion/Departamentos/oe.asp?mOrg=-2147483287&nOrg=SubComit%C3%A9%20Calidad%20de%20Combustibles [August 1st, 2006].

[65] The EN 14214 measures 29 different parameters of which the majority apply to the feedstock (21); 6 are a function of the process and 2 of the post-process (Carlstein, 2006).

(Ferraro, 2006), where soy production faces similar climatic circumstances, soil conditions and production methods (Almada, 2006; Leone, 2006).[66]

There, a recent study undertaken by Pimentel and Patzek (2005) suggests that the energy balance for biodiesel from soy is negative. The researchers conclude that biodiesel production using soy oil as feedstock material requires 27% more fossil energy input than available in the final biodiesel produced (Pimentel & Patzek, 2005, p. 65). Within the energy balance, by-products have to be taken into account. Soy beans only have an oil content of 18% (Pimentel & Patzek, 2005; Table 5-3).[67] The crop is mainly rich in proteins i.e. meal/flour which is primarily used in livestock mast. Taking the protein energy into consideration, the energy balance however still appears to be negative by 8% according to Pimentel and Patzek (2005, p. 72). The authors' results are supported by results made by Sheehan et al. (1998a; 1998b) and a study done by Novem/ADL[68] (1999) who also concluded upon a negative energy return of the conversion of soy beans into biodiesel. Sheehan et al. (1998a; 1998b) report on an energy balance for soy bean derived biodiesel which is around 3% less efficient than conventional diesel.

But there are also claims that an US scenario might not be applicable to the Argentinean setting (Almada, 2006) and that the soy production in Argentina differs significantly from production modes in other countries (Asal et al., 2006, p. 53). In this regard, Asal et al. (2006, p. 53) stress the large-scale production, the extensive use of no-tillage farming (i.e. direct sowing), the high rates of cutting-edge technology implementation (including the use of genetically modified soy), the development of efficient planting, spraying, and harvesting services under control of experts, and the high technical level of professionals and farmers. In fact it was stated by several interviewees that direct sowing has a lower machinery i.e. energy input than conventional tillage (Taboada, 2006; Hilbert, 2006; Almada, 2006; Leone, 2006). In general soy production in Argentina requires only three to four machinery treatments: sowing, herbicide application, watering, and harvesting (Taboada, 2006).

As said, recent research findings in Argentina suggest similar results to those by Pimental and Patzek (2005). At most, taking a lower machinery input through direct sowing into consideration, the detected 8% energy loss rate (as of Pimentel & Patzek, 2005) could become a net energy balance for soy from direct sowing in Argentina. A significant amount of uncertainty however remains if this is the case. As it seems so far, the net energy balance is negative, at most zero for direct sowing.

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[66] The soy bean yield in the USA, around 2,668 kg/ha (Pimentel & Patzek, 2005, p. 72), is about the same as in Argentina where it is 2,700 kg/ha on average (SAGPyA, 2006b).

[67] This is similar to contents for Argentinean soy (see Satorre et al., 2003; Table x-x).

[68] Cited in IEA, 2004, p. 65.

Table 5-3 Biodiesel yield per ha for Argentinean oil crops.

Crop[69]	Yield (kg/ha)	Plant oil content	Yield (kg oil/ha)	Litres of oil/ha[70]	Litres of biodiesel/ha[71]	Energy consumption (litres/ha)[72]	Net biodiesel yield (litres/ha)
Jatropha	2,500	60%	1,500	1,395	1,339	50	1,289
Ricinus	2,500	50%	1,250	1,163	1,116	52	1,064
Rape	2,400	50%	1,200	1,116	1,071	49	1,022
Sunflower	1,950	40%	780	725	696	51	645
Soy	2,700	18%	486	452	434	25	409

Source: SAGPyA (2006b)

Table 5-3 indicates the low net biodiesel yield for soy bean biodiesel compared to other feedstock oil crops. It seems that there might be more suitable oil crops. In fact, the net biodiesel yield per ha is the lowest for soy even though the energy consumption per ha of soy cultivation taking 100% direct sowing into account is around half of that for other oil crops (see Table 5-3). This seems mainly due to the fact that soy beans have a much lower oil content than other oil crops like ricinus or jatropha (see Table 5-3).

Nevertheless, those require a much higher energy input through physical labour instead of machinery (Leone, 2006). This is to say that a cultivation of labour intensive oil crops could lead to a generation of direct work, a benefit that is often connected with the substitution of traditional with alternative transport fuels. The higher energy consumption per ha of cultivated oil crops could however also lead to a negative energy ratio. Therefore it is again questionable if oil crop cultivation – even with the generation of direct employment opportunities, seems sustainable from a net energy perspective. The net energy balance for biodiesel from sunflower seeds e.g. is negative by 118% according to Pimentel and Patzek (2005) which is even worse than for soy beans.

Hence, on the one hand, based on US results, the biodiesel production from soy beans does not seem sustainable from a net energy viewpoint. However this might be different in the Argentinean setting with a significant amount of soy grown through no-tillage farming. A conclusion upon alternative feedstock crops for biodiesel cannot be drawn here without a more thorough investigation. Unfortunately it is not within the scope of this paper to do so.

[69] Direct sowing technique only for soy; conventional sowing for all other crops.

[70] Density factor: 0.93 kg/litre.

[71] Conversion factor: 0.96.

[72] Includes the whole crop-cycle from sowing to harvesting; calculated in energy content per litre of biodiesel.

5.4.2 GHG balance on a life-cycle basis

The GHG emissions for biodiesel from soy should be looked at on a life-cycle or well-to-wheel basis. This means that the GHG emissions from the planting of the seed to the final combustion of the biodiesel will have to be compared to those from traditional diesel. While most studies account a positive i.e. better GHG balance for biodiesel compared to conventional diesel, studies differ however in terms of the actual amount of GHG emission reductions achieved depending on various factors e.g. the feedstock and the compression engine used.

Studies cited by IEA (2004, p. 63) all show a positive GHG balance for biodiesel. Rapeseed-derived biodiesel ranges between 40% to 60% in light-duty compression-ignition engines while a study undertaken by Levelton (1999) shows a 63% improvement for biodiesel derived from soy (IEA, 2004, p. 63). For heavy-duty compression, a study was undertaken by Beer et al. (2000). The results indicate similarly that the net GHG balance favours the use of biodiesel over conventional diesel. Another major study in this regard was undertaken by the National Renewable Energy Laboratory (NREL) in the US under Sheehan et al. (1998a; 1998b) for biodiesel use in a bus. It also indicates that the net GHG balance for biodiesel on a life-cycle basis is better than for conventional diesel. Asal et al. (2006) apply these findings on an Argentinean scenario and come to the same conclusion. Their results are shown in Table 5-4.

Table 5-4 Emission levels for two biodiesel blends compared to regular diesel in an Argentinean scenario.

Emission	**B100**	**B20**
Unburnt Hydrocarbons	- 93%	- 30%
Carbon Monoxide	- 50%	- 13%
Suspended Particles	- 30%	- 22%
Nitrogen Oxides	+ 13%	+ 2%
Sulfates	- 100%	- 20%
Aromatic Polycyclic Hydrocarbons	- 80%	- 13%
Nitrated Aromatic Polycyclic Hydrocarbons	- 90%	- 50%

Source: Asal et al., 2006, p. 53

The findings by Asal et al. (2006) should however be challenged in regards to the utilisation of soy as a feedstock for biodiesel in Argentina as soy is a biological nitrogen fixation (BNF) crop. BNF crops cause direct nitrous oxide (N_2O) emissions which were identified to be a key source for the total GHG emissions in Argentina (FB, 2005b). Nitrous oxide emissions can also take place indirectly (e.g. through the volatilisation of fertilizer) but indirect emissions play a marginal role in Argentina (FB, 2005b).

Direct N_2O emissions in Argentina have three main sources: application of synthetic fertilizer, BNF crops, and burying of agricultural residues. The total direct emissions within the period of 1990/91 to 2000/01 increased sharply by 85% revealing an increase in all three emission sources (FB, 2005b, p. 94). The main cause for this increase is however only revealed in looking at the percentages of the increase in BNF between legume crops (soy, peanuts, etc.) and forages as well as the burying of agricultural residues. Here it shows that soy plays a dominant role due to its sharp increase in production after 1996/1997 (FB, 2005b).

The researchers also stress that soy might be subject to double-counting as the IPCC methodology does not differentiate between conventional tillage farming and direct sowing (FB, 2005b). Under direct sowing, the residues are not buried but left on the field which would reduce the amount of nitrous oxide released. Another contentious issue in this regard is the controversial viewpoint upon direct sowing to actually lead to an increased up-take of GHG gases through carbon sequestration (Taboada, 2006). It seems however that although the energy balance for direct sowing might be better than for conventional tillage farming, the GHG ratio might at most be 'balanced' but not with an increased up-take. This is the result of a study undertaken by Steinbach and Alvarez (2005) which assessed the change in soil through direct sowing and showed the marginal effect upon carbon sequestration for the Argentinean Pampa region.

The major share of soy in GHG emissions is significant as results by Beer et al. (2000, p. 86) show that CO_2 emissions from vehicles with regular diesel do not differ significantly for biodiesel. This means that the feedstock production is in fact critical for the overall life-cycle assessment of GHG emissions from biodiesel. In this regard, due to the lack of studies undertaken in an Argentinean setting and the uncertainty of potential double-counting under the current IPCC methodology (which does not account for direct sowing), no strong conclusion can be made upon the exact performance of GHG emissions for soy biodiesel in Argentina relative to other feedstock alternatives. It appears however that the general GHG balance is in favour of biodiesel compared to conventional diesel.

5.4.3 Competition for land use and other environmental impacts

Competition for land use patterns is relevant for biodiesel feedstock as it is derived from the actual oil crops grown and not from agricultural waste or residues like cellulose. The part of the soy plant used to generate soy oil is the soy bean. Leaves and branches are left on the field if direct sowing i.e. no-tillage farming is applied, or buried as well as burnt.

5.4.3.1 Soy bean oil content and biodiesel suitability

The soy bean as shown in Table 5-3 has a low oil content compared to other oil crops and hence a low net yield of oil or biodiesel respectively per ha. Optimistic estimates say that in order to supply the current diesel market with a 5% biodiesel blend (in volume), 9% of the soy cultivation would have to be donated to biodiesel production (Bakovich, 2006; Almada 2006; SAGPyA, 2006b). In order to supply a 20% blend (in volume), this share rises to 40% of the total soy cultivation (Bakovich, 2006). It is questionable therefore, if soy is in fact the most suitable feedstock for biodiesel production. Other oil crops like jatropha or ricinus (grown e.g. in Brazil) provide a net biodiesel yield that is around three times larger than the one of soy (see Table 5-3).

5.4.3.2 Land domination by soy

Soy bean cultivations dominate the Argentinean land surface devoted to agriculture. They are by far the main crop produced in Argentina. During the last 15 years, the amount of produced soy has almost tripled with a sharp increase after the introduction of genetically modified soy in the 1996/1997 season. In the planting season 2005/2006 soy occupies 15.2 million ha, which is more than half of the total agricultural land surface area in Argentina this share is still rising (SAGPyA, 2006c; SAGPyA & IICA, 2005, p. 28). Reasons for the sharp increase and still the steady grow are numerous (see e.g. Lattuada & Neiman, 2005).

With the introduction of genetically modified, herbicide resistant soy ('round-up-ready'), the cultivation has become very simple compared to the planting of other crops that grow on the same terrain such as maize (Taboada, 2006). Furthermore, the continuously high demand for soy protein (mainly for livestock masting) and soy oil, especially from growing Asian markets has provided incentives to invest in soy production. The positive climatic circumstances of Argentinean territory, the possibility to grow a crop in regions which have been primarily devoted to livestock grazing (such as the humid pampa), and the flat terrain allowing the application of large-scale machinery are other factors (Taboada, 2006; Lattuada & Neiman, 2005, p. 57ff).

Until 1996/1997, soy used to be primarily grown in crop rotation patterns with wheat and maize.[73] Nowadays however, the major part of soy is grown in monocultures. This can be seen in Figure 5-2 which illustrates the land surface used for the cultivation of the main crops in Argentina. The crop rotation between maize/wheat and soy is however better for soil conditions (Taboada, 2006) and still practiced in Argentina.[74] Nevertheless, most often only by farmers which can afford high machinery and seed input (Taboada, 2006). This indicates that soy bean monocropping is more common practice among small- and medium-scale farming. Finally it should be noted that the increase in soy bean production in Argentina is mainly derived from an increase in land use. The introduction of genetically modified soy and the intensification in soy bean production has had no significant effect on the average yield per ha. According to figures from the Agricultural Faculty of the University of Buenos Aires, the yield per ha has increased by around 20% (Taboada, 2006). A figure which is similar for other crops like wheat and maize.

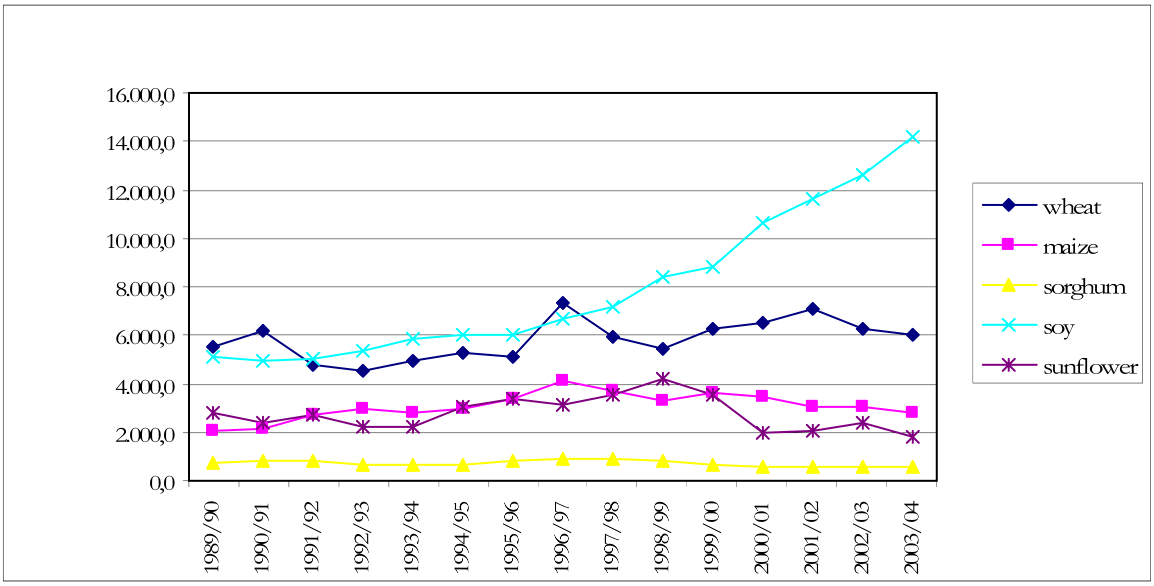

Figure 5-2 Land surface area occupied by the main crops in Argentina between 1989-2004 in million ha.

Source: Taboada, 2006

[73] I.e. sequential cropping of either two or three different crops on the same land surface within two years: wheat/soy bean – maize – soy bean; or full season soy bean – full season maize (Taboada, 2006).

[74] As soy is a BNF crop, and maize e.g. needs a significant amount of nitrogen, the rotation pattern between soy and maize balances the amount of excess nitrogen in the soil and also reduces the amount of nitrogen fertilizers for maize cropping.

5.4.3.3 Main land changes and competition for land with soy cultivation

The main land change has occurred in the humid Pampa, where a significant amount of the area devoted to livestock grazing has been changed into soy bean cultivations (Taboada, 2006). Other regions of the country, where soy bean cultivation has seen the highest relative increase in the amount of land surface throughout the 1990's are Entre Ríos, Chaco, and Santiago del Estero (Lattuada & Neiman, 2005, p. 59). The major production is however still taking place in the provinces of Córdoba, Santa Fe and Buenos Aires (Lattuada & Neiman, 2005, p. 59).

Although the provinces of Chaco and Santiago del Estero host some of the poorest population in Argentina, a significant land change for soy on the cost of food production could not be observed in genereal for the northern territory, the part of the country with still the highest amount of poor people living in rural areas (Taboada, 2006). And in general a competition for food production even taking significant land use changes in the centre region into account could neither be confirmed. The Argentinean agricultural sector produces around three times more food than what would be needed by the Argentinean population (Taboada, 2006). The problems with under nourishment derive therefore mainly from a lack of food distribution throughout the country and the concentration of the agricultural sector in the hands of a few industrialised players (Lattuada & Neiman, 2005).

The land use for soy bean cultivation it is a controversial point in rural areas in the north with low income and a high percentage of micro-, small-, and medium-sized farming activities. A main reason to monocrop soy in these regions is its uncomplicated cultivation and the stable demand and market prize for soy beans (Taboada, 2006). Soy bean cropping is regarded as a secure income. An increase in soy cultivation for biodiesel production would however significantly increase the amount of soy flour which would most likely cause the market price to decrease and hence affect the cost structure for soy cultivation. As a biodiesel feedstock it can therefore not be regarded as a stable source of income.

5.4.3.4 Other environmental impacts

In general, other impacts such as desertification are no problem for Argentinean soils (Taboada, 2006). Soil erosion has become an issue in certain regions. This however cannot be solely accounted to soy bean cropping. The expansion of land for soy monocropping has however lead to the reduction of forest areas which is now mainly a biodiversity issue (Taboada, 2006). This is seen as one of the main environmental impacts by Argentinean soy cultivation (Taboada, 2006). Also, since most soy in grown in monocultures, the missing crop rotation patterns lead to a nutrient depletion and a change in soils.

5.4.4 Soy vs. maize – bioethanol production from corn

There is a significant interest in the country to use maize for bioethanol production rather than sugar cane. The SAGPyA is particularly interested in this issue. One of the potential reasons could be that maize is the main competitor for land use with soy. Both crops grow under similar climatic and soil conditions (Taboada, 2006). While this could lead to a crop rotation which would improve the soil conditions and reduce other impacts such as a loss of biodiversity, the production of bioethanol from maize is highly controversial.

Depending on assumptions made for the life-cycle calculation of energy and GHG throughout the production cycle, the energy balance for bioethanol from maize can be positive or negative (IEA, 2004, p. 52). According to the IEA (2004, p. 54f), studies vary mainly in maize yield per hectare, ethanol conversion efficiency and energy requirements, energy embedded in the fertiliser used to grow maize, assumptions regarding the use of irrigation, and the value given for by-products (mainly animal feed).

In general, it seems however that grain derived bioethanol has a lower energy and GHG efficiency compared to sugar derived bioethanol. According to a comparison of studies done by Coelho and Goldemberg (2005), bioethanol derived from maize shows the worst GHG emission ratio compared to others like sugarcane, wheat straw, beet, or cereal bioethanol.

6 Market development scenario

The liquid biofuel market development in Argentina is looked at from two directions. On the demand side, the local as well as international demand for biodiesel and bioethanol are taken into account. On the production side the biofuel(s), their feedstock(s), the size of production, and the main producers will be indicated.

6.1 The main forces for the development of the biofuel market

In order to describe the most likely direction of the biofuel market in Argentina, this section looks into the main forces that drive the market development in Argentina. As already laid out in Chapter 3.5 on the international experience with liquid biofuel market developments, main influences for a market development can come from either a pull or push direction. Under the pull-factors, policy drivers are laid out as they seem to have mainly influenced the creation of the new law and its blending requirements i.e. a market-pull of liquid biofuels. Under the push-factors, industry incentives and interests are laid out.

6.1.1 Policy and market drivers (pull-factors)

According to local interviews undertaken and observations made, there are two main policy drivers. The first one arises through the discussion around the security of energy supply, the second one around the strong position of the agricultural sector, especially the vegetable oil crop industry in the country, and hence a discussion around opportunity costs.

The country's limited crude oil reserves which lasts only for another 9-12 years at current exploitation, production, demand and efficiency patterns have been pointed out in previous chapter (see e.g. Chapter 1 & 3.3). The high local demand for diesel and the necessity to import diesel in recent years (at 3% of the demand in 2005) has only strengthened this driver as it seems. The **security of energy supply** has been high on the political agenda in Argentina since recent energy crises. Security issues towards transport fuels are already prevalent due to the import of diesel and the seasonal and regional shortages during the harvesting season. A **diversification of energy carriers** seems to become necessary and also easily feasible due to the high share of the agricultural sector in the diesel consumption matrix, the strong oil crop industry in the country and hence the opportunity of autoconsumption. The diversification of energy carriers is supported by the country's competitive position on the world market for vegetable oil production. The diesel imports and the vegetable oil exports have lead to a discussion about **opportunity costs** and might have been one of the main drivers for the final set-up and approval of the liquid biofuel law in Argentina in 2006.

The opportunity costs lead to the other side of the driving factors for biofuels in Argentina. As the IEA (2004) already claims, biofuel market developments are mainly influenced by **agricultural policies** rather than security of energy supply issues. As already laid out in the previous chapter, the Argentinean agricultural industry is a very influential party on the policy level in Argentina. In general, it has a high share of the country's GDP and a strategic role in the country's export ranking. A major part of the social capital is linked to the agricultural sector.

As it seems, the energy policy as well as agricultural policy have lead to the creation of the blending requirements of 5% for liquid biofuels in 2010. Apart from this local market pull, the most important pull-factor in the short-term for the creation of a liquid biofuel market in Argentina seems to be the **potential markets overseas**, foremost Europe (Nadal, 2006).

Other drivers appear minor to the ones stated. They include expected air quality benefits and the potential to reduce GHG emissions as well as waste. *Expected air quality benefits* could become a driver in areas with frequent traffic of trucks and buses. In downtown Buenos Aires e.g. high buildings, narrow streets and a high bus frequency lead to significant and obvious air pollution. On the other hand, a 5% blend would reduce emission not even by 5% because of the 10% methanol content in biodiesel. Air quality benefits from biodiesel combustion are still under discussion on international level.[75] There are apparently state plans to increase the CNG usage in buses and taxis (Acosta et al., 2006). As the buses are currently all diesel powered, the transition would require new engines. Due to the high costs this market development is therefore unlikely in the near future. Diesel will remain the main transport fuel. Proved *GHG emission reductions* would offer e.g. the access to foreign exchange and knowledge transfer through Clean Development Mechanism (CDM) projects. Nevertheless, liquid biofuel CDM methodologies have not yet been accepted by the UNFCCC panel. A *waste reduction* through the usage of used frying oil for biodiesel or the usage of crop residues (cellulose) for bioethanol seem options but is not seen as a significant policy driver for biofuels in Argentina.

6.1.2 Industry drivers (push-factors)

The strongest industry drivers within Argentina for liquid biofuels come certainly from the biodiesel value chain. The export share of the vegetable oil production in Argentina symbolises this strength. As shown in the analysis, until the blending and distribution step, the players and networks within the biodiesel value chain are more influential than those in the bioethanol value chain. Among the most influential are the feedstock production networks, ACSOJA and AAPRESID, as well as the vegetable oil milling companies and their industry networks CIARA and FAIM. Hence, push factors for a biodiesel market development are the **existing infrastructure** and **industry networks** which provide a very strong ground for the development of a biodiesel market that is directed to local as well as international demand.

Another driver for biodiesel are the current differences in **export tariffs** which are 18.5% lower for biodiesel than for vegetable oil provide an indirect incentive to export biodiesel instead of vegetable oil. They are major incentives for the vegetable oil industry, which devotes more than 90% of its production to export. Another industry driver, mainly for farmers seems to be the **possibility for autoconsumption of biodiesel** (as a neat fuel). If this is going to be possible under the new liquid biofuel law remains yet to be seen however. It is although relatively clear that it is not within the interest of policy makers to allow autoconsumption. Therefore, the potential decentralisation of a transport fuel supply could not be identified as a potential policy driver.

6.2 Demand side scenario

6.2.1 International market supply

The most certain demand side development seems to be the increasing international demand for biofuels. Especially the EU, which has set a 5.75% in energy content for biodiesel in diesel as well as bioethanol in petrol, will become a major option for biofuel export.[76] There are

[75] See e.g. http://enius.de/presse/609.html [July 24th, 2006].

[76] This was confirmed by all interviewees.

Argentinean estimates which say that the EU will have to import around 5,000 million litres of biodiesel as of next year.[77]

Argentinean liquid biofuel producers would however have to compete with other international liquid biofuel producing and trading nations – foremost Brazil. Brazil is the undoubted leader in this emerging international market segment. It is the world's largest sugar cane producer with around 450 million tons (in 2004) (SAGPyA & IICA, 2005, p. 13), and has a very efficient sugar cane to bioethanol conversion industry (see Chapter 3.5.4). In this regard, a demand for bioethanol from Argentina seems unlikely as the industry would not be able to compete directly with Brazil's well established bioethanol industry which offers bioethanol at low prices.

Although Brazil has also started a biodiesel programme, Argentina seems to have a competitive edge in the production of vegetable oil and hence biodiesel in general (see Chapter 5.2). A demand for biodiesel, especially from Europe is therefore more likely. There are also already signs for international investment in the set-up of a local biodiesel industry for export to Europe. It has been reported that e.g. the German-Swiss jointly owned company Neckermann-Gate is about to invest AR$ 80 million in the set-up of a biodiesel production plant in San Nicolás.[78]

6.2.2 Local market supply

The local market for transport fuels is distorted and as it seems currently no option for the demand of biodiesel and bioethanol due to its artificially low prices. Consumers in Argentina are not regarded to demand transport fuels due to their environmental performance (which would favour biodiesel or bioethanol) but only based on price (Bakovich, 2006). Since the current production prices for both liquid biofuels are not competitive with the prices for traditional transport fuels, their demand seems impossible. However, biodiesel is currently already used within autoconsumption (e.g. Hilbert, 2006) and seems to have the possibility to become cost-competitive if prices for diesel at the pump rise by around US$ 0.07 (see Chapter 5.2.3). This margin can be expected to be higher for bioethanol due to the more complicated and therefore costly conversion process which makes a local demand unlikely in the near future. Moreover, a local demand for bioethanol seems rather unlikely also in the long run as the demand for petrol is expected to decline more due to an increasing conversion of petrol engines to CNG usage.

As it seems, the local demand for biodiesel and bioethanol can only be reached through a legal blending requirement. The new law on liquid biofuels in Argentina sets these at 5% volume content for biodiesel in diesel as well as bioethanol in petrol as of 2010. It remains to be seen however if this law is going to be enforced and if its incentive setting is strong enough for a production side development.

6.2.3 Local vs. export market

In general, the development of a production for either local or international demand does not seem to be a problem for the 'sustainability' of liquid biofuel markets. The reason for this is that the main driver for an increase in liquid biofuel production will be an increased demand in general (Johansson, 2006). Also, from a policy perspective, it seems more effective and

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[77] See http://prensa.oceba.gov.ar/modules.php?name=News&file=article&sid=9456 [August 1st, 2006].

[78] See http://www.soloenergia.com.ar/news.php?item.2211 [August 8th, 2006].

cost-efficient to diffuse new technologies through a market pull rather than a technology push (Johansson, 2006). Which demand should be created and satisfied first (the domestic or international) seems to be a 'chicken-and-egg problem' (Kåberger, 2006).

Since the local demand in Argentina is not very strong currently and the international demand from e.g. Europe for liquid biofuels is relatively strong, the strengthening of this export potential seems currently attractive for the market development. The switch-back to local supply is then feasible later on, and in regards to a sustainable development of the local and global energy matrix highly desirable (Johansson, 2006). Hence it is not the export that counts but the general increase in production, demand creation and satisfaction.

6.3 Production side scenario

6.3.1 Bioethanol

The development of a bioethanol production for *local supply* seems not probable in the short-run and also rather unlikely in the medium-run (see e.g. SAGPyA & IICA, 2005, p. 2). This is mainly due to the high resistance of the major players in the bioethanol value chain: the petrol companies. Their resistance seems primarily to be based on the low internal prices for petrol, an excess amount of petrol (which is currently exported), and the assumed substitution of petrol with CNG. Moreover, the set-up of a bioethanol industry would not only require high investments in a distillation industry but also in infrastructure. Other main players in the chain that might be in favour of a large-scale bioethanol production do not seem to have sufficient leverage to overcome these barriers.

What's more, sugar cane producers which already now serve the production of beverage, food, and pharmaceutical bioethanol have already secured markets and are limited in their production increase due to limited suitable expansion for planting. Sugar and starch crop producers would have to invest significantly in the set-up of bioethanol plants. Bioethanol production is more complicated and cost intensive than biodiesel production (Bakovich, 2006). The set-up of a bioethanol plant is considered to be three times more expensive than a biodiesel plant of the same production size in Argentina (Bakovich, 2006). The failure of the Alconafta programme, i.e. the bad experience with Argentinean bioethanol production in the past (Almada, 2006; Bakovich, 2006), serves as a major resistance for investments in this area from the state as well as from the industry side.

A production of bioethanol for the *international market* seems also very unlikely in the short-term. The set-up of a large scale industry would require significant investments. The current sugar cane and molasses which is used for bioethanol production has a very limited range of potential growing area expansion, which means that other sugar and starch crops, mainly maize and wheat would have to be used. The production of bioethanol from starch crops however requires the conversion of starch into sugar first, i.e. the production process is more complicated, the investments are higher, and the final product is more expensive per litre than sugar cane bioethanol. On an international market, Argentinean producers would however have to compete with Brazilian bioethanol exports from sugar cane. The Brazilian bioethanol production is regarded to be among the most efficient and price competitive bioethanol production worldwide (see Chapter 3.5.4). Hence, the export markets cannot be regarded as secure.

If and how this would change from short- to medium-run depends strongly on the petrol companies and governments interest. An additional driver for the development could become the very likely net import of crude oil in 9-10 years. It is however rather uncertain how other markets will have developed until then, e.g. if sugar will be included in the Mercosur and bioethanol import from Brazil would be cheaper.

6.3.2 Biodiesel

On the production side, the biofuel with the most likely development in the short- as well as medium-run certainly seems to be biodiesel. The country's worldwide leading and competitive position in the production of vegetable oil, the high efficiency throughout the value chain from crop production to oil milling, the existing infrastructure for to transport, store, and also export the vegetable oil, as well as the secure and diverse feedstock options, make it a very interesting biofuel option for Argentina to supply an *international* market – especially in the short-run.

Within the country, there is a strong industry lobby in favour of a large-scale biodiesel production which arises mainly from the two main bottlenecks within the value chain, the vegetable oil as well as the petrol companies. Apart from the reasons stated, drivers in this regard seem to be the opportunity costs for diesel imports vs. vegetable oil exports combined with the high and rising share of diesel in the Argentinean transport fuel matrix. Biodiesel therefore, seems to be also *the* biofuel for Argentina's local market.[79]

The questions remaining now are those in regards to feedstock, production scale, and main producers. The quality of the biodiesel is mainly influenced by the process and not by the vegetable oil (Martinez Justo, 2006; Carlstein, 2006). Moreover, the main production costs for biodiesel are the raw material costs for the feedstock. Since **soy oil** is the cheapest international as well as local vegetable oil, and it is abundant in Argentina, it will most likely be used as the main and only biodiesel feedstock (e.g. Hilbert, 2006; Acosta et al., 2006; Martinez Justo, 2006).

The size of the production is likely to reach a **large scale** i.e. the set-up of industry plants which produce more than 100,000 tons of biodiesel per annum. This is mainly due to the strong industry interest of the major players in the biodiesel value chain: the vegetable oil companies as well as the petrol companies. Their positions in the value chain give them a strategic advantage for the production of biodiesel. While vegetable oil companies have a direct link to cheap input (vegetable oil) for the production of biodiesel, petrol companies have the advantage of owning refining and blending equipment.

The development of SME production is yet not quite clear mainly for the following reasons. First, regarding the new law, the ranking of the tax exemptions for producers are not specified, biodiesel blending is supposed to be only allowed at the refineries (bottleneck situation), and autoconsumption should be prohibited. Secondly, this means that investment situation for SMEs can be characterised by high uncertainty and perceived risk.

The main driver for a short-term development of a large-scale biodiesel production in Argentina seems to be the opportunity to export biodiesel to Europe. Both, the vegetable oil as well as the petrol companies are situated strategically within the biodiesel value chain, as their current business operations are already export oriented.[80] The access for SME biodiesel

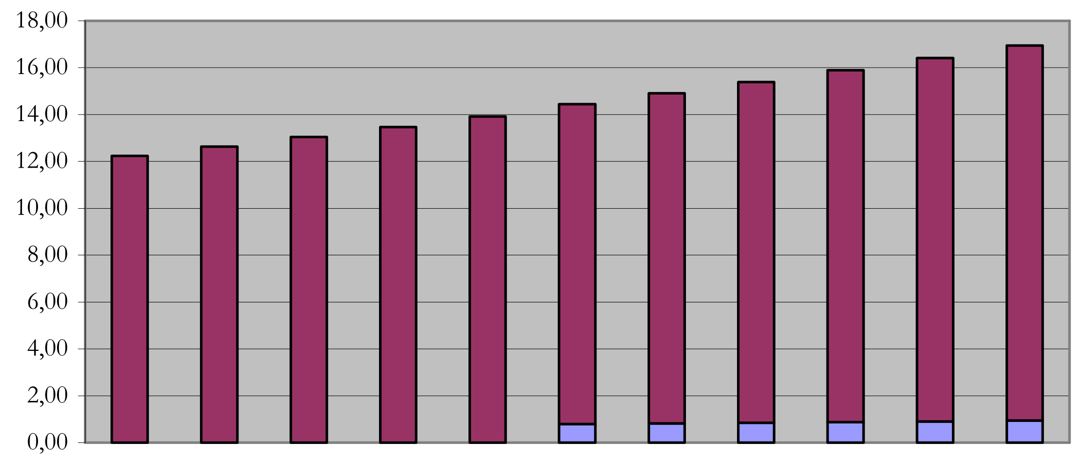
[79] This is meant in the way of political interest without assessing the social and environmental impacts of a potential biodiesel production in Argentina.

[80] What's more, both industries have a strategic geographic positioning as well. Most of the vegetable oil milling facilities are situated along the Río Parana and the Río de la Plata where also most of the major refineries are located.

producers to this export market can be regarded as limited. The secure amortisation of their investments into biodiesel production facilities however is crucial. Since the local market development with its 5% blending requirement in 2010 cannot be regarded as secure due to political uncertainty and instability, these are major barriers for the development of a SME biodiesel production.

If the 5% blending requirement is actually enforced, it remains to be seen which producers supply the needed biodiesel. Currently, SMEs seem to be favoured by the law. Nevertheless, they appear to lack investment incentives at the moment. I.e. that large-scale producers would also be able to easily access the local market if no SME biodiesel production industry evolves.

Current estimates of the diesel supply in Argentina see an increase in consumption between 3% (Acosta el at., 2006) and 3.5% (Almada, 2006; Asal et al., 2006). Current diesel consumption is at 12.24 million m³ in 2005. With an increase of 3.25% in consumption, the 5% share in volume will rise from a current 612,000 m³ of biodiesel to around 720,000 m³ in 2010. But this is only based on volume. Biodiesel has a lower energy content as regular diesel and this amount has to be adjusted in order to fulfil the energy requirements i.e. the increase in diesel consumption will be higher after the introduction of biodiesel blending. With an estimation of an energy content of 90% (IEA, 2004), the 720,000 m³ of biodiesel will only have an energy amount of 648,000 m³ of diesel equivalent which reduces the amount of fuel available under the required market estimation. Taking the energy loss into consideration, the biodiesel share rises from 720,000 m³ to 798,000 m³ or 798 million litres respectively. This means that the total amount of biodiesel-blended diesel rises from an expected 14.36 million m³ to 14.44 million m³.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Diesel	12,24	12,64	13,05	13,47	13,91	13,64	14,09	14,55	15,02	15,51	16,01
Biodiesel						0,798	0,824	0,851	0,878	0,907	0,936

Figure 6-1 Diesel and biodiesel demand projection until 2015 in million m³.

Based on calculation from the Secretary of Agriculture, Livestock, Fishery and Food, the net yield of biodiesel per ha of soy cultivation is around 409 litres (SAGPyA, 2006b). This would mean that in 2010 1.95 million ha of soy cultivation would have to be solely devoted to biodiesel production for internal market use. This area resembles around 12.8% of the total area sown for soy cultivation in the 2005/2006 planting season (15.2 million ha). This is indicated in Table 6-1.

Table 6-1 Biodiesel consumption from soy feedstock – estimation until 2015.

Year	**Total diesel consumption 3.25% net energy increase** (million m³)	**Biodiesel share** (m³)	**Ha of soy cultivation required** (net yield: 409 l/ha)	**Percentage of total area sown for soy production** (05/06 total: 15.2 mill. ha)
2010	14.44	797,920	1,950,904	12.83%
2011	14.91	823,852	2,014,308	13.25%
2012	15.40	850,627	2,079,773	13.68%
2013	15.90	878,273	2,147,366	14.13%
2014	16.41	906,817	2,217,155	14.59%
2015	16.95	936,288	2,289,213	15.06%

Table 6-1 also shows the unlikely 'sustainability' of soy as a major and only feedstock for biodiesel production. This means if Argentina is interested in increasing its biodiesel production significantly for local or international demand, soy cannot be solely remain the main feedstock due to its land occupation (see also Chapter 5.4.3). Assuming a governmental interest to increase the biodiesel blending to 50% would mean that the soy bean production would have to be devoted solely for the local biodiesel market and even expanded. 128.3% of the current agricultural surface devoted to soy beans would be necessary. In this regard, biodiesel from soy oil does not represent a sustainable liquid biofuel option that is able to substitute traditional diesel to a significant share.

7 Conclusions and recommendations

Most likely market development

The starting question, '¿A dónde va la Argentina?' i.e. which direction is Argentina going to take in regards to liquid biofuels now seems feasible to be answered. In general, it appears that the development of a liquid biofuel market in Argentina seems likely. Policy and industry interests link together for the development of a biodiesel market which has the highest potential to be developed – even in the short-run (until 2010).

The main reasons for a biodiesel market and no bioethanol market are that the main players in the two value chains, the vegetable oil companies and the petrol companies are interested in a biodiesel but not a bioethanol market. Their leverage seems stronger than the one of other potential interested parties in bioethanol production. Furthermore, the current agricultural production and infrastructure in Argentina favours the production of oil crops (for export). There are also several industry networks that support biodiesel production. The most evident argument for a local biodiesel and no local bioethanol market is the local transport fuel consumption matrix which is heavily unbalanced. Around 55% of the total vehicle consumption is solely from diesel. Refineries in Argentina operate already at full capacity and try to maximise the diesel output, nevertheless, around 3% of the annual consumption in 2005 had to be imported. The low petrol consumption and the high refinery capacity leave the petrol companies with an excess amount of petrol which is currently exported. Hence, they have no interest in developing a product such a bioethanol which is a substitute to petrol. Moreover, more and more petrol engines are converted to CNG usage. CNG has substituted a significant part of petrol powered engines in recent years and this rate is expected to increase further. The local petrol market is therefore highly uncertain for petrol companies. The diesel market on the other hand is very likely to remain strong as the country's traffic network relies heavily on long distance truck transport, passenger transport, and also agricultural farming equipment. All of which are diesel powered.

As it seems currently, the biodiesel production will primarily consist of large-scale facilities with a domination of the vegetable oil and petrol industry. Their production will however most likely be almost solely export oriented for a number of reasons. First, its local legal blending requirements are not valid until 2010 and the country still has artificially low transport fuel prices, which makes biodiesel (currently still) uncompetitive on the local market. Second, the financial margin and export taxes for exporting biodiesel to markets such as the EU are very attractive and offer foreign exchange to a country still struggling under the burden of its economic downturn. Thirdly, the agricultural sector in Argentina in particular the vegetable oil industry as well as many activities of the petrol companies are already now export oriented.

Bioethanol on the other hand seems to have a much lesser potential to be of significant interest to the market even in the medium-term (post 2010). There is significant doubt that a local bioethanol production for petrol blending will take place on time for the legal blending requirements in 2010. The potential for bioethanol production as it seems currently could be strengthened with net crude oil imports in 2-3 years and depleting oil resources in Argentina in general – which are supposed to last only another 9-12 years (DENA, 2005; EIA, 2006). The liquid biofuels have in this regard however not yet been integrated into an overall energy strategy from the Secretary of Energy. How the bioethanol is going to be produced – if at all, also still remains uncertain. Current interests lie mainly in the usage of maize which however seems to have unfavourable energy and GHG balances.

Uncertainties for a 'sustainable' development

One of the uncertainties for a 'sustainable' biodiesel market development in Argentina is the current domination of large scale enterprises. It seems desirable that a mix of enterprises participates in the emerging market to guarantee that benefits are distributed more equally throughout society. Nevertheless, *the roles of SMEs remain uncertain* and depend on a number of factors.

Among the socio-economic issues, the new law on liquid biofuels and its incentive mechanisms will have a great influence in designing the market. Currently, the incentive mechanism appears too weak to strengthen the role of SMEs. High investment costs and perceived risk prevail in Argentina, people also still have a significant mistrust and disbelief in politics. The law lacks transparency and does not clearly outline the ranking criteria for the tax exemptions. Hence it is too weak to overcome these barriers. Furthermore, the law is not yet integrated in the overall legal framework. There is the risk of overlapping between state and provincial law, and unclear responsibilities resulting in enforcement problems. The major part of the design of the new law as well as its enforcement will lie with the Secretary of Energy. The Secretary has so far however not clearly stated what role liquid biofuels will be playing in the future for the Argentinean energy matrix. No clear level playing field has been outlined yet. Moreover, a high amount of bureaucracy and overlapping support programmes on the institutional level prevailed in the past. The National Biofuel Commission could streamline these actions however it also hosts a variety of members and controversial viewpoints.

Among the market issues, the price development in the short- and medium-run for diesel and petrol will play an eminent role. So far the prices are artificially low compared to international price levels due to a government strategy which aims at supporting people's needs for electricity and fuel at low costs as the country suffered from a severe economic crisis only 4.5 years ago and its consequences are still prevalent in the purchasing power of society. The government i.e. its Secretary of Energy has so far not officially outlined how it will deal with the necessity to import more and more crude oil in the coming years which consequentially will rise the petrol prices. Here again, although a blending requirement of 5% in volume content for diesel with biodiesel and for petrol with bioethanol respectively seems likely, the role of liquid biofuels is unclear in a medium-term energy strategy (post 2010). So far, production costs for biodiesel are low in Argentina and can almost even compete with current local diesel prices at the pump. The current prevailing industry strategy however is to supply solely the export market. Argentina will face a net import of crude oil within 2-3 years, and so far the government's perception i.e. the policy of the Secretary of Energy towards export vs. local usage of liquid biofuels has not been laid out. It is clear however that under the current strategy for biodiesel i.e. the usage of soy bean oil for its production, not both markets can be satisfied at the same time.

Among the technical issues, the most relevant uncertainty for the development of the market is the development of a quality standard. As it seems currently, the Argentinean quality standard will be oriented along the European standard for liquid biofuel. This is seen as a barrier by the industry as the standard is considered to be strict in its requirements. The design of the standard will strongly influence the ability of SMEs (with assumed lower financial capacity) to enter the market. The design is again headed by the Secretary of Energy which is so far neither willing to apply a lower standard than the European one, nor to allow biodiesel production for autoconsumption.

The *exclusive usage of soy for the production of biodiesel for export* is the second major point of uncertainty. A diversification of biodiesel feedstock, a revision of the environmental and social impact of soy bean cropping in Argentina and the 'switch-back' to a local market supply (as stated above) seem desirable. Currently however, soy is the most abundant crop in Argentina, readily available, and also the cheapest. Nevertheless, there is still a lack of evidence that its energy balance is positive in the Argentinean setting. Its GHG balance seems favourable compared to conventional diesel. Soy has seen a significant growth in production in the last decade which was mainly due to the increase in land devoted to soy cultivation. As the Argentinean agricultural surface is large – Argentina produces around three times the amount it would need to feed its population (Taboada, 2006), land competition for food with soy seems only an issue in some parts in rural areas in the northern part of Argentina, the country's poorest region. Here the contentious issue remains that while land competition with food production seems to exist, soy cropping is also an important income for this area (Taboada, 2006). The critical 'sustainability' point in this regard seems to be the distribution of land and benefits from soy cultivation.

Still one of the main issues of concern regarding soy is that the majority is produced through monocropping which has negative effects on soil (nutrient depletion), biodiversity, and also puts farmers in a dependence on soy bean/soy oil market prices. With the development of a strong production of biodiesel for export, the soy production will most likely rise further which will cause the price of its by-products (mainly soy flour) to fall. As soy beans only have an oil content of 18% and their major part are proteins, the by-product sales are significant influential factors for the cost structure of the soy bean cultivation. The other main point of concern is the low oil content of soy bean which makes the net biodiesel yield per ha the lowest for soy beans compared to other oil crops. In order to ensure only a 5% blend of biodiesel in the transport fuel matrix, the land surface of soy bean cultivation devoted solely to biodiesel production reaches estimates of around 13% in 2010 and 15% in 2015 (of the current soy bean cultivation surface area). This means that Argentina could not become diesel self-sufficient through soy bean derived biodiesel if the cultivation area is not extended significantly. This however does not seem to be a desirable option.

Recommendations

The 'sustainability' of the biodiesel market development seems to depend on a number of factors. First, the role of SMEs should be strengthened in order to ensure a more equal share of the benefits from an emerging liquid biofuel market throughout the country's population. Second, a diversification of biodiesel feedstock should be looked into in order to reduce the environmental impact from soy cropping, reduce the dependency of the farmers and the whole biodiesel industry from only one feedstock, and to make use of more efficient and productive biodiesel crops. Finally, the biodiesel production for export should be 'switched-back' to local supply in the long-run. For the development of the market in the short-run (until 2010) it does not seem important from which direction the demand is coming i.e. if it is international or local. After the demand is created and satisfied i.e. the liquid biofuel market emerged, a 'switch-back' to local supply is however desirable in terms of the global energy matrix i.e. the reduction of transport and the insurance of local i.e. decentralised energy supply. The latter point will also become of great interest as Argentina is expected to become a net importer for crude oil within the coming years.

A crucial point to strengthen the role of SMEs and to ensure a more 'sustainable' and fair development of the liquid biofuel market seems to be the definition and enforcement of the legal and political framework, especially the design of the new biofuel law and its regulatory decree. The incentive mechanism should be strong i.e. the current tax exemptions guaranteed, and in this regard the ranking criteria in order to receive tax exemptions clearly outlined. The law has to become more transparent and should be enforced strictly in order not to run the risk to contribute to an unfair market development, and to overcome significant barriers such as high investment costs, a high perceived risk, as well as mistrust and disbelief in politics in general.

The law should therefore also be integrated in the overall legal and political framework in order to avoid overlapping responsibilities between Secretaries as well as state and provincial governmental level, and to ensure a clear and strict enforcement. In order to ensure these developments, the central role will apply to the National Biofuels Commission and the Secretary of Energy. The National Biofuels Commission will have to streamline political activities regarding liquid biofuels and become the central point of integration along the liquid biofuel value chains. In this way it is expected that the amount of bureaucracy always arising in political decision making and enforcement is also reduced and the level playing field for liquid biofuel enterprises more clearly outlined.

Another important point to ensure a clear level playing field is the integration of liquid biofuels into an overall medium- and long-term energy strategy from the state i.e. its Secretary of Energy. So far this has not been undertaken. Argentina will however become a net importer of crude oil in 2-3 years and transport fuel prices are expected to increase. The role of liquid biofuels in this regard becomes of great concern as the purchasing power of society does not seem to have recovered from the economic downturn and the short-term state strategy is to ensure energy access for society in general. The opportunity for Argentina is to lower current vegetable oil exports and to produce instead biodiesel from vegetable oil for the local transport fuel market which would reduce crude oil imports. Biodiesel production costs in Argentina are low and can almost compete with the current diesel prices at the pump. As these prices are expected to rise in the near future due to net crude oil imports, opportunity costs will play a significant role and should be evaluated. The energy strategy for Argentina should therefore include an estimation on the transport fuel market price development and a statement upon whether the Secretary of Energy wishes to develop a liquid biofuel production for local or international supply.

A final recommendation for the Secretary of Energy concerns the quality standard for liquid biofuels. While surely only the most efficient producers for liquid biofuels should have access to the market it should be taken into consideration that the market is only emerging currently. An unsuitably high quality standard would exclude a range of potential producers right from the start. A European quality standard for a country with high investment costs and perceived risk, a country still listed as a developing country seems not advisable at the moment. A quality standard this high would mainly exclude small- and medium-sized producers. This does not seem desirable. The National Biofuels Commission should therefore adapt a preliminary quality standard and only slowly lift the requirements in the following years. This way, producers would be enabled to benefit from learning effects – which play a significant role for emerging technologies.

Finally, the National Biofuels Commission should also push for the diversification of feedstock crops. Soy does not seem a sustainable and efficient option for the production of biodiesel. The SAGPyA will have a crucial role to achieve this point.

The diffusion of liquid biofuels in Argentina is nevertheless only one part of a bigger picture towards a more secure and sustainable energy supply in Argentina. There is a significant necessity to reduce and balance the transport fuel consumption. Measures should include increased energy efficiency in cars, a reduction of diesel consumption to balance the transport fuel consumption matrix, a reduction of road transport in general, and an increased train usage.

Areas for future research

Areas for future research include the development of the regulatory framework in Argentina with special regards to the regulatory decree and its effect on the liquid biofuel market. The diversification of feedstock for biodiesel should also include used frying oil and oil derived from animal fat. Frying oil is a natural component of the Argentinean 'cuisine' and the Argentinean livestock sector is very large. The potential, feasibility, and cost effectiveness of their oil supply for biodiesel should therefore be evaluated.

Also, the role of biogas in Argentina for transport should be investigated. Due to the size of the agricultural sector in Argentina, hence the production of by-products and residues, biogas production should be desirable and also feasible at low costs. Petrol has already seen a significant substitution in the transport energy matrix development, and biogas could be used in local consumption patterns.

A final point of interest seems to be the investigation of the potential impact of liquid biofuel production on rural societies. One of the main policy drivers often stated in favour of bioenergy in general. In the current economic situation, many rural areas in Argentina remain underdeveloped.

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Abbreviations

AABH	Asociación Argentina de Biocombustibles e Hidrógeno
AACREA	Asociación Argentina de Consorcios Regionales de Experimentación
AAPRESID	Asociación Argentina de Productores en Siembra Directa
AAPROTRIGO	Asociación Argentina Pro Trigo
ACA	Asociación Cooperativo Argentino
ACSOJA	Asociación de la Cadena de la Soja Argentina
ASAGIR	Asociación Argentina de Girasol
BC	Bolsa Cereales
BNF	Biological nitrogen fixation
CAA	Centro Azucaero Argentino
CDA	Cámara de Alcoholes
CDM	Clean Development Mechanism
CEPA	Cámara de las Empresas Petroleras Argentinas
CEAP	Cámara Empresaria del Autotransporte de Pasajeros
CETAP	Cámara de Empresarios del Transporte Automotor de Personas
CIARA	Cámara de la Industría Aceitera de la República Argentina
CIP	Cámara de la Industria Petróleo
CNG	Compressed natural gas
CONICET	Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina)
GDP	Gross domestic product
GHG	Greenhouse gas
FAA	Federación Agraria Argentina
FACA	Federal Asociación Cooperativo por la Argentina
FAIM	Federación Argentina de Industría Molinera
FIAA	Federación de las Industrias del Azúcar y del Alcohol
IEA	International Energy Agency
IEE	Instituto de Estudios Económicos (Argentina)
INDEC	Instituto Nacional de Estadistica y Censos (Argentina)
INTA	Instituto Nacional de Tecnología Agropecuaria (Argentina)
IPCC	Intergovernmental Panel on Climate Change
MAIZAR	Maíz Argentina
NGO	Non-governmental organisation
toe	Tons of oil equivalent
RRG	Rural Reflection Group
SAGPyA	Secretaría de Agricultura, Ganadería, Pesca y Alimentos (Argentina)
SAyDS	Secretaría de Ambiente y Desarollo Sustentable (Argentina)
SCI	Secretaría de Comercio e Industria (Argentina)

SE	Secretaría de Energía (Argentina)
SECyT	Secretaría de Ciencia, Tecnología e Innovación Productiva (Argentina)
SIP	Secretaría de Ingresos Públicos (Argentina)
SME(s)	Small and medium sized enterprise(s)
SRA	Sociedad Rural de Argentina
UBA	Universidad de Buenos Aires
UNCU	Universidad Nacional de Cuyo
UNFCCC	United Nations Framework Convention on Climate Change
UNL	Universidad Nacional de Littoral
UTN	Universidad Tecnológica Nacional
VAT	Value-added tax
YPF	Yacimientos Petroliferos Fiscales

Appendix

I. The agriculture sector

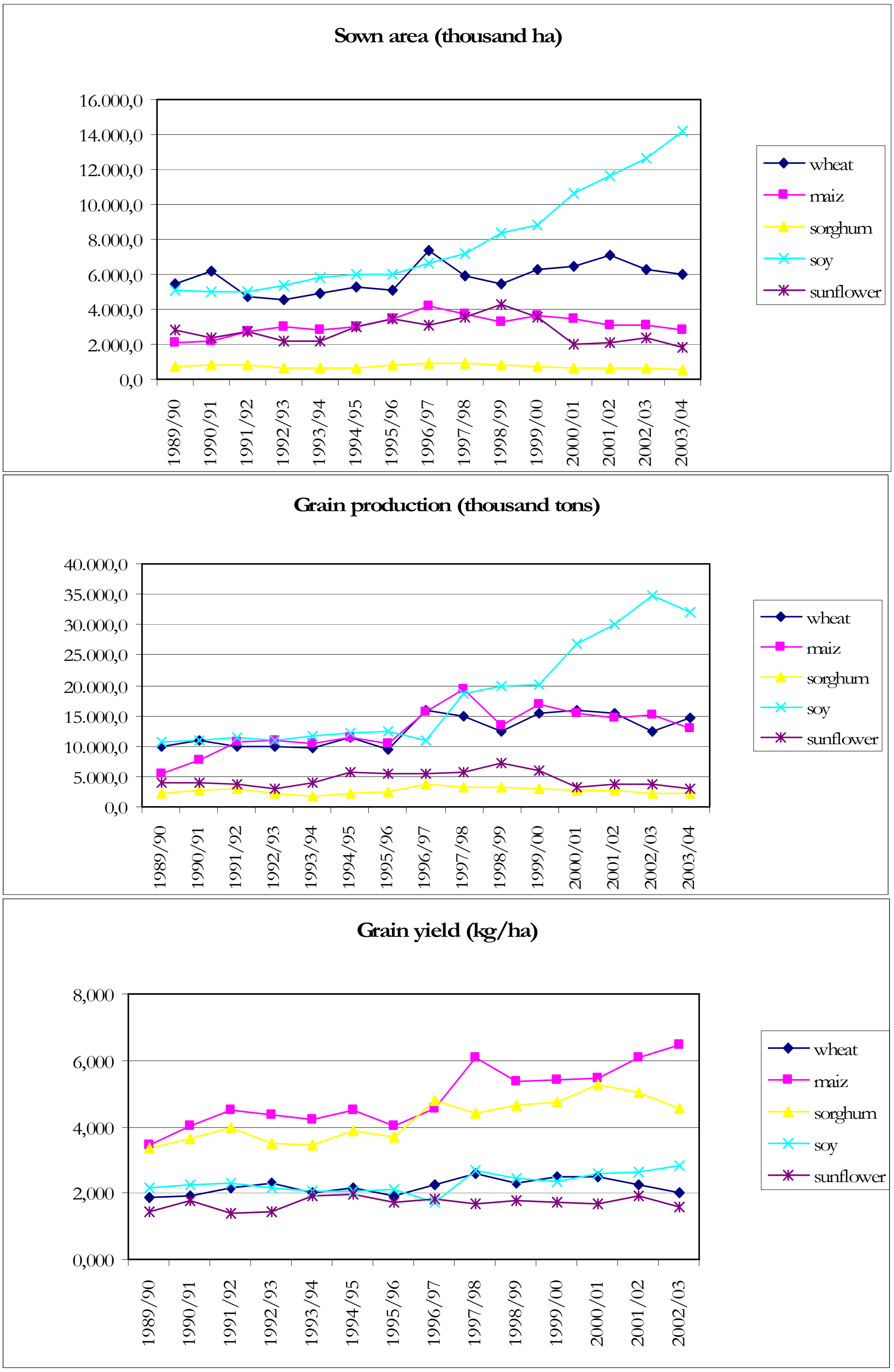


Figure I-I Summary of Argentina's crop matrix

Source: Taboada, 2006; SAGPyA (2006a, 2006b, 2006c)

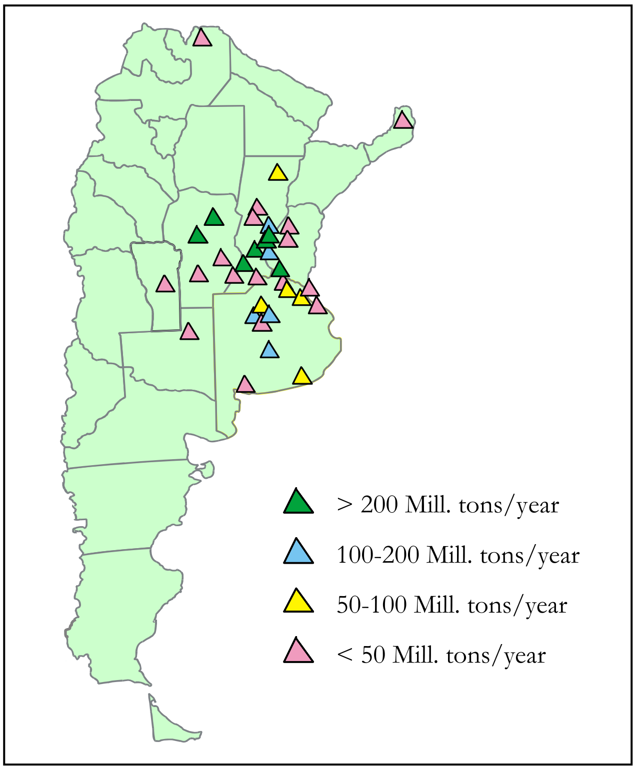


Figure I-II Location and size of vegetable oil milling facilities in Argentina.

Source: SE (2006a)

II. The energy sector

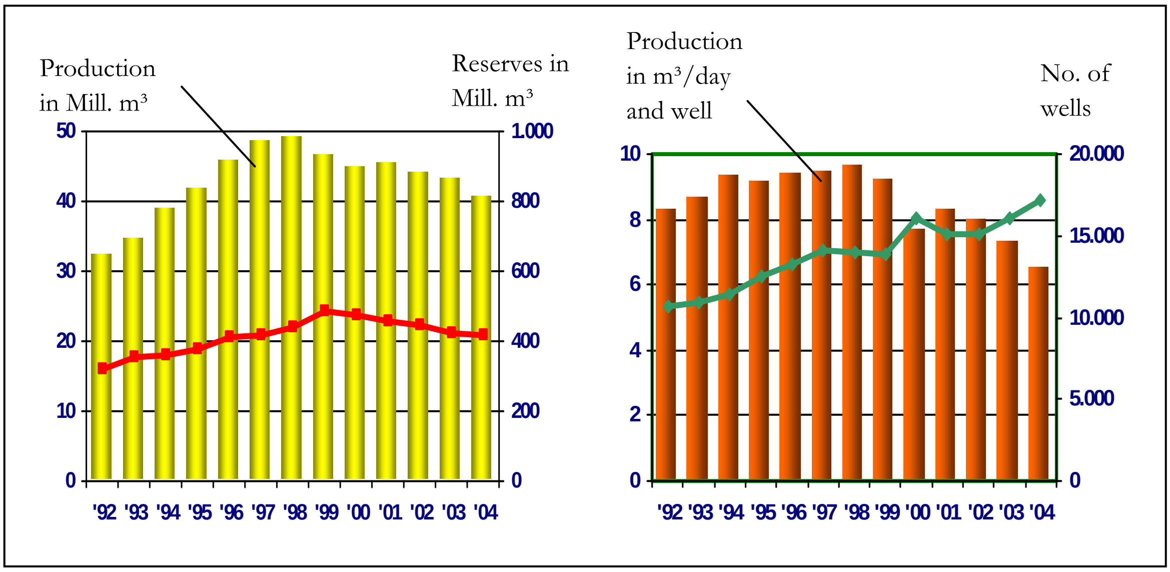


Figure II-I Evolution of the oil extraction activity and quantities in Argentina.

Source: Resnich (2006)

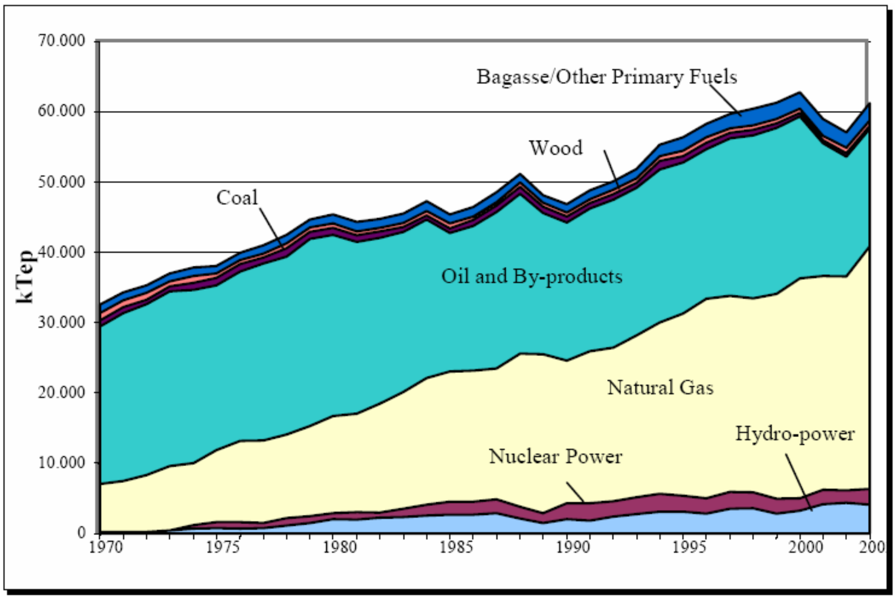


Figure II-II Development of Argentina's primery energy matrix.

Source: FB (2005a).

III. Biodiesel projects in Argentina as of July 2006

Table III-I. Apparently planned big scale biodiesel projects in Argentina as of July 2006

Company	**Location**	**Scale (tons of biodiesel per year)**	**Export or local market**	**Technology**	**Comments**
Repsol YPF	San Lorenzo	100,000	Export	Lurgi	Preliminary
Vicentín-Glencore	San Lorenzo	200,000	Export	Lurgi	
Eurnequian Group	Not defined	3 @ 100,000	Export		Possible participation of ENARSA
Cremer & Asociados	Dock Sud, Buenos Aires	50,000	Export	own	
Terminal Harbour of Rosario	Rosario	200,000	Export	Lurgi	
Aceitera General Deheza	Harbour of San Martín	250,000	Export		
Cargill	Harbour of San Martín	200,000	Export		Only evaluating
Glencore	Quequén	100,000	Export		Only evaluating
Rhasa-ENARSA	Campana	100,000	Export		Only evaluating
San José Group	San Luis or Salta	100,000	***Internal***		Only evaluating
Molinos Río de la Plata	Rosario or San Lorenzo	100,000	Export		Only evaluating
Bunge		100,000	Export		Very early stage only
Dreyfus		100,000	Export		Very early stage only
Cía. Argentina de Semillas		100,000	Export		Very early stage only
Entaban-Nmás1		60,000	Export		Very early stage only
ICI	San Lorenzo	50,000	Export		Only evaluating
Neckermann-Gate together with Biofuels S.A.	San Nicolás	240,000	Export		Only evaluating

IV. The interviews

As stated in the methodology section, the interview strategy was fourth-fold. People from the political level (top-down) and from the implementation or production level (bottom-up) were interviewed. Also other relevant stakeholders such as NGOs were considered. In this setting, it was aimed to have an equal share of parties obviously opposing or promoting the development of a liquid biofuel market. In most cases, statements were overlapping so that a 'double-check' with the interviewees was not always necessary. Interviews were double-checked whenever contradictory statements occurred.

Two main interviews were undertaken in Sweden before leaving to Argentina. They covered a general discussion on a liquid biofuel market development (see Kåberger, 2006; Johansson, 2006). Coming from the outside into an unfamiliar country, and facing the problematic of a very low range of information available on the current market setting, the first interviews in Argentina were designed to get a general understanding of the two main sectors in regards to a liquid biofuel market: the energy as well as the agricultural sector. Hence, the questionnaires were very broad (see below for a sample). Nevertheless, it was obvious that the new law on liquid biofuels would play an important role. Therefore, questions regarding the law were more specific already at the beginning.

Important interviews on behalf of the agricultural sector were at the INTA (see Hilbert, 2006; Moltoni, 2006) as well as at the SAGPyA (see Almada, 2006 & Leone, 2006). In regards to the energy sector, the SE (see Bakovich, 2006) and the Fundación Bariloche (see Nadal, 2006; Mendoza, 2006) were very helpful sources of information. A sample questionnaire for the agricultural sector is outlined below.

Following, the industry side of a potential liquid biofuel production was observed (see Acosta et al., 2006; Carlstein, 2006; Martinez Justo, 2006). Interviews were designed to get a better understanding of the uncertainties of the developing market in regards to the support mechanisms and political framework. Also, the production costs for biodiesel were evaluated in detail. The main outcomes were coherent with statements on the general market setting and outlined significant concern regarding the design of the regulatory framework i.e. the new liquid biofuel law and its incentive mechanisms as well as the quality requirements. The high degree of uncertainty in general in the emerging market setting lead to the observation that no clear level playing field for potential liquid biofuel producers is outlined yet. The observations lead to two additional interviews specifically on the legal and regulatory framework (see Mancini, 2006; Pigretti, 2006).

Following, main environmental and 'sustainability' concerns of a potential market development were evaluated. An important starting point was an interview at the SAyDS (see Lacoste, 2006). Additional interviews covered specific areas of interest such as the energy and GHG balance for certain crops (see Ferraro, 2006; Taboada, 2006). In this regard, main observations made on the agricultural sector could also be double-checked and confirmed.

Finally, interviews were undertaken to get the viewpoints of NGOs and associations (see Molina, 2006; Villalonga, 2006). The interests and concerns revealed in the interviews did not include new statements but rather confirmed observations about future market developments and opinions about potential 'sustainability' problems made beforehand.

1. What is the main driver for Argentina in terms of biofuel development? IEA (2005) claims that it is agricultural policies rather than energy security issues! What is your opinion?

2. Does Argentina have agricultural subsidies of any kind?

3. Where is the current government interest/support in terms of agriculture (crops, region)?

4. Who steers the policy? SAGPyA (Secretaría de Agricultura, Ganadería, Pesca y Alimentos) or others?

5. How does the agricultural sector look like? (Small, medium or large scale; public or privately owned; local or international companies; mono- or polycultures; monopolistic, oligopolistic)

6. What is the influence, farmers have on the policy making? Are there lobby groups (e.g. for specific products like corn (Maizar), or vegetable oil)?

7. Which feedstock-biofuel option would you consider to be <u>sustainable</u> for Argentina?

It is acknowledged that 'sustainability criteria' might vary, however, here they should include:

- Energy input/output ratio
- GHG emission on a life-cycle basis (well-to-wheels)
- Impact per ha: environmental impacts, competition for land use

If possible, please indicate the <u>biofuel</u> (biogas, biodiesel, bioethanol, etc.), the desired <u>feedstock</u> (e.g. corn, barley, soy, switch grass, animal manure, etc.) and the <u>scale of application</u> (small vs. large).

7. What is the energy ratio (input/output) for Argentinean Biodiesel?

8. Was the carbon up-take/capture calculated for different biofuel crops in Argentina? How high is it?

9. Questions regarding the new law on biocombustibles

    a. Do you consider it strong enough to stimulate the market?

        i. Production-side

        ii. Demand-side

    b. What do you think of the role of the "National Biofuel Comission"?

        i. Qualifying producers

        ii. Requirement setting

        iii. Price setting

    c. Are the blending requirements likely to be enforced?

    d. Is a higher blend possible?

    e. Blending is supposed to occur only at refineries. Which impact does this have on auto consumption?

10. What is the current production capacity for biofuels in Argentina, what is feasible and what is actually expected?

11. There are a number of requirements and restraints for a biofuel (biodiesel) market development. Which ones do you consider to be the most relevant, i.e. which direction is actually feasible in Argentina?

    If possible, please indicate the biofuel (biogas, biodiesel, bioethanol, etc.), the desired feedstock (e.g. corn, barley, soy, switch grass, animal manure, etc.) and the scale of application (small vs. large). The following table might guide you.

Supply chain **Issues**	*Production of feedstock*	*Extraction of vegetable oil*	*Conversion into Biodiesel*	*Distribution & Supply (Feed-in)*	*Market demand*
Political					
Social					
Technical					
Environmental					
Financial					
Market					

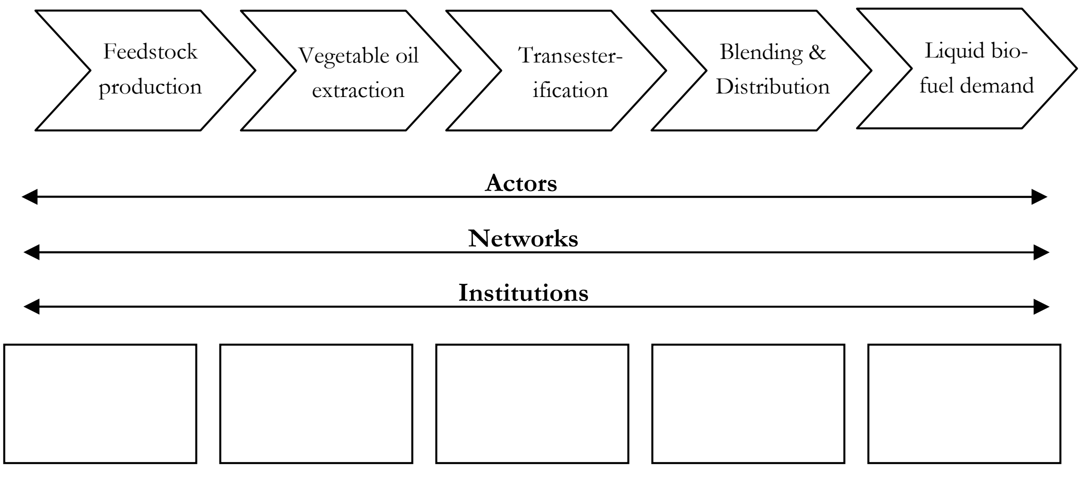
12. What role could other biofuels play in the future apart from biodiesel?

13. Why was Alconafta not successful? What were the factors? Is there going to be a second attempt?

14. What is likely to happen until 2010/within the next 5 years?

    a. Which interest groups exist?

    b. Which ones have the leverage to steer and lead the way in the market development? (prime movers) *Please indicate them along the biodiesel value chain:*



    c. What prospects do other biofuels have apart from biodiesel?

15. Will this market be directed towards export or/and domestic supply? Which market is likely to be developed first