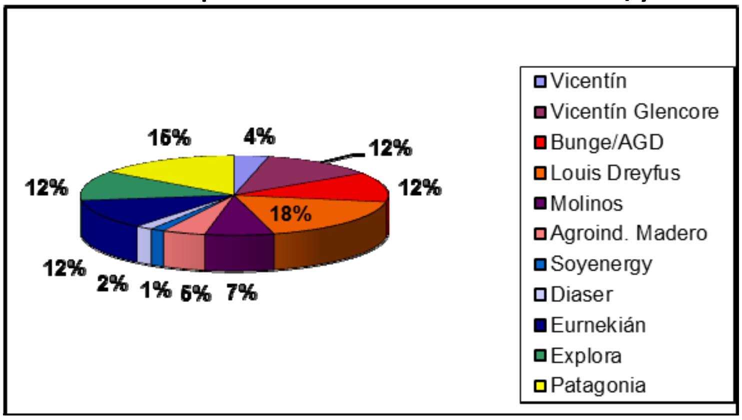
ARGENTINA

	Country: Argentina	
1	**Land Availability and Use**	**hectares**
	Total land area	276,689,000
	Land area per capita	6.83
	Total cultivated land area	31,900,000
	Cultivated land area per capita	0.79
2	**Total land area used for biofuels production**	**hectares**
	Land used for production of:	
	There is no specific area allocated to biofuels production.	
	Only a part of the total soybean harvest is used as	
	raw material for SME production	
3	**Land productivity/Yields (for each biofuel)**	
	• Soy production	47,482,786 t
	• Soy yield	2.91 t /ha
	• Soy meal	28,085,817 t
	• Soy oil	6,962,675 t

TotalCountry										
Sown Area	7.176.250	8.400.000	8.790.500	10.664.330	11.639.240	12.606.845	14.526.606	14.400.000	15.364.574	16.134.837
Harvest Area	6.954.120	8.180.000	8.637.503	10.400.193	11.405.247	12.419.995	14.304.539	14.037.246	15.097.388	15.974.764
Production	18.732.172	20.000.000	20.135.800	26.880.852	30.000.000	34.818.552	31.576.751	38.300.000	40.467.099	47.460.936
Yield	2.693	2.444	2.331	2.584	2.630	2.803	2.210	2.730	2.680	2.971

Argentina´s FAME producers

Total estimated production at Dec´08: 1.580.00 ton/year



Projections:

See information in Annex II

Total demand (litres or tones, for each biofuel)

Mandatory blending of 5% (biodiesel and bioethanol) starting January 1st , 2010: Biodiesel 760.000 tn/year; Bioethanol 270.000 tn/year.

Since June 2007, YPF S.A. is the only Argentina ´s Oil company that is commercializing biodiesel in fossil fuel blend.

Since Nov. 2008, YPF S.A. have launched to the market the D-Euro diesel fuel, (Euro IV Quality)

SME demand, year 2007: 67 m3
SME demand, year 2008: 85 m3
SME estimated demand, year 2009: 1200 m3

1- Exports (litres or tones, for each biofuel)

SME (production and export ,2007): 460.000 tn
SME (production and export ,2008): in progress

7-Imports (litres or tones, for each biofuel)

None

2- Production costs (USD/tone or USD/litre, for each biofuel

In progress

9- Descriptive Qualitative Information:

. Government policies and regulations (incentives, subsidies, exportsubsidies, import duties, etc):

Legal framework- Law 26.093:
.Biofuel market highly regulated.

.Subsidies to the investment, tax relief on fuel and others
.Mandatory blending of 5% starting January 2010
. Distribution quotas established by the government
. Regulated prices

. The benefits will be assigned to companies with major capital of.

.National, provincial or municipal states
.Small and medium companies
. companies mainly dedicated to the agricultural production

. Benefit with fiscal quotas established by the Government

.Standards in use:

Resolution N° 1295 from Argentina´s Energy Secretariat: Bioethanol Quality. These specifications were discussed among Chamber of Petroleum Industry Companies, Chamber of Alcohol Companies, Argentinian Chamber of Biodiesel, ADEFA (Argentinian Automotive Manufacturing Association) and Argentinia´s Energy Secretariat.
At present we are discussing and elaborating a draft for Biodiesel specification.

. Production Technology:

Desmet Ballestra, Lurgi and local technology.

.Research and Development:

Bioenergy Program 2007/2010: taking part in this program through the Faculty of Agrarian Sciences, the Faculty of Applied Sciences to the Industry and the Faculty of Engineering of the National University of Cuyo, together with Argentina´s National Instituteof Agricultural Technology (INTA) and YPF S.A. (see attached program)
Government: National Program of Bioenergy, INTA (Argentina´s National Institute of Agricultural Technology)

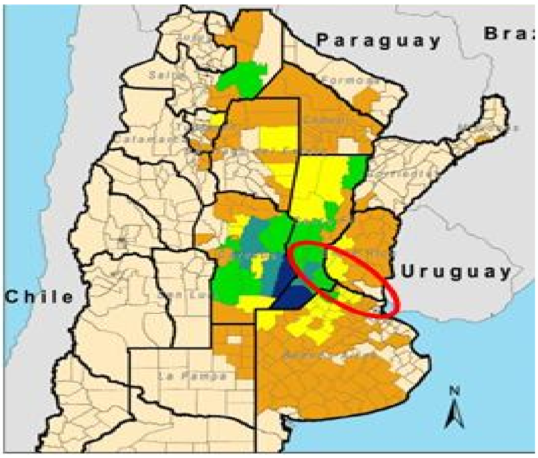
Relevant Information

.Argentina´s Crushing Capacity

Annual Capacity , 2007 : 53.491.020 ton*
Annual Capacity, 2006: 51.841.020 ton*
(*) Source: J.J. Hinrichsen S.A.

.Geography and logistic aspects

First exporter of soy oil and meal
High efficiency along the production chain
Argentina´s main production region within 200 km (average) from crushing and port infrastructure
Significant increase in harvest and crushing capacity in recent years
High investment in crushing infrastructure (35% from period ´04-´06)
Agricultural production area and Industrial complex:



.Type of technology adopted in crops and harvest

No-Till Farming has been adopted as an usual practice for sowing. This is a productive system based on absence of tillage, crop rotation and stubble coverage on the soil surface, has changed the former production patterns and has promoted a new type of agricultural production, much more able to reconcile the needed increase in productivity with environmental friendly practices, among others.

Annex I

Agricultural estimate - Cereals						
Crops	Province	Period	Sown Area	Harvest Area	Production	Yield
			(ha)	(ha)	(tn)	(kg/ha)
CORN	TOTAL COUNTRY	2006/07	3.578.235	2.838.072	21.755.364	7.666
WHEAT	TOTAL COUNTRY	2006/07	5.675.975	5.540.405	14.547.960	2.626
SORGHUM	TOTAL COUNTRY	2006/07	700.010	594.410	2.794.967	4.702
BARLEY (BEER PROD)	TOTAL COUNTRY	2006/07	339.360	335.815	1.265.660	3.769
RICE	TOTAL COUNTRY	2006/07	168.300	164.635	1.080.070	6.560
OATS	TOTAL COUNTRY	2006/07	1.067.180	138.025	242.960	1.760
WHEAT	TOTAL COUNTRY	2006/07	48.955	48.825	114.985	2.355
RYE	TOTAL COUNTRY	2006/07	221.100	14.750	17.483	1.185
MILLET	TOTAL COUNTRY	2006/07	38.310	10.230	14.484	1.416
BIRDSEED	TOTAL COUNTRY	2006/07	8.650	8.570	8.930	1.042
FORAGE BARLEY	TOTAL COUNTRY	2006/07	27.030	1.777	2.805	1.579
Total Cereals		2006/07	11.873.105	9.695.514		
Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production						

Annex I (Cont)

Agricultural estimate - Cereals						
Crops	Province	Period	Sown Area	Harvest Area	Production	Yield
			(ha)	(ha)	(tn)	(kg/ha)
CORN	TOTAL COUNTRY	2007/08	4.144.695	3.328.065	21.286.576	6.396
WHEAT	TOTAL COUNTRY	2007/08	5.935.937	5.762.087	16.308.342	2.830
SORGHUM	TOTAL COUNTRY	2007/08	807.025	618.625	2.936.840	4.747
BARLEY (BEER PROD)	TOTAL COUNTRY	2007/08	438.915	415.325	1.471.650	3.543

RICE	TOTAL COUNTRY	2007/08	183.550	182.460	1.245.800	6.828
OATS	TOTAL COUNTRY	2007/08	1.112.910	224.250	472.420	2.107
WHEAT	TOTAL COUNTRY	2007/08	59.417	57.717	138.810	2.405
RYE	TOTAL COUNTRY	2007/08	227.180	38.700	77.180	1.994
MILLET	TOTAL COUNTRY	2007/08	41.965	10.475	14.824	1.415
BIRDSEED	TOTAL COUNTRY	2007/08	11.200	10.215	9.050	886
FORAGE BARLEY	TOTAL COUNTRY	2007/08	29.770	2.855	7.180	2.515
Total Cereals		2007/2008	12.992.564	10.650.774		
Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production						

Annex I (Cont)

Agricultural estimate - Oilseed						
Crop	Province	Period	Sown Area	Harvest Area	Production	Yield
			(ha)	(ha)	(tn)	(kg/ha)
SOYA	TOTAL COUNTRY	2006/07	16.141.337	15.981.264	47.482.786	2.971
SUNFLOWER	TOTAL COUNTRY	2006/07	2.381.388	2.351.348	3.497.732	1.488
PEANUT	TOTAL COUNTRY	2006/07	215.660	215.060	600.035	2.790
CARTAMO	TOTAL COUNTRY	2006/07	75.500	74.300	58.000	781
FLAX	TOTAL COUNTRY	2006/07	29.130	28.400	34.065	1.199
RAPE	TOTAL COUNTRY	2006/07	10.531	8.986	11.230	1.250
	TOTAL PAIS	2006/07	18.853.546	18.659.358		
Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production						

Agricultural estimate - Oilseed						
Crop	Province	Period	Sown Area	Harvest Area	Production	Yield
			(ha)	(ha)	(tn)	(kg/ha)
SOYA	TOTAL COUNTRY	2007/08	16.596.025	16.380.038	46.232.087	2.822

SUNFLOWER	TOTAL COUNTRY	2007/08	2.622.346	2.578.236	4.646.065	1.802
PEANUT	TOTAL COUNTRY	2007/08	227.889	227.389	625.349	2.750
CARTAMO	TOTAL COUNTRY	2007/08	44.100	44.100	33.480	759
FLAX	TOTAL COUNTRY	2007/08	14.006	12.716	20.411	1.605
RAPE	TOTAL COUNTRY	2007/08	9.450	9.450	9.564	1.012
	TOTAL COUNTRY	2007/08	19.513.816	19.251.929		
Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production						

Agricultural estimate - Industrial Crops						
Crop	Province	Period	Sown Area	Harvest Area	Production	Yield
			(ha)	(ha)	(tn)	(kg/ha)
SUGAR CANE	TOTAL COUNTRY	2004/05	296.790	284.639	18.799.055	66.045
Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production						

Annex II

Biodiesel	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Diesel Fuel demand (thousand ton) (1)	12.041	12.462	12.899	13.350	13.817	14.301	14.801	15.320	15.856	16.411	16.985	17.579	18.195	18.832	19.491	20.173
Domestic demand 5% (thousand ton)			645	668	691	715	740	766	793	821	849	879	910	942	975	1.009
Installed capacity for export (thousand ton) (2)	1.500	1.800	1.980	2.178	2.287	2.401	2.521	2.647	2.780	2.919	3.065	3.218	3.379	3.548	3.725	3.911
Production for export (thousand ton) (3)	1.350	1.620	1.782	1.960	2.058	2.161	2.269	2.383	2.502	2.627	2.758	2.896	3.041	3.193	3.353	3.520
Total Production in thousand ton		1.620	2.427	2.628	2.749	2.876	3.009	3.149	3.295	3.447	3.607	3.775	3.951	4.135	4.327	4.529

(1) The annual deman increases for diesel fuel was estimated in 3,5% for all period.
(2) For the period 2010/11 it was considered 10% of the annual growing rate and 5% for the period 2012/2020
(3) The production for export was estimated taking into account the 90% of the total capacity installed

Bioethanol	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gasoline demand in thousand ton(4)	3.818	3.914	4.011	4.112	4.215	4.320	4.428	4.539	4.652	4.768	4.888	5.010	5.135	5.263	5.395	5.530
Domestic demand 5% (thousand ton)			201	206	211	216	221	227	233	238	244	250	257	263	270	276
Installed capacity for export (thousand ton)			N/D													
Production for export (thousand ton)			N/D													
Total Production in thousand ton		-	201	206	211	216	221	227	233	238	244	250	257	263	270	276

(4) The annual deman increases for gasolines was estimated in 2,5% for all period.

Source: National Biofuel Programme. Secretariat for Agriculture, Livestock, Fisheries and Food Production

TYPE OF TECHNOLOGY ADOPTED IN CROPS AND HARVEST

Comparative Analysis of Energetic consumption and Greenhouse gas emissions from the production of biofuel from soya under conventional and No –Till Farming systems.

Certified Agriculture (CA)

It is a Quality management system that aims to increase agricultural productivity levels within a context of economic, environmental, energetic and social sustainability.
Some benefits of Certified Agriculture : to minimizes soil degradation and improves its fertility. Certified Agriculture require less water to produce the same amount of food , it requires less fossil fuel for machinery among others.
The Certified Agriculture benefits as well as its certification process can be seen at the following address. www.ac.org.ar

Introduction

During the last few years the global energetic context has been increasingly influenced by uncertainties linked to climate change and the vulnerability caused by a gradual exhaustion of fossil fuels versus an increasing demand of energy. This has provoked an intense search for alternative energy sources, able to replace continuously diminishing fossil reserves. Among these alternative sources, biofuels have gained special importance due to their potential use in vehicles and internal combustion engines without any relevant modifications necessary.

Governments have reacted towards this situation by promoting biofuels through laws, decrees and regulations that in many cases created a mandatory cut for internal markets as well as tax and credit incentives. These actions have created a new market for this type of products, strongly influenced by public intervention.

The action of different research centers, environmental NGOs and several stakeholders has raised the issue of the possible threats caused by an uncontrolled expansion of biofuels production in the world. The public sector has reacted to this problem by requesting its regulatory agencies to rule this activity. Said agencies turned to research centers and groups in search of suitable tools to provide a foundation and scientific criteria to the laws being prepared.

Current situation shows that speeds are asymmetrical and there are still lots of doubts and unsolved problems in the scientific field which forces parties to move forward with a great degree of uncertainty. This reality exists in all areas and although the advance of regulations has not stopped, certain measures are being taken in order to correct possible mistakes due to a lack of solid and strong support.

Studies focus on the energetic balances of each alternative, greenhouse gas emissions and global impact caused by the expansion of each feedstock used to produce these biofuels.

During the last couple of years, activity on this issue has been very intense, existing different initiatives from governments as well as national and international institutes and organizations. Among them, we can mention the ones promoted by the European Council, the government of the United States, Global Bioenergy Partnership and the Roundtable on Sustainable Biofuels.

Since 2005, INTA has participated in different technological and scientific forums which have committed to study biofuels sustainable production around the world.

It has consolidated partnerships with the main research centers working on the subject and it has worked on exchanging knowledge and information about Argentina, which in most cases was unknown.

In spite of the uncertain economic, financial and environmental outlook, within the European Union the intention based on turning the production, marketing and finally the consumption of biofuels more friendly towards the environment has gained strength, influenced by a general and increasing concern from citizens and private and public organizations, in view of the rise in greenhouse gas emissions.

Hence, to all the requirements that biofuels have to meet, like abiding quality standards, being economically competitive, or being available in enough volumes necessary to meet mass consumption, we can add a number of analysis that take into account the extremes of the chain, like planting of the crops and final use by consumers.

Due to all of this, it is important that possible environmental benefits of biofuels can be measured, in order to be improved and compared with traditional fuels for their replacement.

These type of measurements and analysis, known as Life Cycle Analysis (LCA), allow quantifying of all consequences for the environment (from the origin of feedstocks up to final use of the product) related to the production and use of alternative fuels, making possible the evaluation of their feasibility.

In this context, Argentina has become a relevant party for the world market, exceeding over 1,3 million tonnes of biodiesel with exports for over 1300 million dollars in 2008. Main feedstock used for the production of these significant volumes is a by-product for the production of soy meal. This oil by-product is turned into biodiesel. Due to the volume, future projections and export market towards the country's production is directed, it is very important to establish the environmental characteristics of the production in order to show the fulfilling of goals and regulations being created both in Europe and the United States markets.

These are the reasons why INTA, within its national bioenergy program, is currently carrying out specific studies that cover the main parameters with special enphasis on biodiesel given its strategic importance as a manufactured product for exports.

Objectives

The general objective of this study is to determine, analyze, compare and evaluate the energetic consumption and greenhouse gas (GHG) emissions of biodiesel production from soy throughout different scenarios within Argentina.

The specific objectives are:

- Start out in the use of the methodology for the calculation of the energetic consumption and GHG emissions of the software *"The CO_2 Bioenergy Tool"*. Version 2.1b.
- Compare different scenarios of energetic consumption and GHG emissions in the production of biodiesel from soy in Argentina, establishing whether there are significant differences among them, and on what stage(s) of the production chain these significant differences are more obvious.
- Give a "reality" context to the national biodiesel production from soy with respect to the energetic consumption and GHG emissions, so as to be able to compare domestic scenarios with those proposed by different organizations from the European Union.
- Compare the base data used in the different studies employed in Argentina with European Comission Join Research Centre (JRC)

Materials and Methods

For the calculation of the energetic consumption and GHG emissions in the production of biodiesel from soy in Argentina, the software *"Greenhouse gas calculator for biofuels"* Version 2.1b (available for free at: http://www.senternovem.nl/gave_english/co2_tool/index.as and developed by the *SenterNovem* Agency of the Dutch Government) was used. The development of this software is framed within the GAVE Program (**Climate Neutral Gaseous and Liquid Energy Carriers**) of the Dutch Government, being its main objective to collaborate together with different governmental agencies and other stakeholders in order to reach in a sustainable and environmentally friendly manner the production, marketing and consumption of biofuels within Holland and the European Union.

For the analysis of the energy consumption and GHG emissions, this software makes the following assumptions (Hamelinck *et al.*, 2008):

- Energy efficiencies are equal between the biofuel and the fossil fuel they replace. In this way and comparatively, in order to travel any given distance the same amount of fuel is needed, whether biofuel or traditional fuel. For traditional diesel fuel the energy efficiency is of 2,08 MJ/km, being the same efficiency applicable to biodiesel from soy.
- The analysis in the energy consumption and GHG emissions is comparative between the entire production chain and transportation of biofuels and the entire production chain and transportation of the fossil fuel it replaces.
- The production chain of biodiesel from soy is not completely known until now, neither in Argentina nor the United States. This means that more studies and additional information are required in order to strength the data and presumptions that the energy consumption and GHG emissions studies throw.
- All the table parameters in the software, can be calculated from three different types of values:
    - *Conservative values*, which are the worst values available in the market.
    - *Typical values*, which are medium values available in the market.
    - *Best practice values*, which are the best values available in the market or the values provided by the user. Different local values were introduced in this study, taking into account Argentine reference values derived from own research and from industry's surveys for each analyzed situation.
- A change in the results product of the modification in any of the *parameters or conservative, typical or best practice values* of 5% or more is considered significant:
    - If the results of the calculation of GHG emissions change at least 2% or more in comparison with the reference fossil fuel (in the case of biodiesel from soy it would be traditional diesel).
    - If the result of the parameter or value changes 20% or more, contributing this variation greatly in the change of the final results.

Besides and based on a relative scale, where the lower energy consumption or GHG emissions scenario in any of the stages represents 100% of the energy consumption or emission, its percentage differences with respect to the highest energy consumption or emissions scenario were determined. Based on this and according to the software assumptions, these differences were used as a tool to determine significant or not differences between the parameters and values.

Parameters used for the Argentine case

Type of Agriculture*[1]		CA	NT SAT	NT	NT	NT	NT
Stage		Zone of reference					
Agrícola		SouthEast of Bs. As. (Tandil)	South of Santa Fe (Venado Tuerto)	North of Bs. As./South of Sta. Fe (Pergamino)	West of Bs. As. (Pehuajo)	South of Córdoba (Rio Cuarto)	Salta
Feedstock (Kg/ha/year)*[2]	Soybean	2.800	4.500	3.600	3.600	2.750	2.750
Energy consumption (MJ/ha/year) *[3]	Diesel	1.575	998	998	998	998	998
Fertilizers*[4] (Kg/ha/year)	Nitrogen	10	14	4,4	4,4	0	0
	P_2O_5	23	78	21	21	0	0
	K_2O	0	0	0	0	0	0
Feedstock transportation[5]*							
Transport (km)	Conv. Diesel truck	614	191	139,9	436	395	1130
Drying and storage							
Feedstock (Kg/Kg)	Soybean	1	1	1	1	1	1
Energy Consumption	Electricity*[6a] (KWh/ton)	1,2	1,2	1,2	1,2	1,2	1,2
	Natural gas*[6b] (MJ/ton)	141	141	141	141	141	141
	Conv. Diesel*[7] (MJ/ton)	3	3	3	3	3	3
Crushing							
By-product (Kg/Kg of seed)	Vegetable oil	0.194	0,194	0,194	0,194	0,194	0,194
	Meal	0,714	0,714	0,714	0,714	0,714	0,714
Energy Consumption[8]	Electricity (KWh/ton s)	34,3	34,3	34,3	34,3	34,3	34,3
	Natural Gas MJ/ton[9]	4770	4770	4770	4770	4770	4770
	Hexane[10] (MJ/ton)	4,66	4,66	4,66	4,66	4,66	4,66
Estherification							
By-product (Kg/Kg oil)	Biodiesel	0,95	0,95	0,95	0,95	0,95	0,95
(Kg/Kg oil)	Glycerine[11]	0,12	0,12	0,12	0,12	0,12	0,12
Energy use	Electricity (KWh/ton bio[12]	34,8	34,8	34,8	34,8	34,8	34,8
	Natural gas MJ/Ton biod[13]	1499	1499	1499	1499	1499	1499
	Methanol (Kg/ton seeds)	99	99	99	99	99	99
Biodiesel transportation							
Transport (km)*[14]	Diesel ship	12.091	12.091	12.091	12.091	12.091	12.091
	Diesel truck*[15]	15	15	15	15	15	15

Table 1. *"Inputs" for the agriculture stage, feedstock transportation, drying and storage, crushing, estherification and transport of biodiesel for different production scenarios in Argentina.*

*[1] Type of Agriculture: CA: Conventional Agriculture, NT SAT: No Till with State of the Art Technology, NT: No Till
*[2] Average yields for each area according to Márgenes Agropecuarios Magazine (2008)
*[3] Energy consumption for the agriculture stage estimated by Donato & Huerga (2007)
*[4] More frequent use of fertilizers for each zone according to Márgenes Agropecuarios magazine (2008)
*[5] Distance calculated with Guía YPF (www.guiaypf.com.ar) from feedstock production area to Port complex at Pto. San Lorenzo/Pto. Gral. San Martín (Prov. of Santa Fe)
*[6a] Electricity consumption 1 Kwh/T estimated by de Dios Carlos Grains drying and dryers (2000) Editorial Hemisferio Sur 244 pages. Diego de la Torre quotes values for 0,6 in seven districts of Argentina
*[6b] Estimated energy consumption for grain drying at the agricultural stage according to de la Torre & Bartosik(2008). (25 % is dried at storage and 75 % at the industry with 3 and 2 points of drying respectively over a total of 40,4 million tonnes. http://www.inta.gov.ar/balcarce/info/indices/tematica/agric/posco/gral.htm . Diego de la Torre personal communication quotes efficiencies in Argentine dryers between 982 to 2046 Kcal/kg of water and taking a reference value of 1900 Kcal/kg of water in the calculation which is conservative for Argentina reality.
*[7] Estimated energy consumption for grain drying at the agricultural stage according to de la Torre & Bartosik(2008). (8 % a gasoil over a total of and 92 % a gas GLP y GN
*[8] IIR-BC-INF-03-09 Energy Balances of Argentine Biodiesel Production with local industrial data I Huerga; J.A.Hilbert;L.Donato 2009
*[9] 1,45 kg steam/tonnes of oil – Maximum value for the two surveyed companies 785,7 kcal/kg of steam – average consumption value in Argentina Raúl Bernardi UnitecBio personal communication.
*[10] Corresponds to 981 Kcal/kg of hexane and to 24 MJ/T of oil. IIR-BC-INF-03-09
*[11] Corresponds to the average value registered on the survey of biodiesel production companies in Argentina 0,121 T crude glycerine moist base/T biodiesel IIR-BC-INF-03-09
*[12] Corresponds to the average value registered on the survey of biodiesel production companies in Argentina 34,79 Kwh/T biodiesel given the high dispersion of results IIR-BC-INF-03-09
*[13] Corresponds to the average value registered on the survey of four biodiesel production companies in Argentina 0,456 T.vapor/Tbiodiesel IIR-BC-INF-03-09. This gives a value of 1499 MJ/T of oil
*[14] Distance calculated from the Port complex Pto. San Lorenzo/Pto. Gral. San Martín (Prov. of Santa Fe) to the Port of Rotterdam, Holland (Ciani *et al.*, 2007, Panichelli, 2005)L.
*[15] Argentine production companies for export are located near the ports and biodiesel transport is performed through pipes from the plants to the terminal ports. Smaller production ones are located not farther than 30 km away.

Results obtained by use of the calculating tool:

The following results obtained are detailed and commented upon for each of the production scenarios stated for Argentina and input of the values detailed in Table 1 into the system.

	Energy consumption (per km)			GHG emissions (Kg/km)		
Zone of reference	**MJ per km**	**% of the reference *[16]**	**% of reductions*[16]**	**Kg CO_2-eq**	**% of the reference *[16]**	**% of reductions*[16]**
South East of Bs. As. (Tandil)	0,6450	26,8	73,2	0,047	24,5	75,5
South of Sta. Fe (Venado Tuerto)	0,5715	23,8	76,2	0,0385	21,1	78,9
North of Bs. As./South of Sta. Fe (Pergamino)	0,5435	22,6	77,4	0,0342	18,7	81,3
West of Bs. A.s (Pehuajo)	0,5745	23,9	76,9	0,0344	19,9	80,1
South of Córdoba (Río Cuarto)	0,5648	23,5	76,5	0,0341	18,7	81,3
Salta (Las Lajitas)	0,6419	26,7	73,3	0,0394	21,6	78,4

Table 2. *Energy consumption and GHG emissions for the different scenarios.*

*16 In comparison to conventional diesel, of fossil origin, expressed in MJ/km having as reference for gasoil 2,08 MJ/km

Zone of reference	Stage	Energy consumption (MJ/km)	GHG emissions (g CO_2-eq/km)	Total emissions per stage (g CO_2-eq/MJ fuel LHV)*[17]	Annual saving in CO_2 Emissions (ton CO_2/ha/year)
South East of Bs. As. (Tandil)	**Agriculture**	0,1037	12,2	**21.5**	**1,3**
	Industrial	0,4627	27		
	Transport*[18]	0,0787	5,4		
	Total	**0,6450**	**44,7**		
South of Sta. Fe (Venado Tuerto)	**Agriculture**	0,0745	9,1	**18,5**	**2,1**
	Industrial	0,4624	27		
	Transport	0,0343	2,4		
	Total	**0,5715**	**38,5**		
North of Bs. As./South of Sta. Fe (Pergamino)	**Agriculture**	0,0518	5,2	**16,4**	**1,8**
	Industrial	0,4627	27		
	Transport	0,0290	2		
	Total	**0,5435**	**34,2**		
West of Bs. A.s (Pehuajo)	**Agriculture**	0,0518	5,2	**17,5**	**1,7**
	Industrial	0,4627	27		
	Transport	0,0600	4,1		
	Total	**0,5745**	**36,4**		
South of Córdoba (Río Cuarto)	**Agriculture**	0,0464	3,2	**16,4**	**1,4**
	Industrial	0,4627	27		
	Transport	0,0557	3,9		
	Total	**0,5648**	**34,9**		
Salta (Las Lajitas)	**Agriculture**	0,0464	3,2	**18,9**	**1,3**
	Industrial	0,4627	27		
	Transport	0,1328	9,2		
	Total	**0,6419**	**39,4**		

Table 3. *Energy consumption and GHG emissions for the different agriculture, transport (feedstock and biodiesel transportation) and industrial (drying and storage, crushing and estherification) stages for the different scenarios.*

*[17] LHV: Lower Heating Value: difference in enthalpy of a fuel at 25 °C and the products of its combustion at 150 °C
*[18] The relative impact of sea transportation is very low.

In this comparative study varies: **the energy consumption** (No Till Farming vs. Conventional Agriculture in different areas of reference of Argentina), **the quantity of fertilizers used per hectare** (idem), **the distance with respect to the location for processing the feedstock** -soybean- (which depended on each respective zone of reference), **the energy consumption for the drying of the grain**. On the other hand, **the energy consumption for the industrial stage** kept constant for all different scenarios **according to surveys done in Argentina**.

Based on these comparisons, it was possible to obtain results with respect to global and specific (by stage or step) energy consumption; and with respect to global and specific (by stage or step) GHG emissions.

In this way and taking into account the software's assumptions (see Materials and Tools), with respect to the **energy consumption** (MJ/km), at a **global level** it could be said that:

- The scenario that shows the **highest energy consumption** is the scenario of **Salta** (0,6419 MJ/km). Compared to conventional diesel, **savings of energy consumption** is of **73,3 %**. If we arbitrary determine a relative scale, where the lowest energy consumption scenario (North of Bs. As./South of Sta. Fe) represents 100% of the energy consumption, its **percentage difference with the relative highest energy consumption scenario** (Salta) is of: $\Delta_{\text{Salta- NBUE S Sta. Fe./NBUE S Sta. Fe}}$ = **17,3 %**. In spite of the fact that several of the assumptions from the software are fulfilled (yields between each scenario vary in 200%, the use of fertilizers between 100 and 11,5% and the distance to the location for processing the feedstock in 463%) these differences are considered **not significative**.

- The scenario that shows the **lowest energy consumption** is the scenario of **North of Bs. As./South of Sta. Fe** (0,5435 MJ/km). Compared to conventional diesel, **savings in energy consumption** are of a **77,4 %.**

At a **specific level**, and with respect to **energy consumption** (MJ/km) for the **Agricultural Stage**:

- The scenario that shows the **highest energy consumption for the Agricultural Stage**, is the scenario of **South East of Bs. As** (0,1037 MJ/km). If arbitrarily we determine a relative scale, where the scenario for the lowest energy consumption for the agricultural stage (South of Cordoba 0,0464 MJ/km) represents 100% of the energy consumption, its **percentage difference with the scenario with the relative highest energy consumption for the agricultural stage** (scenario of South East of Bs. As.) is of: $\Delta_{\text{SouthEast of Bs. As-South of Córdoba.}}$ = **125,4 %.** Being fulfilled the assumptions of the software (yields between each scenario vary in 4,0%, the energy consumption varies in 57% and use of fertilizers in 100%) these differences are considered **significant.**
- The scenario that shows the **lowest energy consumption for the Agricultural Stage** is the scenario of **South of Córdoba.** (0,0464 MJ/km).

At a **specific level**, and with respect to the **energy consumption** (MJ/km) for the **Transport Stage**:

- The scenario that shows the **highest energy consumption for the Transport Stage**, is the scenario of **Salta** (0,1328 MJ/km). If arbitrarily we determine a relative scale, where the scenario of the lowest energy consumption for the Transport Stage (North of Bs. As./South of Sta. Fe) represents 100% of the energy consumption, its **percentage difference with the scenario with the relative highest energy consumption for the Transport Stage** (South West of Bs. As.) is of: $\Delta_{\text{Salta-Norte de Bs. As./Sur de Sta. Fe}}$ = **355,5 %.** Being fulfilled the assumptions of the software (distance between the different scenarios and the location where the feedstock is processed varies in 491%), theses differences are considered **significant.**
- The scenario that shows the **lowest energy consumption for the Transport Stage** is the scenario of **North of Bs. As./South of Sta. Fe** (0,0290 MJ/km).

With respect to **GHG emissions** (Kg CO_2 eq/km), at a global level it could be said that:

- The scenario that shows **more GHG emissions** is the scenario of **South East of Bs.As.** (0,0447 Kg CO_2 eq/km). Comparatively and **percentage** with conventional diesel, its **GHG emissions** are of **21,5%** and its **reductions** of **GHG emissions** are of **75,5 %.**
- The scenario that shows **less GHG emissions** is the scenario of **South of Córdoba** (0,0464 Kg CO_2 eq/km). Comparatively and **percentage** with conventional diesel, its **GHG emissions** are of **23,5%** and its **reductions** of **GHG emissions** are of **76,5%.**

- There is an important **annual saving of CO_2 emissions** (ton CO_2/ha/year) on the scenarios of **North of Bs.As./South of Sta. Fe** (1,8 ton CO_2/ha/year) and the scenario of **West of Bs. As.** (1,8 ton CO_2/ha/year).

Impact of sea transportation from Argentina

Sea transportation's impact, in spite of being significant the distance in km between the port of origin and the final destination of the product in Europe, is relatively low. An exercise was performed by lowering the amount of kilometers of transportation of the product to 0 in order to evaluate its impact over the final numbers for the best and worst played scenarios. For the case of North of Buenos Aires the reduction in energy consumption of MJ/km went up from 77,4 to 77,9% and of GHG emissions (Kg/km) from 81,3 to 81,8 %.

At a **specific level**, and with respect to **GHG emissions** (g CO_2 eq/km) for the **Agricultural Stage** it can be observed that:

- The scenario that shows **more GHG emissions for the Agricultural Stage** is the scenario of **South East of Bs.As.** (12,2 g CO_2 eq/km). If arbitrarily we determine a relative scale, where the scenario of less GHG emissions for the Agricultural Stage (South of Córdoba and Salta) represent 100% of the GHG emissions, its **percentage difference with the scenario with relatively more GHG emissions** (scenario of South of Santa Fe) is of: $\Delta_{\text{S of S.Fe.-West of Bs.As.}}$ = **284%**. Being fulfilled the assumptions of the software (yields between each scenario vary in 103% and the use of fertilizers varies in 100%) these differences are considered **significant**.
- The scenario that shows **less GHG emissions** is the scenario of **West of Bs.As. and Salta with** 3,2 g CO_2 eq/km.

At a **specific level**, and with respect to **GHG emissions** (g CO_2 eq/km) for the **Transport Stage** it can be observed that:

- The scenario that shows **more GHG emissions for the Transport Stage** is the scenario of **Salta** (9,2 g CO_2 eq/km). If arbitrarily we determine a relative scale, where the scenario with less GHG emissions for the Transport Stage (North of Bs. As./South of Sta. Fe) represents 100% of GHG emissions, its **percentage difference with the scenario with relatively more GHG emissions** (Salta) is of: $\Delta_{\text{Salta. –North of Bs. As./South of Sta. Fe}}$ = **360%.** Being fulfilled the assumptions of the software (distance between the different scenarios and the location where the feedstock is processed varies in 463%) these differences are considered **significant**.
- The scenario that shows **less GHG emissions for the Transport Stage** is the scenario of **North of Bs. As./South of Sta. Fe** (2 g CO_2 eq/km).

Discussion and Conclusion

- ✓ In general lines, the **Industrial Stage**, in first place, together with the **Agricultural Stage**, in second place, are the **stages that jointly generate higher energy consumption**.

- ✓ Among possible domestic scenarios, the scenario of **South East of Bs.As.** (Tandil) was specifically where a **higher energy consumption** (with reductions in the order of 73,2% of energy consumption in comparison with conventional diesel) was observed. The scenario of **North of Bs. As./South of Sta. Fe** (Pergamino) was specifically the context where the **lowest energy consumption** (with a reduction of 77,4% in energy consumption) was observed.

- ✓ Among possible domestic scenarios, the scenario of **South East of Bs. As.** (Tandil) was specifically the context where the **highest energy consumption for the Agricultural Stage** (0,1037 MJ/km) was observed. The scenario of **South of Córdoba** (Rio Cuarto) was specifically the context where the **lowest energy consumption for the Agricultural Stage** (0,0464 MJ/km) was observed. The differences between both scenarios seem to stem from the fact that in the scenario of South East of Bs. As. – Tandil- they use a conventional agriculture system, with a higher energy consumption per hectare (1.575 MJ/ha/year) than using No-Till farming (998 MJ/ha/year).

- ✓ It does not seem to exist a **direct relation between a higher consumption of fertilizers per hectare in the Agricultural Stage** (although this does not necessarily mean an increase in yield per hectare), and a **lower efficiency in energy consumption** in that same stage (West of Bs. As.-Pehuajo-). The **efficiency in energy consumption** seems to be related with **high yields** and **low energy consumption** per hectare (No-Till Farming vs. Conventional Agriculture).

- ✓ At a **greater distance** between the place where the feedstock (soybean) is obtained) and the place where it is being processed **increases the impact of the Transport Stage in the global energy consumption** (Examples: North of Bs. As. – Pergamino – and Salta scenarios).

- ✓ Among possible domestic scenarios, the scenario of **Salta** (Las Lajitas) was specifically the context where the **highest energy consumption for the Transport Stage** (0,1328 MJ/km) was observed. The scenario of **North of Bs. As./South of Sta. Fe** (Pergamino) was specifically the context where the **lowest energy consumption for the Transport Stage** (0,0290 MJ/km) was observed. This is due to the **larger distance** that separates the area of Salta from the location where feedstock is processed (Port complex of Pto. San Lorenzo/Pto. Gral. San Martín, Prov. of Santa Fe).

- ✓ In general lines, the **Industrial Stage** in first place, together with the **Agricultural Stage**, in second place, are the stages that jointly generate **more GHG emissions**.

- ✓ Among possible domestic scenarios, the scenario of **South of Córdoba** (Rio Cuarto) and of **North of Bs.As.** (Pergamino) were specifically the contexts where the **highest reduction in GHG emissions** (with savings of 81,3% in GHG emissions compared to conventional diesel) was observed. The scenario of **South East of Bs.As.** (Tandil) was specifically the context where the **lowest reduction of GHG emissions** (with savings of 75,5% in GHG emissions) was observed.

- ✓ Among possible domestic scenarios, the scenario of **South East of Bs.As.** (Tandil) was specifically the context where the **highest GHG emissions for the Agricultural Stage** (12,2 g CO_2 eq/km) was observed. The scenarios of **South of Córdoba and Salta** (Rio Cuarto and Las Lajitas) were specifically the contexts where the **lowest GHG emissions for the Agricultural Stage** (3,2 g CO_2 eq/km) was observed. It is very likely that the differences observed are due to different types of farming and **use of fertilizers** between scenarios.

- ✓ At a **largest distance** between the location where feedstock is obtained (soybean) and the location where it is processed, **the impact of the**

Transport Stage on global GHG emissions increases (Example: scenario of Salta).

- ✓ Among possible domestic scenarios, the scenario of **Salta** (Las Lajitas) was specifically the context where the **highest GHG emissions for the Transport Stage** (9,2 g CO_2 eq/km) was observed. The scenario of **North of Bs. As./South of Sta. Fe** (Pergamino) was specifically the context where the **lowest GHG emissions for the Transport Stage** (2 g CO_2 eq/km) was observed. The difference between both scenarios lies on the **large distance** between the location where feedstock (soybean) is obtained and the location where it is processed (Example: scenario of Salta –Las Lajitas- 1130 km).

Comparative analysis with the JRC:

- ✓ If we compare the values proposed by the European Comission Join Research Centre (JRC) on its calculation template Biofuels pathway RED method as of 14/11/2008 for soy with values included for Brazil, the following comments can be made:
  - The average yield value taken is 2798 kg/ha at 15% of water content and Argentine yields, depending on studied production regions range between 2750 and 4500 kg/ha
  - The Nitrogen N(ha/year) fertilizer value taken is 8 kg/ha, depending on studied production regions in Argentina, values range between 0 and 14 kg/ha
  - The Potasium K_2O(ha/year) fertilizer value taken is 62 kg/ha, this type of fertilizer is not used on studied Argentine production regions.
  - The Phosphorus P_2O_5(ha/year) fertilizer value taken is 66 kg/ha, depending on Argentine production regions, values range between 0 and 78 kg/ha.
  - Methodology used for this analysis does not allow the incorporation of other agrochemicals to the calculation but their energetic impact is peripheral compared to other inputs.
  - Transport distances by truck are calculated on a basis of 700 km, in the Argentine case, distances range between 191 and 1130 km. On this issue it has to be taken into account that most of Argentine production is made in areas close to processing and shipment centers, which is an additional advantage on this issue.
  - Shipping freight distance considered by the JRC is 10186 km and for the value taken for the Argentine case is 12091 km.
  - Hexane values considered by the JRC are of 0,7 kg/Tn of grain and for the Argentine case the average value considered is 0,76.
  - Oil yield value taken by the JRC is of 188 kg/Tn of grain, the average value considered for Argentina's big production plants is 193 kg/Tn grain.
  - The amount of steam considered by the JRC is 1000 MJ/tn of grain for the extraction step and 296 MJ/Tn of grain for the refining step, the average value for two Argentine plants for both processes combined is 1952 MJ/Tn.
  - Electricity consumption considered by the JRC is 60 kWh/tn of grain for the refining step, the average value for two Argentine plants for both processes combined is 34,3kWh/Tn of grain.
  - Electricity consumption per ton of biodiesel by JRC and the Argentine study is the same, 30 kWh/t biodiesel.
  - Phosphoric acid is not considered on the calculation methodology used by this study, average values used in Argentina tally values considered by JRC 1,74 kg/Tn of biodiesel.

- Hydrochloric acid is not considered on the calculation methodology used in this study, average values used in Argentina threw values of 10,41kg/Tn bio at 32% while JRC references consider a value of 20 kg/Tn of biodiesel. Differences on this issue are important, thus Argentine data was esthekiometricaly corroborated in the lab, verifying the consistency of the values declared by the industry.
- Methanol considered by the JRC is of 109 kg/Tn biodiesel and in the Argentine case the average from surveyed plants and used as reference for the calculations is of 99 kg/Tn biodiesel.
- Sodium hydroxide is not considered on the calculation methodology used in this study, the average values used in Argentina threw values of 4,9 kg/Tn bio at 32% while the references of JRC consider a value of 6,72 kg/Tn of biodiesel.
- The value of energy needed for the generation of steam taken by the JRC is of 1545 MJ/Tn of biodiesel, average value of Argentina used on the calculations was 1183 MJ/tn of biodiesel. It should be clarified that in this case from all the companies surveyed the highest value of steam consumption was taken.
- Among the transformation values the JRC takes 1111 MJ/MJ of steam and the Argentine calculation takes 1276 MJ/MJ steam.
- Calculated values by JRC for all the steps issue a result of 47,5 g CO_2 eq/MJbiodiesel with maximum values of 55,9 and minimum of 39,7. On the calculations made in this study for different Argentine scenarios the results ranged between 14,7 and 20 g CO_2 eq/Mjbiodiesel.

Recommendations

Since the majority of soybean production is focused on the central agricultural areas were the results were more favorable a single number for the characterization of Argentine production would be closer to the results obtained for North of Bs. As./South of Sta. Fe (Pergamino).
Calculations made allow identifying and characterizing Argentine production in order to be able to compare it with other agricultural industry systems worldwide.

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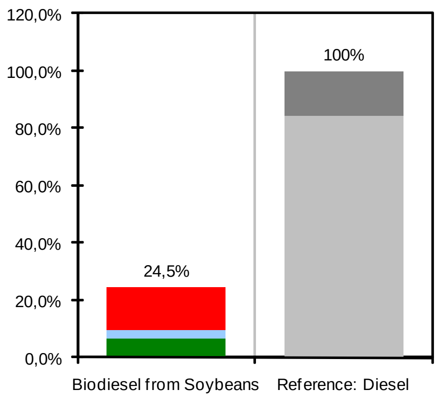
Results for the Sudeste of Bs.As. (Tandil) with Conventional Farming

Summary Input		**Summary output**	Biodiesel from Soybeans				Reference: Diesel			
			Energy use (per km)		GHG emissions (kg/km)		Energy use (per km)		GHG emissions (kg/km)	
			(MJ)	(% of ref.)	(kg CO2-eq.)	(% of ref.)	(MJ)	(%)	(kg CO2-eq.)	(%)
Biofuel	Biodiesel	Feedstock production	0,1037	4%	0,0122	7%				
Feedstock	Soybeans	Transport actions	0,0787	3%	0,0054	3%				
Reference	Diesel	Conversion operations	0,4627	19%	0,0270	15%				
Print summary results										
		End use					2,0800	87%	0,1541	84%
Show detailed results		Fossil indirect					0,3224	13%	0,0285	16%
		Total	0,6450	26,8%	0,0447	24,5%	2,4024	100%	0,1826	100%
Return to input		**% Reduction**		**73,2%**		**75,5%**				**0%**
		GHG emission (kg CO2-eq/MJ LHV fuel)			**0,0215**				**0,0878**	
		Avoided emission (tonne CO_2/ha/yr)			**1,3**					

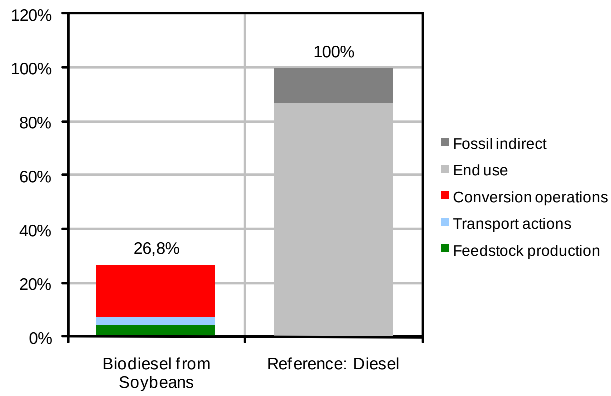
Biofuels greenhouse gas calculator

Developed by Ecofys Netherlands and CE Delft / Commissioned by SenterNovem

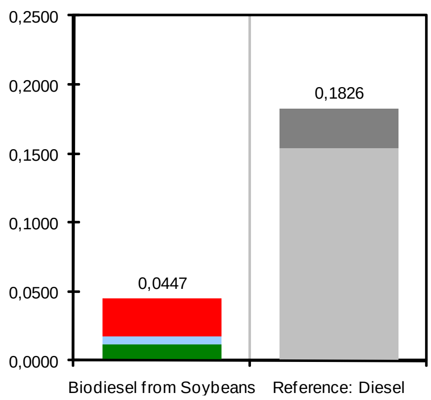
GHG emissions [% of reference]



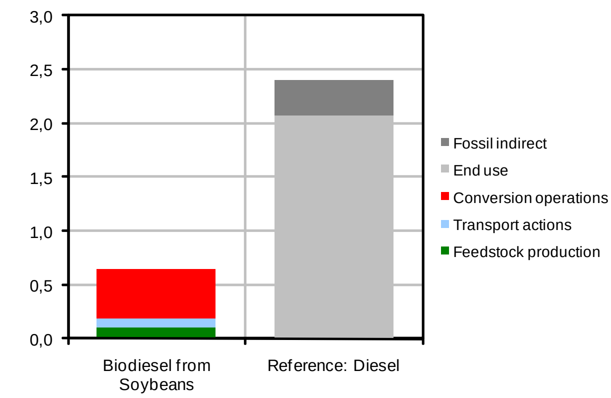
Energy use [% of reference]



GHG emissions [CO_2-eq./km]



Energy use [MJ/km]

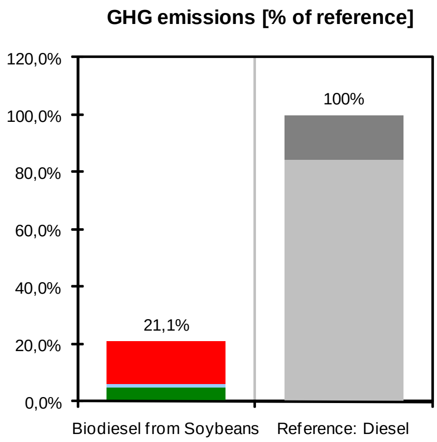


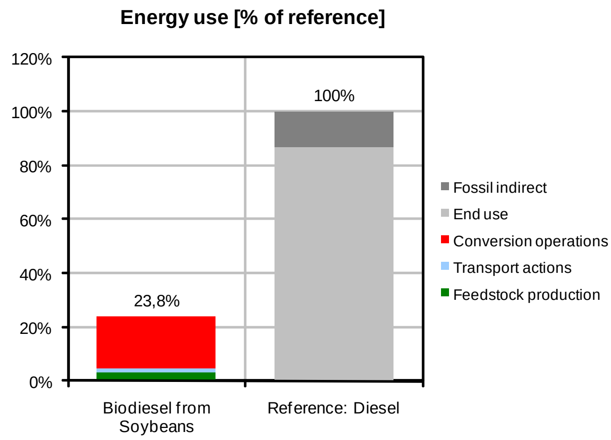
Results for the South of Santa Fe, Venado Tuerto – No Till

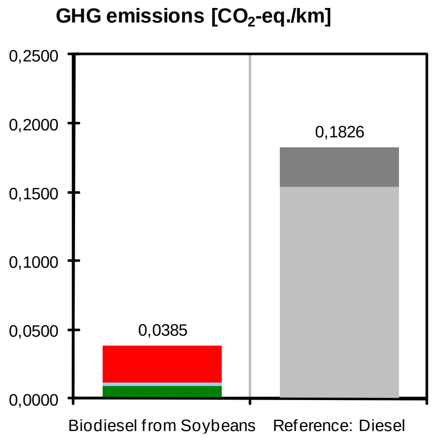
Summary Input		Summary output	Biodiesel from Soybeans				Reference: Diesel			
			Energy use (per km)		GHG emissions (kg/km)		Energy use (per km)		GHG emissions (kg/km)	
			(MJ)	(% of ref.)	(kg CO2-eq.)	(% of ref.)	(MJ)	(%)	(kg CO2-eq.)	(%)
Biofuel	Biodiesel	Feedstock production	0,0745	3%	0,0091	5%				
Feedstock	Soybeans	Transport actions	0,0343	1%	0,0024	1%				
Reference	Diesel	Conversion operations	0,4627	19%	0,0270	15%				
Print summary results		End use					2,0800	87%	0,1541	84%
Show detailed results		Fossil indirect					0,3224	13%	0,0285	16%
Return to input		Total	0,5715	23,8%	0,0385	21,1%	2,4024	100%	0,1826	100%
		% Reduction		**76,2%**		**78,9%**				**0%**
		GHG emission (kg CO2-eq/MJ LHV fuel)			**0,0185**				**0,1826**→**0,0878**	
		Avoided emission (tonne CO_2/ha/yr)			**2,1**					

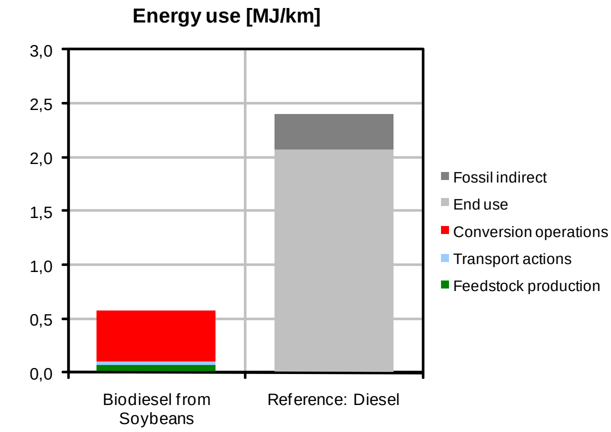
Biofuels greenhouse gas calculator

Developed by Ecofys Netherlands and CE Delft / Commissioned by SenterNovem





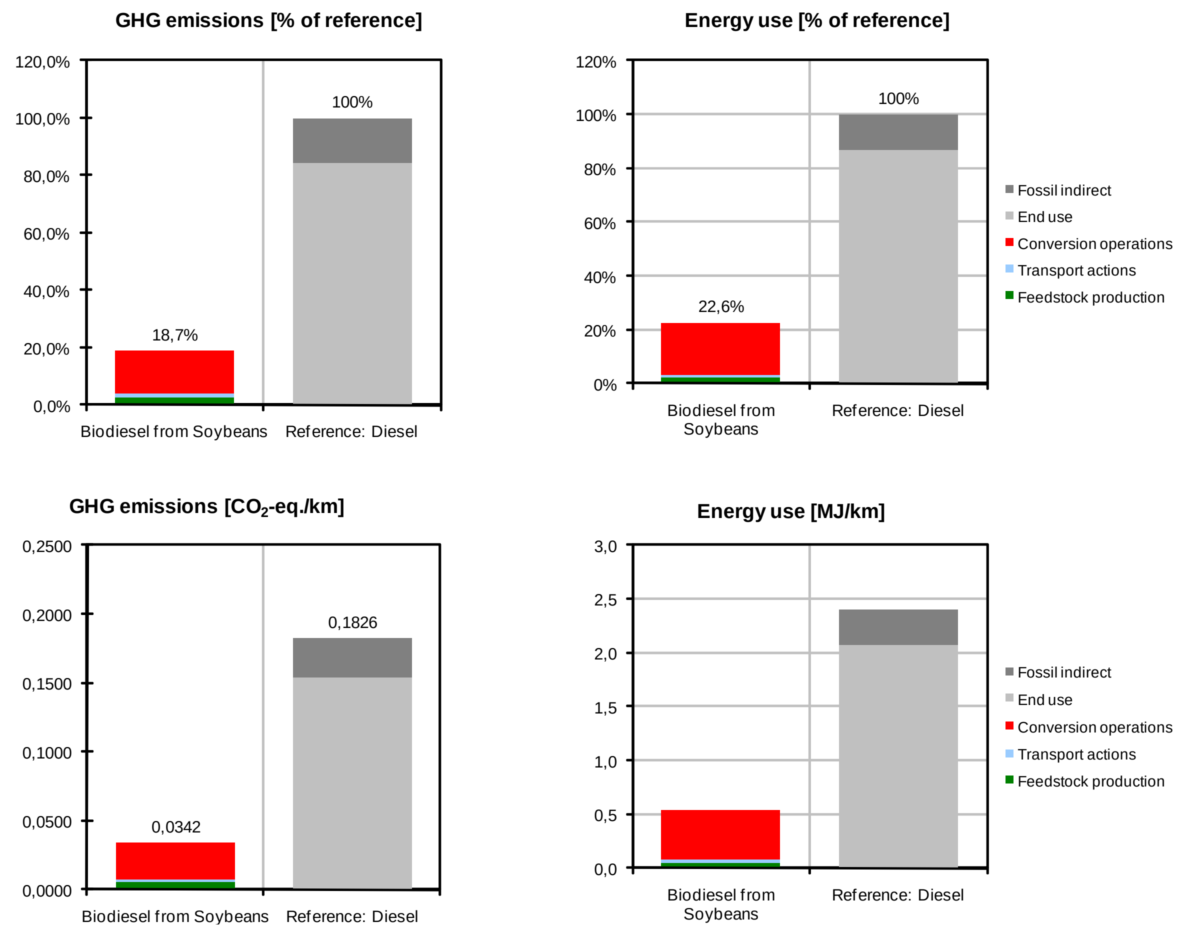




Results for the North of Bs.As./Santa Fe, Pergamino – No Till

Summary Input		**Summary output**	Biodiesel from Soybeans				Reference: Diesel			
			Energy use (per km)		GHG emissions (kg/km)		Energy use (per km)		GHG emissions (kg/km)	
			(MJ)	(% of ref.)	(kg CO2-eq.)	(% of ref.)	(MJ)	(%)	(kg CO2-eq.)	(%)
Biofuel	Biodiesel	Feedstock production	0,0518	2%	0,0052	3%				
Feedstock	Soybeans	Transport actions	0,0290	1%	0,0020	1%				
Reference	Diesel	Conversion operations	0,4627	19%	0,0270	15%				
Print summary results										
		End use					2,0800	87%	0,1541	84%
Show detailed results		Fossil indirect					0,3224	13%	0,0285	16%
		Total	0,5435	22,6%	0,0342	18,7%	2,4024	100%	0,1826	100%
Return to input		**% Reduction**		**77,4%**		**81,3%**				**0%**
GHG emission (kg CO2-eq/MJ LHV fuel)					**0,0164**				**0,0878**	
Avoided emission (tonne CO_2/ha/yr)					**1,8**					

Biofuels greenhouse gas calculator
Developed by Ecofys Netherlands and CE Delft / Commissioned by SenterNovem



Results for the West of Buenos Aires, Pehuajó – No Till

Summary Input

Biofuel	Biodiesel
Feedstock	Soybeans
Reference	Diesel

Print summary results

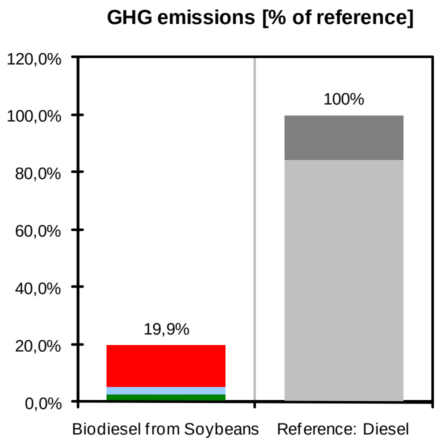
Show detailed results

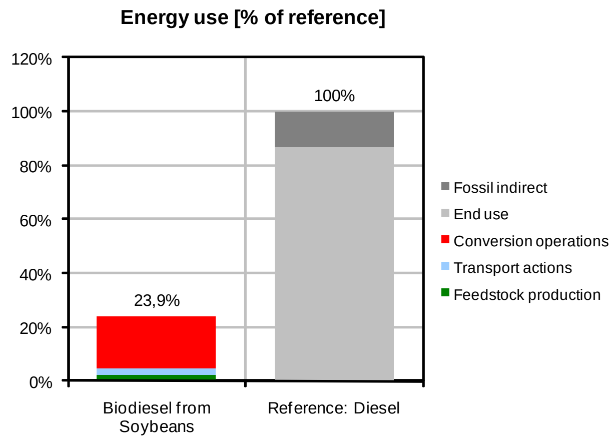
Return to input

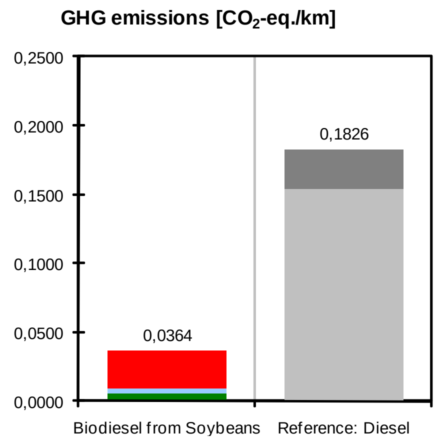
Summary output	Biodiesel from Soybeans				Reference: Diesel			
	Energy use (per km)		GHG emissions (kg/km)		Energy use (per km)		GHG emissions (kg/km)	
	(MJ)	(% of ref.)	(kg CO2-eq.)	(% of ref.)	(MJ)	(%)	(kg CO2-eq.)	(%)
Feedstock production	0,0518	2%	0,0052	3%				
Transport actions	0,0600	2%	0,0041	2%				
Conversion operations	0,4627	19%	0,0270	15%				
End use					2,0800	87%	0,1541	84%
Fossil indirect					0,3224	13%	0,0285	16%
Total	0,5745	23,9%	0,0364	19,9%	2,4024	100%	0,1826	100%
% Reduction		**76,1%**		**80,1%**				**0%**
GHG emission (kg CO2-eq/MJ LHV fuel)			**0,0175**				**0,0878**	
Avoided emission (tonne CO_2/ha/yr)			**1,7**					

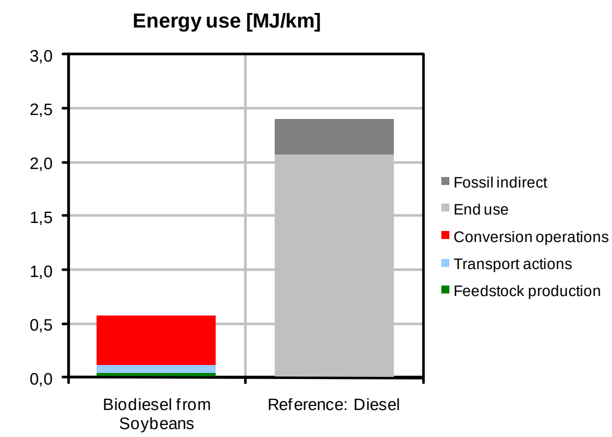
Biofuels greenhouse gas calculator

Developed by Ecofys Netherlands and CE Delft / Commissioned by SenterNovem







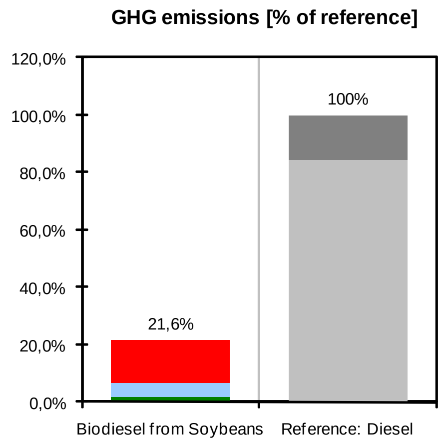


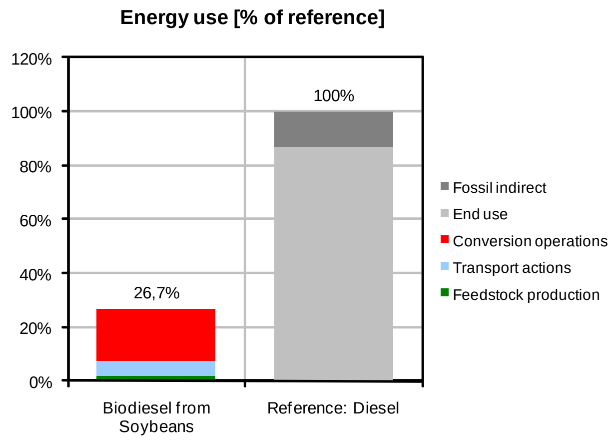
Results obtained for Salta (Las Lajitas) – No Till

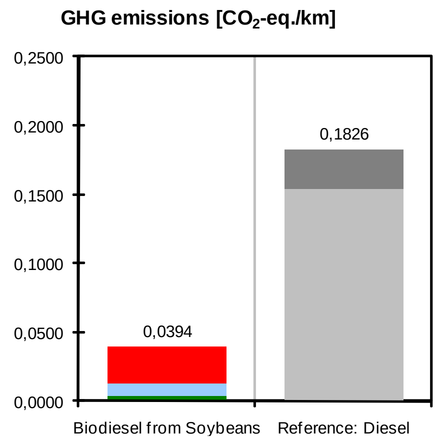
Summary Input		**Summary output**	Biodiesel from Soybeans				Reference: Diesel			
			Energy use (per km) (MJ)	(% of ref.)	GHG emissions (kg/km) (kg CO2-eq.)	(% of ref.)	Energy use (per km) (MJ)	(%)	GHG emissions (kg/km) (kg CO2-eq.)	(%)
Biofuel	Biodiesel	Feedstock production	0,0464	2%	0,0032	2%				
Feedstock	Soybeans	Transport actions	0,1328	6%	0,0092	5%				
Reference	Diesel	Conversion operations	0,4627	19%	0,0270	15%				
Print summary results										
		End use					2,0800	87%	0,1541	84%
Show detailed results		Fossil indirect					0,3224	13%	0,0285	16%
		Total	0,6419	26,7%	0,0394	21,6%	2,4024	100%	0,1826	100%
Return to input		**% Reduction**		**73,3%**		**78,4%**				**0%**
		GHG emission (kg CO2-eq/MJ LHV fuel)			**0,0189**				**0,0878**	
		Avoided emission (tonne CO_2/ha/yr)			**1,3**					

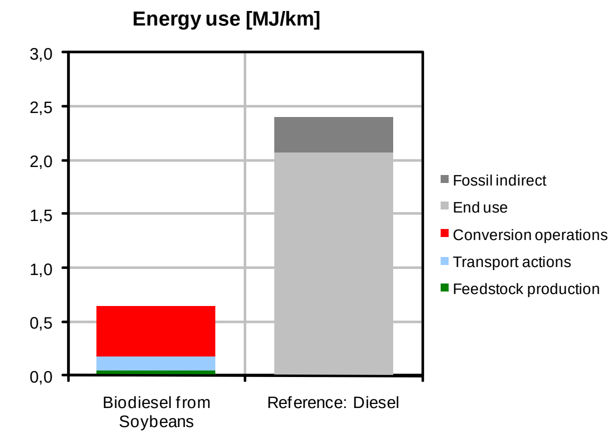
Biofuels greenhouse gas calculator

Developed by Ecofys Netherlands and CE Delft / Commissioned by SenterNovem









Brazil Case Study

	Country: Brazil	
1	**Land Availability and Use**	**hectares**
	Total land area	851,000,000
	Land area per capita	4.47
	Total cultivated land area	66,600,000
	Cultivated land area per capita	0.35
2	**Total land area used for biofuels production**	**hectares**
	• Sugar cane	6,700,000
	• Oils (food and biodiesel)	21,500,000

Brazil has a total area of 851,000,000 hectares and is one of the biggest countries in the World. It has a population of 190,273,300 (2008 estimation) habitants, what means 45 hectares per capita. It has too, a big biofuels use program, the oldest one, which focuses the two most important transportation fuels, gasoline and Diesel. Total cultivated area can be estimated in 66,600,000 hectares in which the area dedicated for biofuels production is responsible for about 6,700,000 hectares (sugar cane). Land use for agricultural use can be distributed as follows:

a) Grains: 22,800,000 ha (food)
b) Oils: 21,500,000 ha (impossible to separate edibles from oils for biodiesel production)
c) Biofuels: 6,700,000 ha (sugar cane)
d) Others: 8,100,000 ha (food)

There is not a competition between food and bio-energy production and neither a natural forest destruction to produce bio-energy. Land use in Brazil can be summarized as follows:

a) Total area: 851,000,000 ha
b) Native Amazon forest: 370,000,000 ha
c) Secondary Amazon forest and others: 154,000,000 ha
d) Pasture: 197,000,000 ha
e) Temporary Cultures: 59,000,000 ha
f) Permanent Cultures: 7,600,000 ha
g) Available land: 263,000,000 ha
h) Available land with low impact: 90,000,000 ha

Ethanol productivity per area has shown a huge increase since the late seventies when ethanol Program, PROALCOOL, has been created. In the seventies, when PROALCOOL begun, ethanol productivity was 4.6 liters/ha and nowadays ethanol industry in Brazil shows a productivity of 7.6 liters/ha. This productivity will increase when it will be available a commercial process to produce ethanol form sugar cane straw and bagasses (cellulosic raw material). This means that will be possible to increase ethanol production almost two fold in the same planted area.

Brazil is a potential ethanol exporter. In 2007 numbers, ethanol production was 22,500,000 cubic meters and its internal demand reaches 19,000,000 cubic meters of both types, anhydrous and hydrated, where hydrated type demand was around 64% of total ethanol demand. Numbers for ethanol exported shows that in 2007 Brazil exported around 3,500,000 cubic meters. Ethanol production increase from 2000/2001 to 2007/2008 year.harvest was of 122%.

Ethanol addition to gasoline was not done in a regular basis up to the end of the seventies. This was the main complain from consumers and automotive industry that start to produce automobiles in Brazil in the fifties. Ethanol addition to gasoline change the sthoiquiometric air/fuel ratio leaning the mixture, this means poor driveability of the vehicles. As ethanol addition became a fixed amount it was possible to start a lead phase down and in 1989 all gasoline produced by Petrobras was lead free. In 1992 all gasoline in Brazil was lead-free, seven years ahead the environmental legislation that requires a lead-free gasoline. In 1993 ethanol addition to gasoline became a law and the amount fixed was 22% volume. Years late, ethanol producers ask the government to increase the amount to 25% and nowadays the legislation stated that the amount is determined by the government between 20 and 25% according ethanol availability.

Biodiesel use program in Brazil begun in 2005 and originally it was regulated that from 2005 to 2007 addition was optional and in 2% volume maximum. From 2008 to 1012 biodiesel addition should became mandatory in 2% volume. From 2013, addition was still mandatory and the amount of biodiesel should be 5% volume. The original program was speed up and in July of 2008 the amount of biodiesel was increased to 3% volume mandatory.

There are two types of ethanol in Brazilian market, anhydrous and hydrated, for historical reasons that can be easily explained. In the past, when ethanol begun to be added to gasoline in Brazil, gasoline was produced almost exclusively from straight run naphtha, it means a very high paraffinic hydrocarbons content product. In this situation, ethanol solubility in gasoline was greatly influenced by ethanol water content and it was necessary to use an anhydrous product in order to avoid phase separation. Anhydrous ethanol has a higher production cost compared with hydrated. To promote Brazilian Ethanol Program – PROÁLCOOL, it was chosen to fuel neat ethanol vehicles with hydrated ethanol, the lower cost option for ethanol production. Nowadays, considering ethanol content in gasoline, up to 25% in volume, and gasoline composition, maybe a higher water content ethanol should be used in the mixture. In a near future, it is possible that ethanol specifications will change to have just one type to ease logistical constrains that having two ethanol types brings.

Ethanol raw material in Brazil is sugar cane that is produced in Brazil since its settlement. Years ago some experiments were done to produce ethanol from cassava but this experience was not successful. As mentioned before, ethanol productivity has increased in both agriculture and industrial sides. Ethanol producers have been investing in the research of sugar cane species that show a higher sugar content to improve ethanol productivity and all distilleries uses sugar cane bagasses to generate heat for the process, lowering production costs. Ethanol produced from sugar cane shows nowadays the lowest production cost when compared with other raw materials.

Biodiesel in Brazil can be produced from several raw materials and the choice of raw material to produce biodiesel is a matter of its availability and incentives that the Brazilian government established. Biodiesel program is considered as a way to increase social end economical upgrade for small planters, family agriculture.

Several Brazilian governments have been adopting for a long time policies that incentive the use of biofuels. Sometimes creating subsidies to empower some programs or reducing or even eliminating taxes selectively to create conditions to develop sustainable bio-energy programs. Sometimes policies to remove some incentives, when is believed that the program is mature enough to survive without some support, caused some drawn backs in programs. This happened in late eighties when the government remove some incentives from the ethanol program and cause an ethanol shortage. This situation generates a fear among consumers that practically reduced to almost zero neat ethanol vehicles sales. Since 2002, when was put in the Brazilian market flexible fuel vehicles, hydrated ethanol demand has increased sharply. Fuel option by consumers that have flexible fueled vehicles is predominantly price oriented when they choose the fuel at gas stations, although there are some consumers that show a fidelity to gasoline or ethanol. Flexible fuel vehicle fuel consumption is higher when it is fuelled with ethanol than with gasoline and there is a break even point where that defines at what price differential is more convenient to fuel the vehicle with gasoline or ethanol.

When PROALCOOL begun there was not a specification for hydrated ethanol and the first specification uses the one that was adopted for pharmaceutical ethanol. Automotive industry adopted for the metallic components the same protection adopted for gasoline fuelled vehicles. These solutions showed to be not enough to avoid the high metallic components corrosion the first neat ethanol vehicles experienced. Automotive industry, ethanol producers, Petrobras and government agencies start a program to evaluate what properties must be considered for hydrated ethanol do protect vehicles metallic components from corrosion. At the same time, automotive industry started to test other materials and coatings to be applied to engine components to protect them from corrosion. The sum of these two initiatives gave to the market vehicles with more resistant components and an ethanol specification that considered the most important properties ethanol should have to have quality. Brazilian ethanol specification was used later for other countries as the basis for their own specifications.

Brazilian specification for biodiesel was based in European specification because as Brazilian specification for ethanol is used as the base for several specifications around the world, European specification for biodiesel can be considered the up to date specification for biodiesel. Brazilian biodiesel production can use several raw materials and for this reason its specification must be wide enough to accommodate this situation. Nowadays Brazilian biodiesel specification is more similar to the European one.

Recently a tripartite group was created to discuss how to harmonize the specifications adopted for ethanol and biodiesel. This group was formed by Brazil, US and Europe and recently invited India, China and South Africa to present their suggestions. This group issued in December of 2007, the "White paper on Internationally Compatible Biofuel Standards" that show the work performed by the tripartite group toward a harmonization of biofuels specification. In mid of 2008 was issued, for comments, a biofuels guideline by the Worldwide Fuel Chart. These initiatives show that there is a world tendency to establish a harmonized biofuels specification to facilitate the international trade of biofuels.

CANADA CASE STUDY

Data is for 2006 unless otherwise noted, sources noted below

	Country: Canada	
1	**Land Availability and Use**	**hectares**
	Total land area	909,350,700
	Land area per capita	27.58
	Total cultivated land area	35,912,247
	Cultivated land area per capita	1.09
2	**Total land area used for biofuels production**	**hectares**
	Land used for production of:	
	• Sugar beet	19,488
	• Grains	17,579,272
	• Oils	7,404,627
	• Others	7,969,209
	These numbers are total production, not only biofuels	
3	**Land productivity/Yields (for each biofuel)**	**tonnes/hectare**
	• Sugar cane/beet	50
	• Grains: o Wheat o Oats o Barley o Corn o Rye	2.3 2.4 3.1 7.0 2.1
	• Oils: o Canola o Flax	1.7 1.2
	These numbers are total production, not only for biofuels	

Population 32,976,000

Total supply (litres or tonnes, for each biofuel)

ethanol production	715,000,000	litres
ethanol under construction	905,000,000	litres
biodiesel production	97,000,000	litres
biodiesel under construction	225,000,000	litres

These numbers represent production capacity, not necessarily actual supply
Production/construction data for 2007

Production Costs

ethanol (from grains)	0.29-0.37	US$/litre
biodiesel (from canola)	0.65	US$/litre

Estimates based on 1 CAN$ = 0.8 US$ (approx. exchange rate as of Dec 1 2008)

Trade:

There is no official data available for either fuel ethanol or biodiesel trade. However, statistics show that Canada imported about 100 million liters of total ethanol (all grades – potable and denatured) in 2006, exclusively from the United States. Several Canadian companies import biodiesel from the United States as well.

Under the North American Free Trade Agreement (NAFTA), there is a free trade of renewable fuels among the United States, Mexico, and Canada. However, Canada has a tariff on ethanol imported from Brazil ($0.05 per liter).

Policy:

In July 2007, the Canadian government announced that it would provide up to $1.5 billion in incentives over nine years to producers of renewable alternatives to gasoline and diesel fuel. The incentives are primarily for producers to "bridge the gap" between the current production level and the 3,000 million tonnes/year that will be needed to meet the 2012 targets, which were set by the government in December 2006 and passed into law in May 2008. Essential elements of the new energy policy include:

- Reaching an average of 5% renewable content in gasoline by 2010 and 2% renewable content in diesel fuel and heating oil by 2012.
- Federal incentives provided through excise tax exemptions, amounting to $0.10 per liter for ethanol and $0.04 per liter for biodiesel.
- A National Biomass Expansion Program providing $140 million in contingent loan guarantees to encourage financing for new plants that produce ethanol from biomass material such as crop residues.

Government Programs:

- The eco Agriculture Biofuels Capital Initiative (ecoABC) is a federal $200 million, four-year capital grant program that provides funding for the construction or expansion of transportation biofuel production facilities. It appears funding is focused on cellulosic ethanol.
- On July 5, 2007, Prime Minister Stephen Harper announced the ecoENERGY for Biofuels Initiative, which will invest up to $1.5 billion over nine years to boost Canada's production of biofuels.
- The ecoAUTO Rebate Program encourages Canadians to buy fuel-efficient vehicles, including FFVs. It offers rebates from $1,000 to $2,000 to people who, beginning March 20, 2007, buy or enter a long-term lease (12 months or more) for a fuel-efficient vehicle.

Several Canadian provinces have additional policies and incentives:

- Ontario's regulation requires an average of 5% ethanol in gasoline and went into effect in January 2007. Ontario announced in June 2006 that it was phasing out its road tax exemption and replacing it with the Ethanol Growth Fund intended to provide ethanol production incentives of $520 million over 12 years.
- Saskatchewan's 7.5% ethanol requirement in gasoline took effect in October 2006. Saskatchewan also offers a distributor tax credit for ethanol of up to $0.15 per liter, provided that ethanol is produced and consumed in the province.
- Manitoba has passed legislation requiring 10% ethanol content in 85% of the province's fuel, but has not yet set a date for entry into force. Manitoba offers a provincial tax credit of $0.25 per liter for fuels containing at least 10% ethanol (provided the fuel is produced and consumed in Manitoba), as well as a $0.115 per liter tax exemption for biodiesel.
- Quebec has set a goal of 5% ethanol in gasoline by 2012 and expects that target to be met by next-generation cellulosic ethanol. Quebec provides an income tax credit for ethanol producers that produce and sell in Quebec. Quebec also offers reimbursement of fuel taxes paid on the purchase of biodiesel.
- British Columbia has road tax exemptions for ethanol and biodiesel of $0.145 and $0.150 per liter, respectively. The BC Energy Plan, announced in August 2007, will implement a 5% average renewable fuel standard for diesel by 2010 and will increase the ethanol content of gasoline to 5% by 2010.
- Alberta announced a Bio-Energy Program in October 2006 that replaced its provincial ethanol road tax exemption and allocates $209 million over four years to renewable fuels, and $30 million for commercialization support. It includes a Bio-Energy Producer Credit program, a Bio-Refining Commercialization and Market Development Program, and the Bio-energy Infrastructure Development Program.

Sources:

Statistics Canada, Land and freshwater resources, http://www40.statcan.gc.ca/l01/cst01/phys01-eng.htm
Statistics Canada, 2006 Census for Agriculture, http://www.statcan.gc.ca/ca-ra2006/index-eng.htm
Canadian Sugar Institute, http://www.sugar.ca
Canadian Wheat Board, http:///www.cwb.ca
Ontario Corn Producers Association, http://www.ontariocorn.org
Canadian Renewable Fuels Association, http://www.greenfuels.org
Canadian Canola Growers Association, http://www.ccga.ca
APEC Biofuels, http://www.apec.biofuels.org

Colombia Case Study

The following information, data and estimates should be included if available:

<table>
<tr><td></td><td colspan="6">Country: Colombia</td></tr>
<tr><td>1</td><td colspan="4">Land Availability and Use</td><td colspan="2">hectares</td></tr>
<tr><td></td><td colspan="4">Total land area</td><td colspan="2">114´174.800</td></tr>
<tr><td></td><td colspan="4">Land area per capita</td><td colspan="2">2,6</td></tr>
<tr><td></td><td colspan="4">Total cultivated land area</td><td colspan="2">3´962.761</td></tr>
<tr><td></td><td colspan="4">Cultivated land area per capita</td><td colspan="2">0,09</td></tr>
<tr><td>2</td><td colspan="4">Total land area used for biofuels production</td><td colspan="2">hectares</td></tr>
<tr><td></td><td colspan="4">Land used for production of:</td><td colspan="2"></td></tr>
<tr><td></td><td colspan="4">• Sugar cane/beet</td><td colspan="2">45.000</td></tr>
<tr><td></td><td colspan="4">• Grains</td><td colspan="2">N.A</td></tr>
<tr><td></td><td colspan="4">• Oils *(Ha estimated for 2009 with a B5 blend)</td><td colspan="2">55.000*</td></tr>
<tr><td></td><td colspan="4">• Others</td><td colspan="2">N.A</td></tr>
<tr><td>3</td><td colspan="4">Land productivity/Yields (for each biofuel)</td><td colspan="2">tonnes/hectare</td></tr>
<tr><td></td><td colspan="4">• Sugar cane/beet **(Tonnes biomass/ha)</td><td colspan="2">120**</td></tr>
<tr><td></td><td colspan="4">• Grains</td><td colspan="2">N.A</td></tr>
<tr><td></td><td colspan="4">• Oils ***(palm fruit)</td><td colspan="2">22***</td></tr>
<tr><td></td><td colspan="4">• Others</td><td colspan="2">N.A</td></tr>
<tr><td>4</td><td colspan="6">Total Supply (litres or tonnes, for each biofuel)</td></tr>
<tr><td></td><td>1990</td><td>1995</td><td>2000</td><td>2005</td><td>2006</td><td>2007</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>1´050.000</td><td>1´050.000</td><td>1´050.000</td></tr>
<tr><td>5</td><td colspan="6">Total Demand (litres or tonnes, for each biofuel)</td></tr>
<tr><td></td><td>1990</td><td>1995</td><td>2000</td><td>2005</td><td>2006</td><td>2007</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>1´050.000</td><td>1´050.000</td><td>1´050.000</td></tr>
<tr><td>6</td><td colspan="6">Exports (litres or tonnes, for each biofuel)</td></tr>
<tr><td></td><td>1990</td><td>1995</td><td>2000</td><td>2005</td><td>2006</td><td>2007</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td colspan="6">Imports (litres or tonnes, for each biofuel)</td></tr>
<tr><td></td><td>1990</td><td>1995</td><td>2000</td><td>2005</td><td>2006</td><td>2007</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>8</td><td colspan="6">Production costs (USD/tonne or USD/litre, for each biofuel)</td></tr>
<tr><td></td><td>1990</td><td>1995</td><td>2000</td><td>2005</td><td>2006</td><td>2007</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>Unavailable</td><td>Unavailable</td><td>Unavailable</td></tr>
<tr><td>9</td><td colspan="6">Descriptive Qualitative Information:</td></tr>
<tr><td></td><td colspan="6">• Government policies and regulations (incentives, subsidies, export subsidies, import duties, etc)
Biodiesel
Mandatory blend for 2008 (B5) North of the country
Mandatory blend for 2009 (B5)
Mandatory blend for 2010 (B10)
Mandatory blend for 2012 (B20) in approval
Ethanol
Mandatory blend for 2006 (E10) except north of the country
Mandatory blend for 2010 (E10) when the national production increase to reach the national demand.
(E14) under study</td></tr>
</table>

- Standards in use: Biodiesel: NTC5444

PARÁMETRO	**UNIDADES**	**ESPECIFICACIÓN Vigencia (Febrero 1º de 2007)**	**MÉTODOS DE ENSAYO**
Densidad a 15 °C	Kg/m3	860 – 900	ASTM D 4052 ISO 3675
Número de cetano	Cetanos	47 mínimo	ASTM D 613 ISO 5165
Viscosidad (cinemática a 40 °C)	mm2/s	1,9 – 6,0	ASTM D 445 ISO 3104
Contenido de agua	mg/kg	500 máximo	ASTM E 203 ISO 12937
Contaminación Total	mg/kg	24 máximo	EN 12662
Punto de inflamación	°C	120 mínimo	ASTM D 93 ; ISO 2719
Corrosión lámina de cobre	Unidad	1	ASTM D 130 ISO 2160
Estabilidad a la oxidación (3)	Horas	6 mínimo	EN 14112
Estabilidad Térmica	% de reflectancia	70 % mínimo	ASTM D 6468
Cenizas sulfatadas	% en masa	0,02 máximo	ASTM D 874 ISO 3987
Contenido de fósforo	% en masa	0,001 máximo	ASTM D 4951 ISO 14107
Destilación (PFE)	°C	max 360	ASTM D 86 ISO 3405
Número ácido	mg de KOH/g	0,5 máximo	ASTM D 664 EN 1404
Temperatura de Obturación del filtro frío (CFPP)	°C	Reportar (4)	ASTM D6371 EN 116
Punto de nube/ enturbiamiento	°C	Reportar (4)	ASTM D 2500 ISO 3015
Punto de fluidez	°C	Reportar (4)	ASTM D 97
Carbón residual	% en masa	0,3 máximo	ASTM D 4530 (ISO 10370 (5)
Contenido de sodio y potasio	mg/kg	5 máximo	ASTM D 5863 EN 14108 EN 14109
Contenido de calcio y magnesio	mg/kg	5 máximo	ASTM D 5863 EN 14108 EN 14109
Contenido de Monoglicéridos	% en masa	0.8 máximo	ASTM D 6584 ISO 14105
Contenido de Diglicéridos	% en masa	0.2 máximo	ASTM D 6584 ISO 14105
Contenido de Triglicéridos	% en masa	0.2 máximo	ASTM D 6584 ISO 14105
Glicerina libre y total	% en masa	0,02/0,25	ASTM D 6584 ISO 14105 ISO 14106
Contenido de metanol o etanol	% en masa	0,2 máximo	ISO 14110
Contenido de éster	% en masa	96,5 mínimo	EN 14103
Contenido de alquilester de acido linoléico	% en masa	12 máximo	EN 14103
Índice de yodo	gr de yodo/100 gr	120 máximo	EN 14111

Ethanol:

Característica	Unidad	Especificación Fecha de vigencia Noviembre 1º de 2005	Métodos de prueba
1	Color	-	IncoloroVisual
2	Aspecto		**(1)**Visual
3	Acidez total (como ácido acético), máximo	mg/l	56ASTM D 1613 ó ABNT/ NBR9866 ó MB2606
		% masa	0,007
4	Conductividad eléctrica, máxima	S/m	500ASTM D 1125 ó **(2)**ABNT/ NBR 10547 ó MB2788
5	Densidad a 20 °C, máximo	kg/m3	791,5ASTM D 4052 ó ASTM D 891ó ABNT/ NBR5992 ó MB1533
6	% de etanol, mínimo	% Vol.	99,5ASTM D 5501
7	% alcohólico a 20 ºC, mínimo	°INPM	99,2ABNT/ NBR5992 ó MB1533
8	Material no volátil a 105 ºC, máximo	Mg/l	30ABNT/NBR 2123

ITALY CASE STUDY

	Country: ITALY	
1	**Land Availability and Use**	**hectares**
	Total land area	30.100.000
	Land area per capita	0,52
	Total cultivated land area	12.900.000
	Cultivated land area per capita	0,224
2	**Total land area used for biofuels production**	**hectares**
	Land used for production of:	
	• Sugar cane/beet	-----
	• Grains	3.882.000
	• Oils	261.000
	• Others	-----
3	**Land productivity/Yields (for each biofuel)**	**tonnes/hectare**
	• Sugar cane/beet	----
	• Grains	5,25
	• Oils	3,01
	• Others	-----

4 Total Supply (litres or tonnes, for each biofuel) BIODIESEL

1990	1995	2000	2005	2006	2007
60.000	125.000	125.000	200.000	250.000	170.000

5 Total Demand (litres or tonnes, for each biofuel) BIODIESEL

1990	1995	2000	2005	2006	2007
60.000	125.000	125.000	200.000	250.000	170.000

6 Exports (litres or tonnes, for each biofuel) BIODIESEL

1990	1995	2000	2005	2006	2007
-	-	-	-	-	170.000

7 Imports (litres or tonnes, for each biofuel) BIODIESEL

1990	1995	2000	2005	2006	2007
0	0	0	0	0	10.000

8 Production costs (USD/tonne or USD/litre, for each biofuel) BIODIESEL

1990	1995	2000	2005	2006	2007
-	-	-	170 $/ton	170 $/ton	180 $/ton

9 Descriptive Qualitative Information:

- **BIODIESEL**
- Government policies and regulations (incentives, subsidies, export subsidies, import duties, etc)
- Financial law 2007 points out a mandatory blending of 1% in 2007 of calorific value versus automotive fuels, 2% in 2008, 3% in 2009, 2010 is still to be defined. Any biofuel is award for any mandatory target (i.e. blend of biodiesel gasoil can be used to reach the mandatory target versus gasoline).
- System of certificate in place for control on mandatory target.
- Penalty of 600 € per certificate (1 certificate = 10 gcal).
- Availability of 250kt for each year for the programme of partially detaxed biodiesel under quota allocation.
- Priorirty for quota allocation given to farm filiera contract.
- **BIOETHANOL:** it is produced only for export to North Europe.
- **ETBE** is the second application in order to reach the mandatory target object of the financial law 2007. It is difficult to extimate the volume of ETBE commercialized in Italy for the moment, but up to 2009, company will be obliged to put all the data entry regarding to the blending with the biofuel, into the web -site of the Minister.
- Standards in use: BIODIESEL EN14214.
- Production technologies, availability to the most common market technologies (transesterification).
- Research and Development: a research cooperation between biodiesel producers to developed for algae technologies.

Japan Case Study

	Country: JAPAN					
1	**Land Availability and Use**					**hectares**
	Total land area					37,792,300
	Land area per capita					2.95
	Total cultivated land area					4,671,000
	Cultivated land area per capita					0.36
2	**Total land area used for biofuels production**					**hectares**
	Land used for production of:					
	• Sugar cane/beet					0 (41,000 for food)
	• Grains					0 (1,976,000 for food)
	• Oils					0
	• Others					0
3	**Land productivity/Yields (for each biofuel)**					**tonnes/hectare**
	• Sugar cane/beet					0
	• Grains					0
	• Oils					0
	• Others					0
4	**Total Supply (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	0	0	0	0	0	0
5	**Total Demand (litres or tonnes, for each biofuel)**					
ETBE	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
	0	**0**	**0**	**0**	**0**	**8,880,000**
6	**Exports (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	0	**0**	**0**	**0**	**0**	**0**
7	**Imports (litres or tonnes, for each biofuel)**					
ETBE	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
	0	**0**	**0**	**0**	**0**	**8,880,000**
8	**Production costs (USD/tonne or USD/litre, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	ND	**ND**	**ND**	**ND**	**ND**	**ND**

Mexico Case Study

	Country: ITALY	
1	**Land Availability and Use**	**hectares**
	Total land area	197,255,000
	Land area per capita	1.77
	Total cultivated land area	21,900,000
	Cultivated land area per capita	0,19
	Mostly wheat, bean, corn, sorghum, sugarcane, coffee, barley, oat, orange and banana.	

As in other developing countries, Mexico is mainly approaching biofuels from a social perspective. Developed economies normally see biofuels as a mean to reducing the usage of fossil fuels, as well as decreasing pollutant emissions to the atmosphere. Nevertheless, Mexico also sees in biofuels an opportunity to boost rural development by creating jobs and reactivating local economies.

In 2007, Mexico took specific actions in order to incorporate biofuels into its energy matrix, based on three premises: increase energy security, boost rural development and reduce negative environmental impacts, without jeopardizing food availability.

Fuels market structure

Mexico is a large automotive fuels consumer. In 2008, Mexico demanded more than 780 thousand barrels a day of automotive gasoline as well as almost 300 thousand barrels a day of diesel. In real terms, Mexico consumes twice the amount of gasoline than the United Kingdom and 40% more the amount of diesel than Canada. Having said that, in terms of fuel consumption per capita, Mexico demands similar amounts of gasoline as the UK and three times less than Canada.

According to the Ministry of Energy in Mexico, by 2017, the demand for automotive gasoline in the country will grow 24%, reaching almost one million barrels a day.

However, despite being a large oil producer, Mexico's transport sector relies heavily on imports; more than 43% of automotive gasoline comes from abroad, whilst diesel imports reached 18% in 2008.

Refining sector

Petróleos Mexicanos is the single State-owned petrol company, entitled to produce, distribute and sell automotive fuels across all the country. Petróleos Mexicanos owns and operates six full-scale refineries across the country with total refining capacity of 1.5 million barrels a day, 77 in-land storage-sales terminals and 8,900 kilometres of pipelines for refining products. However, domestic fuels production has not been able to cope with the growing demand (4.3% annual growth in the last 10 years for automotive gasoline, raising more than 50%).

Biofuels industry

During the last few years, there have been a number of studies trying to determine the feasibility of the use of biofuels in Mexico.

Despite of the fact that there is still a great controversy and debate as to whether a major oil-producer country should promote the creation of a new market (under clear disadvantages vis à vis other major biofuels producers), the Mexican Government has taken the first steps in order to develop a biofuels industry.

Government policies and regulations for biofuels

In February 2008, Mexico approved the Law for the Promotion and Development of Biofuels. This law aims to create confidence and attract private investments, under a legal framework that defines the role of the State in guiding, coordinating and promoting the development of biofuels.

The main objective of this law is to promote the production of raw materials for the development of a biofuels industry, including agriculture, forest, waterweed and biotechnological processes. All of this without risking Mexico's food security and sovereignty, as established by the Law for Sustainable Rural Development.

Under the Law for the Promotion and Development of Biofuels, the Mexican Ministry of Energy will establish permissions to develop activities such as production, storage, transportation, distribution and commercialization of biofuels throughout the country.

This legislation will contribute to setting the legal framework bases to promote the reduction of pollutant emissions to the atmosphere, as well as the reduction of greenhouse gases. This law seeks to enforce international treaties such as the Kyoto protocol.

Finally, in order to promote and coordinate all the activities embraced under this law, the Mexican Government has also created the Bioenergy Commission, integrated by the Ministry of Energy, the Ministry of Agriculture, the Ministry of Environment and Natural Resources, the Ministry of the Economy and the Ministry of the Treasury.

Ethanol industry

A few years ago, the Mexican Government ran a series of studies in order to determine the most adequate production method for automotive ethanol in Mexico. Based on specific selection criteria (such as available technology, costs, investments, land requirements, energy indexes, emissions to the atmosphere and greenhouse gas reductions) in the short-term, sugarcane is considered the most promising crop. In the mid and long-term, sugarcane could be complemented with other crops and technologies.

It is important to mention that the use of corn for ethanol production is not considered feasible in Mexico because of the importance of this crop as part of the staple diet. The development of this crop for energy use could, at some point, create a dilemma between producing corn to meet food demand or as an energy source.

Across the country, Mexico has more than 600 thousand hectares of sugarcane and approximately 60 sugar refineries, which produce nearly 5 million tons of sugar a year. Some of these refineries already have distilleries with output capacity of 167 thousand cubic meters (167 million litres) of ethanol per year, including 33 thousand cubic meters (33 million litres) of anhydride ethanol. However, a large percentage of this production is committed to the pharmaceutical and the liquor industry. Furthermore, Mexico imports more than 50% of its ethanol requirements.

Current Situation

During the last couple of years, Petróleos Mexicanos has performed a series of studies in order to assure the technical feasibility of using ethanol on its gasoline mix. Results have shown that using ethanol in small amounts does not significantly affect either the performance of vehicles, or the distribution systems.

Considering that current environmental guidelines establish that automotive gasoline in large metropolitan areas must fulfil specific oxygen requirements (between 1.0 and 2.7% in weight), an attractive opportunity for the introduction of ethanol could be the gradual substitution of oxygen components (MTBE).

Nowadays, the amount of oxygen in gasoline, in major metropolitan areas, is set at 2.0% in weight, using MTBE (methyl-terbutil-ether) at 11% in volumetric terms.

In early 2009, the Ministry of Energy established the terms to incorporate anhydride ethanol into the automotive gasoline mix. In this sense, the Ministry divided the introduction of ethanol in three major phases:

- Phase I: Substitution of MTBE by ethanol (5.8% volume) in the three major Mexican metropolitan areas: Mexico City, Monterrey and Guadalajara. Using ethanol, at 5.8% in volume, will fulfil oxygen requirements for metropolitan areas. Current gasoline consumption in these three areas is approximately 220,000 barrels per day. This phase will demand approximately 880 million litres of anhydride ethanol per year (2,410,000 litres per day).

  This phase will consider first the introduction of ethanol to the Metropolitan Area of Guadalajara (2010-2011) and eventually the introduction of ethanol to the Metropolitan Areas of Monterrey and Mexico City.

- Phase II: Substitution of MTBE by ethanol (10% volume) in the three major metropolitan areas. This phase will demand 19,000 barrels per day (3,000,000 litres) of anhydride ethanol and would require approximately 400,000 hectares of cropland a year.

- Phase III: Substitution of MTBE by ethanol (10% volume) in the total gasoline pull across the country. This phase will demand 46,000 barrels per day (7,300,000 litres) of anhydride ethanol and would require more one million hectares of sugarcane cropland a year. Under this scenario, 400 thousand new jobs could be created throughout the whole production process.

Nevertheless, the integration of ethanol in each phase will be subject to the evolution of the market and the availability of ethanol and resources.

For Phase I, in December 2008 and January 2009, Petróleos Mexicanos ran a pilot programme using anhydride ethanol as the oxygenation component for regular gasoline, in one of its storage-sales terminal. The aim of this programme was to evaluate the performance of the gasoline mix throughout the distribution chain, from the storage of raw gasoline and ethanol up to the final sale. The pilot programme also evaluated the use of the gasoline mix in commercial vehicles under specific local conditions.

During 58 days of tests, the pilot programme supplied 2.5 million litres of a mixture of gasoline and ethanol at 5.8% in volumetric terms (2.38 million litres of regular gasoline and 151,600 litres of ethanol), to 2,250 vehicles per day.

The results of this test showed that, technically, the use of anhydride ethanol in small concentrations with regular gasoline is perfectly feasible. Minimum corrosion problems only were identified and these were solved with the use of specific gasoline components.

Ethanol pricing

An important issue related to the introduction of ethanol in Mexico is the setting of a competitive price.

Nowadays, the price of ethanol using sugarcane in Mexico rises to approximately 1.6 US dollars per gallon, compared to 1.3 or 0.5 US dollars per gallon in the US or Brazil. In this sense, the price conditions in Mexico are still far from competitive compared to more technologically advanced countries.

Under real-life conditions, in the pilot test recently performed in Mexico, the price per litre of ethanol was 14.79 Mexican pesos (1.10 US dollar per litre), non including transportation costs and some other special taxes.

Moreover, the massive use of ethanol in Mexico will require additional investments in order to upgrade the infrastructure in the distribution chain. Preliminary studies show that Petróleos Mexicanos needs to invest approximately 10 million dollars into each distribution terminal. In Phase I, the required investments for the distribution terminals of Guadalajara, Monterrey and Mexico City reaches 70 million dollars.

Immediate challenges

Despite being a marginal ethanol producer, Mexico has the possibility to develop a successful ethanol programme. However, in order to do so, it would be necessary to reduce production costs by adopting state of the art technology and investing heavily on the supply side. Only then, will Mexico be able to successfully join the biofuels industry without compromising energy security and development.

It is not considered that ethanol will completely substitute the use of regular gasoline. On the contrary, ethanol could contribute to increasing the life span of hydrocarbon resources.

Nowadays, Mexico does not have the same conditions as Brazil or the US in order to develop a large-scale ethanol industry. Agriculture conditions are different; water availability in Mexico is a delicate issue, agriculture is based on seasonality, plus the sugarcane industry is heavily unionized.

Technically, introducing ethanol to the country's energy mix does not imply relevant challenges. However, there are very important issues to address in order to achieve a self-sustainable ethanol industry: raw material supply, pricing and investments to develop infrastructure.

Mexico is not self-sufficient in ethanol production. An accelerated development of an ethanol industry will have high costs for the country and might limit the benefits of the whole Mexican biofuels programme (increase energy security and boost rural development), jeopardising its success in the long term.

Biodiesel

Currently, Mexico produces small amounts of biodiesel, primarily for research purposes. In 2007, Mexico produced about 70 barrels of biodiesel per day, less than 0.02% of the domestic demand for regular diesel.

Similar toethanol, the Mexican Ministry of Energy recommended the gradual introduction of biodiesel in the country.

Recently, due to more strict environmental regulations, Petróleos Mexicanos is currently substituting regular automotive diesel with ultra low sulphur diesel; however, a negative side effect of reducing sulphur in regular diesel is a significant decrease in lubricity. In this sense, the use of biodiesel could represent an attractive niche market. One of the physical characteristics for some biofuels is the high degree of lubricity.

Currently, Petróleos Mexicanos is evaluating the use of biodiesel as a lubricant for ultra low sulphur diesel. Since November 2008, one of Petroleos Mexicanos refineries is using biodiesel as an additive to increase lubricity in the production of ultra-low sulphur diesel. Total ultra-low sulphur production in this specific refinery is approximately 30 thousand barrels per day.

Biodiesel is used in small concentrations (0.2-0.3%). The current biodiesel consumption in this refinery is 90 barrels a day.

It is important to consider that the cost of using biodiesel, rather than other conventional chemical additives, is higher. However, contrary to the use of ethanol, biodiesel does not require large investments in order to upgrade its infrastructure as biodiesel is mixed within the refineries rather than at distribution terminals.

In the mid to long term, large-scale use of biodiesel in Mexico will be dependent on profitability and availability, as well as environmental benefits.

Nigeria Country Case Study

	Country: NIGERIA	
	Land Availability and Use	**hectares**
	Total land area	92 million
	Land area per capita	723.3
	Total cultivated land area	34 million
	Cultivated land area per capita	267.2
	Total land area used for biofuels production	**hectares**
	Land used for production of:	
	• Sugar cane/beet	33,000
	• Grains	5,142,000 (Maize) 6,095,000 (Sorghum)
	• Oils (Soybean)	617,000
	• Others	2,944,000 (Cassava) 301,000 (Potato)
	Land productivity/Yields (for each biofuel)	**tonnes/hectare**
	• Sugar cane/beet	17.8
	• Grains	1,100 (Maize) 0.8 (Sorghum)
	• Oils (Soybean)	0.55
	• Others	10.8 (Cassava) - (Potato)
	Descriptive Qualitative Information:	

	• Government policies and regulations (incentives, subsidies, export subsidies, import duties, etc) The National Policy on Biofuels, (2007) seeks to establish a thriving fuel ethanol industry utilizing agricultural products as means of improving the quality of automotive fossil-based fuels in Nigeria. It hopes to prepare regulations for sale and use, and guarantee off-take under contractual terms. It aims to achieve job creation, rural and agricultural development and technology acquisition and transfer; attract foreign investment and streamline roles of Federal, state and local governments in bio fuels development. Implementation plan include initial market seeding (E-10), biofuel production programme (PPP) to achieve 100% domestic production by 2020, complete biofuel uptake arrangement, joint-venture distilleries. This is anchored on agricultural productivity and competitiveness. Already US$4 billion committed to sugar-cane sourced ethanol project in the northern states of Jigawa and Benue while cassava-sourced ethanol projects are earmarked for the southern Anambra and Ondo states.
	• Standards in use - Internationally recognized standards
	• Production technologies: Local Technologies
	• Research and Development - NIGERIAN NATIONAL PETROLEUM CORPORATION (NNPC), NATIONAL BIOTECHNOLOGY DEVELOPMENT AGENCY (NABDA), RAW MATERIALS RESEARCH AND DEVELOPMENT COUNCIL (RMRDC)
	• Other relevant information

TOTAL SUPPLY (Litres or Tonnes)

Biofuel	1990	1995	2000	2005	2006	2007
Biodiesel	-	-	-	20T	50T	60T
Bioethanol				30T	70T	80T
Biogas						
Other						

TOTAL NATIONAL DEMAND (Litres or Tonnes)

Biofuel	1990	1995	2000	2005	2006	2007
Biodiesel	200T	250T	275T	280T	290T	300T
Bioethanol	300T	310T	320T	340T	360T	380T
Biogas	-	-	-	-	-	-
Other	-	-	-	-	-	-

EXPORTS (Litres or Tonnes)

Biofuel	1990	1995	2000	2005	2006	2007
Biodiesel	-	-	-	-	-	-
Bioethanol	-	-	-	-	-	-
Biogas	-	-	-	-	-	-
Other	-	-	-	-	-	-

IMPORT (Litres or Tonnes)

Biofuel	1990	1995	2000	2005	2006	2007
Biodiesel	NA	NA	NA	100T	165T	200T
Bioethanol	NA	NA	NA	200T	250T	300T
Biogas	NA	NA	-	-	-	-
Other	-	-	-	-	-	-

PRODUCTION COST (USD/Litre or USD/Tonne)

Biofuel	1990	1995	2000	2005	2006	2007
Biodiesel	NA	NA	NA	500/T	560/T	600/T
Bioethanol	NA	NA	NA	400/T	530/T	550/T
Biogas	NA	NA	NA	300/T	400/T	450/T
Other	-	-	-	-	-	-

Sweden Country Case Study

	Country: SWEDEN					
1	**Land Availability and Use**				**hectares**	
	Total land area				**41 100 000**	
	Land area per capita (9 215 021 Jun 30 2008)				**4,4601**	
	Total cultivated land area				**2 647 700**	
	Cultivated land area per capita				**0,2873**	
2	**Total land area used for biofuels production**				**hectares**	
	Land used for production of:				**(for Biofuels)**	
	• Sugar cane/beet				**0**	
	• Grains				**27 000 (2008)** **100 000 (2009)**	
	• Oils				**15 000 (2008)** **Up to 40 000 (2009)**	
	• Others				**0**	
3	**Land productivity/Yields (for each biofuel)**				**tonnes/hectare**	
	• Sugar cane/beet				**0**	
	• Grains				**1,67**	
	• Oils				**n.a.**	
	• Others				**0**	
4	**Total Supply (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	Etanol	**0**	**0**	**283 000Nm3**	**318 000Nm3**	**359 000Nm3**
	FAME	**0**	**0**	**10 500Nm3**	**65 000Nm3**	**130 000Nm3**
	Biogas	**0**	**0**	**16 100Nm3**	**23 700Nm3**	**28 400Nm3**
5	**Total Demand (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	Same	**as**	**above**	**-**	**-**	**-**
6	**Exports (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	0	**0**	**0**	**0**	**0**	**0**
7	**Imports (litres or tonnes, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	Ethanol		**n.a.**	**213 000**	**248 000**	**288 000**
	Fame		**n.a.**	**0**	**35 000**	**100 000**
8	**Production costs (USD/tonne or USD/litre, for each biofuel)**					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
	n.a.	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
9	**Descriptive Qualitative Information:**					
	• Government policies and regulations (incentives, subsidies, export subsidies, import duties, etc) **Tax exemption on all biofuels**					
	• Standards in use **SS155480 E85, SS155438 Biogas, SS155437 E95, EN14214 FAME improved**					
	• Production technologies **None**					
	• Research and Development **None**					
	• Other relevant information **None**					