ANNEX 2

JI-Project for Bio-diesel Production under the Kyoto Targets

ASTRA BIO DIESEL PLANT, BULGARIA

Baseline Study

Mai 2007

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1 Project activity

The purpose of the project activity is to produce bio-diesel derived from sunflower and rape crops for substituting petroleum diesel. The produced bio-diesel will be distributed on the base of contracts with buyers. These contracts will obligate the buyers to use the bio-diesel only in Bulgaria. The new "Law for stimulating use of RES, AES and bio-fuels" guarantees that the produced bio-diesel will be distributed only in Bulgaria. This law transposes the Directive 2001/77/EC and 2003/30/EC into Bulgarian law.

The reduction of the greenhouse gas (GHG) emissions will be achieved by partially or fully substituting petroleum diesel in transportation. The proposed project aims to reduce GHG in context of JI procedures under the Kyoto Protocol. The project has a capacity of 60,000 tons of bio-diesel per year and is expected to be commissioned in July 2007. The bio-diesel plant will be located in the Rousse Region in the municipality of Slivo pole. This region is one of the 28 Bulgarian regions and consists of eight municipalities. The administrative centre is the city of Rousse. Under article 6 of the Kyoto Protocol the proposed Joint Implementation project aims at reducing GHGs by replacing petroleum diesel with bio-diesel. Due to the following facts the project will contribute significantly to the sustainable environmental-socio-economic development of the whole region of Rousse:

As a result of thorough researches and visits to bio-diesel plants in the Czech Republic and the Slovak Republic, as well as contracting foreign project consultants, ASTRA BIO PLANT Ltd. came to the decision to purchase a modular type of plant that will lead to optimized activities, to develop and modernize production and in future increase the capacity by purchasing and installing other production modules.

The proposed bio-diesel plant will produce bio-diesel according to the requirements of the Norm DIN EN 14214 (equivalent to Bulgarian BDS EEM 14-214) and will have the following content:

№	PARAMETERS	Minimum	Maximum
1	Ester content (% m/m)	96.5	-
2	Density at 15° C g/cm^3	0.86	0.90
3	Viscosity at 40° C mm^2/s	3.5	5.0
4	Flash point ° C	> 120	-
5	Sulphur content %	-	0.01
6	Carbon residue of (10 % mm)	-	0.30
7	Cetane number	51.0	-
8	Sulfate ash content (%)	-	0.02
9	Water content (mg/kg)	-	500
10	Total contamination (mg/kg)	-	24
11	Corrosion copper band (3 h at/50° C)	1	1
12	Oxidation stability at 110° C	6	0
13	Acid value (mg KOH/gr)	-	0.50
14	Iodine value	-	120
15	Linoleum Acid Methyl ester (5 m/m)	-	12
16	Methanol content (% m/m)	-	0.2
17	Free Glycerol (% m/m)	-	0.020

18	Monoglycerides (% m/m)	-	0.80
19	Diglycerides (% m/m)	-	0.20
20	Triglycerides (% m/m)	-	0.20
21	Total Glycerol (% m/m)	-	0.25
22	Alkaline metals (Na + K) mg/kg	-	5
23	Other metals content (Ca + Mg) mg/kg	-	5.0
24	Phosphorus content mg/kg	-	10.0

Table 1: BDS EEM 14-214

To meet the requirements of the norm DIN EN 14214 (equivalent to Bulgarian BDS EEM 14-214) the following technology will be used:
Three main steps are necessary for the production of bio-diesel from rape and sunflower seeds.

The first step is to produce crude oil from the raw material (rape and sunflower seed). The extraction of the raw material process, which takes place in the extractor, includes the use of hexane. The liquid path within the extraction plant is as follows: Fresh hexane is pumped from the hexane storage tanks over the solvent/water separator into the plant. From the solvent/water separator the hexane enters the solvent working tank from where the hexane is fed by the fresh hexane pump over a shower to the extractor. After further processing, the remaining hexane is removed by indirect heating and addition of stripping steam. The hexane phase flows by gravity to the solvent working tank which is equipped with the conical bottom. Fresh hexane is taken out from this tank by the fresh solvent pump of the extractor at an elevated level so that eventually contained traces of water settles in the conical bottom from where it is returned by the water-return pump to the solvent/water separator. The water phase from the water/solvent separator goes by gravity to the waste-after-evaporator, where by the injection of live steam traces of hexane are driven off. The wastewater leaving this wastewater boiler will have only traces of residual hexane and can be piped via wastewater security pit directly into the sewer system. The solvent working tank has an overflow to the underground hexane storage tanks since the capacity of the working tank is not big enough to take up all the solvent coming out of the plant when the plant is being stopped.

The oil press residue will be sold as fertilizer or fodder or fertilizer back to farmers in the region.

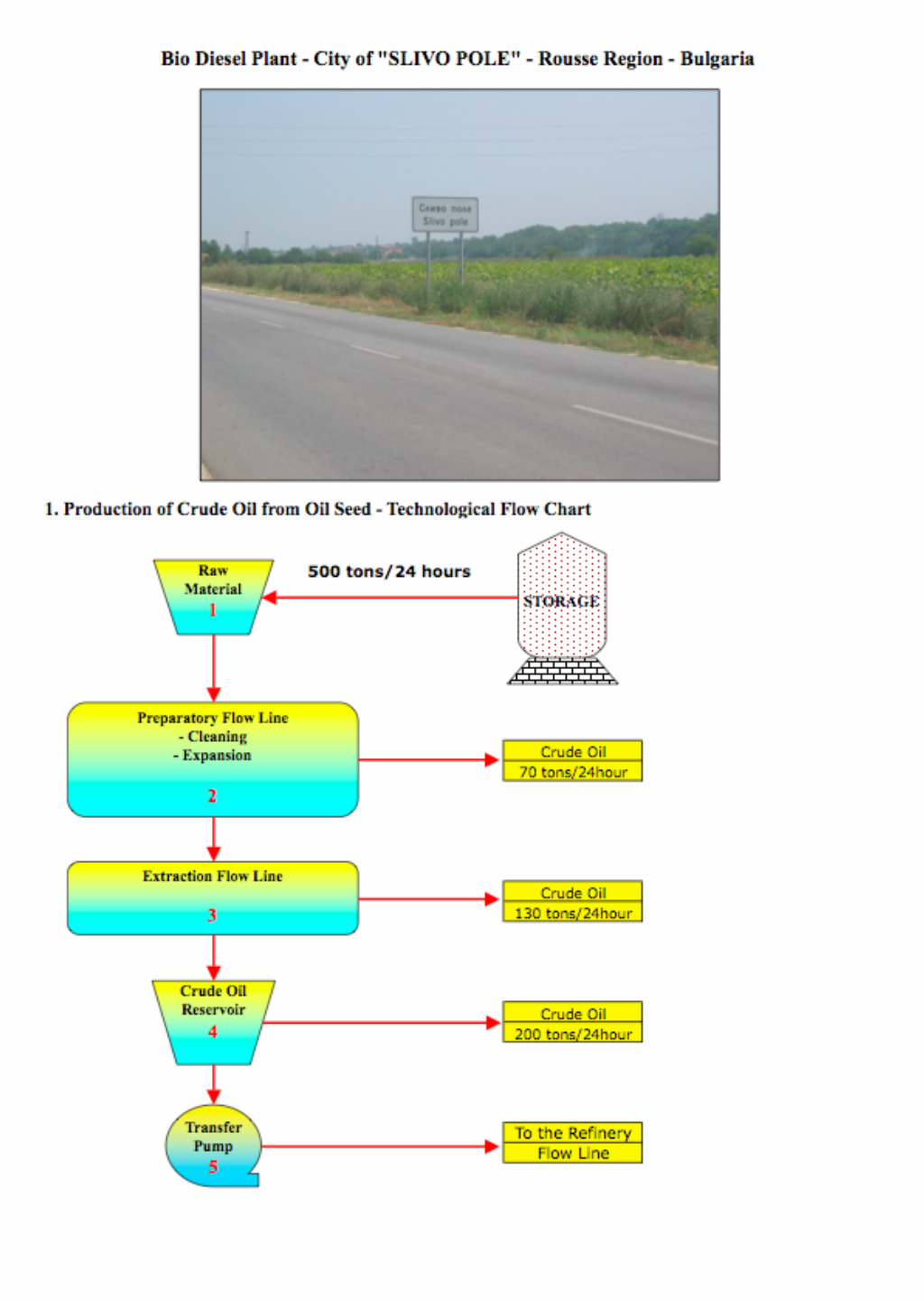

Illustration 1: Production of crude oil form oil seeds

Processing 500 tons/24 hours sunflower seed:

- 200 tons crude oil – 40 %
- 75 tons sunflower peelings – 15 %
- 35 tons water by 7 % humidity
- 10 tons foreign materials by – 2 %
- 180 tons groats – 36 %

The second step is the hydration and neutralization of the crude oil together with phosphoric acid, water and sodium hydroxide. After bleaching and deodorization, the second step is completed with the refined sunflower and rape oil as main output. In case of emergency there is the opportunity to purchase crude oil from the national market.

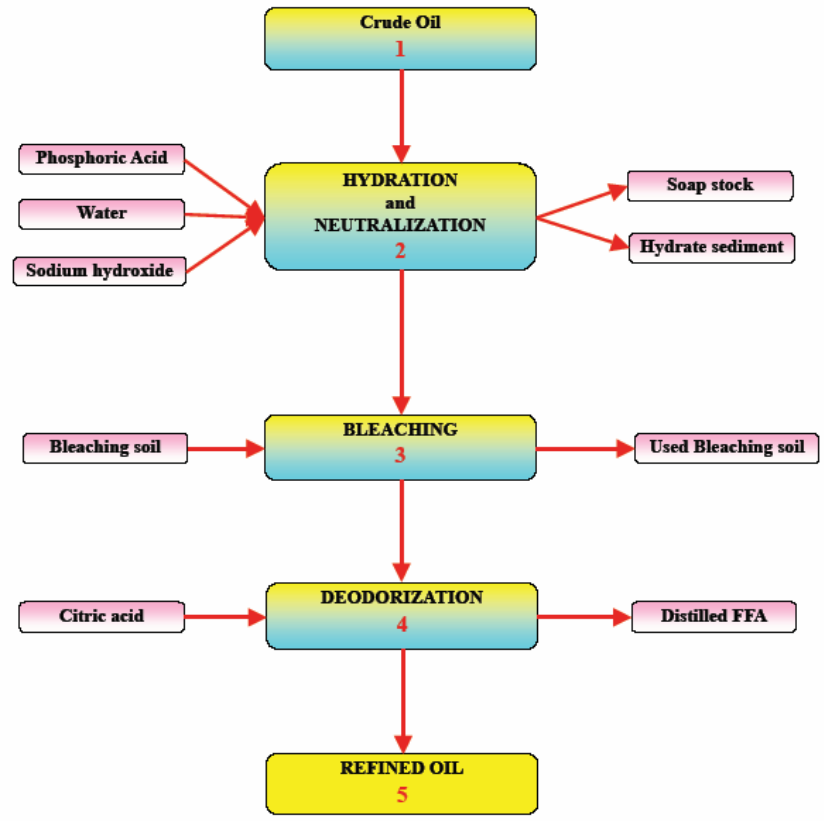

Illustration 2: Refinery flow line – Technology chart

The third step involves the core technology of pre-esterification. Sunflower/rape oil and methanol react (with sodium hydroxide under heating) to bio-diesel and glycerin. After the esterification process the desorption follows, where the two components bio-diesel and glycerin are separated. After neutralization (with phosphoric acid and sodium hydroxide), washing, drying and filtering the end product is the clean bio-diesel.

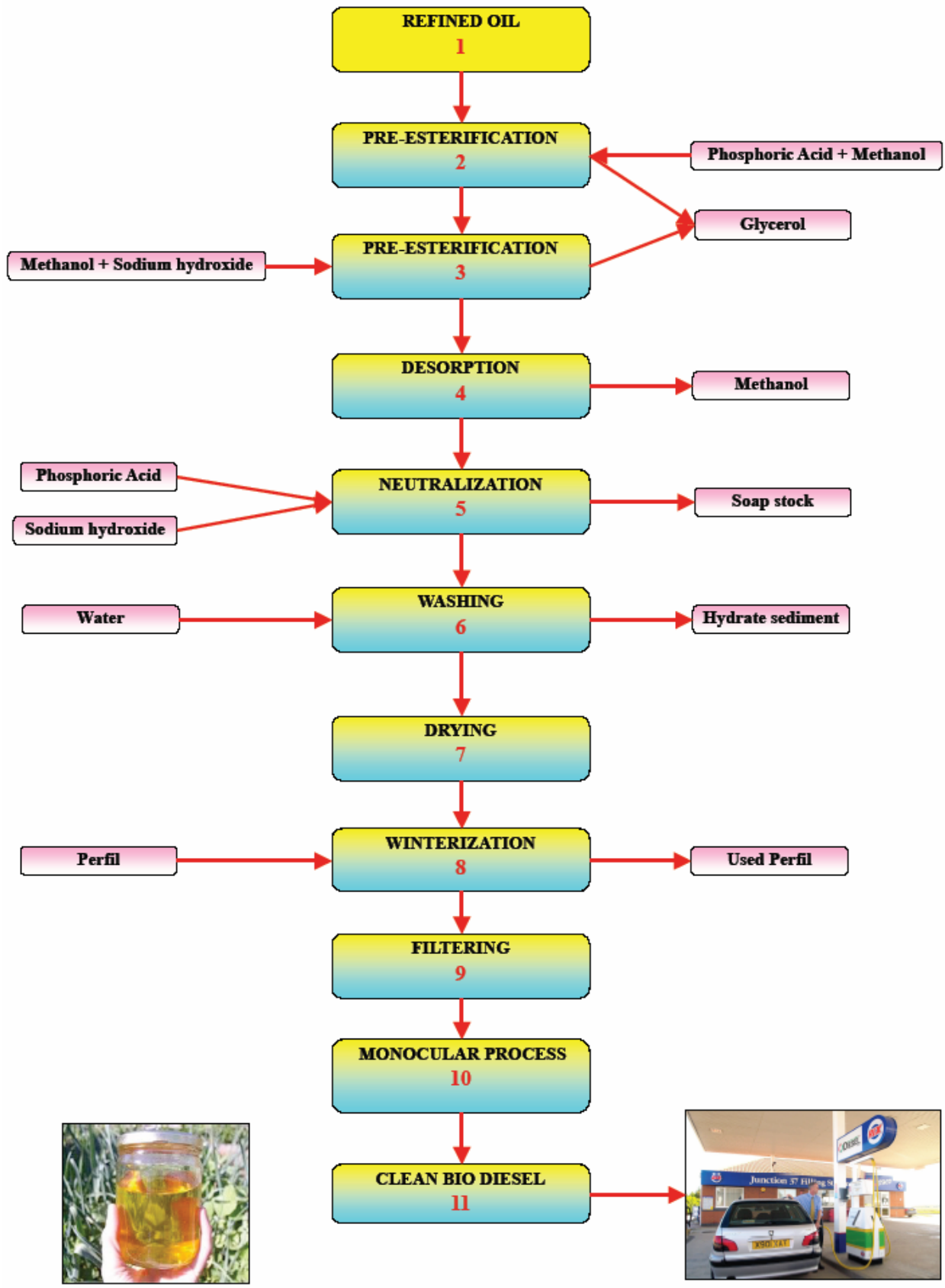

Illustration 3: Production of bio-diesel – Technology chart

The main output of ASTRA bio-diesel plant is bio-diesel and glycerin. For the glycerin ASTRA BIO PLANT Ltd. has three opportunities to exploit:

1. ASTRA BIO PLANT Ltd. uses the glycerin to produce the necessary heating for the process and to heat the building.
2. ASTRA BIO PLANT Ltd. delivers the glycerin to the local heating plant and they use it instead of heavy fuel.

   In any of this case the emissions are calculated, because the emissions during the cultivation and the emissions for the methanol are counted.

3. ASTRA BIO PLANT Ltd. could reprocess the glycerin to a higher quality and sell it to the medicine or cosmetic industry.
   In this case the CO_2-emissions will be reduced, because the carbon content from the glycerin is removed from the system. The same carbon content of glycerin and methanol leads to the situation a reduction of the purchased methanol by the glycerin sold in the emission calculation. As buy-product ASTRA get a fertilizer K_2SO_4. This fertilizer will also be purchased to local farmers.

Bio-diesel fuel as the end product can be used pure (100 % bio-diesel for the ASTRA BIO PLANT Ltd. owned trucks) or will be blended with petroleum diesel to be used as mixed fuel like B5 or B 10. That mixture reduces air pollutants such as particulate matter (PM), polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO), sulphur oxides (SO_x) etc. in comparison to petroleum diesel. Pure bio-diesel fuel has a more pollutant reduction effect than the mixture. The reduction of GHG-emissions will occur through the substitution of petroleum diesel, currently used as energy source, with bio-diesel fuel that would be produced in the ASTRA BIO PLANT Ltd. CO_2-emission will be reduced by substituting petroleum diesel, because combusting of bio-diesel fuel can be counted as zero or “carbon neutral” under IPCC guidelines.

In all contracts between ASTRA BIO PLANT Ltd. and other companies trainings of the employees are stated explicitly:

<u>Training of the operational staff:</u>
Five operators and a mechanic are already employed by ASTRA BIO PLANT Ltd. and they work together with the employees of BIOENERGOMASHPROJECT Ltd.
In the contract between ASTRA BIO PLANT Ltd. and BIOENERGOMASHPROJECT Ltd. is noted

- In chapter “Rights and Obligation of BIOENERGOMASHPROJECT Ltd.”, page 5, clause (6) that BIOENERGOMASHPROJECT Ltd. has “to train specialists employed by ASTRA BIO PLANT Ltd. to work with the installations.”
- In chapter “Rights and Obligation of ASTRA BIO PLANT Ltd.”, page 6, clause (5) that ASTRA BIO PLANT Ltd. has to provide to BIOENERGOMASHPROJECT Ltd. own specialists for training by the BIOENERGOMASHPROJECT Ltd.”

Workshop:
In the workshop three employees will work – an electrician, a fitter and a mechanic. Responsible for workshop will be the Chief Engineer.

2 Project boundary

The project boundaries of the proposed project activities are shown in the figure below. Processes that should be included in the project boundary are:

- Transportation of raw material (sunflower and rape seed) from the field to ASTRA BIO PLANT Ltd. with ABP owned trucks
- Production of crude oil
- Production of bio-diesel
- Transportation of bio-diesel (blended or pure) with ABP owned trucks
- Consumption of bio-diesel and blended diesel by vehicles

The rape and sunflower cultivation processes are not included in the project boundary, because the project proponents cannot directly control these processes. However, the emissions from sunflower and rape seed cultivation outside of the project boundary are calculated as leakage. The emissions caused by the fertilizer production (direct and indirect N_2O emissions) are also calculated as leakage.

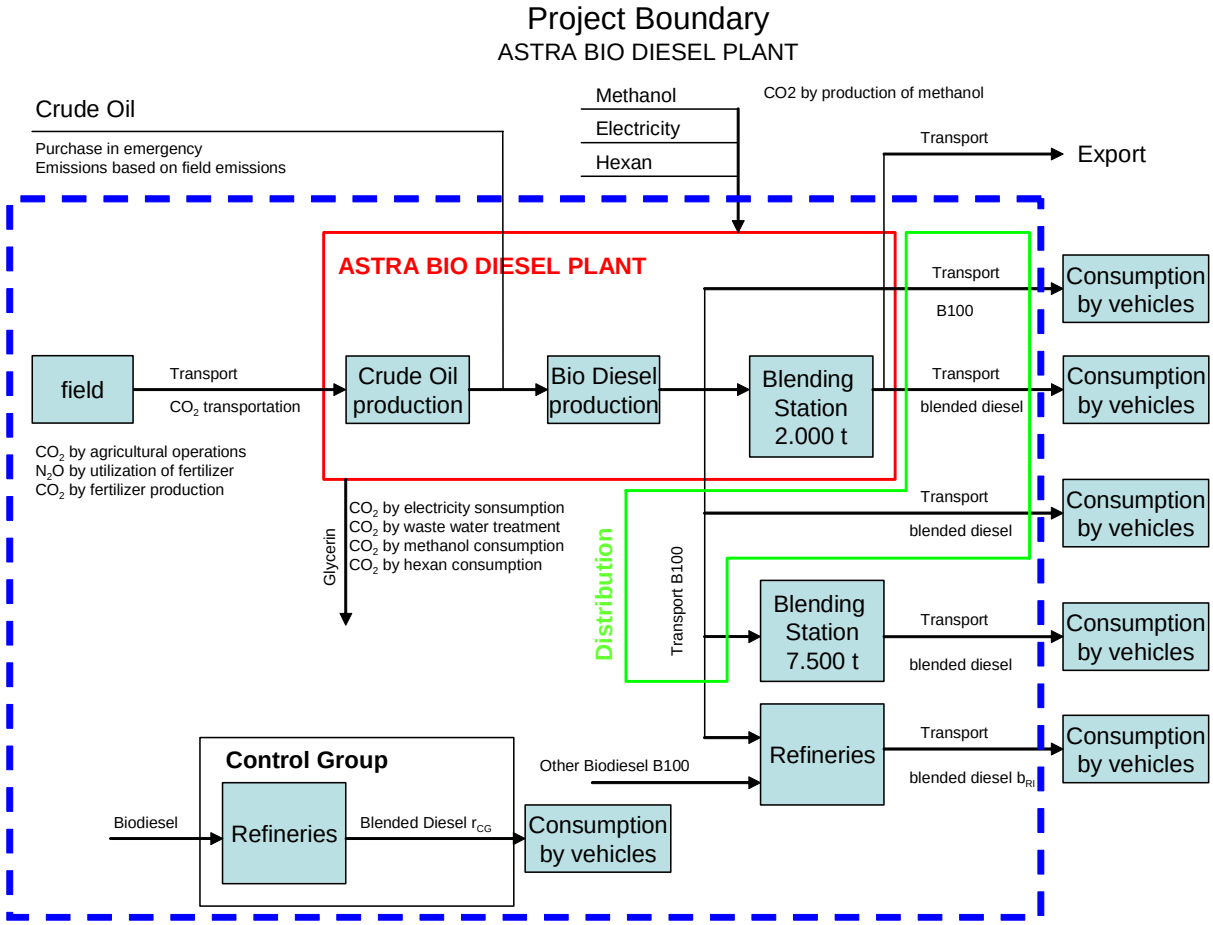

Illustration 4: Project boundaries

	Source	Gas	Included	Monitored	Justification/Explanation
Baseline	Vehicles consuming biodiesel	CO_2	Yes	Yes	Main source of baseline emissions
		CH_4	No	No	Small emission source, and no systematic difference to project activity
		N_2O			
	Mining, transportation of crude oil, refining and transportation of displaced petrodiesel, Well-to-Tank" emissions	CO_2	Yes	Yes	Small emission source
		CH_4	No	No	Small emission source, and no systematic difference to project activity
		N_2O			

	Source	Gas	Included	Monitored	Justification/Explanation
Raw material production	Fossil fuel consumption in agricultural operations	CO_2	Yes	Yes	Outside of the boundary, leakage
		CH_4	No	No	Negligible small
		N_2O			
	Emissions from production of crops	CO_2	Yes	Yes	fertilizer and the production of fertilizer, Outside of the boundary, leakage
		CH_4	Yes	Yes	Negligible small
		N_2O	No	No	
	Fuel combustion during raw material transportation	CO_2	Yes	Yes	"Emission neutral", trucks working with bio diesel
		CH_4	No	No	Negligible small
		N_2O			
Bio diesel fuel production	Electricity consumption in bio diesel production	CO_2	Yes	Yes	Emissionfactor www.moew.government.bg/index_e.html
		CH_4	No	No	Negligible small
		N_2O			
	Hexan consumption for crude oil production	CO_2	Yes	Yes	Measured on the mass of carbon fraction in hexan
		CH_4	No	No	Negligible small
		N_2O			
	Methanol consumption in bio diesel production	CO_2	Yes	Yes	Measured on the mass of carbon fraction in the alcohol
		CH_4	No	No	Negligible small
		N_2O			
	Emissions during methanol production	CO_2	Yes	Yes	Outside of the boundary, leakage
		CH_4	No	No	Negligible small
		N_2O			
	Fuel combustion during fuel transportation	CO_2	Yes	Yes	"Emission neutral", trucks working with bio diesel
		CH_4	No	No	Negligible small
		N_2O			
	Waste water treatment in bio diesel plant	CO_2	No	No	Negligible small
		CH_4	Yes		
		N_2O	No		
Bio diesel consumption	Electricity consumption in refuelling bio diesel or blended bio diesel	CO_2	No	No	Common process in baseline
		CH_4			
		N_2O			
	Pur or blended bio diesel consumption	CO_2	Yes	Yes	CO2 reduction
		CH_4	No	No	Negligible small
		N_2O			

Table 2: Emission sources from baseline and project activities

3 Baseline scenario

The following explanation refers to the latest version[1] of the UNFCCC document: "Tools for the demonstration and assessment of additionality" that provides a step-wise approach to demonstrate and assess additionality:

- Step 0: Preliminary screening based on the starting date of the project activity
- Step 1: Identification of alternatives to the project activity consistent with current laws and regulations
- Step 2: Investment analysis or
- Step 3: Barrier analysis
- Step 4: Common practice analysis
- Step 5: Impact of JI registration

Step 0: Preliminary screening based on the starting date of the project activity

a) The incentive of JI has been considered since the beginning of the project planning. A prove for seriously considering JI in the decision making process is demonstrated by the following illustration that shows the chronology of the PIN and other relevant documents. The PIN was revised twice by the Bulgarian MOEW in order to clarify some details (mainly related to the technology and standard norms of the produced bio-diesel) and sent again to the Bulgarian Ministry of Environment and Water (MOEW) to apply for the Letter of Support. In the PIN the project owner states its interest to obtain the JI incentive for the proposed project. During May 2006 the Letter of Support was issued by MOEW.
Below the chronology of the Bulgarian JI procedures and relevant documents issued and obtained are shown:

[1] Version 2 of 28th November 2005

Date	Description of the Document and Action	Number
22.02.06	First version of PIN sent by ABP to MOEW	188-21/02/06
17.03.06	Letter from MOEW to ABP with request for improvement of the PIN	26-00-587
24.03.06	Second version of PIN sent by ABP to MOEW	
04.05.06	Standpoint by MOEW on the second version of PIN	
May 2006	LETTER OF SUPPORT by MOEW	26-00-587

Date	Description of the Document and Action	Number
12.05.06	Notification Letter for Investment intend	A02079
25.05.06	Standpoint by MOEW – Branch Rousse on the Notification Letter	1860

Date	Description of the Document and Action	Number
03.04.06	Letter from ABP to the mayor of SLIVO POLE – Notification for Investment in the area of the municipality	1527-03/04/06
	Announcement in the local newspaper – Notification for Investment in the area of the municipality	

Illustration 5: Chronology of the PIN, Letter of Support and other relevant documents

Republic of Bulgaria

MINISTRY OF ENVIRONMENT AND WATER

To Whom It May Concerns:

LETTER OF SUPPORT

The Ministry of Environment and Water supports in principle the proposed project idea

Proposal number/date	26-00-587/29.03.2006
Title	Bio Diesel Plant
Location	Rousse Region, City of Slivo polc
Supplier	"Astra Bio Plant" Ltd.

and confirms that it falls within the scope of Joint Implementation projects under the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

The Ministry of Environment and Water will consider granting formal approval of the Joint Implementation project according to the Bulgarian procedures and under the following conditions:

- sufficient amount of allowances is available for electricity production and electricity demand reduction projects in the Joint Implementation set aside in the approved by the European Commission National Allocation Plan;
- positive Environmental Impact Assessment Decision;
- submission of a Project Designed Document, validated by an Independent Entity;
- the buyer of the emission reduction generated by the project is a country that has signed a Memorandum/Agreement on cooperation under Article 6 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change with the Republic of Bulgaria;
- the assessment of the project by the Steering Committee established for this purpose, and according to the Bulgarian criteria is positive.

May, 2006
Sofia, Bulgaria
Jordan Dardov
Deputy Minister of Environment and Water

Illustration 6: Letter of Support by MOEW

The translation of the announcement from 1st April 2006 at the newspaper "UTRO" is shown below.

ASTRA BIO PLANT Ltd.
23 BULGARIA STREET,
CITY OF SLIVO POLE

Makes the announcement that it
has investment intent to build
A BIODIESEL PLANT
In quarters 119, 136 and 137

Illustration 7: Announcement of 1st April 2006 at the local newspaper UTRO

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity

The project activity has two alternatives that are realistic and credible, as given below:

a) Substituting petroleum diesel with bio-diesel (proposed project activity not undertaken as a JI project activity)
b) Continuation of existing practice of using petroleum diesel (business-as-usual)

There are also two non-realistic alternatives:

c) Substituting petroleum diesel with CNG, LNG or LPG
Gas as fuel alternative (CNG, LNG or LPG) for diesel driven engines are non-realistic because diesel driven engines work only with diesel or with a diesel alternative like bio-diesel. Therefore benzene (gasoline), electric or hybrid vehicles are also non-realistic scenarios for diesel vehicles. A switch to alternative fuels as mentioned above bonded with high investments for the vehicle owners due to the exchange of engine.
d) Substituting petroleum diesel with crude oil from sunflower and rape
The development of alternative fuels such as crude oil from sunflower or rape requires creation of additional infrastructure to handle and distribute crude oil fuels for transportation sector. In addition vehicles engines need additional retrofits to use crude oil fuels. All these measurements require huge investments both for the government in creation of infrastructure as well as for the vehicle owners for retrofits. Hence, development of other fuels such as crude oil from sunflower or rape (or mixed) are non-realistic and credible baselines for the project activity.

Sub-step 1b: Enforcement of applicable laws and regulations

The alternatives identified above are in compliance with all applicable legal and regulatory requirements. Moreover, there is no foreseeable regulatory change that would make the above alternatives non-compliant.

Although the EC Directive 2003/30 requires the promotion of bio-fuels by blending it with petroleum diesel, it doesn't include any sanctions for the EU members, if they don't follow the directive.

In addition, the Regulation No 113/17.10.2006 (published on the State Gazette No 88/31.10) was developed. This regulation sets out the conditions and the order for awarding financial grants for the development of environment-friendly agricultural activities under pilot projects under the Special Accession Program of the European Union (EU) for agricultural and rural development in the Republic of Bulgaria. Support will be provided to projects for agro-ecological activities in agricultural entities, which will contribute to the achievement of the objectives of the measure "Development of environment-friendly agricultural activities" from the National plan on agricultural and rural development over the period 2000 – 2006.

In order to include the impact of future binding and enforced legal regulations on bio-diesel production in Bulgaria, this legislative development will be monitored and will therefore be reflected in the Monitoring Plan of this project.

Step 2: Investment analysis to determine that the proposed project activity is not the most economically or financially attractive

This step was not applied to show additionality of the project activity as step 3 was deemed more applicable to the type of project.

Step 3: Barrier analysis

Project proponents selected the barrier analysis for the proposed project activity since the project is with its capacity the first of its kind in Bulgaria and is therefore facing several barriers.

Sub-step 3a: Identify barriers that would prevent the implementation of type of the proposed project activity

The following barriers are identified for the proposed project activity:

Administrative and social barriers
The bio-diesel factory, which is the first implemented project of ASTRA BIO PLANT Ltd., is the first bio-diesel factory with such capacity in Bulgaria. Bio-diesel plants with a capacity with 60,000 tons; such as planned in SLIVO POLE, have not been installed in Bulgaria before. Thus, the affected project participants (authorities, local companies, farmers, neighbors) still lack critical experience with this type of project (environmental impacts, social impacts, technical standards, operational health and safety, etc.).

Barriers due to prevailing practice
The proposed project is with its capacity the first of its kind in Bulgaria and faces some implementation risks. Although the bio-diesel manufacturing is already established in other countries such as the United States of America or European Countries, it has not been successfully implemented in Bulgaria yet.

Due to technological concerns there is no incentive for consumers to change from petroleum diesel to bio-diesel now. One apprehension is that the bio-diesel may affect vehicular performance anticipating poor quality bio-diesel due to the lack of long-term experience. Hence, most vehicle owners prefer to continue using petroleum diesel instead of driving with bio-diesel.

Legal barriers

The European Commission has proposed new legislation to promote the use of alternative fuels for transport, starting with the regulatory and fiscal promotion of bio-fuels like bio-diesel. The regulatory package, which has not been adopted by the member countries but is subject to serious discussions, includes an action plan and two proposals for directives. According to the European Commission, the use of fuels derived from agricultural sources (bio-fuels) is the technology with the greatest potential in the short to medium term. The action plan outlines a strategy to achieve a 20 % substitution of diesel and gasoline fuels by alternative fuels in the road transport sector by 2020.

The taxation directive proposal, which would modify the existing EC Directive 92/81 on excise duties, would allow member states, but not oblige them, to reduce excise duties on pure bio-fuels or bio-fuels blended into other fuels, when they are used for heating or transport purposes. The proposal would allow the countries to reduce excise duties in proportion to the percentage of bio-fuel incorporated in the fuel or end product. No such moves have been initiated in Bulgaria until the end of 2006.[2] At the conference "The Market of Bio-fuels in Bulgaria", organized by Dnevnik newspaper (30 October 2006, Sheraton Sofia hotel Balkan) the new draft act for promotion of the development of bio-fuels was discussed. It deals with the elimination of excise duties on bio-fuels, even when they are in a mixed form. So far fuel, which is a mixture of normal diesel and bio-diesel, was liable to excise duty as pure diesel. The new draft act provides that the excise duty of the mixed fuel will be reduced with such percentage, equal to the percentage of bio-diesel that it contains. The law already passed the first reading by the Bulgarian Parliament.

At the conference mentioned above the Minister of the Economy Rumen Ovcharov announced that "the government has not yet guaranteed for the producers of bio-products the required legal framework so that their projects may become efficient". Mr. Ovcharov thinks that this will be set out in the Renewable Energy Resources Act, which is being developed at present.[3]

Bio-fuels are intended for diesel engines and are environment-friendly. The demand of bio-diesel grows quickly worldwide and the EC Directive 30/2003 encourages in a long-term aspect to sharply increase the share of bio-fuels on the account of petroleum derivatives. In this aspect, bio-diesel will in future occupy basic place among alternative bio-fuels. But up to now due to the barriers mentioned above consumers are scarcely willing to change to bio-diesel and the directive doesn't include any sanctions.

[2] The Sofia Echo, Ivan Vatahov, http://www.sofiaecho.com/article/lower-excise-duties-on-fuels/id_10754/catid_23, status: 2006-09-07

[3] http://www.ebb-eu.org/ and www.mi.government.bg/eng/gzakone/gzakone.html

Economic barriers

At present, there exists a severe implementation risk and investment risk due to the fact that no incentives are available to encourage setting up bio-diesel projects, no framework for removal of barriers, no guidelines are available for bio-diesel manufacturing and no economic incentives are proposed for actual bio-diesel consumers in Bulgaria. Hence, the project activity faces several barriers that prevent the project activity from occurring.

Another noteworthy barrier is the preference of users for price competitiveness with petroleum diesel. Consumers prefer bio-diesel only if the price is set below the market price of petroleum diesel irrespective of costs of production. Up to now, in Bulgaria no price for bio-diesel fuel exists yet. This proves to be a significant barrier to the promoters of bio-diesel projects.

Sub-step 3 b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The identified barriers are not affecting the other realistic alternative identified in Step 1, which is continuation of existing practice of using petroleum diesel that is already widespread and viable.

Step 4: Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity

Bulgaria complies with the requirements of the UNFCCC, ratified by the Bulgarian Parliament in March 1995. Besides, the Parliament of the country ratified the Kyoto protocol to the Convention on 17th July 2002. In Bulgaria, JI projects are viewed as an economically acceptable way of reducing the emissions of anthropogenic greenhouse gases and receiving, at the same time, financial, economic, technical assistance and expertise. In order to start work by the so called “flexible mechanism” under the Kyoto protocol, JI projects have been signed with the Kingdom of Netherlands, the Republic of Austria, the Kingdom of Denmark and the European Bank for Reconstruction and Development (EBRD).

The history of bio-diesel developments in Bulgaria is young.[4] In 2001, the company SAMPO Inc.[5] started the manufacturing of bio-diesel with an annual capacity of 3,000 tons. The effective production volume in 2001 amounted to 26 t, which was sold to fuel distributors and the transport company Trayana Trans. SAMPO used mostly cooking oil supplied by McDonalds, KFC, and Happy etc. The technical standard complies with the Technical Specification TC 0301 (similar to EN 14214). A production plant with an annual capacity of about 500 tons started operation in 2003 and is situated in Gabrovo. The bio-diesel is used as fuel in trucks owned by the company and for heating during the winter. Another plant with an annual capacity of 15,000 tons is currently in process of commissioning. Project proponent is the Green Oil Ltd.[6] in Silistra. The technical standard will comply with EN 14214 and the raw material in use is going to be sunflower, rape and used waste cooking oil. The biggest bio-diesel projects so far planned to be finalized in 2008. The future investment project is developed by Ecopetroleum

[4] Ilian Jeliazkov, February 2005, http://www.esdb.bg

[5] http://www.bio-diesel.bg

[6] http://greenoil.hit.bg

Industries EAD and will be situated in Vidin with its own port on the Danube River. The planned annual capacity amounts to 150,000 tons, rape seeds will use as raw material.

Due to the differences in capacities of the production plants no other identified project activity is comparable with ASTRA's bio-diesel plant project. After searching the website of UN FCCC[7] it can be noted that no other project has applied for getting support from JI mechanism.

It can be concluded that the manufacturing and the use of bio-diesel in the transportation sector has not been fully established in Bulgaria and experiences with the technology is insufficient. Therefore it is not considered as common practice in this country. There is just little local technology available and there are just few experts in the field to apply knowledge in actual projects.

Sub-step 4b: Discuss any similar options that are occurring

Since similar projects are hardly observed in Bulgaria and above all, there are no examples of such projects (with similar capacity) in operation yet, there is no basis for an analysis of similar activities.

Step 5: Impact of JI registration

The proposed project faces a number of barriers. The JI registration would help to surmount these barriers due to the income generated from the Emission Reduction Units (ERUs) sales. The most important element is:

1. JI status of the project activity will alleviate implementation risks and investment risks, because of the additional benefits earned by the emission reduction units. The economy of Bulgaria requires new investments from international sources in the sphere of environmental protection. Transferring the necessary technology and know-how to Bulgaria including the required equipment for bio-diesel production, distribution etc. or the building of local know-how about the technology of bio-diesel production through the involvement of Bulgarian partners in the project will also help to reduce the lack of technical know-how.

Other barriers that can be surmounted by JI registration are:

2. Due to the young history of JI projects in Bulgaria local authorities are inexperienced with JI-procedures (legal framework, handling, competences/responsibility, participants, settlement, monitoring etc.), which means a high risk of delays and maybe even errors in the approval procedures. With the help of this project local authorities will gain more experience, but at the same time the connected financial risks due to delays are covered

[7] http://ji.unfccc.int/

by the revenues of ERUs.

3. It can be demonstrated how trading in emission reductions via the mechanisms of the Kyoto Protocol could support and assist in making the practice of bio-diesel production economically viable, because the project will reduce greenhouse gas emissions and thereby generate ERUs. Approval and registration of the project as a JI project enables the project promoters to reduce the sale price of the bio-diesel in proportion to the benefits received by selling emission reductions. This reduced price enables the bio-diesel to penetrate into the market and removes the barriers that exist in respect of market conditions and low motivation to switch over to the bio-diesel. The current price for 1 liter petroleum diesel to the end consumer is 1.45 BGN/liter in Bulgaria. The production costs for 1 liter bio-diesel are currently 1.09 BGN/liter, while the distribution costs for 1 liter bio-diesel are 1.0 to 1.1 BGN/liter.
4. Further, the project will also deliver local community benefits related to the creation of new jobs during construction, operation and maintenance stages of the production plant and the cultivation of the feedstock. Due to these effects the inhabitants will connect such projects with positive feelings and raises the environmental awareness. Besides, the replication of the project activities in other regions, cities and towns around the country will also trigger environmental awareness related to renewable energy resources and climate change in the involved communities and motivate more people to switch over to bio-diesel driven cars.
5. The project will enable the project developer to carry out additional training activities for staff and construction workers with regard to the new technology being employed.

The emission reductions would not occur in the absence of the project activity due mainly to the barriers mentioned above. Based on the previous considerations, the business-as-usual scenario (use of petroleum diesel) is the most likely scenario without claiming emission reductions through the project activity.

4 Emissions

4.1 Baseline emissions

For the calculation of baseline emissions the following two steps are necessary:

- Methodology to estimate the amount of bio-diesel produced by ABP (Calculation and Check 1-4)
- Calculation of baseline emissions

1. Methodology to estimate the amount of bio-diesel produced by ABP

The calculation of the amount of bio-diesel is shown on spreadsheets “7 BD” in the workbook.

Basis of the calculation is the total amount of sold bio-diesel by ABP:

BD_{sold}:	Name:	Total amount of sold bio-diesel by ABP
	Unit:	t
	Source:	Sale recording data of ABP (Conversion from t in m³ with the value NCVbdf)

Check 1: Countries separation
At first it has to be distinguished between Bulgarian and foreign consumers. Only the amount sold to Bulgarian customers can be used for the calculation of the reduction units. Therefore the address of the consumers has to be monitored or an additional clause concerning the use of the bio-diesel has to be added to the general terms and conditions of the contract. Following that clause the consumers are obliged to use the bio-diesel only in Bulgaria and traders are obligated to sell the bio-diesel only to customers in Bulgaria.

All bio-diesel purchased by Bulgarians is included in the following variable:

$BD_{Bulgarian}$:	Name:	Bio-diesel sold in Bulgaria by ABP
	Unit:	t
	Source:	Sale recording data of ABP

Check 2: Split in distribution channels
The amount $BD_{Bulgarian}$ has to be split in different distribution channels as shown on illustration 9 “Distribution flow chart” of the PDD. The approval delivered by the refineries makes it easy to split up into channel 1-3 and 4. The information delivered in the approval is described later in Check 3.

(BD_1) $BD_{1-3} = BD_{Bulgarian} - BD_4$

BD_{1-3}:	Name:	Bio-diesel sold in Channel 1-3
	Unit:	t
$BD_{Bulgarian}$:	see Check 1	
BD_4:	Name:	Bio-diesel sold in Channel 4
	Unit:	t

Source: Annex 2: Approval delivered by refineries

Check 3: Utilization of purchased bio-diesel by refineries

To be able to guaranty that the produced bio-diesel from ABP delivered to refineries will be used in Bulgaria only, an approval of the refineries with the following content is necessary (the information of these approvals is the basis for check 2 and 3): The approval (see annex 2) will be used to collect the necessary information of all refineries under contract.

Approval of refineries: Annex 2

- Name of refinery and location
- Date
- Name and function of responsible representative
- Signature from responsible person
- Amount of bio-diesel delivered to refinery by ABP: BD_{Ri_Input}
- What happened to this amount of bio-diesel (until to combustion)?
- Amount of bio-diesel sold by refinery to consumers in Bulgaria (t): BD_{Ri_Output}

or

- Amount of sold blended diesel to Bulgarian consumers (t): m_{Ri}
- Quality of sold blended diesel to Bulgarian consumers (%): b_{Ri}

For a conservative calculation the following described methodology is in use:

$BD_4 = BD_{Ri\ Input}$ (Input) → [Refinery i Storage i] → $BD_{Ri\ Output}\ (m_{Ri}, b_{Ri})$ (Output)

(BD$_2$) $$BD_{Ri} = (BD_4) = \begin{cases} BD_{Ri\ \ Input,t} & BD_{Ri\ \ Input,t} < BD_{Ri\ \ Output,t} \\ BD_{Ri\ \ Output,t} & BD_{Ri\ \ Input,t} > BD_{Ri\ \ Output,t} \end{cases}$$

BD_{Ri}	Name:	Conservative amount of bio-diesel of refinery i
	Unit:	t
$BD_{Ri\_Input,t}$	Name:	Amount of bio-diesel sold by ABP to refinery i in year t
	Unit:	t
	Source:	Annex 2: Approval delivered by refineries
$BD_{Ri\_Output,t}$	Name:	Amount of bio-diesel sold in the form of blended diesel by the refinery i in year t
	Unit:	t
	Source:	Annex 2; Approval delivered by refineries
	(BD$_3$)	$BD_{Ri\_Output} = m_{bld} \times b_{Ri} \times NCV_{PD} / NCV_{bdf}$
	m_{Ri}	Name: Amount of sold blended diesel of refinery i
		Unit: (t)
	b_{Ri}	Name: Percentage (energetic) of bio-diesel in sold blended diesel, Quality of sold blended diesel of refinery i
		Unit: (-)
	Sources:	Annex 2: Approval delivered by refineries

Check 4: Checklist for the amount of emission reductions of the refineries due to the "Law to encourage production, distribution and use of bio-fuels"

In compliance with Directive 2003/30/EC the Bulgarian Ministry of Economy and Energy is working on a "Law to encourage production, distribution and use of bio-fuels". The law already passed the first reading by the Bulgarian Parliament. The final voting by the National Assembly of the Republic of Bulgaria is expected by the end of June 2007. The law will provide all necessary information on how bio-fuels (production, distribution or demand) are subsidized in Bulgaria or otherwise supported.[8]

(BD$_4$) $$CF_{Ri} = \left\{ \sum_i \left(\frac{b_{Ri} - r_{CG}}{b_{Ri}} \right) \right\}^{1}$$

CF_{Ri} Name: Correction factor due to uncertainty of law
Unit: (-)
Description: As long as any of the questions of check 4 are answered with "NO", the operation of Astra Bio Diesel JI-Project and all its deliveries of bio-diesel to refineries are additional. Only in case that all answers are "YES" the amount of bio-diesel, which has been blended in the refineries supplied by ABP above the average blending of bio-diesel from non JI bio-diesel producers in the refineries of the control group, contributes to emission reductions compared to the baseline.

Checklist for the amount BD_{Ri}:

- Check 4.1: Legally valid:
  Law passed the parliament and comes into effect: Yes/No
  Source: Annex 1 Ministry of Economy and Energy Questionnaire

- Check 4.2: Specified Target:
  Does the law specify any targets concerning the blending of bio-diesel with petroleum diesel? Yes/No
  Source: Annex 1 Ministry of Economy and Energy Questionnaire

- Check 4.3: Incentives or penalties:
  Is there a penalty or an incentive for the refineries to reach these targets, which in case of non-compliance with the target results in an severe economic loss or benefit for the refinery compared to compliance (e.g. zero excise tax)? Yes/No
  Source: Annex 2: Approval delivered by refineries

- Check 4.4: Control Groups:
  Is the level of blended bio-diesel with petroleum diesel in a comparable control group of refineries in Bulgaria considerable to the level of the ABP delivered refineries? Yes/No

  (BD$_5$) $b_{Ri} \sim r_{CG}$

[8] Secretary of the Energy Committee, 1169 Sofia, 1 Kniaz Al. Batenberg Square; status 2007-05-10

r_{CG} Name: Blended bio-diesel in petroleum diesel in control group
Unit: In energetic %
Source: Annex 4: Information by control group
Description: Amount of bio-diesel not produced in the framework of a JI-project and blended with petroleum diesel in the refineries of the control group

Control group definition for bio-diesel:

Under the current legal framework, Bulgaria can continue existing practice of using petroleum. The EC Directive 2003/30 requires the promotion of bio-fuels by blending it with petroleum diesel, but doesn't include any sanctions for the EU members, if they don't follow the directive. As a result of the implementation of the directive 2003/30 in Bulgaria, the refineries could be forced to blend the petroleum diesel with bio-diesel up to a fixed percentage (target), complying with the standards set out in the directive.

In order to be able to monitor the baseline in the ABP project regarding implementation of the directive 2003/30 in Bulgaria, a control group approach has been proposed. The control group, which is a representative sample to the refinery market in Bulgaria, should meet the following criteria:

- The refineries are situated in Bulgaria.
- Private industrial enterprises, which have ongoing operations in Bulgaria
- The refineries sell diesel to the same kind of costumers.
- The refineries sell bio-diesel as blended diesel according to the directive 2003/30 in Bulgaria.
- The refineries are approximately of the same size as the refineries supplied by ASTRA.

Members of the control group:

- Eko-Elda Bulgaria EAD
  Sofia 1040, 36 Dragan Tzankov Blvd
  Tel: + 359 2 8172020, Fax: + 359 2 9733211
  Activities: 1. Trade of petroleum products
  2. Development and operation of a network of gas stations
  www.hellenic-petroleum.gr/online/generic.aspx?mid=170
- Prista Oil
  7012 Ruse, 73 Borisova Street
  Tel.: +359 2 810111, Fax: +359 2 823253
  www.prista-oil.com
  Activities: 1. Manufacture of more than 150 types and grades of lubricants
  2. Sales and marketing of lubricants, greases, coolants, etc.
  3. Distribution and transportation of lubricants
  4. Purchase, storage and sales of base oils
  5. Collection of waste oils
  6. Cleaning of oil spills
  7. Manufacture of starter, traction and stationary batteries
  8. Sales, marketing and distribution of batteries
  9. Collection and recycling of used batteries
- Shell Gas Bulgaria

1309 Sofia, 117 Zaichar Street
Tel: +359 2 8237337, Fax: +359 2 8284778
www.shell.bg
Activities: 1. Investigation and production
2. Petrol products
3. Chemical products
4. Natural Gas and Electricity
5. Renewable Energy sources

After the "Law for stimulating use of RES, AES and Bio-fuels" has passed the parliament ASTRA will check the suitability of the control group and if applicable will revise the control group.

The control group defined above will be used as a conservative method of monitoring the implementation of the directive 2003/30 of the baseline. The Ministry of Economy and Energy will be approached annually and a written statement requested, which describes the current status of the implementation of the directive across Bulgarian enterprises fitting the defined criteria. When the information of the Ministry of Economy and Energy (Annex 1) states that the directive is being implemented in Bulgaria and bio-diesel – not produced by ABP – sold to refineries in Bulgaria is not arising from any JI/CDM project, then the emission reductions earned by bio-diesel, which was sold to refineries of the project, will no longer be captured.

The questionnaire in Annex 1 will be used to collect the necessary information from the Ministry of Economy and Energy. Annex 2 + 4 provides the necessary information to compare the ABP delivered refineries with refineries in the control group. When this comparison shows that the utilization of bio-diesel in petroleum diesel is common practice, then the emission reductions earned by bio-diesel, which was sold to refineries of the project, will no longer be captured. The questionnaire in Annex 3 will be used to estimate the leakage field emissions associated with the utilization of fertilizer during the crop growing.

Summary of the determination of the amount of bio-diesel fuel:

The above mentioned methodology to evaluate the amount of eligible bio-diesel sold by ABP via distribution channel 1 – 4 is part of the monitoring workbook and Emission Reduction calculation.

Calculation of eligible amount of bio-diesel sold to customers, filling stations, wholesaler or refineries in Bulgaria per year:

(BD$_5$) $BD_y = BD_{1\text{-}3} + \sum_i BD_{Ri} * CF_{Ri}$

BD_y	Amount of bio-diesel	(t)
$BD_{1\text{-}3r}$	Amount of sold bio-diesel in distribution channel 1-3	(t)
CF_{Ri}	Correction factor because of check 4	(-)
$\sum_i BD_{Ri}$	Conservative amount of bio-diesel delivered to refineries	(t)

2. Calculation of baseline emissions

Baseline emission includes emissions from following processes:

- Petroleum diesel consumption by vehicles
- Pre-combustion emissions from production of fossil fuels in the baseline scenario

(II) $BE_y = BE_{BL\_PC,y} + BE_{v,y}$

Pre-combustion emissions from production of fossil fuels in the baseline scenario

$$BE_{BL\_PC,y} = BD_y \times NCV_{bdf} / NCV_{PD} \times EF_{BL\_PC,y}$$

BD_y	Volume of bio-diesel sold to filling stations, wholesaler or in region per year (t)
NCV_{bdf}	Net calorific value of bio-diesel (MJ / kg)[9]
NCV_{PD}	Net calorific value of petroleum diesel (43,33 MJ / kg)[10]
$EF_{BL\_PC,y}$	Emission factor for pre-combustion from production of fossil fuels (0,5 t CO_2 / t)

Leakage associated with production of fossil fuels is calculated based on the amount of displaced fossil fuels and an emission factor for the pre-combustion emissions. The default value for the emission factor $EF_{BL\_PC,y}$ is 0,5 t CO_2 / t of petroleum diesel fuel. This is a conservative value applicable to all types of fossil fuels, in particular: petroleum diesel, gasoline and kerosene. It covers emissions of CO_2 and CH_4 during all steps in the production chain of the fossil fuels until they reach the regional fuel distribution center, such as exploration, production, refining and the different transport steps. The default value for $EF_{BL\_PC,y}$ is based on European data for petroleum diesel.

Emissions from petroleum diesel consumption by vehicles

$$BE_{v,y} = BD_y \times NCV_{bdf} \times EF_{C,petrod} \times OXID_{petrod} \times 44/12 \times 10^{-3}$$

BD_y	Volume of bio diesel sold to filling stations, wholesaler or in region per year (t)
NCV_{bdf}	Net calorific value of bio diesel (MJ / kg)[11]
$EF_{C,petrod}$	Carbon content of petroleum diesel (20,2 t C / TJ)[12]
$OXID_{petrod}$	Oxidation factor of petroleum diesel (0,99)[13]

4.2 Project emissions

(I) $PE_y = PE_{elec,y} + PE_{MeOH,y} + PE_{TfABP} + PE_{TAC} + PE_{ww} + PE_{Hexane} - PE_{Glycerin,y}$

$PE_{Elec,y}$ from electricity consumption in the bio-diesel plant (t CO_2)

[9] Laboratory analysis by SGS BULGARIA Ltd.
[10] Revised 1996 IPCC; Guidelines for national Greenhouse Gas; Table 1-3
[11] Laboratory analysis by SGS BULGARIA Ltd.
[12] Revised 1996 IPCC; Guidelines for national Greenhouse Gas; Table 1-2
[13] Revised 1996 IPCC; Guidelines for national Greenhouse Gas; Table 1-4

$$PE_{Elec,y} = EC_y \times EF_{CO2e,elec,y} \times 1{,}1 \times 10^{-3}$$

EC_y	Grid electricity consumption in bio-diesel plant per year (MWh)
$EF_{CO2e,elec,y}$	CO_2-emission factor of grid electricity consumption by bio diesel plant (kg CO_2/MWh)
1,1	10% additional emissions because of the electricity transport losses Source: JI - Bulgarian Energy Efficiency Project Portfolio, Bulgaria PDD Version 04 – 21 November 2005, Page 3, 4-5

The emission factors $EF_{CO2e,elec,y}$ were taken from the official website of the Bulgarian government http://www.moew.government.bg/index_e.html. The values for the next years are shown in table below:

Emissionfactor for grid electricity	2007	2008	2009	2010	2011	2012
t CO2/MWh	1,102	1,017	0,894	0,858	0,849	0,838

Table 3: Emission factor for electricity

$PE_{MeOH,y}$ from reaction of fossil carbon contained in methanol (t CO_2)

$$PE_{MeOH,y} = ME_y \times 12/32 \times 44/12$$

ME_y Amount of methanol consumed in bio diesel plant per year (t)

The calculation is based on the molar weight ratio 12/32 between the carbon content of methanol and methanol (CH_3OH). To get GHG-emissions from the carbon content is the term 44/12 necessary. It is the molar weight ratio from carbon dioxide and carbon.

PE_{TfABP} from transport field to Astra Bio Plant (t CO_2)

$$PE_{TfABP} = (2 \times D_{fABP} \times EF_{CO2,Truck} \times FE_{Truck} \times (m_{,rape,y} + m_{sunflower,y})) \times 10 / TC_{fABP}$$

D_{fABP}	Average round trip distance between field and ABP (km)
$EF_{CO2,truck}$	CO_2-emission factor of the truck fuel (kg CO_2/l) = 0 kg CO_2/km if truck operates with bio diesel or otherwise

Emission factor conversion			Source
Carbon content in petrodiesel	t C /TJ	20,2	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-2
NCV Petrodiesel	GJ/t	43,33	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-3
Density Petrodiesel	t/m³	0,845	BDS EEM 14-214
Oxidation	t/t	0,99	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-4
Emission of Petrodiesel	t CO2/m³	2,68	Calculated
Emission of Petrodiesel	t CO2/t	3,18	Calculated

$FE_{Truck,}$	Average fuel efficiency of truck (litre/100 km)
$m_{,rape,y}$	Annual mass of purchased crops rape (t)
$m_{sunflower,y}$	Annual mass of purchased crops sunflower (t)
TC_{tABP}	Average truck capacity transport crops (t)

Data Astra Bio Diesel owned trucks:
Type: Mercedes-Benz – 1843 LS / 4x2 / 3600 Axor
Serial Number: 94403212
Power: 428 HP
Fuel consumption: Bio-diesel – 35 l / 100 km

PE_{TAC} from transport Astra Bio Plant to consumers (t CO_2)

$$PE_{TAC} = (D_{fAC} \times EF_{CO2,Truck} \times FE_{Truck} \times BD_{,y}) \times 10 / TC_{tAC}$$

D_{fAC}	Weighted average round trip distance between ABP and consumer (km)
$EF_{CO2,truck}$	CO_2-emission factor of the truck fuel (kg CO_2/l) = 0 kg $_{CO2}$ / km if truck operates with bio-diesel
$FE_{Truck,}$	Average fuel efficiency of truck (l / 100 km)
$BD_{,y}$	Annual mass of purchased bio-diesel (t)
TC_{tAC}	Average truck capacity transport bio-diesel (t)

PE_{ww} associated with the treatment of waste water (t CO_2)

$$PE_{ww} = COD_t \times WW_y \times Bo \times MCF \times GWP_{CH4} \times 10^{-3}$$

WW_y	Waste water production from Astra Bio Plant per year (t)
COD_t	Chemical oxygen demand from oil mill (1,2 kg COD / t WW) IPCC Good Practice Guidance, 5.2.1.2; Table 5.4
Bo	Maximum methane producing capacity (0,25 kg CH_4 / kg COD) IPCC Good Practice Guidance, 5.2.1.2
MCF	Methane conversion factor (1) AM0013; MCF = 1 for conservativeness
GWP_{CH4}	Global warming potential of CH_4 (= 21 t CO_2 / t CH_4)

The source of this calculation is the IPCC Good Practice Guidance (GPG) method for "Emissions from wastewater handling (section 5.2.1.2 (Industrial wastewater) of the GPG report).

PE_{Hexane} from the carbon content in the used hexane (t CO_2)

$$PE_{Hexane} = HEX_y \times 72/86 \times 44/12$$

HEX_y Amount of hexane consumed in bio-diesel plant per year (t)

The calculation is based on the molar weight ratio between the carbon content of hexane and hexane (C_6H_{12}). To get GHG-emissions from the carbon content is the term 44/12 necessary. It is the molar weight ratio from carbon dioxide and carbon.

$PE_{Glycerin,y} = 0$ reduction because of the substituted Glycerin in other industries (0 t CO_2)

This amount is zero because of the conservativeness assumption of calculation.

4.3 Leakage

Leakage emissions:

(III) $L_y = L_{Meth,y} + (L_{argo,y} + L_{PD,y} + L_{field,y}) \times Alpha_y + L_{CrudeOil,,y}$

Leakage emission includes emissions from following emissions

$L_{Meth,y}$ from production of methanol ($t CO_2$)

$L_{Meth,y} =: ME_y * EF_{Meth,pc}$

ME_y Amount of methanol consumed in bio diesel plant per year (t)
$EF_{Meth,pc}$ Pre-reaction emission factor for methanol production (2,0 t CO_2 / t)[14]

$L_{argo,y}$ from consumed fossil diesel during agricultural operation ($t CO_2$)

$L_{argo,y} = (ADC_{rape} \times m_{rape,y}/ Y_{rape,y} + ADC_{sunflower} \times m_{sunflower,y}/ Y_{sunflower,y}) \times density_{PD} \times \times EF_{CO2,petrod} \times 10^3$

ADC_{rape} Annual average diesel consumption per hectare rape (l / ha)
$ADC_{sunflower}$ Annual average diesel consumption per hectare sunflower (l / ha)
$Y_{rape,y}$ Annual average yield rape (t / ha)
$Y_{sunflower,y}$ Annual average yield sunflower (t / ha)
$m_{rape,y}$ Annual mass of purchased crops rape (t)
$m_{sunflower,y}$ Annual mass of purchased crops sunflower (t)
$density_{PD}$ density petroleum diesel (0,845 kg / l)[15]
$EF_{CO2,petrod}$ Emission factor for petroleum diesel (3,18 t CO_2 / t)

Emission factor conversion			Source
Carbon content in petrodiesel	t C /TJ	20,2	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-2
NCV Petrodiesel	GJ/t	43,33	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-3
Density Petrodiesel	t/m³	0,845	BDS EEM 14-214
Oxidation	t/t	0,99	Revised 1996 IPCC; Guidelines for national Greenhous Gas; Table 1-4
Emission of Petrodiesel	t CO2/m³	2,68	Calculated
Emission of Petrodiesel	t CO2/t	3,18	Calculated

$L_{PD,y}$ from pre-emissions of diesel production for agricultural operation ($t CO_2$)

Leakage GHG-emission from mining and transporting of crude oil, refining and transportation of consumed petroleum during agricultural operation ($t CO_2$).

[14] http://edj.net/sinor/SFR4-99art7.html; Specific primary energy consumption in methanol plants is assumed as 30 GJ / t MeOH (Source: http://edj.net/sinor/SFR4-99art7.html). CO_2-emission factor is assumed as 65 kg CO_2 / MJ (average of IPCC emission factors for natural gas and diesel).
[15] EN 590:2004

$$L_{PD,y} =: (ADC_{rape} \times m_{rape,y} / Y_{rape,y} + ADC_{sunflower} \times m_{sunflower,y} / Y_{sunflower,y}) \times density_{PD} \times \times EF_{BL\_PC,y} \times 10^{-3}$$

ADC_{rape}	Annual average diesel consumption per hectare rape (l / ha)
$ADC_{sunflower}$	Annual average diesel consumption per hectare sunflower (l / ha)
$Y_{rape,y}$	Annual average yield rape (t / ha)
$Y_{sunflower,y}$	Annual average yield sunflower (t / ha)
$m_{rape,y}$	Annual mass of purchased crops rape (t)
$m_{sunflower,y}$	Annual mass of purchased crops sunflower (t)
$density_{PD}$	density petroleum diesel (0,845 kg / l)[16]
$EF_{BL\_PC,y}$	Emission factor for pre-combustion from production of fossil fuels (t CO_2 / t)

$L_{field,y}$ from production of crops (t CO_2)

$$L_{field,y} = \sum_i \left(\frac{Mcrop_{i,y}}{Y_{i,y}} \right) * EF_{N,i,y}$$

$Y_{i,y}$	Annual average yield feedstock per ha and crop i (t / ha)
$Mcrop_{i,y}$	Annual purchased mass of crop i (t) = $m_{rape,y}$, $m_{sunflower,y}$
$EF_{N,I,y}$	Emission factor for enhanced N for crop i (t CO_2 / ha)

Emissions from agricultural operations are calculated based on the measured annual purchase of mass of crop i, average yield from crop i, annual average diesel consumption, as shown in equation above.

The emission factor $EF_{N,i,y}$ is composed of three components: Fertilizer N converted to N_2O when applied to the soil, energy consumption for production of synthetic N-fertilizer, and crop residue N converted to N_2O after being returned to the soil.

$$EF_{N,i,y} = EF_{FN,i,y} + EF_{FP,i,y} + EF_{RN,i,y}$$

$EF_{FN,I,y}$	Emission factor N_2O emissions from fertilizer N applied to soil (t CO_2 / ha)
$EF_{FP,I,y}$	Emission factor for GHG-emissions associated with N-fertilizer production (t CO_2 / ha)
$EF_{RN,i,y}$	Emission factor for N_2O emissions from crop residue N returned to soil (t CO_2 / ha)

$$EF_{FN,I,y} = m_{SN,I,y} \times EF_1 \times 44/12 \times GWP_{N2O}$$

The N_2O-emission factor for fertilizer N, $EF_{FN,i,y}$ is calculated based on the amounts of organic and synthetic fertilizer applied to oil crop i, and a default emission factor EF 1, in accordance with equation above.

[16] EN 590:2004

$$EF_{FP,I,y} = (m_{SN,I,y} - m_{RNEXI,y}) \times EF_2$$

The emission factor for production of synthetic fertilizer, $EF_{FP,i,y}$ is calculated based on monitoring consumption of both synthetic and organic fertilizer for crop i, and adjusted for residue N exported as fertilizer to other farmers $m_{RNEXI,y}$, in accordance with equation above. Organic fertilizers such as animal manure (but not residues from the oil crops) are included because such fertilizers are usually scars; hence consumption for the oil crops will likely induce higher consumption of synthetic fertilizer elsewhere. Residue N exported to other farmers (especially de-oiled seed cake) is deducted because these residues will likely displace synthetic fertilizer elsewhere, based on the same logic.

$$EF_{RN,i,y} = (m_{RN,I,y} - m_{RNEXI,y}) \times EF_1 \times 44/12 \times GWP_{N2O}$$

The N_2O-emission factor for residue N returned to soils, $EF_{RN,i,y}$ is calculated from the total amount of residue N from crop i that is returned to (any) soil $m_{RN,I,y}$, minus the amount of residue N exported as fertilizer to other farmers $m_{RNEXI,y}$. The deduction for exported N is again based on the assumption that these exports will displace other fertilizer, which would result in the same N_2O-emissions in the baseline scenario. The total amount of residue N $m_{RN,I,y}$ is defined by the mass of the residues returned to soils and their respective N-contents. It includes de-oiled cake as well as any other residues of relevant volume and N content which are returned to soils, such as e.g. shells, butt not the leaves shed by deciduous trees.

$m_{SN,I,y}$-	Synthetic fertilizer-N applied to crop i in year y (kg N / ha)
$m_{RNEXI,y}$	Residue-N from crop i exported as fertilizer (= not returned to crop plantation i) (kg N / ha)
$m_{RN,I,y}$	Amount of residue-N from crop i that is returned to any soil (kg N / ha)
EF_1	Fraction of fertilizer N converted to N_2O-N (0,0125 kg / kg)[17]
EF_2	Upstream emission from production of synthetic fertilizer (2,2 kg CO_2 / kg N)[18]
GWP_{N2O}	Global warming potential of N_2O (= 310 t CO_2 / t N_2O)

$Alpha_y$ because of the utilization of fellow land during agricultural operations (-)

$$Alpha = Area_{FL} / Area_{AP}$$

$Area_{FL}$	Area of fellow land in Bulgaria (ha)
$Area_{AP}$	Area with agricultural purpose in Bulgaria (ha)

The value Alpha shows the fraction of used fellow land by ASTRA BIO PLANT. The demanded rape and sunflower crops have an influence on the demand of agricultural used area in Bulgaria. The additional production of rape and sunflowers replaces on the one hand the crop production on the existing agricultural land and on the other hand, if fellow land will be used, the fraction between fellow and already cultivated land. If the crops grow up on already existing fields the emissions from transportation, diesel consumption during the agricultural cultivation

[17] IPCC 1996 Revised Guidelines for Natural GHG Inventory, Reference Manual p. 4.89
[18] Average emission factor for production of N fertilizer, assuming primary energy demand of 38,9 MJ / kg N and natural gas as the primary energy source (http://www.fao.org/wairdocs/lead/x6113e/x6113e09.htm).

(leakage) and from the already used fertilizer (leakage) are not additionally, because the emissions are now in the baseline. If fellow land will be used for the cultivation of rape and sunflowers the emissions are additional. Because the allocation of additionally used fellow land by the ASTRA BIO PLANT is difficult and too many factors influence this value, in case of conservativeness, the fraction between fellow land and land with agricultural purpose ascribe to the project demand.[19]

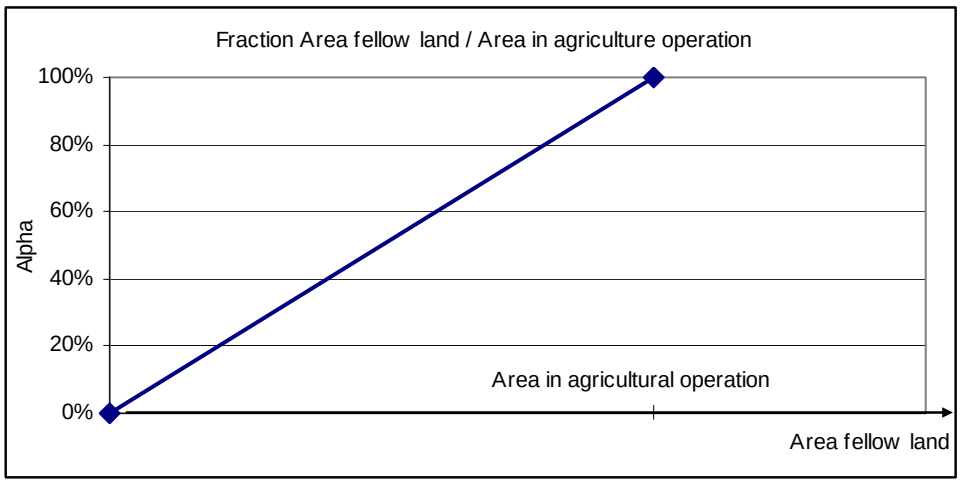

Illustration 8: Alpha; Fraction area fellow land / area in agriculture operation

The illustration above gives a better understanding for the value alpha. In case that the entire agricultural area in Bulgaria is used, the value for alpha is zero. The additional demand on farmland, which is needed to produce oil crops, will be satisfied by existing agricultural used areas. The emissions from the fields are not additional, because of the emissions for the production of other crops. If all of the land is fellow land, then the emissions during the production of oil crops are 100 % additional.

$L_{CrudeOil,,y}$ from purchase of crude oil in emergency cases (t CO_2)

$$L_{CrudeOil,,y} = (L_{argo,y} + L_{PD,y} + L_{field,y}) / (m_{rape,y} + m_{sunflower,y}) \times m_{CrudeOil,y} \times alpha / CF_{CrudeOil/Crops}$$

$m_{rape,y}$ Annual mass of purchased crops rape (t)
$m_{sunflower,y}$ Annual mass of purchased crops sunflower (t)
$m_{CrudeOil,y}$ Annual mass of purchased crude oil in emergency cases (t)
$CF_{CrudeOil/Crops}$ Conversion factor for received mass of crude oil per mass crops [0,3]

As shown on page 5, the production of 400 kg crude oil needs 1.000 kg crops (sunflowers). The mass of crude oil is 40 % of the mass of purchased sunflowers. The exploitation of the pre-treatment depends on the bonded oil content in the crop. Rape has a lower oil content as sunflowers. For a conservative calculation of emission reduction units a value of 30 % will be used.

[19] http://www.mzgar.government.bg; The values are released by the Bulgarian ministry of agriculture and forestry in Annual Reports.

4.4 Emission reduction

(24) $ER = BE_y - PE_y - L_y$

ER	Annual emission reduction	t CO_2
BE_y	Annual baseline emissions	t CO_2
PE_y	Annual project emissions	t CO_2
L_y	Annual leakage emissions	t CO_2