ENERFISH

Integrated Renewable Energy Solutions for Seafood Processing Stations

Project number:	219008	*Funding scheme:*	Collaborative projects
Start date:	2008.10.01	*Duration:*	36 months
Call identifier:	FP7-ENERGY-2007-2-TREN		

Deliverable 10
Environmental Impact Assessment Report

Revision	Organization	Date & Visa	Due date of the Deliverable
Written by	TÜV	01.04.2011	
Checked by	All Partners	18.04.2011	
Validated by	VTT	21.04.2011	30.04.2011

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
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2	Technische ûberwachungsverein Rheinland	TÜV	Germany
3	Technofi	Technofi	France
4	National Energy Foundation	NEF	Great Britain
6	Hiep Thanh Seafood Joint Stock Company	HT-FOOD	Vietnam
7	Preseco	Preseco	Finland
8	Vahterus	Vahterus	Finland
9	ECC	ECC	Vietnam
10	RCEE Energy and Environment JSC	RCEE	Vietnam
11	AF Industry JSC	AFI	Vietnam

ENERFISH Pilot Plant

at

HT FOOD

In

Vietnam

EIA Report

Date: 18.04.2011

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List of Abbreviations:

EIA	Environmental Impact Assessment
EMP	Environmental Monitoring Program
EMPs	Environmental Management Plans
TOR	Terms Of Reference
scm	Standard cubic meter
mg	Milligrams
rpm	Revolutions per minute
Noise and Vibration “NV”	Acronym meaning the main relevant noise and vibration emissions occurring during the plant operation phase caused by drilling and blasting processes.
US-EPA	United States Environmental Protection Agency that for examples releases US standards.
db (A)	Unit for sound pressure level in decibel
DIN	Deutsche Industrie Norm; Germany industry standard
accum.	accumulated
Pa	Pascal (physical unit for pressure)

1. Executive Summary

1.1. Project Description

A new polygeneration application with renewable energy sources was planned for the fishery industry. A pilot plant which is subject of this Environmental Impact Assessment was erected in Vietnam.
There, the distributed energy system utilizes cleaning waste of a fish processing plant to produce biodiesel. The biodiesel is used to produce the locally needed cooling/freezing and heating energy. In addition, a power surplus is generated for the electricity network or local industrial use. The cooling/freezing system is based on an advanced CO_2/ NH_3 based technique.

Within the pilot plant, the main product of the fish processing plant is catfish filet (about 40 t/d). The fat content of 22 per cent in the fish cleaning waste results in a production of biodiesel of about 13 t/d. A part of biodiesel is used to produce electricity for the locally needed cooling/freezing (0.3 MW) and heating (1,3 MW) energy. In addition, a power surplus (0,8 MW) is generated for the local industrial use.

1.2. Findings

Source	**Kind of impact**	**Relevance of impact (low, medium, high)**	**Recommendable measure**	**Appropriate measure planned**	**Overall assessment on environmental impact**
Additional transportation measures mainly during construction and decommissioning phase	Noise and air emissions	low	none	Not applicable	acceptable
Accidents during operation phase	Spilling of oil or methanol	Medium (theoretical danger, no direct impact)	emergency response plans, training of staff	Yes	acceptable

Table 1 Main findings on environmental impacts

In general it can be stated, that the environmental impact the project causes is comparatively small. The worst theoretical impact is an accident. Taking accidental events out of consideration, the maximum impact reflects additional emissions (noise and air) due to transportation measures caused by the construction and deconstruction phase respectively.
The amount of these additional emissions is very small.

2. Introduction

2.1. Project Title and Project Proponent

Project Title	Enerfish
Project Location	
Project Proponent	HT-FOOD Mr. Nguyen Van Phan Managing Director address
Proponent's Consortium Partner	Enerfish Project team VTT TUV Technofi NEF Preseco Vahterus ECC RCEE AFI please find further information and addresses of the partners at www.enerfish.eu

2.2. EIA Consultants

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2.3. Project Rationale

Part of the EU-funded Enerfish project was the erection of the pilot plant using fish wastes and producing energy.

As it was part of the project approach to demonstrate the ability of such biodiesel process, also the impacts of the process torwards the environment shall be regarded.

TÜV Rheinland acts as work package leader within the Enerfish project, leading work package 4 and being responsible for the provision of this EIA report.

TÜV Rheinland Energie und Umwelt GmbH / TÜV Rheinland Group, established in 1872, is since many years a well established and accredited test institute. TÜV Rheinland advises, develops, facilitates, test and certificates. The worldwide network of experts assists leading enterprises and institutions with the continuous improvement of products, systems and processes.

In the fields of Environmental Protection and Energy Technology applied research projects have been conducted for more than 25 years, such as:

- Air pollution and noise control for all type of emission sources/pollutants,
- Environmental analysis / planning / licensing / impact studies (air, noise, waste),
- Certifications of automated monitoring instruments (flue gas emissions, air quality, acquisition and telecommunication of data),
- Energy technologies with efficiency testing and certification (boilers, armatures, safety and systems e.g. fuel cell, co-generation) and of renewable energies (solar/wind, PV, biomass).

Testing and auditing of both, simple and complex systems and processes are the core business of TÜV Rheinland. Typical working fields concern about:

- Environmental protection (multi-media in sectors: air, noise, soil, water, waste)
- Innovative measurement techniques and process operations
- Conventional energy technologies and energy efficiency measures
- Renewable energies (esp. solar) with utilisation in test rigs and field plants
- Safety and performance testing as well as certification of products and systems
- Greenhouse gases and climate protection (including associated strategies for Emissions Trading acc. Kyoto Protocol and EU Directives).

For the appropriation of these services for industrial and public clients nationally and internationally there are working approx. 120 experienced experts of different faculties.

Extensive laboratories, test facilities and mobile measuring devices are available with most modern equipment. The practical knowledge is permanently improved by performing consulting contracts for various clients. Especially in the field of assessment of the state of art technology and of balances and impacts of pollutants from industries, trade, traffic etc. the company has already performed several studies for private companies, government agencies, national and international institutes/ organisations (e.g. EC). TÜV Rheinland's experts are participating in bodies for standardisation of technical rules, such as VDI/DIN and CEN/ISO.

3. Legal Framework

In general for EIA reports the directives 85/37/EEC and 97/11/EC define requirements on EIA reports. According to this, in the following chapters specific aspects will be described which are concerned by the Enerfish project. It is aimed to point out significant effects on the environment by virtue, inter alia, of the nature, size and location of the project.
Specific national legislation will be considered whenever applicable and affected.

In general, the environmental impact of projects shall be investigated in order to avoid avoidable negative impacts to the environment or at least to minimize unavoidable impacts and elaborate appropriate mitigation or compensation measures. It shall not be neglected that also positive impacts might occur.
Any potential risk (both positive and negative effect) shall be discussed.
Furthermore, legal requirements affected by the proposed project must be met e.g. compliance with technical, safety and environmental regulations.

4. Project Description

4.1. Statement of Need

In Vietnam the commercial final energy use shows an average growth rate of 12.4 % per year (during the period from 1999-2006) [1]. Whilst the GDP only grew by 7.2 % in the same period there is a high need for measures and projects to increase the energy efficiency or to exploit additional energy sources. Regarding additional energy sources, it is not a sustainable solution to increase the use of fossil energy sources. Therefore, specific attention should be paid to sustainable solutions like renewable energies and waste-to-energy approaches.

The proposed project is connected to a fish-farming company which location is predicted by the existing water resources in the Mekong delta. The processing of fresh fish is done at the company's premises in order to avoid long distance transportation of living animals and goods like water, fish bones etc. which is not needed to be transported at all. In order to ensure high quality fish product, the fishes are processed on site and the fish filet must become frozen immediately after the processing. Both for the fish freezing process as well as for the storage of frozen fish there is a high demand on electric energy.

Energy supply in Vietnam is characterized by a comparatively high number of power black outs. This is always a danger for the frozen storage, because in case the temperature inside the warehouse increases too much, the entire fish amount would have to be thrown away.
Therefore emergency power generator is provided at the plant location and there exists a general approach to provide self-sufficient solutions for energy and power production.

The proposed project offers solutions for both, a new and sustainable utilization of fish waste for production of bio diesel and, by this, a self-sufficient power generation option.
Furthermore by installation of a new and modern cooling and freezing system, consisting of CO_2 and NH_3 cooling cycles, an important contribution to an energy-efficient use of electricity is done.

Because of the nature of energy source becoming utilized and the increase of energy efficiency by the installation of new cooling and freezing applications, there is a clear need to realize the project which is by the way also co-financed by the EU aiming to promote such new technical developments and supporting countries like Vietnam.

4.2. Concept and Phases

The general concept of the project is to use fish waste that anyway occurs during the existing daily operation of the fish factory. This waste is currently not used anymore by the company HT Food but sold out to the market. Specific companies buy this waste material in order to produce fish food for fish breeding farms. As this is a kind of cannibalism as the same species of animals get food from its own species, this would not be allowed in Europe. Also due to this, within the concept of this project the fish waste should be used for another purpose as it still has a high fat content. First the fat has to be separated e.g. from bones and a fish oil is separated. The fatty fish oil can be used within the Preseco process adding methanol and performing an esterification. By this bio diesel is produced which can be burned within power generators.

In order to realize this project more than two year of project definition and documentation was done. During this time, also the detailed engineering for the entire process was performed.

Nowadays, the entire project can be divided into three main phases. As mentioned there was a previous phase of planning which is not further regarded by this Environmental Impact Assessment.
The three main phases now concerned are:

- construction phase for realizing the project infrastructure and devices
- operation of the biodiesel and cooling/freezing system and
- decommissioning

In contrast to the construction and operation the decommissioning is not yet intended, but nevertheless also environmental impacts occurring during this phase will be discussed based on a theoretical approach.

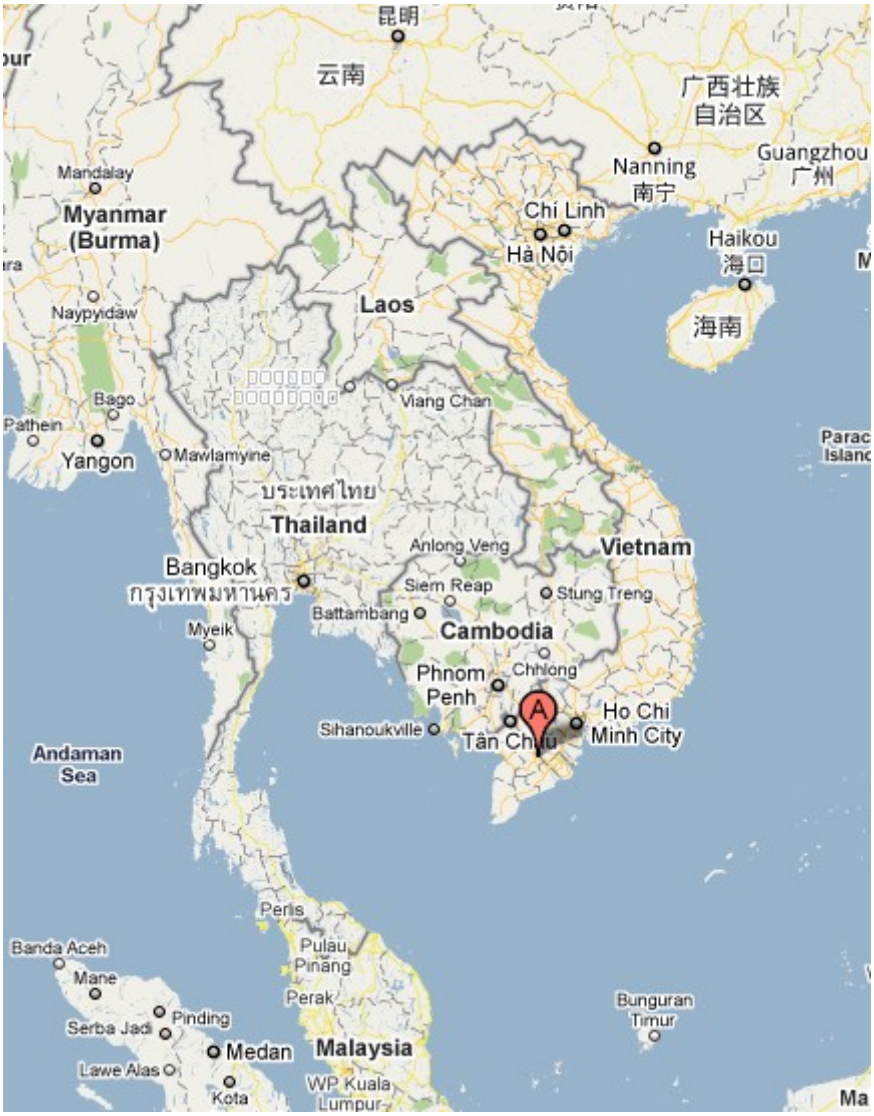
The realization of the construction phase is done by the parties involved within the EU-funded Enerfish project. Preseco as well as Vatherus in cooperation with the Finnish company Suomen Tekojaa will deliver their systems and take care for the installation.
The Vietnam company RCEE is responsible for the overall engineering tasks. AFI will develop an overall monitoring and control system for the new biodiesel and cooling/ freezing plant. HT Food will provide respective space at their premises and will support the installation by provision of technicians. Furthermore they will provide auxiliary systems such as storage tanks and the power generator.
The construction phase also includes test runs of the systems.

Later on the operation phase is handled by HT-Food.

The decommissioning phase, that is not yet intended to be done, is within the responsibility of HT Food.

4.3. Location, Scale and Scheduling of Activities

The realization of the project will take place in Vietnam at the premises of HT Food, a fish factory located in National Highway 91, Thot Not District, Can Tho City Viet Nam. The exact location of the factory can be seen in the following figures.


昆明
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自治区
Nanning
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Guangzhou
广州
Mandalay
Myanmar
(Burma)
Chi Linh
Hà Nội
Haikou
海口
Naypyidaw
Laos
海南
Bago
Viang Chan
Pathein
Yangon
Mawlamyine
Paracel Islands
ประเทศไทย
Thailand
Anlong Veng
Vietnam
Bangkok
กรุงเทพมหานคร
Siem Reap
Stung Treng
Battambang
Myeik
Cambodia
Chhlong
Phnom
Penh
Ho Chi
Minh City
Sihanoukville
Tân Châu
Andaman
Sea
Perlis
Banda Aceh
Pulau
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Medan
Malaysia
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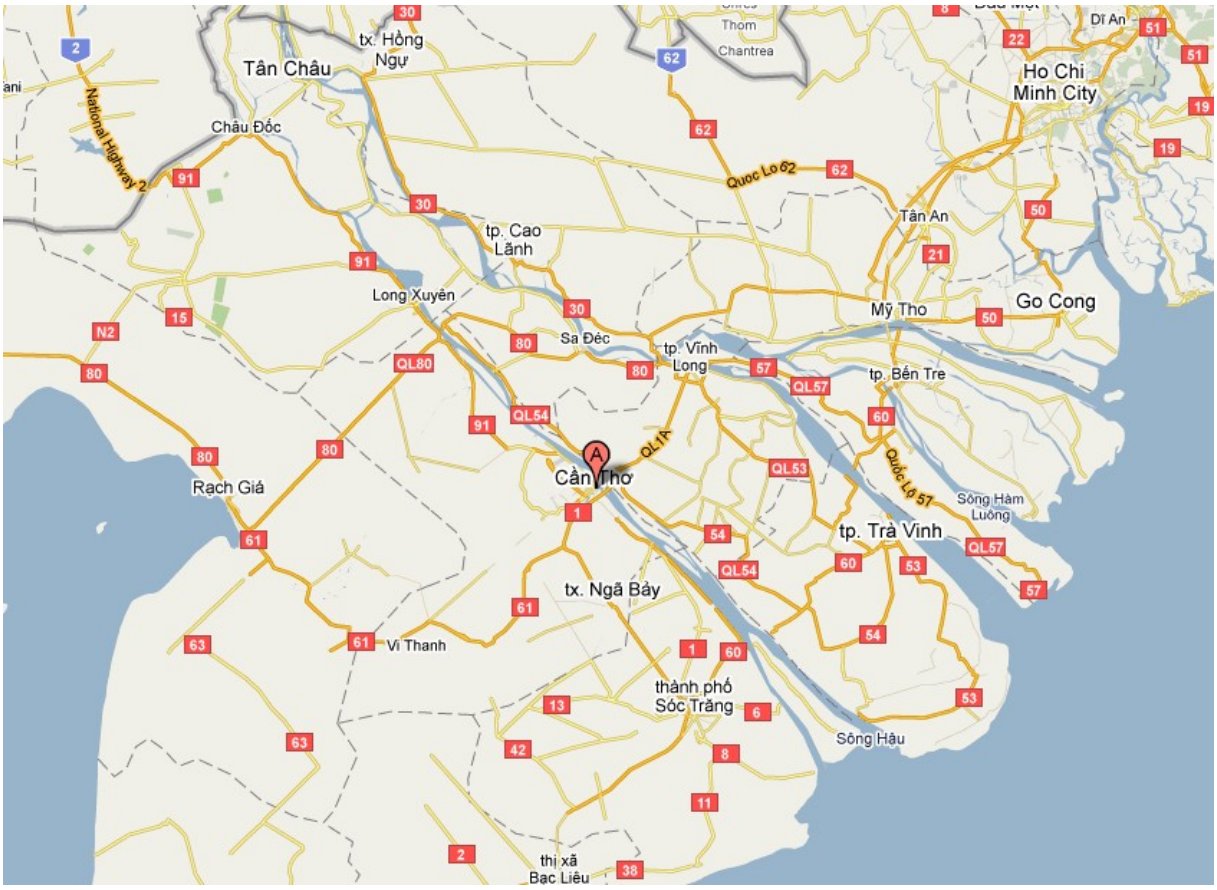
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Châu Đốc
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Dĩ An
Ho Chi Minh City
Quốc Lộ 62
Tân An
tp. Cao Lãnh
Long Xuyên
Mỹ Tho
Go Cong
Sa Đéc
tp. Vĩnh Long
tp. Bến Tre
QL80
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QL1K
QL53
QL57
Cần Thơ
Rạch Giá
Sông Hàm Luông
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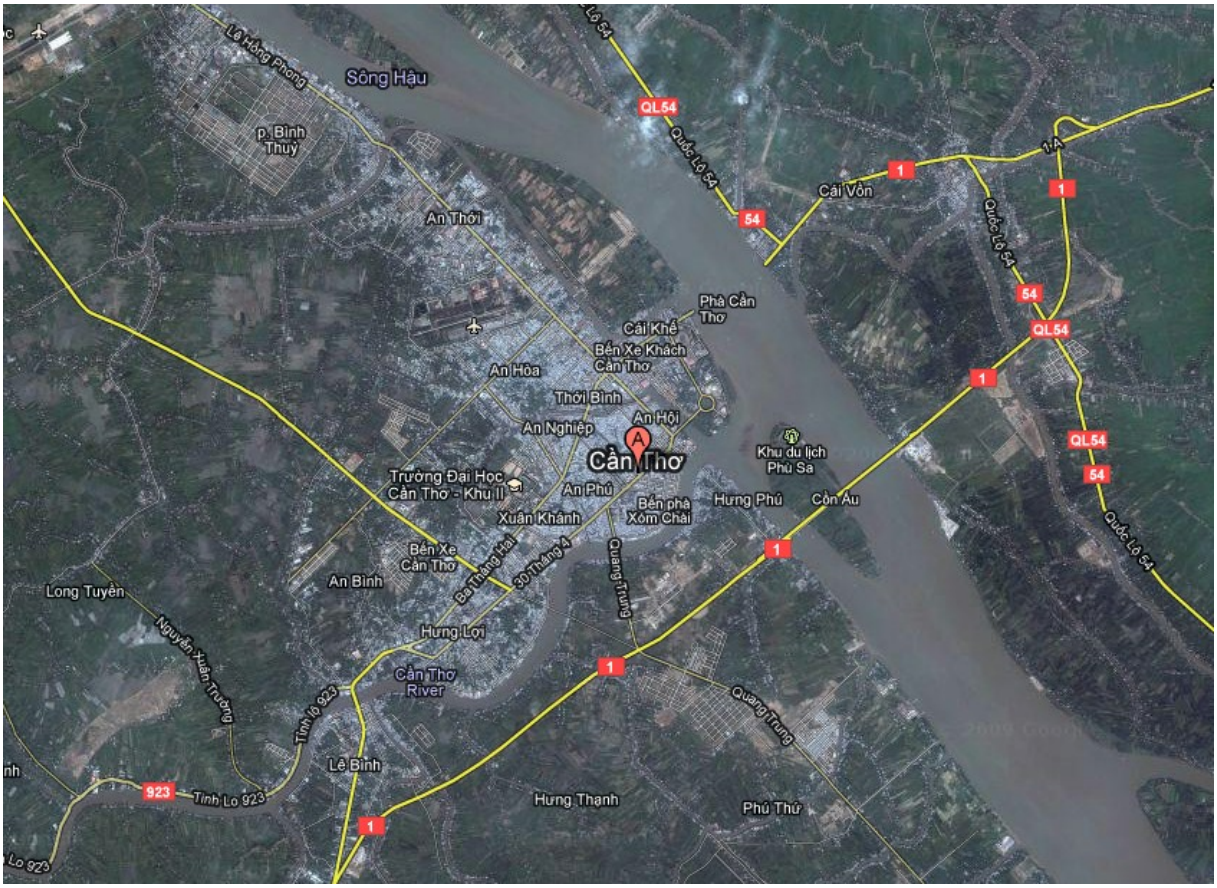
Vị Thanh
thành phố Sóc Trăng
Sông Hậu
thị xã Bạc Liêu


Lộ Hồng Phong
Sông Hậu
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QL54
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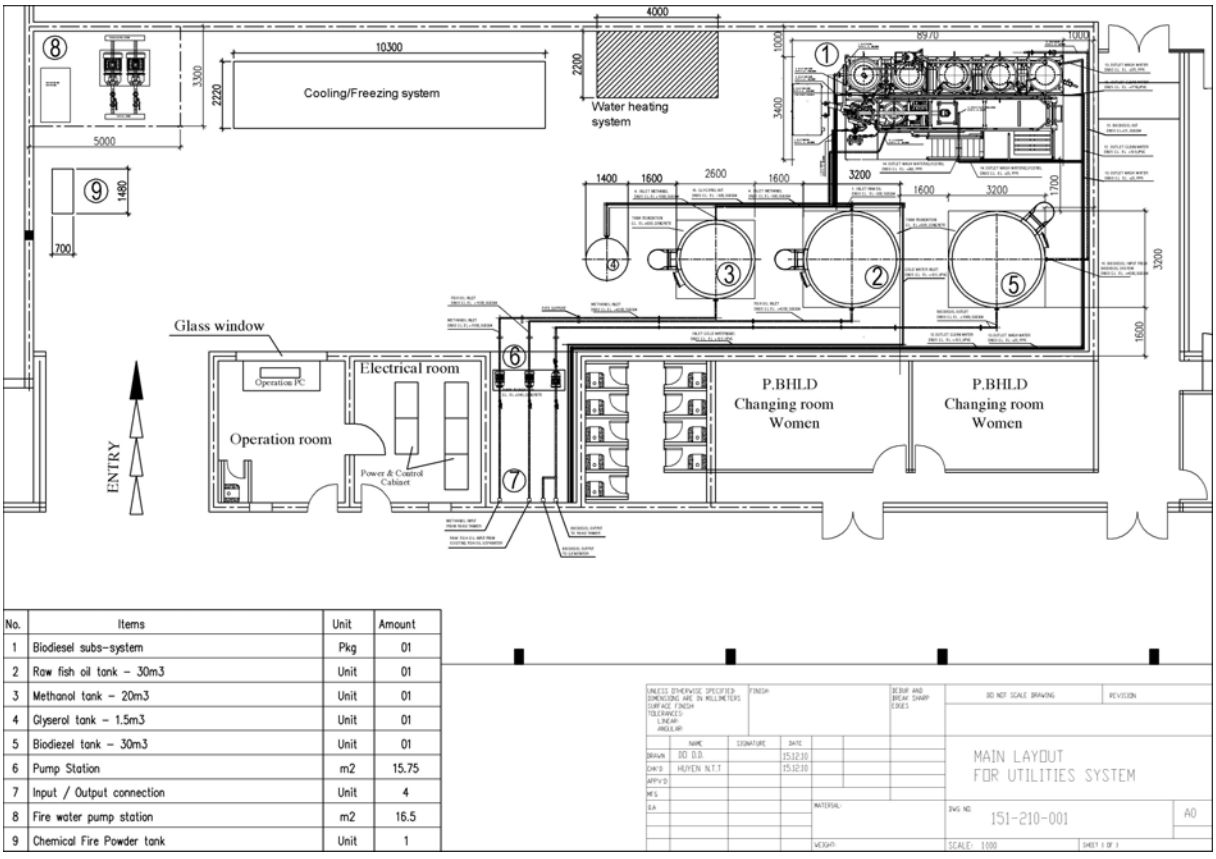
An Thới
Cái Vồn
Phà Cần Thơ
Cái Khế
Bến Xe Khách Cần Thơ
An Hòa
Thới Bình
An Hội
An Nghiệp
Cần Thơ
Khu du lịch Phú Sa
Trường Đại Học Cần Thơ - Khu II
An Phú
Hưng Phú
Cồn Ấu
Bến phà Xóm Chài
Xuân Khánh
Bến Xe Cần Thơ
Ba Tháng Hai
30 Tháng 4
Quang Trung
An Bình
Long Tuyền
Nguyễn Xuân Trường
Hưng Lợi
Cần Thơ River
Tỉnh lộ 923
Lê Bình
Hưng Thạnh
Phú Thứ

The project itself (bio diesel process including storage tanks and the new freezing and cooling system) will be installed directly at the building, so that the project does not really has a land use or even conversion of nature sites. The layout of the process can be seen in the next figure.



No.	Items	Unit	Amount
1	Biodiesel subs-system	Pkg	01
2	Raw fish oil tank – 30m3	Unit	01
3	Methanol tank – 20m3	Unit	01
4	Glyserol tank – 1.5m3	Unit	01
5	Biodiezel tank – 30m3	Unit	01
6	Pump Station	m2	15.75
7	Input / Output connection	Unit	4
8	Fire water pump station	m2	16.5
9	Chemical Fire Powder tank	Unit	1

The Finnish systems are on the shipment to Vietnam. Latest parts of equipment are expected to reach Vietnam in week 20 (16.-22.05.2011). Thus, the installation and performance of test runs will be done during the first half of 2011. So the construction phase can be defined as the first half of 2011.
Beginning second half of 2011 the operation phase will start.
The duration of the operation phase is not yet limited. Therefore it is currently not possible to determine the decommissioning phase that is anyway not intended at the moment.

4.4. Project Status

With date of this report the Finnish subsystems are produced and already tested in Finland. Currently the equipments are on their way (or soon leaving) to Vietnam and arrival is estimated for week 18 (cooling and freezing subsystem) and week 20 (biodiesel subsystem) respectively. In parallel the necessary infrastructure is prepared in Vietnam at the installation site.

5. Description of the Environment

5.1. Baseline Conditions

The Can Tho Province is located in the centre of the Mekong Delta. The provinces next to it are Dong Thap, Vien Long, Soc Trang, Bac Lieu, Kien Giang and An Giang.
The Hau River crosses the city and is from an environmental point of view, the lifeline of the region. The water and especially the periodic floods are responsible for large mangrove forests and high-yielded rice fields. The Hau River and the waters near Bac Lieu also provide living space for a variety of plants and water-affine animals like fish, crabs and also snakes. Due to the fact that there are many rivers or arms of the Mekong river, the entire region is part of the Mekong Delta and build a green lung of the country.

The specific company premises are an industrial area where the fish factory is located. In the near surroundings of the company there is infrastructure such as roads, buildings and other industrial companies such as Seafood processing, rice processing and feed mill.

There have been seen birds and other animals but the main species is wild fish in the Mekong River.

The typical plants at the area are rice, vegetables and some small forest of cajuput

Groundwater is available at an average depth of 100 m, but ground water of good quality is available at a depth of 200 m.

The climate is characterized by a dry season and a raining season.

The use of land for the project is comparatively small and only land is concerned by this project, which is already part of the fish processing company.

5.2. Components Likely To-Be-Affected

In general any operation may affect the environment by the following aspects:

- Soil
- Air
- Water
- Flora
- Fauna

In order to identify which components are really affected by the project it is advisable to investigate measures and activities caused by the project and compare the effect to the situation which would exist if the project would not be realized. By this one will get an examination of the differences only. These differences allow to assess the effects really caused by the project.

Assessment boundaries and limits:

For the following investigation and assessment the project boundary is defined as the limit of the industrial site itself. So for example any environmental impact potentially occurring in Finland caused by the assembling of the biodiesel system or even emissions caused by the

production of needed steel parts or impacts caused by the exploration and treatment of raw materials is not assessed within this report.
But the report will additionally mention environmental impacts caused by direct transportation measures for handling the process materials during the operation phase.

During the construction phase soil, meant as use of land, is used for installation of equipments and components. As there is no exploration of unused land and substitution of nature, soil is not directly affected. The land use is negligible. No drilling is necessary and no substances are intended to be brought into the soil.

Emissions into the air could be caused by machinery used for the installation. Some trucks need to bring the components to the site. As the equipments are already pre-installed, they only have to become assembled but no major construction work is necessary.
As the phase for construction is limited to six months only, the air emissions caused by additional road traffic and use of assembling machinery like cranes is also limited.

Water resources especially ground water is not used during the construction phase.

Regarding the negligible use of land and soil, also the impact on flora and fauna is not a topic at all during the construction phase. At the planned location for the installation of equipment neither plants exists nor could animals become chased away.

The remaining environmental impact during the construction phase could be noise emissions occurring due to the construction work. As the area, where the installation is done, is already an industrial plant, the additional noise emissions should be negligible and no environmental components should be significantly affected.

In conclusion the remaining additional impact caused by the project during the construction phase is the impact caused by the limited transportation of equipment and the linked air and noise emissions. This impact is limited by the amount of equipment becoming transported and the duration of the construction phase. From a current point of view the entire equipment will fit into 2-3 oversea containers plus the locally produced assembly parts like tanks and infrastructure.

Operation, production and maintenance phase

Once the plant is installed and operational following aspects are relevant.

- Use of materials / transportation
- Use of power / heat
- Produced products
- Produced waste
- Air and noise emissions
- Potential accident risks

The input materials for the process are fish oil, methanol, potassium hydroxide (KOH), water and antioxidants. The output materials are biodiesel, glycerine and waste water. The biodiesel can be sold or directly burned by a generator.
Environmental impacts occur at any kind of transportation (mainly air and noise emissions of the trucks). Therefore it is important to know from where the materials come and where they go.
The fish oil is produced from fish wastes. As HT Food is a fish farming and processing factory, the fish wastes occur directly on site. In order to get fish oil from fish waste it is necessary to perform a separation process. As it is not intended yet to do the separation process necessary at the premises by HT Food itself, additional transportation is necessary. Actually the fish waste is also transported from the company area to a separation plant. Thus, this situation does not change. Due to the project now the fish oil is transported back to

HT Food. Regarding the alternatives, otherwise the fish oil would be transported to any other purchaser. One can only speculate if the alternative purchaser will be closer to the separation plant and less transportation is necessary. It is assumed, that the distances might be the same, so therefore there is no additional environmental impact caused by the transportation of fish oil. Anyway, the maximum daily amount of fish oil used in the biodiesel process is 17 tons per day, so this amounts to two trucks arriving at the plant per day.

Methanol, KOH and antioxidants need to be additionally brought to the plant. Related to 17 tons fish oil per day about 2 tons of methanol are needed. The amounts of KOH and antioxidants are negligible. Furthermore 3 tons of water per day is used for the process. This water comes directly from the drill at the plant area, thus transportation is not a topic at all.

The used power and heat for the biodiesel process will be provided by an additional water boiler or will be taken from the waste heat of the cooling system. As for the first option an electrical boiler will be used, there is only an increased electricity demand but no other environmental effects like emissions. The second option would be absolutely neutral without affecting the environment anyhow.

The produced biodiesel can either be sold to the market (transportation to purchaser) or become used by the generator at the plant itself.
Again it is only speculative if there occur additional transportation distances of biodiesel from HT Food to any purchaser or from where otherwise the diesel would come. For this report it is assumed, that the distances are equal and no additional transportation effects occur. In case the biodiesel is burned directly at site, any transportation activity would even become superfluous thus overall there is no additional environmental impact caused by the project activities connected to transportation measures.
The waste water occurring by the biodiesel project is of quality no able to cause harmful effects. Nevertheless the waste water (about 3 tons per day) will be treated by the existing waste water treatment plant of HT Food before it is released to the Mekong River.

The biodiesel process unit does not cause any noise emissions apart from some pumps needed to pump the liquids from one tank to another.
Regarding air emissions, only methanol and biodiesel have a volatile potential but as the entire system is closed, during normal operation no air emissions occur.

In case the biodiesel is burned in the generator in order to produce electricity, noise emissions occur and biodiesel is converted to power and air emissions. The emissions into air depend on the quantity and quality of biodiesel and the generator itself. The maximum quantity is about 13 tons biodiesel per day which is produced and could be burned on site in the generator. Regarding the differences the projects causes compared to the situation by not realizing the project, the impact is negligible. Because in case not the self-produced biodiesel would be used for the generator, alternative fuel would be bought. This causes additional transportation of biodiesel to the plant. The occurring air emissions from the generator might be slightly different depending on the fuel used. But from a current point of view it is not to be expected, that the amount of emissions like NOx and CO would recognizably differ.

The main environmental effect would occur in case accidents happen. Such accidents might mainly be leakage of tanks and spilling of fuel. Also it is imaginable in case the biodiesel process is stopped for any reason, that intermediate products exist in the tanks which can not be further processed. Also the explosion of the methanol tank is a theoretical risk. Currently such scenario is not known. But for risk prevention and accident response plans should exist giving clear advice how to handle such situations.
It has to be prevented that fuel, methanol or other batch charges become released which would mainly affect soil and/ or water.

In summary the operational phase will not effect the environment in a significant manner. Risk prevention and emergency response plans should exist.

The decommissioning phase, which is not yet intended to be performed, might also have an impact to the environment. The extend of that impact is difficult to foresee as the decommissioning phase is not planned on detail. Regarding the situation – as it exists before the construction phase – it must be the aim of the decommissioning phase to establish at least the same conditions as they have been before. This means that during the decommissioning phase mainly the installed equipment need to be dismantled and remaining liquids have to be disposed correctly. The necessary measures would be of the same extend and effect like during the construction phase. Also the duration of the decommissioning phase could be similar, so after project closedown it would take maximum half year to restore previous conditions.

In summary the environmental components likely to be affected by the decommissioning phase are analogue to the construction phase for which the environmental impact is negligible.

6. Impact Prediction and Evaluation

6.1. The Most Important Environmental Impacts

Important environmental impacts are air and noise emissions caused by any transportation measure. Trucks and cranes carrying materials such as equipment, fish waste, fish oil, methanol and biodiesel cause noise emissions and emissions into the air by waste gas of there combustion engines. The magnitude of these emissions is negligible especially when compared to the alternative solutions. These emissions (except emissions occurring during construction and reconstruction work) anyway occur. In total the project has the potential to minimize these emissions because the holistic solution of treating the fish waste directly at site, processing the oil, producing biodiesel and converting it to locally needed energy would reduce transportation.

The most important environmental impacts would occur in case of accidents and unforeseeable incidents. Such accidents might be spilling of fuel by which soil and/ or water could be contaminated. Another scenario would be the explosion of the methanol tank. As local safety requirements exist and respective technical components are EX-shielded the risk potential is very low. Also further components like level measurements devices of oil tanks are EX-shielded.

6.2. The EIA Matrix

Deduction of EIA Matrix

All identified and relevant environmental impacts are summarized and assessed within the next tables.
These are the preceding tables of the EIA Matrix.
The Matrixes are filled by use of the following criteria and scores.

Phase of impact occurrence:

(i) exploration and construction / implementation phase
(ii) operation production and maintenance phase
(iii) decommissioning phase

Magnitude of change / effect

(1) change / effect only within the project site
(2) change / effect to local conditions and / or to areas immediately outside
(3) regional / national / international change / effect
(+) indicating beneficial impact

Permanence of impact

(1) no change / not applicable
(2) temporary
(3) permanent

Reversibility of impact

(1) no change / not applicable
(2) reversible
(3) irreversible

Extent the impact is cumulative

(1) no change / not applicable
(2) non-cumulative / single
(3) cumulative
(+) indicating beneficial impact

Phase of impact occurrence:		(i) exploration and construction / implementation phase			
		Magnitude of impact	Permanence of impact	Reversibility of impact	cumulative effects
Location	Impact				
Plant site	Noise emissions	(1)	(2)	(1)	(1)
Plant site	Air emissions	(1)	(2)	(1)	(1)
Plant site and surroundings	Emissions due to transport	(2)	(2)	(1)	(1)

Table 2 Preceding EIA Matrix table 1

Phase of impact occurrence:		(ii) operation production and maintenance phase			
		Magnitude of impact	Permanence of impact	Reversibility of impact	cumulative effects
Location	Impact				
Plant site	Noise emissions	(1)	(2)	(1)	(1)
Plant site	Air emissions	(1)	(2)	(1)	(1)
Plant site and surroundings	Emissions due to transport	(2) (+)	(2)	(1)	(1)
Plant site	Splilling of fuel	(1)	(2)	(2)-(3)	(1)
Plant site	Explosion of methanol tank	(2)	(2)	(2)-(3)	(1)
Plant site	Disposal of unfinished batches	(2)	(2)	(2)	(1)

Table 3 Preceding EIA Matrix table 2

Phase of impact occurrence:		(iii) decommissioning phase			
		Magnitude of impact	Permanence of impact	Reversibility of impact	cumulative effects
Location	Impact				
Plant site	Noise emissions	(1)	(2)	(1)	(1)
Plant site	Air emissions	(1)	(2)	(1)	(1)
Plant site and surroundings	Emissions due to transport	(2)	(2)	(1)	(1)

Table 4 Preceding EIA Matrix table 3

Within the following EIA matrix a summarization of the existing and occurring environmental impacts will be given. In comparison to the preceding EIA matrix tables, the following summarizing table additionally contains an assessment figure which is calculated by the following formula:

Magnitude of impact
\+ Permanence of impact
\+ Reversibility of impact
\+ cumulative effects

Wherever a (+) is stated, the respective figure is not added but subtracted from the sum.
Wherever the given figure is not a unique number but a range, for the calculation the average of that range will be taken into account.

Location	Impact	Phase of impact occurrence:	Magnitude of impact	Permanence of impact	Reversibility of impact	cumulative effects	Assessment sum
Plant site	Noise emissions	(i) (ii) (iii)	(1) (1) (1)	(2) (2) (2)	(1) (1) (1)	(1) (1) (1)	5 5 5 Ø 5
Plant site	Air emissions	(i) (ii) (iii)	(1) (1) (1)	(2) (2) (2)	(1) (1) (1)	(1) (1) (1)	5 5 5 Ø 5
Plant site and surroundings	Emissions due to transport	(i) (ii) (iii)	(2) (2) (+) (2)	(2) (2) (2)	(1) (1) (1)	(1) (1) (1)	6 2 6 Ø 5
Plant site	Splilling of fuel	(ii)	(1)	(2)	(2)-(3)	(1)	6,5
Plant site	Explosion of methanol tank	(ii)	(2)	(2)	(2)-(3)	(1)	7,5
Plant site	Disposal of unfinished batches	(ii)	(2)	(2)	(2)	(1)	7

Table 5 Summarizing EIA matrix table

6.3. Impact Assessment

The previous table shows the environmental impacts. In general it can be stated, that the environmental impact the project causes is comparatively small (no score above 10). The maximum score it 7,5 and this is only a theoretical impact in case of an accident. Taking accidental events out of consideration, the maximum impact scores at 6. This score reflects additional emissions (noise and air) due to transportation measures caused by the construction and deconstruction phase respectively.
The amount of these additional emissions is very small.

7. Mitigation Measures

7.1. Recommendations

Within the previous chapters realistic and potential environmental impacts have been elaborated and assessed. As there are no significant impacts expected that could become reduced by specific measures, no direct recommendations need to be given.
Only the unexpected accidental impacts should be subject of mitigation measures of such kind, that respective emergency response plans exists and the staff operating the plant are educated and trained on how to operate the biodiesel plant as well as the generator in a safely manner and how to respond in case of emergencies.
The construction of the methanol and diesel tanks shall prevent spilling of methanol and diesel for example by respective soil construction (basin to catch liquids) and provision of respective materials such as oil vehicle. Respective devices like methanol pump and level measurement devices shall be EX-shielded.

7.2. Additional Mitigation Measures

Additional mitigation measures could only address identified environmental impacts. As the magnitude of environmental impact is small, no additional mitigation measures are directly recommendable.
The plant operator should minimize occurring noise emissions during construction and decommissioning phase up to a minimum. This can be reached by good planning and probably performance of noisy installation works during times, when only few people are affected (e.g. plant holidays). Furthermore, during the operation phase, the niose level of the generator should be assessed and potential mitigation measures, such as capsulation / insulation can be arranged.

7.3. EMPs / Statement of Commitments

Currently the environmental management plan consists of documented measures in order to be compliant with the local legislative requirements. For example the fresh water from the drill as well as the waste water from the waste water treatment plant are frequently analyzed. Furthermore there exists a maintenance plan for the cooling and freezing units as well as for the power generator.
In future there will also be a maintenance plan and operation instruction manuals for the biodiesel plant available.
Last but not least the finished plant will be checked by TÜV Rheinland for energy and mass flow balance. In parallel to this check, the expert from TÜV Rheinland will also assess any project-related potential environmental impact and recommend further mitigation measures and improvements of the environmental management plan. The plant operator HT Food declared to be willing to take such recommendations into consideration and act accordingly.

8. Alternatives

Based on the current situation that the fish farming and processing plant is already existing, alternatives can only focus on the specific project scope of erecting a biodiesel processing system converting fish oil to biodiesel and using it for electricity generation.

Because of the frequent power black outs in Vietnam, there is also no alternative to the emergency generator that already exists.

The alternative of producing biodiesel from fish oil is to sell the fish waste and buy petroldiesel for the generator. From a sustainable point of view, the production of biodiesel from fish waste is clima neutral, the petroldiesel alternative not. So the main difference is the positive effect on the climate change.
A further alternative would be to erect the biodiesel plant somewhere else than at the plant location of HT Food. But as the fish waste is produced on site and also diesel is needed on site, this would only cause additional transportation measures but the environmental impact of operation of such a plant would be the same also at different locations.

In summary there is no real alternative to this project. Only the non-realization of the project is an alternative. This alternative does not show any benefit for the climate change but the proposed project does. So it is absolutely recommendable to realize this project instead of any alternative solution.

9. Monitoring Program

9.1. Monitoring Program for Compliance of Monitoring Measures

There are three impacts identified that can become subject to a monitoring program.

1) Measurement of air emission limits of the electricity generator
2) Assessment of noise emissions occurring at the electricity generator
3) Measurement of the waste water parameters

Currently the national legislation about the air emissions of power generators states:

- Emission limits according to Vietnam National Technical Regulation on Industrial Emission of Inorganic Substances and Dusts - QCVN 19:2009/BTNMT.

No.	**Parameter**	**Concentration** (mg/Nm^3)	
		A	B
1	Total dust	400	200
2	Dust containing silica	50	50
3	Ammonia and ammonium compounds	76	50
4	Antimony and its compounds, calculated by Sb	20	10
5	Arsenic and its compounds, calculated by As	20	10
6	Cadmium and its compounds, calculated by Cd	20	5
7	Lead and its compounds, calculated by Pb	10	5
8	Carbon monoxide, CO	1000	1000
9	Chlorine	32	10
10	Copper and its compounds, calculated by Cu	20	10
11	Zinc and its compounds, calculated by Zn	30	30
12	Hydrogen chloride, HCl	200	50
13	Fluoride, HF, or other inorganic compounds of fluorine, calculated by HF	50	20
14	Hydrogen sulfide, H2S	7,5	7,5
15	Sulfur dioxide, SO2	1500	500
16	Nitrogen oxides, Nox, calculated by NO2	1000	850
17	Nitrogen oxides, NOx (for chemical production facilities), calculated by NO2	2000	1000
18	H_2SO_4 or SO_3 vapor, calculated by SO_3	100	50
19	HNO3 vapor (other source), calculated by NO2	1000	500

Column A: applied until 12/31/2014
Column B: applied from 1/1/2015

But not all parameters will be checked frequently and are sensible to become applied for a diesel power generator. So it is recommended to measure at least the components Carbon monoxide and Nitrogen oxides as these are indicating parameters for the quality

of the burning process. Furthermore the measurement of formaldehydes could become of interest.

About noise emissions the national legislation requires the following:

At the residential area around the factory, noise emission is limited as follow, according to Vietnam National Technical Regulation on Noise – QCVN 26:2010/BTNMT:

- from 6:00 to 21:00: 70dB
- from 21:00 to 6:00: 55dB
-

To the workers inside the plant, noise emission is limited as follow, according to Vietnamese standard: Acoustics – Allowable noise levels at workplaces - TCVN 3985:1999.

- Allowable average noise level for one work shift (8 hours) is 85dB, and maximum noise must not exceed 115dB.
- If total time expose to noise is not exceed:
    - 4 hours: Allowable average noise level is 90dB
    - 2 hours: Allowable average noise level is 95dB
    - 1 hours: Allowable average noise level is 100dB
    - 30 minutes: Allowable average noise level is 105dB
    - 15 minutes: Allowable average noise level is 110dB

  Maximum noise must not exceed 115dB in all cases. The rest time of working day workers must not expose to noise above 80dB

It is recommended to check the occurring noise levels once after erection of the plant and later on in case of complaints of the workers.

The treated waste water, released to the Mekong River, must fulfill the following criteria, according to Vietnam National technical regulation on the effluent of aquatic products processing industry - QCVN 11:2008/BTNMT:

- parameters / limits

No.	Parameter	Unit	Limit value
1	pH	-	6-9
2	BOD at 20ºC	mg/l	30
3	COD	mg/l	50
4	Total suspended solids	mg/l	50
5	Amonium (caculated by Nitrogen)	mg/l	10
6	Total nitrogen	mg/l	30
7	Total oil and fat	mg/l	10
8	Residual chlorine	mg/l	1
9	Total Coliforms	MPN/100ml	3000

The quality of the treated water is occasionally checked and monitored. This procedure shall be continued.

9.2. Monitoring Program for Residual Impacts

The residual impacts might mainly be caused by accidents. In order to prevent such accidents, a monitoring program can be established defining checks of maintenance and

training measures. Regular maintenance of the entire biodiesel plant and the generator as well as educational measures and emergency response trainings shall be documented. By the monitoring program, potentially performed by an independent third party, the implementation and effectiveness of these measures can be checked.
Furthermore an annual environmental check up by an environmental consultant / auditor could be performed.

Literature & References

[1] VNEEP, The energy efficiency situation in Vietnam, Phuong Hoang Kim, Deputy Director General, Science and Technology department, Ministry of Industry and Trade, 2007

[2] 85/37/EEC; Environmental Impact Assessment Directive

[3] Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

[4] Vietnam National Technical Regulation on Industrial Emission of Inorganic Substances and Dusts - QCVN 19:2009/BTNMT

[5] Vietnam National Technical Regulation on Noise – QCVN 26:2010/BTNMT

[6] Vietnam National technical regulation on the effluent of aquatic products processing industry - QCVN 11:2008/BTNMT

Annexes

Annex 1 List of References

Contractor	period	Project title	Project work
Infraserv GmbH & Co. Höchst KG	2005	Incineration plant for the use of substitute fuels	Environmental Impact Assessment Report (EIA report)
RWE Power AG	2005	Incineration of substitute fuels within power plant Berrenrath	Scoping document, Environmental Impact Assessment Report (EIA report)
RWE Power AG	2004	New construction of two ballast gas turbines within power plant Weisweiler	Environmental Impact Assessment Report (EIA report)
RWE Power AG	2003/4	New construction of two power units 1100 MW each at location Neurath	Scoping document, Environmental Impact Assessment Report (EIA report)
Moritz J. Weig GmbH & Co. KG	2004	Capacity enlargement of package machines, Mayen	Scoping document, Environmental Impact Study (EIA study)
IBS Scherer GmbH	2004	Extension of chemical-physical waste treatment plant	Scoping document, Environmental Impact Assessment Report (EIA report)
E.ON Kraftwerke GmbH	2003	Use of petrol cokes at power plant Staudinger, unit 5	General Pre-Assessment on specific project
Ministerium für Verkehr, Energie und Landesplanung NRW	2003/4	AVR Pilot nuclear power plant	General Pre-Assessment on specific project
Infraserv GmbH & Co. Höchst KG	2003	Modernization of cogeneration plant Römerbrücke of Electrabel Deutschland AG at location Saarbrücken	General Pre-Assessment on specific project
E.ON Kraftwerke GmbH	2003	Waste water sludge incineration at power plant Staudinger, unit 5	General Pre-Assessment on specific project
Fichtner GmbH & Co. KG	2002/03	Shutdown of nuclear power plant Stade (KKS)	Environmental Impact Assessment Report (EIA report)
RWE Rheinbraun AG	2003	Co-incineration of Waste water sludge and pulp at power plant Goldenberg	Environmental Impact Assessment Report (EIA report)
RWE Rheinbraun AG	2003	Co-incineration of pulp and paper sludge at lignite power plant Weisweiler	Scoping document, Environmental Impact Assessment Report (EIA report)
Ministerium für Umwelt und Forsten Rheinland-Pfalz	2001-2003	Shutdown of nuclear power plant Mülheim-Kärlich	Environmental Impact Assessment Report (EIA report)
RWE Rheinbraun AG	2002	Revision of area development plan, Düsseldorf	Preparation of documents for the indication of new locations for power plants

RWE Rheinbraun AG	2002	Revision of area development plan, Köln	Preparation of documents for the indication of new locations for power plants
RWE Power AG	2002	Redesign of power plant Niederaußem	General Pre-Assessment on specific project
RWE Rheinbraun AG	2002	Co-incineration of pulp and paper sludge at lignite power plant Frimmersdorf	Environmental Impact Assessment Report (EIA report)
GEW Rheinenergie AG	2002	Co-incineration of animal meal at power plant Merkenich	Concept for fullfilment of new air pollution guideline Environmental Impact Assessment Report (EIA report)
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit	2002	Extension of industrial power plant at Svit, Slowakei	Environmental Impact Assessment Report (EIA report)
RWE Rheinbraun AG	2002	Co-incineration of pulp and paper sludge at lignite power plant Weisweiler	Scoping document, Environmental Impact Assessment Report (EIA report)
MVV Energie AG	2002	Industrial power plant - industry park -Oberbruch, biomass (mature wood)	Scoping document, Environmental Impact Assessment Report (EIA report)
RWE Rheinbraun AG	2001/02	Co-incineration of Waste water sludge and mature wood at power plant Wachtberg	Scoping document, Environmental Impact Assessment Report (EIA report)
RWE Power AG	1999-2001	Cogeneration power plant Duisburg-Hamborn	Environmental Impact Assessment Report (EIA report)
Kasseler Fernwärme GmbH	2001	Redesigne of district heating power plant Kassel	Location-specific pre-assessment of specific project
RWE Energie AG	2000	combined-cycle gas turbine industrial area Höchst	Environmental Impact Assessment Report (EIA report)
Uppenkamp & Partner GmbH	2000	combined-cycle gas turbine Dortmund-Derne	Scoping document, Environmental Impact Assessment Report (EIA report)
Uppenkamp & Partner GmbH	2000	combined-cycle gas turbine Ahaus	Scoping document, Environmental Impact Assessment Report (EIA report)
RWE Energie AG	1999	combined-cycle gas turbine industrial area Höchst	Scoping document, Env. Consideration study
Krupp Uhde GmbH	1998	Cellulose plant Wittenberge (incl. Waste water sludge incineration)	Env. Consideration study, Environmental Impact Assessment Report (EIA report), Verification of necessity for special investigation
GEW Köln AG	1997	combined-cycle gas turbine Köln-Merkenich	Env. Consideration study , Preparation of documents according § 4e, 9. Federal Immission Control Act
Projektgesellschaft Überlandwerke Groß-Gerau GmbH, RWE Energie AG, Kraftwerke Mainz-Wiesbaden AG, Energieversorgung Opel oHG	1997	combined-cycle gas turbine power plant Rüsselsheim	Env. Consideration study, Environmental Impact Assessment Report (EIA report)

RWE Energie AG	1996/97	Lignite power plant Niederaußem	Env. Consideration study, Verification of necessity for special investigation Environmental Impact Assessment Report (EIA report)
Saarbergwerke AG	1995	Power plant Bexbach II	Assessment of effect of new construction of power plant to the nature