CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

Greenhouse Gas Emission in the Fish Meal Industry in Morocco – Central Steam Production Plant
Version 2.0

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SECTION A. General description of project activity

A.1 Title of the project activity:

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Greenhouse Gas Emission in the Fish Meal Industry in Morocco – Central Steam Production Plant

Version 2 – 18.04.2008

A.2. Description of the project activity:

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Background information on the energy situation in Morocco

Morocco has limited indigenous oil, gas and hydro resources; as a result it has historically been dependent on the import of fossil fuels (oil, coal and diesel). Approximately 97% of its primary energy comes from foreign sources, which weighs heavily on foreign exchange payments.
At the same time Morocco is very suited for the implementation of solar techniques since it ranks among the most favoured sites worldwide concerning solar irradiation.
A substitution of fossil fuel by solar heat and power would be of a high ecological relevance. Additionally to that it would enhance Morocco's security of supply and reduce its dependency from energy imports.
A switch from fossil to solar energy is also economically attractive, especially on a mid- and long-term perspective: even though capital costs for solar installations are relatively high, only very low operating expenses occur.

General information:

The CDM-project focuses on the centralized steam production for 8 fish meal factories in Laâyoune Plage/Western Sahara. Presently steam is being generated in several timeworn (25 yrs. average) steam boilers. Additionally to that every company has its own, very discontinuous steam supply, which makes steam generation very inefficient. A site visit in June 2007 showed energy optimisation potentials of the factories between 30 and 50 %, if supply- and demand-side measures are implemented.

The project will be realised in the years 2008 and 2009.

Technologies employed:

The present project focuses on supply-side measures for fuel saving. For that purpose the existing 24 decentralized fossil fuel boilers will be replaced by a central steam production plant: A solar field, using Fresnel-Technology, will provide baseload energy, one huge HFO-boiler will provide steam for peak demand and night operations.
The planned solar field ranks among the biggest applications of solar heat for industrial processes worldwide.

Thus following measures are considered for the project:

- A **solar field plus a fossil fuel back-up system** shall be implemented to centrally provide steam for the 8 fish meal plants on site.
- The **old fuel oil boilers** used for steam production in the fishmeal plants shall be **abandoned** and replaced by one centralized boiler.

- All companies shall be connected to a **centralized steam grid**.

Additional technologies, not considered in the PDD:

- **Energy efficiency measures** should be implemented in the fish meal plants in order to reduce energy demand (demand-side measures). Since the implementation of suggested measures cannot be guaranteed the efficiency measures cannot be taken into account in this methodology.
- Additionally to that it is considered also to potentially **produce electricity with the solar field** and feed in excess power into the national grid operated by Office National de l'Electricité (ONE).

A.3. Project participants:

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Party involved	**Legal entity project participant (as applicable)**	**Please indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Morocco – Host Country	GIE Al Wahdaoui (Project owner)	No
Austria	denkstatt GmbH (Consultant to the CDM – project)	No
Austria	Austrian JI/CDM Programme Komunalkredit Public Consulting GmbH (Buyer)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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The project will be implemented in the city of Plage (Laâyoune – Plage), 20 kilometres south-west of the city of Laâyoune at the Atlantic coast. This is the location of eight fish meal plants.

A.4.1.1. Host Party(ies):

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Morocco

A.4.1.2. Region/State/Province etc.:

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Laâyoune, (South Morocco)

A.4.1.3. City/Town/Community etc:

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City of Laâyoune and City of Plage

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

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The centralized steam production unit will be located in Laâyoune – Plage, 20 kilometres south-west of the city of Laâyoune, besides the fish meal factories at the Atlantic coast (see pictures below).

Figure 1: Location Laayoune at the Atlantic costs of Morocco / West Sahara

Figure 2: Location of the project site: City of Laayoune and City of Plage

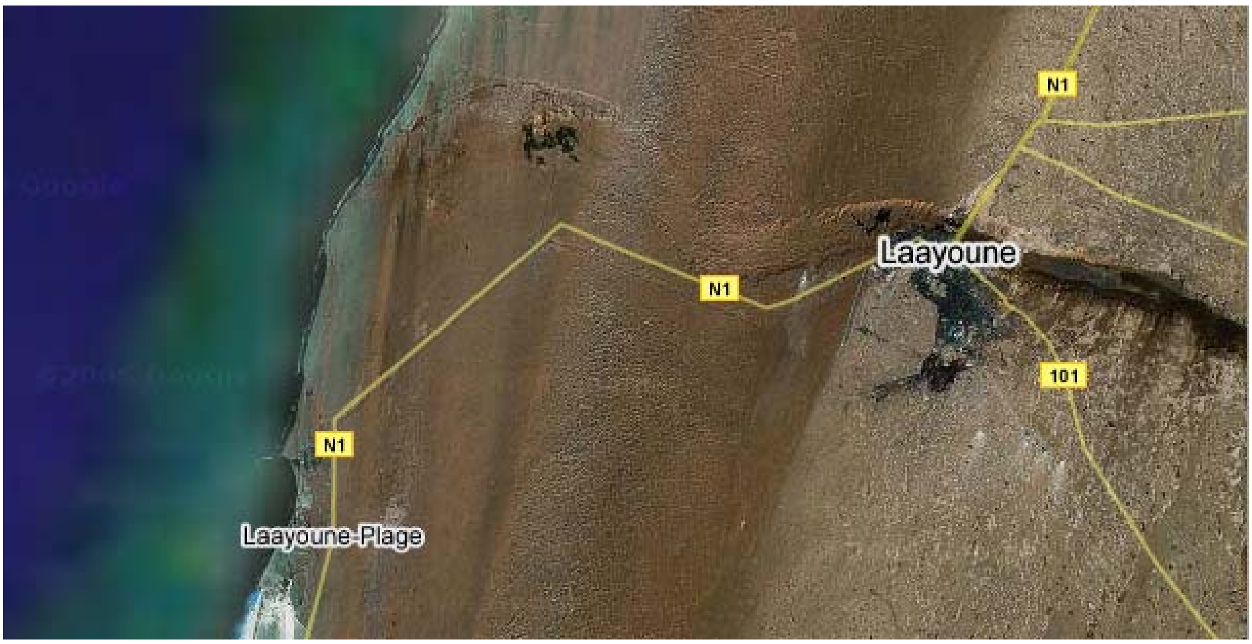

Figure 3: Map of the project site


M 1: 500
100
200
300 m
ZONE NON AEDIFICANDI
SEPOMER SAHARA
ANAFAP
SITUATION PROPOSEE DU PROJET
CENTRALE THERMIQUE " ANAFAP "
Lignes électriques Haute Tension

A.4.2. Category(ies) of project activity:

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This project falls into CDM-category 1 - Energy industries (renewable - / non-renewable sources)

A.4.3. Technology to be employed by the project activity:

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General

The 24 decentralized fossil fuel boilers will be replaced by a **central solar steam production unit** combined with a **fossil fuel back-up solution** (for peak demand and night operations).

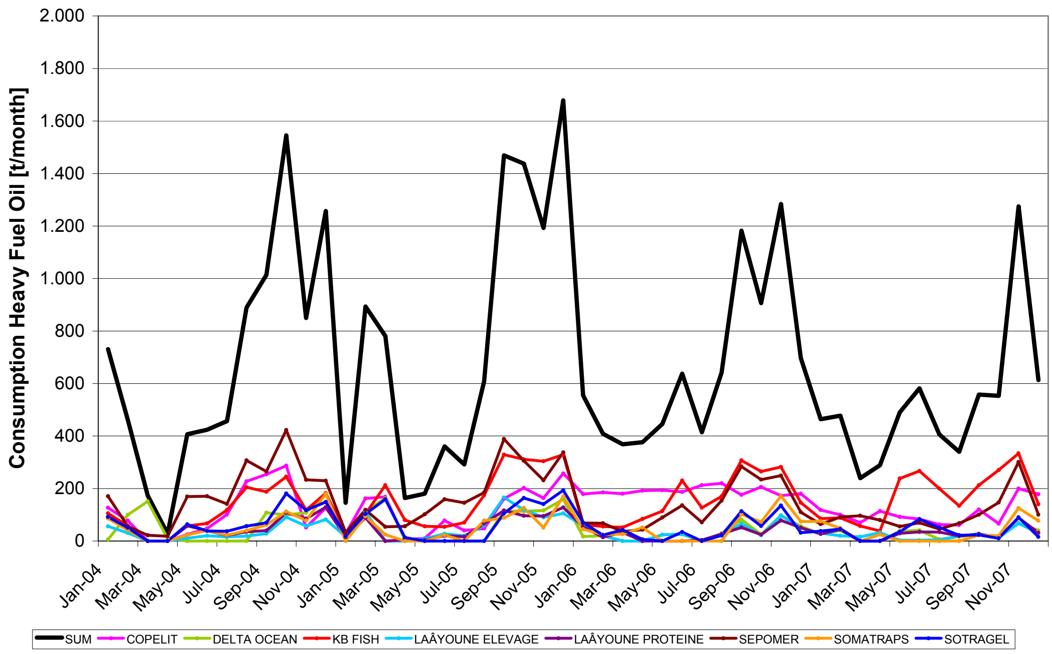
The suggested site is Laâyounne Plage on the Atlantic coast of Morocco (27,05° Lat and -13,24° Lon). Irradiation data for this site where generated with the software Meteonorm 5.1. The yearly direct normal irradiation (DNI) is 2.478 kWh/m² and the yearly global horizontal irradiation is 2.224 kWh/m².

Yearly energy demand and min./max. load

The current yearly fuel demand (heavy fuel oil) mounts up to 9,200 t/yr. or 102 GWh/yr fuel energy. It should be reduced to about 80 GWh/yr. due to boiler replacement and continuous steam-demand. The current min./max. heat demand of all companies is estimated to range between 5 and 36 MW.

The typical load from late August to December is roughly two to three times the load compared to the rest of the year. A minimum heat load occurs in April, the maximum between September and December. The heat load curve is shown indirectly in the following figure which shows the consumption of heavy fuel oil for the years 2004-2007.

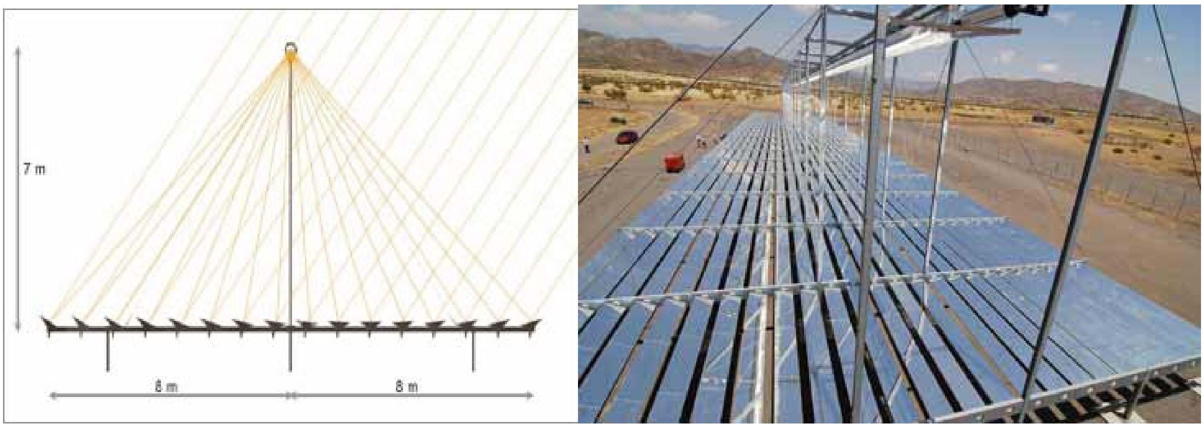
Figure 4: Consumption Heavy Fuel Oil 2004-2007



Plant Design

In order to ensure cost-effectiveness the hybrid plant will be constructed as follows: Baseload energy will be provided by the solar field with a max. capacity of 5 MW, producing approx. 11,712 MWh/yr. steam and heat. Further energy demand (back-up, night) should be covered by a heavy fuel oil boiler (once 36 MW). The land area required is approx. 18,000 m² (16,854 for the solar field, the rest for the central boiler house).

Figure 5: Linear Concentrating Fresnel-Collectors (courtesy of PSE AG)



The details for both solutions for this hybrid plant is given below.

<u>a) Central solar steam production unit</u>

The solar steam generator with a mirror area of 10.272 m² for use in a solar/fossil hybrid power plant providing steam to 8 fish factories in Laâyounne, South Morocco.

Figure 6: Picture of a concentrating solar field (courtesy of Novatec Solar)

The solar field has been designed using the following parameters:

- Design Temperature 180°C
- Design Pressure 10 bar
- Steam Quality 1,00
- Maximum Pressure 20 bar

Performance parameters of NOVA-1:
Thermal loss per m² of primary reflector

- $u0 = 0.045$ W/(m²K)
- $u1 = 0.00025$ W/(m²K)

A technical acceptance test certifying the performance of solar field equipment will be provided by the DLR (German Aerospace Center), who will act as an independent consultant.

b) Fossil Fuel Back-up Solution

The following table provides an overview on the baseline boilers and the whole baseline steam system currently installed in the 8 installations:

Fuel: heavy fuel oil
Steam quality:
Pressure range: 4 – 8.5 bar
Temperature range: 120 – 250 °C

Table 7: Description of the boilers used in the companies

Company Name		Year of construction	Degree of efficiency η	Steam generation capacity (CAP)	Operation mode	Operation range
	Unit	year	%	t/h		% of CAP
COPELIT	Boiler No 1	1971	20,0	7	High-Low-Off	0-100 %
	Boiler No 2	1971	87,5	7	High-Low-Off	21-100 %
	Boiler No 3	1977	85,9	7	High-Low-Off	21-100 %
DELTA OCEAN	Boiler No 1	1979	*n.a.*	13	Modulating	61-80 %
	Boiler No 2	1985	*n.a.*	8	Modulating	81-100 %
	Boiler No 3	1976	*n.a.*	5	High-Low-Off	81-100 %
KB FISH	Boiler No 1	1995	88,6	12	Modulating	41-60 %
	Boiler No 2	1983	83,9	10	Modulating	41-60 %
	Boiler No 3	1982	80,0*	10	Modulating	41-60 %
LAÂYOUNE ELEVAGE	Boiler No 1	1996	90,0	12	*n.a.*	*n.a.*
	Boiler No 2	1989	78,4	10	*n.a.*	*n.a.*
	Boiler No 3	1989	*n.a.*	10	*n.a.*	*n.a.*
LAÂYOUNE PROTEINE	Boiler No 1	1984	88,9	8	On-Off	41-60 %
	Boiler No 2	1977	91,7	12	On-Off	21-40 %
	Boiler No 3	1995	n.a.	12	On-Off	21-40 %
SEPOMER	Boiler No 1	1994	89,9	8	*n.a.*	*n.a.*
	Boiler No 2	1994	*n.a.*	6	*n.a.*	*n.a.*
	Boiler No 3	1970	*n.a.*	6	*n.a.*	*n.a.*
	Boiler No 4	1985	*n.a.*	5	*n.a.*	*n.a.*
SOMATRAPS	Boiler No 1	1973	75,0*	8	High-Low-Off	*n.a.*
	Boiler No 2	1977	70,0*	8	High-Low-Off	*n.a.*
SOTRAGEL	Boiler No 1	1977	68,5	12	*n.a.*	*n.a.*
	Boiler No 2	1984	*n.a.*	8	*n.a.*	*n.a.*
	Boiler No 3	1983	*n.a.*	7	*n.a.*	*n.a.*
mean value		**1983**	***78,45***	**8,8**		

* values are provided by the companies.
n.a. = not available

The following table shows the data of the steam boiler to be installed under the project activity that will replace the currently installed boilers:

Fuel: heavy fuel oil
Type: Boiler with two fire-tubes
Steam quality:
Pressure range: 6 – 8 bar
Temperature range: 160 – 180 °C

Table 2: Description of the new boiler

	Year of construction	Degree of efficiency η	Steam generation capacity (CAP)	Operation mode	Operation range
Unit	year	%	t/h		% of CAP
Boiler	2008	> 93,0	19	Modulating	7-100 %

The project activity will contribute to sustainable development as it involves the reduction of fossil fuel. Hence, it will considerably reduce the CO_2 emissions as well as local pollutants such as NO_x, CO and SO_2 during boiler operation.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

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Table 3: Overview of the emission reductions for the 10 year crediting period

Years	**Annual estimation of emission reductions in tonnes of CO_{2e}**
2008	0
2009	4.500
2010	7.364
2011	7.364
2012	7.364
2013	7.364
2014	7.364
2015	7.364
2016	7.364
2017	7.364
2018	7.364
Total estimated reductions (tCO_{2e})	**70.776**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tCO_{2e})	**7.078**

Additional savings are expected for saving of fuel due to the avoiding of several hundred start ups from 24 single boilers. The amount of t CO_2 saved cannot be seriously calculated although it is estimated to range between 10 and 12 % of the baseline emissions (i.e. **2.500-2.900 t CO_2/yr**.). For the monitoring the specific HFO consumption per t product (fish meal) might be used.

A.4.5. Public funding of the project activity:

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For public funding for the development of this project activity has been applied for in Austria and might be applied for in Germany.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

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The study is based on the Approved baseline and monitoring methodology AM0056 / Version 01 "Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems".

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

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The proposed project activity complies with the Approved baseline and monitoring methodology AM0056 since the project activity aims to "completely replace one or more boilers with some remaining lifetime".

The 24 de-centralised fuel oil boilers will be replaces with a central steam production unit, dispatching it's product to the 8 fish meal plants.

The methodology is applicable since the following conditions are applied with:

- Steam generation in the project activity is carried out through the use of fossil fuel fired steam boilers
- Moroccan/local regulations do not require the replacement or retrofit of the existing equipment.
- There are no enforced Moroccan/local regulations/standards on minimum efficiency ratings for the boilers included in the project boundary.
- Moroccan/local regulations/programmes do not constrain the facility from using the fossil fuel being used prior to fuel switching
- The steam quality (i.e. pressure and temperature) is the same before and after the start of the implementation of the project activity
- The existing steam generating system in the facility where the project activity is implemented has more than one boiler
- Only one type of fossil fuel is used in all boilers included in the project boundary

B.3. Description of the sources and gases included in the project boundary

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The emission sources in the Baseline case are the emissions related to fossil fuel combustion in 24 steam boilers, using heavy fuel oil (same grade for all boilers). The same grade of heavy fuel oil would be used in the Project case for the back-up fuel oil boiler.

Gases includes in this project activity are mainly carbon dioxide (CO_2). Only in the case of calculating leakage, methane (CH_4) emissions will be taken into account. For an overview on gases and sources see the following table.

Table 4: Overview of sources and gases for the baseline and the project activity

	Source	Gas	Included?	Justification / Explanation
Baseline	Fossil fuel consumption in the boilers	CO_2	Yes	Main source of GHG emissions (from fossil fuel combustion)
		CH_4	No	Only taken into account when calculating leakage
		N_2O	No	Not applicable
	Fuel processing and transportation	CO_2	No	See leakage
		CH_4	No	See leakage
		N_2O	No	Not applicable
Project Activity	Fossil fuel consumption in the boilers	CO_2	Yes	Main source of GHG emissions (from fossil fuel combustion)
		CH_4	No	Only taken into account when calculating leakage
		N_2O	No	Not applicable
	Fuel processing and transportation	CO_2	No	See leakage
		CH_4	No	See leakage
		N_2O	No	Not applicable

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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The version 02.1 of the “Combined tool to identify the baseline scenario and demonstrate additionality” has been used to identify the baseline scenario.

Step 1. Identification of alternative scenarios:

In the course of the project development a range of different possible project scenarios have been evaluated in detail:

1) The replacement of the current equipment with a new central pure heavy fuel oil combustion unit (producing only steam)
2) The replacement of the current equipment with a combined heat and power plant (producing electricity and steam; electricity to be fed in into the public grid)
3) Development of a municipal waste incineration plant for the production of steam for the fish meal plants
4) Continuation of current operation. Usage of the existing boilers with frequent repairs as done in the past plus potential on demand purchase of again second-hand equipment if needed.

For the above mentioned project scenarios detailed technical, environmental and economical assessments have been performed. Those led to the identification of scenario 3 “Development of a solar field plus fuel oil backup” as to only possible project.

The comparison of the different potential project options is attached in the Annex.

Step 2. Barrier analysis:

Sub-step 2a. Identify barriers that would prevent the implementation of alternative scenarios

Barrier 1: Investment barriers: The costs for the implementation of this kind of technology (solar field) are quite high. Even with the sales of the certificates the financial incentive is nearly not given to implement this project. The financial attractiveness comes from the assumed savings of energy costs.

It is nearly impossible to find a foreign investor for that kind of project in Morocco.

Barrier 2: Technological barriers: The 8 fish meal plants are run with poorly skilled personnel, the production processes are run improperly (i.e. wrong dimensioned components), and there is a huge potential for energy saving through energy efficiency measures.

The plants are equipped with old material, bought second-hand from foreign countries, repaired over and over. Skilled and/or properly trained personnel to operate and maintain the technology is not available in Morocco.

Barrier 3: Lack of prevailing practice: The planned project activity (solar field) is the first of its kind in this region and one of the first worldwide

Sub-step 2b. Eliminate alternative scenarios which are prevented by the identified barriers:

- Alternative 1 (replacement of the current equipment with a new central pure heavy fuel oil combustion unit) is prevented by the barriers as there would be no fuel switch and the CO_2-emission reduction potential would be too low.
- Alternative 2 (replacement of the current equipment with a combined heat and power plant - producing electricity and steam; electricity to be fed in into the grid) is prevented by the barriers as this project activity would generate even more greenhouse gas emissions as the baseline.
- Alternative 3 (municipal waste incineration plant for the production of steam) is prevented by the barriers as this project activity would be far too expensive (no positive return on investment even including potential sales or CERs), the collection of the waste is prevented by the local authorities. Furthermore the emission of greenhouse gases would exceed the baseline emissions.

Step 3. Investment analysis: → not applicable

Step 4. Common practice analysis

The planned project activity is the first of it's kind in Africa, no similar activities have been implemented or are known to the consultant to be prepared currently.

There are very few providers of industrial size solar power modules, which are capable of providing the amount and quality of steam needed in this industria processes.

All CDM-projects related to the use of solar energy for the production of heat or steam known so far are small domestic applications (e.g. solar cooking), which cannot be compared with this industrial size hybrid project.

=> Thus the baseline scenario is Alternative 4.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

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The version2 of the "Combined tool to identify the baseline scenario and demonstrate additionality" is used to demonstrate additionality.
As seen from the results in B.4 (see above), the project activity would not be conducted without the CDM-mechanism. The project is quite expensive and gives only little revenues (both in energy savings and in revenues from CER-sales) and the technology is new and has not been applied in Morocco so far.

The implementation and the registration of the CDM project activity will alleviate the barriers that prevent the proposed project activity from occurring in the absence of the CDM because it results in a small additional revenue stream plus contributes to the sustainable development in the region.

=> The proposed project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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Project emissions will be calculated using the Approved baseline and monitoring methodology AM0056.

Baseline emissions are calculated via the degree of efficiency of the overall steam generation system of the 8 fish meal companies. Calculation procedure according to the methodology AM0056 cannot be undertaken due to the absence of measuring equipment for 24 boilers for the amount of steam at different qualities.

As the project activity involves real fuel saving due to steam production via a solar field, the solar-produced amount of energy is simply deducted from prospected energy demand.

B.6.2. Data and parameters that are available at validation:

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The following data and parameters are included in this methodology but do not need to be monitored during the crediting period. These data and parameters mainly describe the baseline equipment.

Data / Parameter:	CAP_j
Data unit:	t/h
Description:	Steam generation capacity: Maximum long term load (capacity) of the boiler$_j$ or steam generation system (tonnes of steam output per hour at full load)
Source of data used:	Information of technical reports of the companies. Values not proved by measurement.
Value applied:	Values of all boilers → see overview of the baseline boilers, table 1, p.8 The total CAP of all 24 boilers is 211 t/h steam
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since there doesn't exist any equipment for measuring the produced amount of steam, values have been applied according to the specifications of the manufacturer.
Any comment:	The total CAP of all companies (211 t/h) exceeds by far the maximum steam demand which would constitute 139 t/h, according to the maximum processing capacity of all companies (assuming that all companies are in full operation at the same time). The actual maximum steam demand is calculated to be far lower: Considering a maximum daily production of ½ of the maximum processing capacity (in reality the max. daily production ranges from 4 to 50 % of max. processing capacity) and a coincidence factor of 0.8, the new centralized steam production requires a steam generation capacity for the project CAP_P of $CAP_P = 139 \cdot 0,5 \cdot 0,8 = 55,2$ t/h or 35,8 MW nominal load.

Data / Parameter:	η_i
Data unit:	Fraction
Description:	Degree of efficiency for boiler i
Source of data used:	The degree of efficiency has been measured by a boiler expert in August 2007 for 11 boilers. For three boilers values have been given by the companies, for

	boilers without any information concerning the degree of efficiency (the companies were not in operation when boiler-efficiency was measured) the mean value of the other boilers is being used instead.
Value applied:	Values are listed in table 5.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since there doesn't exist any equipment for measuring the produced amount of steam, the efficiency of the baseline steam generation system is calculated by using the degree of efficiency for each boiler. Thus the amount of steam generated by the project activity is indirectly derived by the consumption of heavy fuel oil, assuming that the heat of combustion is quantitative converted into steam-enthalpy, according to the degree of efficiency. Losses, e.g. from radiation, are being neglected.
Any comment:	Missing values need to be proved by further investigations.

Data / Parameter:	$S_{i,j}$
Data unit:	%
Description:	Share of operating time of a boiler i in the total operating time of all boilers of a company j
Source of data used:	given or estimated
Value applied:	Only one company (COPELIT) provided information about operating hours for each boiler. All other companies have no records about operating hours which is why it is assumed that the boilers are operated all the same length of time (e.g. for three boilers every boiler is estimated to operate $1/3^{rd}$ of the total time).
Justification of the choice of data or description of measurement methods and procedures actually applied :	Every company has 2 or more boilers. Since most of the boilers exceeded their technical life-time they often need to be repaired. This is why the companies switch steam generation from one to another boiler, depending on the operating state of the boilers, while the other boilers are repaired.
Any comment:	Share of use needs to be proved by further investigations.

Data / Parameter:	x_j
Data unit:	Fraction
Description:	Share of total production: Share of company j in the total fish meal-production of all companies (mean values for the years 2004-2007)
Source of data used:	Production data provided by the companies.
Value applied:	Production figures for fish meal for the years 2004-2007 are given in Annex I.
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	h_{Steam}
Data unit:	MJ/t
Description:	Enthalpy of steam at a certain temperature level.
Source of data used:	Literature data used.
Value applied:	Steam enthalpy at 180 °C = 2776 MJ/t
Justification of the	The temperature of steam produced ranges from 120 to 350 °C. Provided values

choice of data or description of measurement methods and procedures actually applied :	are shown in Annex II. It is impossible to gain any information about amounts for different temperature levels for past years. Therefore steam enthalpy is being uniformly assumed at 180 °C.
Any comment:	

Data / Parameter:	h_{Feed}
Data unit:	MJ/t
Description:	Enthalpy of feed-water at a certain temperature level.
Source of data used:	Literature data used.
Value applied:	Water enthalpy at 105 °C = 440 MJ/t
Justification of the choice of data or description of measurement methods and procedures actually applied :	Feed-water has a mean temperature of 23°C, information about amount and quality of return-water and condensate is not available. There is only information about temperature levels of the processes, but even these values vary in a wide range from 23 to 170 °C. Provided values are shown in Annex II. For standardisation a uniform value at 105 °C is being assumed.
Any comment:	

Data / Parameter:	NCV_{HFO}
Data unit:	GJ/t
Description:	Net caloric value of fossil fuel (heavy fuel oil) used in the baseline boiler
Source of data used:	No local data available. Literature value is being used instead (Recknagel, Sprenger, Schramek (1997), Taschenbuch für Heizung und Klimatechnik, R.Oldenburg Verlag, S. 207).
Value applied:	39.77
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$EF_{C,HFO}$
Data unit:	tC/GJ
Description:	Carbon emission factor of heavy fuel oil
Source of data used:	No local data available. Factor for German refineries are being used instead.
Value applied:	0.0221
Justification of the choice of data or description of measurement methods and procedures actually applied :	$EF_{C,HFO}$ = Carbon content [%]/NCF_{HFO} [GJ/t]/100 = 87,8/39,77/100 = 0.0221
Any comment:	

Data / Parameter:	$OXID_{HFO,BL}$
Data unit:	Fraction

Description:	Oxidation factor for the fossil fuel used in the baseline boiler.
Source of data used:	IPCC default factor
Value applied:	0.995
Justification of the choice of data or description of measurement methods and procedures actually applied :	Common practise.
Any comment:	

Data / Parameter:	Average consumption of heavy fuel oil $m_{HFO,BL}$
Data unit:	t/yr
Description:	Average consumption of heavy fuel oil in the baseline within the years 2004-2007
Source of data used:	Data provided by the companies. Values are shown in Annex I.
Value applied:	**year** **t/a** 2004 8.235 2005 9.202 2006 7.918 2007 6.286 **mean value** 7.910
Justification of the choice of data or description of measurement methods and procedures actually applied :	Consumption on HFO is directly related to the amount of raw material processed (= fish meal). As it can be seen above (more detailed information in Annex I) the amount of production varies from year to year, depending on the amount of available fish. 2007 was a very bad year for the companies due to a lack of fish.
Any comment:	Used for the calculation of the specific fuel consumption: $m_{HFO,BL}$/amount of fish meal produced.

Data / Parameter:	$EF_{BL,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the baseline equipment from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied:	4.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

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Baseline Emissions

According to the methodology baseline emissions should be calculated on the basis of specific fuel consumption (*SFC*)[1] for steam generation under the best possible operating conditions of the baseline steam generation system, the amount of steam generated by the project activity, and the baseline fuel emission factor (*EF*).

Since there doesn't exist any equipment for measuring the produced amount of steam, the efficiency of the baseline steam generation system is calculated by using the degree of efficiency for each boiler. Thus the amount of steam generated by the project activity is indirectly derived by the consumption of heavy fuel oil, assuming that the heat of combustion is quantitative converted into steam-enthalpy, according to the degree of efficiency. Losses, e.g. from radiation, are being neglected.

The degree of efficiency has been measured by a boiler expert in August 2007 for 11 boilers. For three boilers values have been given by the companies, for boilers without any information concerning the degree of efficiency (the companies were not in operation when boiler-efficiency was measured) the mean value of the other boilers is being used instead. The values are listed in table 5.

Because there is no information about the *SFC* per load class available either, it is assumed that the degree of efficiency for each boiler is constant, neglecting a variable performance at different load classes.

Step 1: Determination of the mean boiler efficiency η_j of company j

As a first step for every company the mean boiler efficiency is calculated. For that the degree of efficiency η_i is multiplied with the share of use S_i of each boiler i. Only one company (COPELIT) provided information about operating hours for each boiler. All other companies have no records about operating hours which is why it is assumed that the boilers are operated all the same (e.g. for three boilers every boiler is estimated to operate $1/3^{rd}$ of the total time).

Thus the mean boiler efficiency η_j for a company j can be calculated with the formula

$$\eta_j = \Sigma(\eta_i \cdot S_i)$$

Where:

η_j	Mean boiler efficiency of company j [-]
η_i	Degree of efficiency of boiler i (measured, given or calculated) [-]
S_i	Share of use of boiler i (given or estimated) [%]

The values for η_j, η_i and S_i are given in table 5.

Step 2: Determination of the mean boiler efficiency of all companies η_{Sys}

As a next step the mean boiler efficiency of the whole system η_{Sys} is being calculated. For that the mean boiler efficiency η_j is multiplied with the share of total production x_j of each company j. The share of total production x_j is derived from production figures for fish meal for the years 2004-2007 (Annex I).

Thus the mean boiler efficiency of all companies η_{Sys} can be calculated with the formula

$$\eta_{Sys} = \Sigma(\eta_j \cdot x_j)$$

Where:

[1] Expressed as fuel consumed per ton of steam produced [GJ/t Steam].

η_{Sys} Boiler efficiency of all companies [-]
x_j Share of total fish meal production for each company j [%]

The values for η_{Sys} and x_j are given in table 5. The value for η_{Sys} therefore constitutes 0.794 [-].

Table 5: Boiler efficiency of the 8 companies

company name	boiler	construction	degree of efficiency	percentage share of use		mean boiler efficiency
			η_i	S_i	$\eta_i \cdot S_i$	$\eta_j = \Sigma(\eta_i \cdot S_i)$
	No	year	-	%	-	GJ/t
COPELIT	No 1	1971	0,200	20,0%	0,040	0,733
	No 2	1971	0,875	39,6%	0,346	
	No 3	1977	0,859	40,5%	0,347	
DELTA OCEAN	No 1	1979	0,785**	33,3%	0,262	0,785
	No 2	1985	0,785**	33,3%	0,262	
	No 3	1976	0,785**	33,3%	0,262	
KB FISH	No 1	1995	0,886	33,3%	0,295	0,842
	No 2	1983	0,839	33,3%	0,280	
	No 3	1982	0,800*	33,3%	0,267	
LAÂYOUNE ELEVAGE	No 1	1996	0,900	33,3%	0,300	0,823
	No 2	1989	0,784	33,3%	0,261	
	No 3	1989	0,785**	33,3%	0,262	
LAÂYOUNE PROTEINE	No 1	1984	0,889	33,3%	0,296	0,863
	No 2	1977	0,917	33,3%	0,306	
	No 3	1995	0,785**	33,3%	0,262	
SEPOMER	No 1	1994	0,899	25,0%	0,225	0,813
	No 2	1994	0,785**	25,0%	0,196	
	No 3	1970	0,785**	25,0%	0,196	
	No 4	1985	0,785**	25,0%	0,196	
SOMATRAPS	No 1	1973	0,750*	50,0%	0,375	0,725
	No 2	1977	0,700*	50,0%	0,350	
SOTRAGEL	No 1	1977	0,685	33,3%	0,228	0,751
	No 2	1984	0,785**	33,3%	0,262	
	No 3	1983	0,785**	33,3%	0,262	

* values are provided by the companies
** mean value of measured boilers

Table 6: Overview on the emission reductions for the 10 year crediting period

company name	mean boiler efficiency	share of total fish meal-production	
	η_j	x_j	$\eta_j \cdot x_j$
	GJ/t	%	-
COPELIT	0,733	18,15%	0,133
DELTA OCEAN	0,785	7,10%	0,056
KB FISH	0,842	21,69%	0,183
LAÂYOUNE ELEVAGE	0,823	6,84%	0,056
LAÂYOUNE PROTEINE	0,863	7,48%	0,065
SEPOMER	0,813	20,80%	0,169
SOMATRAPS	0,725	7,99%	0,058
SOTRAGEL	0,751	9,96%	0,075

Step 3: Calculation of the specific energy consumption of the system SEC_{Sys}

The specific energy consumption of the system SEC_{Sys} is then calculated with the formula

$$SEC_{Sys} = (2776\text{-}440) \cdot 1/1000 \cdot GJ/MJ/\eta_{Sys}$$

Where:

SEC_{Sys} Specific energy consumption of the system [GJ/t]
2776 Steam enthalpy at 180 °C [MJ/t]
440 Water enthalpy at 105 °C [MJ/t]

The value for SEC_{Sys} therefore constitutes 2.939 [GJ/t].

Step 4: Calculation of the baseline emissions

Baseline emissions BE_y [tCO_2/yr] are based on the quantity of HFO combusted and the CO_2 emission coefficient of HFO, as follows:

$$BE_y = 44/12 \cdot EF_{C,HFO} \cdot OXID_{HFO,BL} \cdot m_{HFO,BL} \cdot NCV_{HFO}$$

Where:

BE_y Baseline emissions resulting from steam generation within the capacity of the baseline equipment in the years 2004-2007 [tCO_2/yr]
44/12 Ratio of molar masses from CO_2/C
$EF_{C,HFO}$ Carbon emission factor of HFO [tC/GJ] = 0.0221
$OXID_{HFO,BL}$ Oxidation factor of baseline fossil fuel = 0.995
$m_{HFO,BL}$ Average consumption of heavy fuel oil (HFO) 2004-2007 = 7,910 [t/yr] (see Annex I)
NCV_{HFO} Net calorific value of HFO = 39.77 [GJ/t]

The value for BE_y therefore constitutes:

$BE_y = 44/12 \cdot 0.0221 \cdot 0.995 \cdot 7910 \cdot 39.77 = 25{,}343$ [tCO_2/yr].

Project emissions

The CO_2 emissions from fossil fuel consumption in the project activity (PE_y) are calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 01).
CO_2 emissions from fossil fuel combustion for steam generation in the boilers are calculated based on the quantity of HFO combusted and the CO_2 emission coefficient of HFO, as follows:

$PE_y = 44/12 \cdot EF_{C,HFO} \cdot OXID_{HFO,BL} \cdot H_{HFO,P}$

Where:
PE_y CO_2 emissions from fossil fuel combustion in the Project during the year 2009-2018 [tCO_2/yr]
$H_{HFO,P}$ Prospective HFO consumption [GJ/yr]

With:
$H_{HFO,P} = (m_{HFO,BL} \cdot NCV_{HFO} \cdot \eta_{Sys} - SE_{SOL} \cdot 3.6)/\eta_{new}$

Where:
SE_{SOL} Steam energy which is produced by the solar field = 11,712 MWh according to the information of the provider
η_{new} degree of efficiency of the new boiler to be installed = 0.93 [-]

The value for $H_{HFO,P}$ therefore constitutes:
$H_{HFO,P} = (7{,}910 \cdot 39.77 \cdot 0.794 - 11{,}712 \cdot 3.6 \cdot GJ/MWh)/0.93 = 223{,}272$ [GJ/yr]

The value for PE_y therefore constitutes:
$PE_y = 44/12 \cdot 0.0221 \cdot 0.995 \cdot 223{,}272 = 17{,}987$ [tCO_2/yr].

Leakage

Leakage is calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 01).
Since no LNG is used leakage emissions from LNG are not considered →
$LE_y = LE_{CH4,y}$

Where:
LE_y Leakage emissions in the year 'y' [tCO_2e/yr]
$LE_{CH4,y}$ Leakage emissions due to fugitive upstream CH_4 emissions in the year 'y' [tCO_2e/yr]

And:
$LE_{CH4,y} = (H_{HFO,P} - m_{HFO,BL} \cdot NCV_{HFO}) \cdot EF_{HFO,upstream,CH4} \cdot GWP_{CH4}$

Where:
$EF_{HFO,upstream,CH4}$ Default emission factor for fugitive upstream CH_4 emissions of oil = 4.1 t CH_4/PJ
GWP_{CH4} 21

The value for LE_y therefore constitutes:
$PE_y = (223{,}554 - 7{,}910 \cdot 39.77) \cdot 4.1 \cdot 1/1{,}000{,}000 \cdot PJ/GJ \cdot 21 = -7.8$ [tCO_2e/yr].
Emission Reduction

Emission reductions are calculated as follows:

$ER_y = BE_y – PE_y – LE_y$ [tCO_2e/yr].

Where:

ER_y Emissions reductions of the project activity during the year ‘y’ [tCO_2e/yr]

The value for ER_y therefore constitutes:

ER_y = 25,343-17,987 +7.8 = **7,364 [tCO_2e/yr]**.

B.6.4 Summary of the ex-ante estimation of emission reductions:

>>

In total the project activity will reduce annually **7,364 tCO_2e**.

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$P_{PJ,I,y}$
Data unit:	t/yr
Description:	Generated steam in the year ‘y’ subdivided into load classes in the case of single boiler installations.
Source of data used:	Measurement, calculation. Use test result minus uncertainty for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) of the mass flow rate of generated steam (t/h) following international acknowledged norms and guidelines such as ASME PTC 4-1998. Steam generation is allocated to the associated load class by comparison of measured steam mass flow and the range of the load classes. By multiplication of every 15-minutes-value with 0.25 hours the amount of generated steam is determined. At the end of each year the steam generation within each load class is aggregated.
Monitoring frequency:	Every 15 minutes, allocated and aggregated into load classes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$EF_{PJ,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the project activity from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	Local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories.
Measurement procedures (if any):	
Monitoring frequency:	Yearly

QA/QC procedures:	
Any comment:	For further guidance consider the most recent version of AM0029.

Data / Parameter:	$EF_{BL,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the baseline equipment from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	Local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	For further guidance consider the most recent version of AM0029.

Data / Parameter:	$PRESS_{PJ}$
Data unit:	bar
Description:	Pressure of the generated steam
Source of data used:	Measurement. Use test result for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Monitoring frequency:	Every 15 minutes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$TEMP_{PJ}$
Data unit:	K
Description:	Temperature of the generated steam
Source of data used:	Measurement. Use test result for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Monitoring frequency:	Every 15 minutes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	Only required in the case of superheated steam

Data / Parameter:	Fish meal production
Data unit:	t/yr
Description:	Yearly produced amount of fish meal.
Source of data used:	Monitoring data of each single company
Measurement procedures (if any):	On demand.
Monitoring frequency:	Monitoring on a daily basis.

QA/QC procedures:	Measuring instruments should be subject to a regular maintenance (i.e. calibration) in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	Fish oil production
Data unit:	t/yr
Description:	Yearly produced amount of fish oil.
Source of data used:	Monitoring data of each single company
Measurement procedures (if any):	On demand.
Monitoring frequency:	Monitoring on a daily basis.
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance (i.e. calibration) in accordance to appropriate national/international standards.
Any comment:	

B.7.2 Description of the monitoring plan:

>>
See monitoring plan.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
The project activity starts with the technical implementation of the solar field as well as the construction of the new steam grid and the fuel oil back-up solution. In the most positive scenario, the solar field will be built starting with September 2008. The emission reductions will be calculated starting with 1.1.2009.

C.1.2. Expected operational lifetime of the project activity:

>>
The project boilers lifetime is assumed to exceed the crediting period of 10 years. At least a 12 year period of solar field operation is scheduled.

C.2 Choice of the crediting period and related information:

A fixed crediting period of 10 years is used.

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>>
not applicable

C.2.1.2. Length of the first crediting period:

>>

not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

1.1.2009

C.2.2.2. Length:

>>

10 years (until 31.12.2018)

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>

The environmental impacts resulting from the project activity are seen only positive. Trough the major reduction in fuel oil consumption there will be less environmental pollution, less emissions both of greenhouse gases from fossil fuel combustion and less emission from air pollutants (actual boilers are not equipped with filters).

The project activity includes the installation of a solar field which will be installed in the industrial zone. The area is not especially valuable from a biodiversity perspective.

Figure 8: Construction site of the project activity

Figure 9: Picture of a concentrating solar field (courtesy Novatec Solar)

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>
Not applicable.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>
Since the project activity will be implemented in the industrial zone of Laayoune – Plage, the only neighbours are the other fish meal plants or other industrial facilities in the fish industry (e.g. canning). There are no close residentials in this area.

Various discussions have been held with the relevant stakeholders to this project activity: this includes inter alia Mr. Sentissi al Idrissi, the president of ANAFAP, the representative of the Moroccan fish meal industry as well as the majors and representatives of the cities of Laayoune and of Layoune – Plage.

In July 2007 a delegation of representatives of the stakeholders had been to Vienna, to discuss the project and negotiate necessary contracts. The delegation included following persons:

Mr. Hassan SENTISSI EL IDRISSI
Mr. ABDEL AMADOUR
Mr. OULD ERRACHID HAMDI
Mr. HICHAM BOURBOUH
Mr. MOHAMED EL IMAM KADIR
Mr. MOHAMED ALI HABOUHA

In summer 2007 the eight respective fish meal companies were visited also by a team of experts for the evaluation of the energy efficiency potential in the companies. In the course of those visits the comments of the plant personnel on the planned project activity were also discussed. Following fish meal plants were evaluated:

- Copelit
- Sepomer
- Delta Ocean
- KB Fish
- Laayoune Elevage
- Laayoune Proteine
- Somatraps
- Sotragel

Detailed reports for the respective energy efficiency audits are available.

E.2. Summary of the comments received:

>>

E.3. Report on how due account was taken of any comments received:

>>

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

BACKGROUND

Morocco has limited indigenous oil, gas and hydro resources; as a result it has historically been dependent on the import of fossil fuels (oil, coal and diesel). Ap-proximately 97% of its primary energy comes from foreign sources, which weighs heavily on foreign exchange payments.
At the same time Morocco is very suited for the implementation of solar techniques since it ranks among the most favoured sites worldwide concerning solar irradia-tion.
A substitution of fossil fuel by solar heat and power would be of a high ecological relevance. Additionally to that it would enhance Morocco's security of supply and reduce its dependency from energy imports.
A switch from fossil to solar energy is also economically attractive, especially on a mid- and long-term perspective: even though capital costs for solar installations are relatively high, only very low operating expenses occur.

Project outline

The CDM-project focuses on the centralized steam production for 8 fish meal factories in Laâyoune Plage/Western Sahara (see map below).
Presently steam is being generated in several timeworn (25 yrs. average) steam boilers. Additionally to that every company has its own, very discontinuous steam supply, which makes steam generation very inefficient. A site visit in June 2007 showed energy optimisation potentials of the factories between 30 and 50 %, if supply- and demand-side measures are implemented.
The present report focuses on supply-side measures for fuel saving, which are:

1) fuel saving via solar steam-production
2) enhancement of the overall degree of efficiency of the fossil fuel-based steam generation by boiler replacement
3) fusion of eight separate steam systems to one connected steam grid

History

In the beginning of the project, several options had been discussed, including following:

1) The replacement of the current equipment with a new central pure heavy fuel oil combustion unit (producing only steam)
2) The replacement of the current equipment with a combined heat and power plant (producing electricity and steam; electricity to be fed in into the public grid)
3) Development of a municipal waste incineration plant for the production of steam for the fish meal plants
4) Development of a solar field combined with a fossil fuel back-up solution, producing steam for the plants.

For the above mentioned project scenarios detailed technical, environmental and economical assessments have been performed. Those led to the identification of alternative 4 "Development of a solar field plus fuel oil backup" as to only possible project.

Of those four options, three had to be phased out in earlier stages of the project:

- Alternative 1 (replacement of the current equipment with a new central pure heavy fuel oil combustion unit) is prevented by the barriers as there would be no fuel switch and the CO_2-emission reduction potential would be too low.
- Alternative 2 (replacement of the current equipment with a combined heat and power plant - producing electricity and steam; electricity to be fed in into the grid) is prevented by the barriers as this project activity would generate even more greenhouse gas emissions as the baseline.
- Alternative 3 (municipal waste incineration plant for the production of steam) is prevented by the barriers as this project activity would be far too expensive (no positive return on investment even including potential sales or CERs), the collection of the waste is prevented by the local authorities. Furthermore the emission of greenhouse gases would exceed the baseline emissions by far.

For a detailed analysis of the respective scenarios information is attached in the Annex.

Description of the solar field / back-up solution

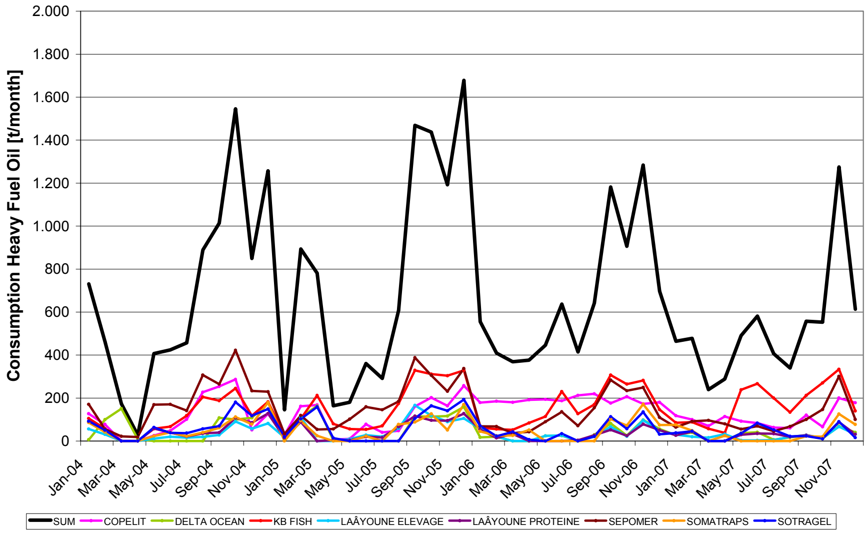
A centralized solar/fossil hybrid plant will be realized, providing baseload energy via a solar field and in addition to that covering peak demand via fossil fuel fired boilers. For the solar field Linear Concentrating Fresnel-Collectors shall be used. The planned solar field ranks among the biggest applications of solar heat for industrial processes worldwide.

- The old fuel oil boilers used for steam production in the fishmeal plants will be abandoned.
- Energy efficiency measures will be implemented in the fish meal plants in order to reduce energy input. Since the implementation of suggested measures cannot be guaranteed the efficiency measures cannot be taken into account in this methodology.
- A solar field plus a fossil fuel back-up system will be implemented to centrally provide steam for the 8 fish meal plants on site.
- It is considered also to potentially produce electricity with the solar field and feed in excess power into the national grid operated by Office National de l'Electricité (ONE).

General
The 24 decentralized fossil fuel boilers will be replaced by a **central solar steam production unit** combined with a **fossil fuel back-up solution** (for peak demand and night operations).
The suggested site is Laâyounne Plage on the Atlantic coast of Morocco (27,05° Lat and -13,24° Lon). Irradiation data for this site where generated with the software Meteonorm 5.1. The yearly direct normal irradiation (DNI) is 2.478 kWh/m² and the yearly global horizontal irradiation is 2.224 kWh/m².

Yearly energy demand and min./max. load
The current yearly fuel demand (heavy fuel oil) mounts up to 9,200 t/yr. or 102 GWh/yr fuel energy. It should be reduced to about 80 GWh/yr. due to boiler replacement and continuous steam-demand. The current min./max. heat demand of all companies is estimated to range between 5 and 36 MW.
The typical load from late August to December is roughly two to three times the load compared to the rest of the year. A minimum heat load occurs in April, the maximum between September and December.
The heat load curve is shown indirectly in the following figure which shows the consumption of heavy fuel oil for the years 2004-2007.

Figure 10: Consumption Heavy Fuel Oil 2004-2007



Plant Design

a) Solar Field

Figure 11: Picture of a concentrating solar field (courtesy of Novatec Solar)

The solar field has been designed using the following parameters:

- Design Temperature 180°C
- Design Pressure 10 bar
- Steam Quality 1,00
- Maximum Pressure 20 bar

Performance parameters of NOVA-1:
Thermal loss per m² of primary reflector

- $u0 = 0.045$ W/(m²K)
- $u1 = 0.00025$ W/(m²K)

A technical acceptance test certifying the performance of solar field equipment will be provided by the DLR (German Aerospace Center), who will act as an independent consultant.

In order to ensure cost-effectiveness the hybrid plant will be constructed as follows: Baseload energy will be provided by the solar field with a max. capacity of 5 MW, producing approx. 11,712 MWh/yr. steam and heat. Further energy demand (back-up, night) should be covered by a heavy fuel oil boiler (once 36 MW). The land area required is approx. 18,000 m² (16,854 for the solar field, the rest for the central boiler house).

b) Fossil Fuel Back-up Solution

The following table provides an overview on the baseline boilers and the whole baseline steam system currently installed in the 8 installations:

Fuel: heavy fuel oil
Steam quality:
Pressure range: 4 – 8.5 bar
Temperature range: 120 – 250 °C

Table 12: Description of the boilers used in the companies

Company Name	Boiler No	Year of construction	Degree of efficiency η	Steam generation capacity (CAP)	Operation mode	Operation range
		year	%	t/h		% of CAP
COPELIT	No 1	1971	20,0	7	High-Low-Off	0-100 %
	No 2	1971	87,5	7	High-Low-Off	21-100 %
	No 3	1977	85,9	7	High-Low-Off	21-100 %
DELTA OCEAN	No 1	1979	*n.a.*	13	Modulating	61-80 %
	No 2	1985	*n.a.*	8	Modulating	81-100 %
	No 3	1976	*n.a.*	5	High-Low-Off	81-100 %
KB FISH	No 1	1995	88,6	12	Modulating	41-60 %
	No 2	1983	83,9	10	Modulating	41-60 %
	No 3	1982	80,0*	10	Modulating	41-60 %
LAÂYOUNE ELEVAGE	No 1	1996	90,0	12	*n.a.*	*n.a.*
	No 2	1989	78,4	10	*n.a.*	*n.a.*
	No 3	1989	*n.a.*	10	*n.a.*	*n.a.*
LAÂYOUNE PROTEINE	No 1	1984	88,9	8	On-Off	41-60 %
	No 2	1977	91,7	12	On-Off	21-40 %
	No 3	1995	n.a.	12	On-Off	21-40 %
SEPOMER	No 1	1994	89,9	8	*n.a.*	*n.a.*
	No 2	1994	*n.a.*	6	*n.a.*	*n.a.*
	No 3	1970	*n.a.*	6	*n.a.*	*n.a.*
	No 4	1985	*n.a.*	5	*n.a.*	*n.a.*
SOMATRAPS	No 1	1973	75,0*	8	High-Low-Off	*n.a.*
	No 2	1977	70,0*	8	High-Low-Off	*n.a.*
SOTRAGEL	No 1	1977	68,5	12	*n.a.*	*n.a.*
	No 2	1984	*n.a.*	8	*n.a.*	*n.a.*
	No 3	1983	*n.a.*	7	*n.a.*	*n.a.*
mean value		**1983**	***78,45***	**8,8**		

* *values are provided by the companies.*
n.a. *not available*

The following table shows the data of the steam boiler to be installed under the project activity that will replace the currently installed boilers:

Fuel: heavy fuel oil
Type: Boiler with two fire-tubes
Steam quality:
Pressure range: 6 – 10 bar
Temperature range: 160 – 180 °C

Table 13: Description of the new boiler

	Year of construction	Degree of efficiency η	Steam generation capacity (CAP)	Operation mode	Operation range
Unit	year	%	t/h		% of CAP
Boiler	2008	> 93,0	19	Modulating	7-100 %

The project activity will contribute to sustainable development as it involves the reduction of fossil fuel. Hence, it will considerably reduce the CO_2 emissions as well as local pollutants such as NO_x, CO and SO_2 during boiler operation.

SELECTION OF THE BASELINE

The study is based on the Approved baseline and monitoring methodology AM0056 / Version 01 "Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems".
The 24 de-centralised fuel oil boilers will be replaces with a central steam production unit, dispatching it's product to the 8 fish meal plants.

The methodology is applicable since the following conditions are applied with:

- Steam generation in the project activity is carried out through the use of fossil fuel fired steam boilers
- Moroccan/local regulations do not require the replacement or retrofit of the existing equipment.
- There are no enforced Moroccan/local regulations/standards on minimum efficiency ratings for the boilers included in the project boundary.
- Moroccan/local regulations/programmes do not constrain the facility from using the fossil fuel being used prior to fuel switching
- The steam quality (i.e. pressure and temperature) is the same before and after the start of the implementation of the project activity
- The existing steam generating system in the facility where the project activity is implemented has more than one boiler
- Only one type of fossil fuel is used in all boilers included in the project boundary

The emission sources in the Baseline case are the emissions related to fossil fuel combustion in 24 steam boilers, using heavy fuel oil (same grade for all boilers). The same grade of heavy fuel oil would be used in the Project case for the back-up fuel oil boiler.

<u>Identification of the baseline scenario</u>

The version2 of the "Combined tool to identify the baseline scenario and demonstrate additionality" has been used to identify the baseline scenario.

<u>Step 1. Identification of alternative scenarios:</u>
In the course of the project development a range of different possible project scenarios have been evaluated in detail:

5) The replacement of the current equipment with a new central pure heavy fuel oil combustion unit (producing only steam)
6) The replacement of the current equipment with a combined heat and power plant (producing electricity and steam; electricity to be fed in into the grid)
7) Development of a municipal waste incineration plant for the production of steam for the fish meal plants
8) Continuation of current operation. Usage of the existing boilers with frequent repairs as done in the past plus potential on demand purchase of again second-hand equipment if needed.

For the above mentioned project scenarios detailed technical, environmental and economical assessments have been performed. Those led to the identification of scenario 3 "Development of a solar field plus fuel oil backup" as to only possible project.

Step 2. Barrier analysis:

Sub-step 2a. Identify barriers that would prevent the implementation of alternative scenarios

Barrier 1: Investment barriers: The costs for the implementation of this kind of technology (solar field) are quite high. Even with the sales of the certificates the financial incentive is nearly not given to implement this project. The financial attractiveness comes from the assumed savings of energy costs. It is nearly impossible to find a foreign investor for that kind of project in Morocco.

Barrier 2: Technological barriers: The 8 fish meal plants are run with poorly skilled personnel, the production processes are run improperly (i.e. wrong dimensioned components), and there is a huge potential for energy saving through energy efficiency measures.

The plants are equipped with old material, bought second-hand from foreign countries, repaired over and over. Skilled and/or properly trained personnel to operate and maintain the technology is not available in Morocco.

Barrier 3: Lack of prevailing practice: The planned project activity (solar field) is the first of its kind in this region and one of the first worldwide.

Sub-step 2b. Eliminate alternative scenarios which are prevented by the identified barriers:

- Alternative 1 (replacement of the current equipment with a new central pure heavy fuel oil combustion unit) is prevented by the barriers as there would be no fuel switch and the CO_2-emission reduction potential would be too low.
- Alternative 2 (replacement of the current equipment with a combined heat and power plant - producing electricity and steam; electricity to be fed in into the grid) is prevented by the barriers as this project activity would generate even more greenhouse gas emissions as the baseline.
- Alternative 3 (municipal waste incineration plant for the production of steam) is prevented by the barriers as this project activity would be far too expensive (no positive return on investment even including potential sales or CERs), the collection of the waste is prevented by the local authorities. Furthermore the emission of greenhouse gases would exceed the baseline emissions.

Step 3. Investment analysis: → not applicable

Step 4. Common practice analysis

The planned project activity is the first of it's kind in Africa, no similar activities have been implemented or are known to the consultant to be prepared currently.

There are very few providers of industrial size solar power modules, which are capable of providing the amount and quality of steam needed in this industria processes.

All CDM-projects related to the use of solar energy for the production of heat or steam known so far are small domestic applications (e.g. solar cooking), which cannot be compared with this industrial size hybrid project.

⇨ **Thus the baseline scenario is Alternative 4.**

Life-time of the project

For this CDM-project a fixed life-time of 10 years is foreseen, starting from 1.1.2009 and ending in 31.12.2018.
Implementing the project activity is planned to start in 2008, project implementation will be finished in 2009, thus CERs will be generated starting from 2009.

Calculation of the emission reductions

The following table provides an overview on the emission reductions for the 10 year crediting period. The emissions reductions shown here are based only upon the fuel saving through the implementation of the solar field plus the fuel oil back-up solution.

Table 14: Overview of the emission reductions for the 10 year crediting period

Years	Annual estimation of emission reductions in tonnes of CO_2e
2008	0
2009	4.500
2010	7.364
2011	7.364
2012	7.364
2013	7.364
2014	7.364
2015	7.364
2016	7.364
2017	7.364
2018	7.364
Total estimated reductions (tCO_2e)	**70.776**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tCO_2e)	**7.078**

Additional savings are expected for saving of fuel due to the avoiding of several hundred start ups of 24 single boilers. The amount of t CO_2 saved cannot be seriously calculated although it is estimated to range between 10 and 12 % of the baseline emissions (i.e. **2500-2900 t CO_2/yr**.). For the monitoring the specific HFO consumption per t product (fish meal) might be used.

Baseline emissions

Some initial remarks

Within the project 24 steam boilers shall be replaced in 8 different companies. The boilers in place are quite old (year of construction: 1970–1996, mean value is 1983). A usual replacement of the equipment according to average life time of 25 years is not done. Boilers have been bought second-hand and are repaired over and over again, thus extending any possible lifespan a provider would state.

The average degree of efficiency of the boilers is quite low (< 80 %). Additionally to that the boiler operation is very discontinuous since every single company produces its own steam, and only when raw material (= fish) is available. The 8 companies produce in an alternating way as follows: after arrival at the harbour of Laâyoune Plage raw material is provided to the companies in stipulated portions. Beginning with the first company it is provided as long as fish is available. The companies start with their operation after one another, a simultaneous operation of all company practically never occurs.

Since the companies do not use a connected steam grid it requires much energy to start-up the "cold" boilers respectively keep them at high temperature. Additional energy- and CO_2-savings for that aspect are estimated to range between 10 and 12 % or 2500-2900 t CO_2/yr. Nevertheless these additional savings cannot be considered within the calculations since they cannot be seriously calculated.

One big advantage of the project therefore is the connection of all companies to one steam-supply-systems and the replacement of many inefficient boilers by one centralized steam production plant, providing continuous baseload energy and thus avoiding hundreds of energy-intensive start-ups of cold boilers.

Calculation

According to the methodology baseline emissions should be calculated on the basis of specific fuel consumption (*SFC*)[2] for steam generation under the best possible operating conditions of the baseline steam generation system, the amount of steam generated by the project activity, and the baseline fuel emission factor (*EF*).

Since there doesn't exist any equipment for measuring the produced amount of steam, the efficiency of the baseline steam generation system is calculated by using the degree of efficiency for each boiler. Thus the amount of steam generated by the project activity is indirectly derived by the consumption of heavy fuel oil, assuming that the heat of combustion is quantitative converted into steam-enthalpy, according to the degree of efficiency. Losses, e.g. from radiation, are being neglected.

The degree of efficiency has been measured by a boiler expert in August 2007 for 11 boilers. For three boilers values have been given by the companies, for boilers without any information concerning the degree of efficiency (the companies were not in operation when boiler-efficiency was measured) the mean value of the other boilers is being used instead. The values are listed in table 4.

Because there is no information about the *SFC* per load class available either, it is assumed that the degree of efficiency for each boiler is constant, neglecting a variable performance at different load classes.

<u>Step 1: Determination of the mean boiler efficiency η_j of company j</u>

As a first step for every company the mean boiler efficiency is calculated. For that the degree of efficiency η_i is multiplied with the share of use $S_{i,j}$ of each boiler i. Only one company (COPELIT) provided information about operating hours for each boiler. All other companies have no records about operating hours which is why it is assumed that the boilers are operated all the same length of time (e.g. for three boilers every boiler is estimated to operate 1/3rd of the total time).

Thus the mean boiler efficiency η_j for a company j can be calculated with the formula

$$\eta_j = \Sigma(\eta_i \cdot S_{i,j})$$

[2] Expressed as fuel consumed per ton of steam produced [GJ/t Steam].

Where:

η_j Mean boiler efficiency of company j [-]

η_i Degree of efficiency of boiler i (measured, given or calculated) [-]

$S_{i,j}$ Share of use of boiler i (given or estimated) [%]

The values for η_j, η_i and $S_{i,j}$ are given in table 4.

Step 2: Determination of the mean boiler efficiency of all companies η_{Sys}

As a next step the mean boiler efficiency of the whole system η_{Sys} is being calculated. For that the mean boiler efficiency η_j is multiplied with the share of total production x_j of each company j. The share of total production x_j is derived from production figures for fish meal for the years 2004-2007 (Annex I).

Thus the mean boiler efficiency of all companies η_{Sys} can be calculated with the formula

$$\eta_{Sys} = \Sigma(\eta_j \cdot x_j)$$

Where:

η_{Sys} Boiler efficiency of all companies [-]

x_j Share of total fish meal production for each company j [%]

The values for η_{Sys} and x_j are given in table 5. The value for η_{Sys} therefore constitutes 0.794 [-].

Table 15: Boiler efficiency of the 8 companies

company name	boiler	construction	degree of efficiency	percentage share of use		mean boiler efficiency
			η_i	$S_{i,j}$	$\eta_i \cdot S_{i,j}$	$\eta_j = \Sigma(\eta_i \cdot S_{i,j})$
	No	year	-	%	-	GJ/t
COPELIT	No 1	1971	0,200	20,0%	0,040	0,733
	No 2	1971	0,875	39,6%	0,346	
	No 3	1977	0,859	40,5%	0,347	
DELTA OCEAN	No 1	1979	0,785**	33,3%	0,262	0,785
	No 2	1985	0,785**	33,3%	0,262	
	No 3	1976	0,785**	33,3%	0,262	
KB FISH	No 1	1995	0,886	33,3%	0,295	0,842
	No 2	1983	0,839	33,3%	0,280	
	No 3	1982	0,800*	33,3%	0,267	
LAÂYOUNE ELEVAGE	No 1	1996	0,900	33,3%	0,300	0,823
	No 2	1989	0,784	33,3%	0,261	
	No 3	1989	0,785**	33,3%	0,262	
LAÂYOUNE PROTEINE	No 1	1984	0,889	33,3%	0,296	0,863
	No 2	1977	0,917	33,3%	0,306	
	No 3	1995	0,785**	33,3%	0,262	
SEPOMER	No 1	1994	0,899	25,0%	0,225	0,813
	No 2	1994	0,785**	25,0%	0,196	
	No 3	1970	0,785**	25,0%	0,196	
	No 4	1985	0,785**	25,0%	0,196	
SOMATRAPS	No 1	1973	0,750*	50,0%	0,375	0,725
	No 2	1977	0,700*	50,0%	0,350	
SOTRAGEL	No 1	1977	0,685	33,3%	0,228	0,751
	No 2	1984	0,785**	33,3%	0,262	
	No 3	1983	0,785**	33,3%	0,262	

* values are provided by the companies
** mean value of measured boilers

Table 16: Boiler efficiency of the 8 companies

company name	mean boiler efficiency	share of total fish meal-production	
	η_j	x_j	$\eta_j \cdot x_j$
	GJ/t	%	-
COPELIT	0,733	18,15%	0,133
DELTA OCEAN	0,785	7,10%	0,056
KB FISH	0,842	21,69%	0,183
LAÂYOUNE ELEVAGE	0,823	6,84%	0,056
LAÂYOUNE PROTEINE	0,863	7,48%	0,065
SEPOMER	0,813	20,80%	0,169
SOMATRAPS	0,725	7,99%	0,058
SOTRAGEL	0,751	9,96%	0,075

<u>Step 3: Calculation of the specific energy consumption of the system SEC_{Sys}</u>
The specific energy consumption of the system SEC_{Sys} is then calculated with the formula

$$SEC_{Sys} = (h_{steam}-h_{feed})\cdot 1/1000\cdot GJ/MJ/\eta_{Sys}$$

Where:
SEC_{Sys} Specific energy consumption of the system [GJ/t]
h_{steam} Steam enthalpy at 180 °C = 2776 [MJ/t]
h_{feed} Enthalpy of feed-water; estimated at 105 °C = 440 [MJ/t]

The value for SEC_{Sys} therefore constitutes 2.939 [GJ/t].

<u>Step 4: Calculation of the baseline emissions</u>
Baseline emissions BE_y [tCO_2/yr] are based on the quantity of HFO combusted and the CO_2 emission coefficient of HFO, as follows:

$$BE_y = 44/12\cdot EF_{C,HFO}\cdot OXID_{HFO,BL}\cdot m_{HFO,BL}\cdot NCV_{HFO}$$

Where:
BE_y Baseline emissions resulting from steam generation within the capacity of the baseline equipment in the years 2004-2007 [tCO_2/yr]
44/12 Ratio of molar masses from CO_2/C
$EF_{C,HFO}$ Carbon emission factor of HFO [tC/GJ] = 0.0221
$OXID_{HFO,BL}$ Oxidation factor of baseline fossil fuel = 0.995
$m_{HFO,BL}$ Average consumption of heavy fuel oil (HFO) 2004-2007 = 7,910 [t/yr] (see Annex I)
NCV_{HFO} Net calorific value of HFO = 39.77 [GJ/t]

The value for BE_y therefore constitutes:
$BE_y = 44/12\cdot 0.0221\cdot 0.995\cdot 7910\cdot 39.77 = 25,343$ [tCO_2/yr].

I. Project emissions
The CO_2 emissions from fossil fuel consumption in the project activity (PE_y) are calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 01).
CO_2 emissions from fossil fuel combustion for steam generation in the boilers are calculated based on the quantity of HFO combusted and the CO_2 emission coefficient of HFO, as follows:

$$PE_y = 44/12\cdot EF_{C,HFO}\cdot OXID_{HFO,BL}\cdot H_{HFO,P}$$

Where:
PE_y CO_2 emissions from fossil fuel combustion in the Project during the year 2009-2018 [tCO_2/yr]
$H_{HFO,P}$ Prospective HFO consumption [GJ/yr]

With:
$$H_{HFO,P} = (m_{HFO,P}\cdot NCV_{HFO}\cdot \eta_{Sys} - SE_{SOL}\cdot 3.6)/\eta_{new}$$

Where:
$m_{HFO,P}$ Prospective consumption of heavy fuel oil (HFO) = 5,614 [t/yr]
SE_{SOL} Steam energy which is produced by the solar field = 11,712 MWh according to the information of the provider

η_{new} degree of efficiency of the new boiler to be installed = 0.93 [-]

The value for $H_{HFO,P}$ therefore constitutes:
$H_{HFO,P} = (7{,}910 \cdot 39.77 \cdot 0.794 - 11{,}712 \cdot 3.6 \cdot GJ/MWh)/0.93 = 223{,}272$ [GJ/yr]

The value for PE_y therefore constitutes:
$PE_y = 44/12 \cdot 0.0221 \cdot 0.995 \cdot 223{,}272 = 17{,}987$ [tCO_2/yr].

II. Leakage

Leakage is calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 01).
Since no LNG is used leakage emissions from LNG are not considered →
$LE_y = LE_{CH4,y}$

Where:
LE_y Leakage emissions in the year 'y' [tCO_2e/yr]
$LE_{CH4,y}$ Leakage emissions due to fugitive upstream CH_4 emissions in the year 'y' [tCO_2e/yr]

And:
$LE_{CH4,y} = (H_{HFO,P} - m_{HFO,BL} \cdot NCV_{HFO}) \cdot EF_{HFO,upstream,CH4} \cdot GWP_{CH4}$

Where:
$EF_{HFO,upstream,CH4}$ Default emission factor for fugitive upstream CH_4 emissions of oil = 4.1 t CH_4/PJ
GWP_{CH4} Global warming potential for methane = 21 according to IPCC 2001

The value for LE_y therefore constitutes:
$PE_y = (223{,}554 - 7{,}910 \cdot 39.77) \cdot 4.1 \cdot 1/1{,}000{,}000 \cdot PJ/GJ \cdot 21 = -7.8$ [tCO_2e/yr].

III. Emission Reduction

Emission reductions are calculated as follows:

$ER_y = BE_y – PE_y – LE_y$ [tCO_2e/yr].

Where:
ER_y Emissions reductions of the project activity during the year 'y' [tCO_2e/yr]

The value for ER_y therefore constitutes:
$ER_y = 25{,}343 - 17{,}987 + 7.8 = 7{,}364$ [tCO_2e/yr].

IV. Data and parameters used for the Baseline Study
The following data and parameters are included in this methodology but do not need to be monitored during the crediting period. These data and parameters mainly describe the baseline equipment.

Data / Parameter:	CAP_j
Data unit:	t/h
Description:	Steam generation capacity: Maximum long term load (capacity) of the $boiler_j$ or steam generation system (tonnes of steam output per hour at full load)
Source of data used:	Information of technical reports of the companies. Values not proved by measurement.
Value applied:	Values of all boilers → see overview of the baseline boilers, table 1, p.8 The total CAP of all 24 boilers is 211 t/h steam
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since there doesn't exist any equipment for measuring the produced amount of steam, values have been applied according to the specifications of the manufaturer.
Any comment:	The total CAP of all companies (211 t/h) exceeds by far the maximum steam demand which would constitute 139 t/h, according to the maximum processing capacity of all companies (assuming that all companies are in full operation at the same time). The actual maximum steam demand is calculated to be far lower: Considering a maximum daily production of ½ of the maximum processing capacity (in reality the max. daily production ranges from 4 to 50 % of max. processing capacity) and a coincidence factor of 0.8, the new centralized steam production requires a steam generation capacity for the project CAP_P of $CAP_P = 139 \cdot 0,5 \cdot 0,8 = 55,2$ t/h or 35,8 MW nominal load.

Data / Parameter:	η_i
Data unit:	Fraction
Description:	Degree of efficiency for boiler i
Source of data used:	The degree of efficiency has been measured by a boiler expert in August 2007 for 11 boilers. For three boilers values have been given by the companies, for boilers without any information concerning the degree of efficiency (the companies were not in operation when boiler-efficiency was measured) the mean value of the other boilers is being used instead.
Value applied:	Values are listed in table 4.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since there doesn't exist any equipment for measuring the produced amount of steam, the efficiency of the baseline steam generation system is calculated by using the degree of efficiency for each boiler. Thus the amount of steam generated by the project activity is indirectly derived by the consumption of heavy fuel oil, assuming that the heat of combustion is quantitative converted into steam-enthalpy, according to the degree of efficiency. Losses, e.g. from radiation, are being neglected.
Any comment:	Missing values need to be proved by further investigations.

Data / Parameter:	$S_{i,j}$

Data unit:	%
Description:	Share of operating time of a boiler i in the total operating time of all boilers of a company j
Source of data used:	given or estimated
Value applied:	Only one company (COPELIT) provided information about operating hours for each boiler. All other companies have no records about operating hours which is why it is assumed that the boilers are operated all the same length of time (e.g. for three boilers every boiler is estimated to operate 1/3rd of the total time).
Justification of the choice of data or description of measurement methods and procedures actually applied :	Every company has 2 or more boilers. Since most of the boilers exceeded their technical life-time they often need to be repaired. This is why the companies switches steam generation from one to another boiler, depending on the operating state of the boilers, while the other boilers are repaired.
Any comment:	Share of use needs to be proved by further investigations.

Data / Parameter:	x_j
Data unit:	Fraction
Description:	Share of total production: Share of company j in the total fish meal-production of all companies (mean values for the years 2004-2007)
Source of data used:	Production data provided by the companies.
Value applied:	Production figures for fish meal for the years 2004-2007 are given in Annex I.
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	h_{Steam}
Data unit:	MJ/t
Description:	Enthalpy of steam at a certain temperature level.
Source of data used:	Literature data used.
Value applied:	Steam enthalpy at 180 °C = 2776 MJ/t
Justification of the choice of data or description of measurement methods and procedures actually applied :	The temperature of steam produced ranges from 120 to 350 °C. Provided values are shown in Annex II. It is impossible to gain any information about amounts for different temperature levels for past years. Therefore steam enthalpy is being uniformly assumed at 180 °C.
Any comment:	

Data / Parameter:	h_{Feed}
Data unit:	MJ/t
Description:	Enthalpy of feed-water at a certain temperature level.
Source of data used:	Literature data used.
Value applied:	Water enthalpy at 105 °C = 440 MJ/t
Justification of the choice of data or description of measurement methods and procedures actually applied :	Feed-water has a mean temperature of 23°C, information about amount and quality of return-water and condensate is not available. There is only information about temperature levels of the processes, but even these values vary in a wide range from 23 to 170 °C. Provided values are shown in Annex II. For standardisation a uniform value at 105 °C is being assumed.
Any comment:	

Data / Parameter:	NCV_{HFO}
Data unit:	GJ/t
Description:	Net caloric value of fossil fuel (heavy fuel oil) used in the baseline boiler
Source of data used:	No local data available. Literature value is being used instead (Recknagel, Sprenger, Schramek (1997), Taschenbuch für Heizung und Klimatechnik, R.Oldenburg Verlag, S. 207).
Value applied:	39.77
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	Carbon emission factor of heavy fuel oil $EF_{C,HFO}$
Data unit:	tC/GJ
Description:	Carbon emission factor of heavy fuel oil
Source of data used:	No local data available. Factor for German refineries are being used instead.
Value applied:	0.0221
Justification of the choice of data or description of measurement methods and procedures actually applied :	$EF_{C,HFO}$ = Carbon content [%]/NCF_{HFO} [GJ/t]/100 = 87,8/39,77/100 = 0.0221
Any comment:	

Data / Parameter:	Oxidation factor of baseline fossil fuel $OXID_{HFO,BL}$
Data unit:	Fraction
Description:	Oxidation factor for the fossil fuel used in the baseline boiler.
Source of data used:	IPCC default factor
Value applied:	0.995
Justification of the choice of data or description of measurement methods and procedures actually applied :	Common practise.
Any comment:	

Data / Parameter:	Average consumption of heavy fuel oil $m_{HFO,BL}$
Data unit:	t/yr
Description:	Average consumption of heavy fuel oil in the baseline within the years 2004-2007
Source of data used:	Data provided by the companies. Values are shown in Annex I.
Value applied:	**year** **t/a** 2004 8.235 2005 9.202 2006 7.918 2007 6.286 **mean value** 7.910
Justification of the choice of data or description of measurement methods and procedures actually applied :	Consumption on HFO is directly related to the amount of raw material processed (= fish meal). As it can be seen above (more detailed information in Annex I) the amount of production varies from year to year, depending on the amount of available fish. 2007 was a very bad year for the companies due to a lack of fish.
Any comment:	Used for the calculation of the specific fuel consumption: $m_{HFO,BL}$/amount of fish meal produced.

Data / Parameter:	$EF_{BL,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the baseline equipment from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied:	4.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Investment analysis

For the investment analysis following standard parameters were used:

Table 17: Standard parameters used for the investment analysis

Parameter		Unit
Discount rate	8	%
Life cycle of the installations	25	Yrs.
Required payback time	15	Yrs.
Price for CERs	12	EUR

Taken into account, that the project activity will omit fuel use on one hand and the need for modernization on the other hand, those factors are included in the investment analysis. Input parameters for the economic model are as following:

Table 18: Data input used for the investment analysis

Input parameters	V1, Fuel Combustion[3]	V2, CHP[4]	V3, Waste incineration	V4, BAU[5]	V5, Project Activity (Solar)
Investment (2008), EUR	1.936.000	9.331.200	45.000.000	-	7.333.000
Investment for modernization, EUR				3747900	-
Running costs project, EUR/yr	2.930.785	4.022.245	2.970.000	2.678.404	1.977.013
Revenues without CERs – omission current costs, EUR/ yr	2.678.404	2.678.404	2.678.404	-	2.678.404
Revenues without CERs – omission modernization equipment, EUR/ yr	374.790	374.790	374.790		374.790
Revenues from CERs, EUR/ yr	44.172	-	-	-	88.368

The results of the investment analysis are as following:

[3] A central fuel oil steam production plant.

[4] CHP = Combined Heat & Power; producing steam and power for the grid.

[5] BAU = Business as usual. This requires frequent modernisation and replacement of the 24 oil boilers.

Table 19: Results the investment analysis

Alternative	Net Present Value [EUR]		IRR		amortisation period [yrs]	
	no CERs	with CERs	no CERs	with CERs	no CERs	with CERs
V1, Fuel Combustion	-1.114.625,65	-818.227,93	-7,57%	-2,64%	none	none
V2, CHP	-15.833.611,09	n.a.	n.a.	n.a.	none	n.a.
V3, Waste incineration	-44.423.233,75	n.a.	n.a.	n.a.	none	n.a.
V4, BAU	-5.894.570,37	n.a.	n.a.	n.a.	none	n.a.
V5, Project Activity	-111.737,89	481.218,58	7,66%	9,43%	none	9,11

Only alternatives 1 and 5 would generate CERs.
For alternative 5, the project activity, the revenues from CER sales contributes to the financial viability of the project nevertheless the amount of CERs is rather small: The IRR is increased from 7,66% to 9,43%, the payback period is 9 years.
Alternative 1, the central fuel oil combustion plant, would also generate CERs trough the reduction of emissions. Anyhow the net present value is negative in the scenario with and without CER-sales, only the IRR increase from minus 7,57% to minus 2,64%, still being negative.

A note on the sensitivity analysis

The investment model is highly sensible to all of the input parameters; very important especially being the discount rate and the actual values for investment, running costs and revenues. Even a small change in those numbers will change the investment calculation significantly.

ANNEX

ANNEX I

Table 20: Consumption of heavy fuel oil 2004-2007

	Consumption heavy fuel oil [t/month]									
		COPELIT	DELTA OCEAN	KB FISH	L. ELEVAGE	L. PROTEINE	SEPOMER	SOMATR.	SOTRAG.	SUM
2004	Jan-04	127	6	105	56	88	171	86	92	**731**
	Feb-04	77	100	57	31	49	55	41	50	**461**
	Mar-04	0	151	0	0	0	22	0	0	**173**
	Apr-04	0	9	0	0	0	18	0	0	**27**
	May-04	25	0	57	11	58	169	23	63	**407**
	Jun-04	48	0	67	20	40	171	40	38	**424**
	Jul-04	101	0	118	16	21	141	23	37	**457**
	Aug-04	227	0	205	19	35	307	40	56	**890**
	Sep-04	254	108	188	28	40	265	61	70	**1.014**
	Oct-04	287	100	245	91	107	422	112	181	**1.545**
	Nov-04	52	108	118	57	85	233	79	117	**850**
	Dec-04	127	180	182	82	128	230	180	149	**1.257**
2005	Jan-05	28	7	27	17	14	33	0	20	**146**
	Feb-05	162	112	104	111	89	119	94	103	**894**
	Mar-05	168	163	212	0	0	54	25	159	**781**
	Apr-05	6	5	80	0	4	56	0	13	**164**
	May-05	10	0	56	9	3	102	0	0	**180**
	Jun-05	78	0	54	27	20	159	22	0	**360**
	Jul-05	40	0	70	20	16	146	0	0	**292**
	Aug-05	48	0	174	59	66	184	77	0	**608**
	Sep-05	161	115	329	166	116	388	88	105	**1.469**
	Oct-05	202	113	311	119	97	306	127	164	**1.438**
	Nov-05	164	116	304	90	95	232	51	140	**1.192**
	Dec-05	257	159	329	105	128	337	170	193	**1.678**
2006	Jan-06	179	17	63	58	54	69	45	70	**555**
	Feb-06	185	20	55	20	14	68	24	23	**409**
	Mar-06	180	0	52	0	33	36	26	42	**369**
	Apr-06	192	0	84	0	0	43	51	6	**376**
	May-06	194	24	114	24	0	89	0	0	**445**
	Jun-06	187	25	230	26	0	136	0	34	**638**
	Jul-06	212	0	127	1	4	71	0	0	**415**
	Aug-06	220	29	170	21	27	154	0	21	**642**
	Sep-06	176	82	307	66	52	284	102	113	**1.182**
	Oct-06	206	25	265	22	25	234	72	57	**906**
	Nov-06	173	98	282	97	79	249	172	135	**1.284**
	Dec-06	180	56	146	49	50	110	74	32	**697**
2007	Jan-07	118	27	85	30	27	64	75	38	**464**
	Feb-07	100	40	88	20	44	92	49	46	**478**
	Mar-07	70	0	57	16	0	96	0	0	**239**
	Apr-07	114	0	38	32	0	80	25	0	**289**
	May-07	92	37	238	3	29	56	0	35	**490**
	Jun-07	83	41	267	3	35	69	0	83	**581**
	Jul-07	63	6	200	5	34	46	0	52	**406**
	Aug-07	61	17	134	19	19	68	0	22	**340**
	Sep-07	120	26	212	27	26	101	22	23	**558**
	Oct-07	66	12	270	14	14	147	20	10	**553**
	Nov-07	200	69	334	67	88	301	126	90	**1.275**
	Dec-07	178	40	140	31	31	100	77	16	**613**

Table 21: Processed raw material 2004-2007

	Raw material processed [t/month]									
		COPELIT	DELTA OCEAN	KB FISH	L. ELEVAGE	L. PROTEINE	SEPOMER	SOMATR.	SOTRAG.	SUM
2004	Jan-04	3.321	160	2.123	2.709	2.750	4.669	2.318	2.539	**20.588**
	Feb-04	1.633	2.500	1.161	1.793	1.521	1.694	1.106	1.187	**12.594**
	Mar-04	146	3.766	0	0	0	9	0	0	**3.921**
	Apr-04	73	230	0	0	0	162	0	0	**465**
	May-04	840	0	1.170	517	1.807	4.491	629	1.800	**11.255**
	Jun-04	1.559	0	1.241	989	1.246	3.664	1.086	1.027	**10.811**
	Jul-04	1.745	0	2.221	758	653	3.102	606	998	**10.083**
	Aug-04	3.844	0	4.138	909	1.106	7.821	1.069	1.892	**20.779**
	Sep-04	5.146	2.700	4.097	1.367	1.241	6.355	1.305	2.107	**24.318**
	Oct-04	5.789	2.500	5.937	4.412	3.354	10.480	3.255	5.282	**41.008**
	Nov-04	974	2.700	2.472	2.777	2.665	5.573	2.272	2.718	**22.151**
	Dec-04	3.614	4.500	3.296	3.961	4.009	5.819	3.721	3.864	**32.783**
2005	Jan-05	416	167	488	404	442	574	402	491	**3.384**
	Feb-05	2.330	2.799	2.246	2.666	2.779	3.441	2.348	2.671	**21.279**
	Mar-05	2.448	4.076	4.100	0	0	268	0	4.096	**14.989**
	Apr-05	110	133	1.409	0	118	772	0	318	**2.860**
	May-05	202	0	907	213	105	2.061	0	0	**3.488**
	Jun-05	1.155	0	872	642	618	3.974	669	0	**7.930**
	Jul-05	569	0	1.114	475	506	3.259	604	0	**6.527**
	Aug-05	1.017	0	2.759	1.423	2.064	4.994	1.866	0	**14.123**
	Sep-05	3.430	2.881	5.729	3.977	3.623	8.432	3.640	3.101	**34.813**
	Oct-05	4.278	2.814	5.986	2.861	3.017	7.704	3.125	4.735	**34.519**
	Nov-05	3.900	2.911	5.296	2.158	2.956	5.651	2.980	4.005	**29.857**
	Dec-05	5.545	3.982	6.212	2.509	3.998	7.020	3.929	4.468	**37.664**
2006	Jan-06	1.744	435	1.176	1.709	1.683	1.971	1.607	1.684	**12.009**
	Feb-06	1.049	500	1.011	582	446	890	499	546	**5.522**
	Mar-06	1.464	0	946	0	1.022	222	1.213	1.099	**5.966**
	Apr-06	1.545	0	1.512	0	0	507	138	155	**3.857**
	May-06	1.708	592	2.775	709	0	1.666	0	0	**7.450**
	Jun-06	3.086	613	4.990	773	0	2.773	0	838	**13.072**
	Jul-06	1.007	0	2.601	20	114	1.077	99	0	**4.919**
	Aug-06	1.657	726	3.325	610	829	3.335	867	581	**11.931**
	Sep-06	5.319	2.051	6.463	1.945	1.628	6.075	2.525	3.457	**29.463**
	Oct-06	2.794	636	5.502	639	771	4.666	1.380	1.460	**17.848**
	Nov-06	7.935	2.449	6.539	2.826	2.454	5.294	3.589	3.551	**34.638**
	Dec-06	4.473	1.395	2.930	1.426	1.577	2.521	2.455	1.442	**18.219**
2007	Jan-07	2.690	683	1.715	1.098	836	1.456	859	883	**10.220**
	Feb-07	2.294	1.007	1.796	718	1.360	1.831	1.605	1.115	**11.726**
	Mar-07	1.953	0	1.053	602	0	1.697	355	0	**5.660**
	Apr-07	3.121	0	720	1.161	0	1.627	727	0	**7.356**
	May-07	2.680	917	4.887	106	910	556	0	976	**11.032**
	Jun-07	2.106	1.021	5.639	107	1.081	1.407	0	2.227	**13.588**
	Jul-07	1.420	148	4.312	189	1.065	797	202	1.351	**9.484**
	Aug-07	2.051	413	2.776	687	606	2.320	648	560	**10.061**
	Sep-07	3.654	642	4.495	1.003	825	2.808	626	606	**14.659**
	Oct-07	1.741	309	6.496	524	433	3.011	740	301	**13.555**
	Nov-07	6.367	1.725	8.018	2.441	2.752	7.208	4.197	2.399	**35.107**
	Dec-07	6.141	989	3.412	1.122	972	2.143	1.819	923	**17.521**

Table 22: Fish meal production 2004-2007

	Production of fish meal [t/month]									
		COPELIT	DELTA OCEAN	KB FISH	L. ELEVAGE	L. PROTEINE	SEPOMER	SOMATR.	SOTRAG.	SUM
2004	Jan-04	666	32	543	533	526	983	464	564	**4.311**
	Feb-04	323	500	277	285	257	337	221	329	**2.531**
	Mar-04	30	753	0	0	0	2	0	0	**785**
	Apr-04	14	46	0	0	0	36	0	0	**96**
	May-04	174	0	286	101	328	946	126	408	**2.369**
	Jun-04	312	0	309	192	231	781	217	229	**2.271**
	Jul-04	405	0	534	132	114	651	121	206	**2.164**
	Aug-04	957	0	971	164	198	1.621	214	326	**4.452**
	Sep-04	1.192	540	957	247	215	1.291	261	416	**5.120**
	Oct-04	1.387	500	1.332	847	629	2.169	651	1.069	**8.584**
	Nov-04	231	540	892	597	505	1.134	455	618	**4.972**
	Dec-04	798	900	823	960	771	1.187	745	747	**6.930**
2005	Jan-05	88	33	115	77	80	115	80	107	**696**
	Feb-05	510	560	565	458	528	694	470	604	**4.389**
	Mar-05	529	815	977	0	0	55	0	895	**3.271**
	Apr-05	18	27	327	0	0	157	0	69	**598**
	May-05	38	0	214	43	20	418	0	0	**733**
	Jun-05	246	0	171	137	118	827	134	0	**1.633**
	Jul-05	180	0	202	94	95	670	121	0	**1.362**
	Aug-05	254	0	666	213	397	994	374	0	**2.898**
	Sep-05	850	576	1.404	749	718	1.707	728	651	**7.384**
	Oct-05	984	563	1.292	543	583	1.574	625	994	**7.158**
	Nov-05	848	582	1.223	356	592	1.151	596	851	**6.200**
	Dec-05	1.348	796	1.404	540	805	1.424	786	986	**8.090**
2006	Jan-06	455	87	270	324	343	395	322	385	**2.581**
	Feb-06	154	100	220	106	85	182	100	126	**1.073**
	Mar-06	341	0	202	0	192	43	243	234	**1.255**
	Apr-06	331	0	328	0	0	91	28	33	**810**
	May-06	370	118	617	137	0	332	0	0	**1.574**
	Jun-06	701	123	1.115	149	0	568	0	182	**2.838**
	Jul-06	221	0	567	3	20	213	20	0	**1.044**
	Aug-06	395	145	770	126	156	677	174	123	**2.566**
	Sep-06	1.312	410	1.481	354	325	1.254	505	698	**6.339**
	Oct-06	624	127	1.259	42	150	961	276	325	**3.764**
	Nov-06	1.911	490	1.453	163	488	1.092	718	809	**7.124**
	Dec-06	1.088	279	646	271	306	517	491	325	**3.924**
2007	Jan-07	568	137	405	211	169	284	172	200	**2.145**
	Feb-07	535	201	414	95	274	380	321	259	**2.479**
	Mar-07	435	0	136	115	0	345	71	0	**1.103**
	Apr-07	729	0	154	220	0	327	145	0	**1.576**
	May-07	648	184	1.080	20	172	116	0	208	**2.428**
	Jun-07	452	204	1.223	20	175	291	0	482	**2.847**
	Jul-07	307	30	890	38	171	167	41	252	**1.895**
	Aug-07	450	83	619	146	93	480	130	122	**2.122**
	Sep-07	889	129	1.034	191	159	605	125	129	**3.260**
	Oct-07	417	62	1.426	105	89	624	148	58	**2.929**
	Nov-07	1.553	345	1.746	529	540	1.530	840	526	**7.609**
	Dec-07	1.400	198	728	176	200	461	364	186	**3.713**

Table 23: Fish oil production 2004-2007

	Production of fish oil [t/month]									
		COPELIT	DELTA OCEAN	KB FISH	L. ELEVAGE	L. PROTEINE	SEPOMER	SOMATR.	SOTRAG.	SUM
2004	Jan-04	96	10	86	127	160	279	45	128	931
	Feb-04	29	150	25	55	26	56	20	44	405
	Mar-04	2	226	0	0	0	0	0	0	228
	Apr-04	0	14	0	0	0	7	0	0	21
	May-04	33	0	61	35	70	276	30	84	589
	Jun-04	102	0	105	66	63	337	35	59	767
	Jul-04	209	0	268	65	44	362	18	101	1.067
	Aug-04	529	0	530	108	85	969	20	173	2.414
	Sep-04	691	162	475	114	71	678	32	204	2.426
	Oct-04	712	150	690	448	311	1.123	70	515	4.019
	Nov-04	87	162	189	186	209	446	50	235	1.565
	Dec-04	253	270	223	326	305	374	80	261	2.092
2005	Jan-05	17	10	20	16	16	17	10	21	127
	Feb-05	82	168	71	81	103	111	50	92	758
	Mar-05	74	245	115	0	0	6	0	132	572
	Apr-05	0	8	34	0	0	25	0	8	75
	May-05	6	0	43	4	0	124	0	0	177
	Jun-05	79	0	10	23	46	395	15	0	568
	Jul-05	83	0	116	29	44	393	10	0	675
	Aug-05	109	0	311	79	166	491	40	0	1.196
	Sep-05	347	173	280	371	305	878	70	248	2.672
	Oct-05	371	169	553	259	262	676	50	442	2.782
	Nov-05	273	175	376	126	213	467	45	282	1.957
	Dec-05	339	239	280	127	185	396	85	192	1.843
2006	Jan-06	36	26	20	18	28	28	35	36	227
	Feb-06	14	30	13	3	3	14	11	10	97
	Mar-06	18	0	13	0	18	0	20	16	85
	Apr-06	36	0	51	0	0	4	25	2	118
	May-06	98	36	194	45	0	80	0	0	453
	Jun-06	233	37	487	54	0	207	0	76	1.094
	Jul-06	96	0	229	1	6	94	22	0	448
	Aug-06	126	44	375	40	83	333	15	55	1.071
	Sep-06	427	123	743	106	91	625	45	267	2.427
	Oct-06	229	38	610	14	48	437	17	127	1.520
	Nov-06	602	147	571	58	183	341	65	247	2.214
	Dec-06	245	84	152	85	271	103	50	72	1.062
2007	Jan-07	66	41	70	33	24	37	15	32	318
	Feb-07	69	60	70	11	54	78	35	39	416
	Mar-07	35	0	38	9	0	60	10	0	152
	Apr-07	111	0	34	24	0	55	12	0	236
	May-07	169	55	409	1	25	38	0	21	718
	Jun-07	184	61	636	3	80	123	0	215	1.302
	Jul-07	118	9	547	8	125	72	5	144	1.027
	Aug-07	201	25	390	83	66	189	9	45	1.007
	Sep-07	385	39	571	100	86	270	15	51	1.517
	Oct-07	189	19	788	42	38	275	13	19	1.383
	Nov-07	630	104	944	186	263	629	90	190	3.036
	Dec-07	509	59	378	46	91	201	45	70	1.399

ANNEX II

Table 24: Steam production – quality ranges

		COPELIT		DELTA OCEAN		KB FISH		LAÂYOUNE ELEVAGE		LAÂYOUNE PROTEINE		SEPOMER		SOMATRAPS		SOTRAGEL	
		min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
Quality Level 1																	
Temperature range	°C			160	200		350	200	250			220	240				
Pressure range	bar	6,0	7,0	6,0	7,0		7,0	5,0	8,5			5,0	8,0				
Quality Level 2																	
Temperature range	°C						350	200	245			220	240				
Pressure range	bar	6,0	7,0				7,0	4,0	6,5			5,0	8,0				
Quality Level 3																	
Temperature range	°C						350	200	245			220	240				
Pressure range	bar	6,0	7,0				7,0	4,0	6,5			5,0	8,0				
Quality Level 4																	
Temperature range	°C											120	140				
Pressure range	bar											5,0	8,0				

Table 25: Steam consumption – quality ranges

		COPELIT		DELTA OCEAN		KB FISH		LAÂYOUNE ELEVAGE		LAÂYOUNE PROTEINE		SEPOMER		SOMATRAPS		SOTRAGEL	
		min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
Quality Level 1																	
Temperature range	°C			160	200		350	200	250			220	240				
Pressure range	bar	6,0	7,0	6,0	7,0		7,0	5,0	8,5			5,0	8,0				
Quality Level 2																	
Temperature range	°C						350	200	245			220	240				
Pressure range	bar	6,0	7,0				7,0	4,0	6,5			5,0	8,0				
Quality Level 3																	
Temperature range	°C						350	200	245			220	240				
Pressure range	bar	6,0	7,0				7,0	4,0	6,5			5,0	8,0				
Quality Level 4																	
Temperature range	°C											120	140				
Pressure range	bar											5,0	8,0				

Annex 4

MONITORING INFORMATION

PROPOSED MONITORING PROCEDURES

The following data are required to be monitored throughout the crediting period.
For monitoring project emissions from combustion of fossil fuels in the project activity the guidance in the latest approved version of the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" should be applied.
Baseline emissions are calculated using the following data:

- Fossil Fuel Consumption (heavy fuel oil)

Based on well-recognized norms (e.g. ASME PTC 4-1998) uncertainty of each parameter has to be calculated resulting into the following 3 values:

- Test result plus uncertainty
- Test result
- Test result minus uncertainty

For each parameter the tables presented below specify which of the three values has to be used for further calculations.

Data and parameters monitored

Data / Parameter:	$P_{PJ,I,y}$
Data unit:	t/yr
Description:	Generated steam in the year 'y' subdivided into load classes in the case of single boiler installations.
Source of data used:	Measurement, calculation. Use test result minus uncertainty for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) of the mass flow rate of generated steam (t/h) following international acknowledged norms and guidelines such as ASME PTC 4-1998. Steam generation is allocated to the associated load class by comparison of measured steam mass flow and the range of the load classes. By multiplication of every 15-minutes-value with 0.25 hours the amount of generated steam is determined. At the end of each year the steam generation within each load class is aggregated.
Monitoring frequency:	Every 15 minutes, allocated and aggregated into load classes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$EF_{PJ,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the project activity from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	Local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	For further guidance consider the most recent version of AM0029.

Data / Parameter:	$EF_{BL,upstream, CH4}$
Data unit:	t CH_4/GJ Fuel
Description:	Emission factor for upstream fugitive methane emissions of fossil fuel used in the baseline equipment from production, transportation, distribution, in t CH_4 per GJ fuel supplied to final consumers
Source of data used:	Local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	For further guidance consider the most recent version of AM0029.

Data / Parameter:	$PRESS_{PJ}$
Data unit:	bar
Description:	Pressure of the generated steam
Source of data used:	Measurement. Use test result for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Monitoring frequency:	Every 15 minutes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$TEMP_{PJ}$
Data unit:	K
Description:	Temperature of the generated steam
Source of data used:	Measurement. Use test result for calculations.
Measurement procedures (if any):	Measurement (every 15 minutes) following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Monitoring frequency:	Every 15 minutes
QA/QC procedures:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	Only required in the case of superheated steam

Data / Parameter:	Fish meal and /or fish oil production
Data unit:	t/yr
Description:	
Source of data used:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	