CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

- Title of the project activity: "Fuel oil to natural gas switch at Solvay Indupa do Brasil S.A."

- Version number of the document: 1

- Date of the document: 23/august/2005

A.2. Description of the project activity:

The purpose of the project activity is switching fuel oil to natural gas in two steam boilers and three process furnaces at Solvay Indupa do Brasil S.A. (referred to as Solvay), in the expansion of the vinyl chloride monomer (VCM) plant at Elclor site, located in the city of Santo André, SP, Brazil. In the baseline scenario, fuel oil would otherwise be used during the crediting period.

Solvay Indupa is a company from the Solvay Group, an international group with headquarters in Brussels. Solvay is one of the most important petrochemical companies in the Mercosur. Its main products are PVC resins and caustic soda. Solvay Indupa has offices in Buenos Aires, Argentina and São Paulo, Brazil, and two industrial sites: one in Bahía Blanca (Argentina) and the other in Santo André (Brazil).

As in other countries where the Solvay Group has industrial facilities, also in Brazil, Solvay Group attention has been directed to the possibilities that natural gas become a key element in supplying plant energy demands, especially because of its operational and environmental benefits. However, the company had always faced barriers to use natural gas at Elclor site mainly because the fuel was not available there and natural gas markets were not well established in Brazil. With the implementation of this project, natural gas started to be used at Solvay's Elclor site.

The furnaces involved in the project activity are used in the pyrolisis of dichloroethane (EDC) to produce vinyl chloride monomer (VCM). There are three EDC cracking furnaces at Solvay site. Two are old ones, that still use fuel oil and will be retrofitted in a next stage of the project. The other one is a new furnace that was installed because of the expansion of the VCM plant.

The boilers involved in the project activity supplies additional thermal energy demands to the plant. The boilers used fuel oil before the project activity and were retrofitted to burn natural gas. The steam produced by the two boilers first drives two steam turbo-generators to supply part of the internal electricity demands, and then is used in the process. The system operates in cogeneration.

The project activity contributes to sustainable development for several reasons:

- Natural gas reduces criteria air pollutants emissions, especially particulate matter, sulphur oxides and carbon monoxide. In Table 1, the reduction of some atmospheric emissions of criteria pollutant due to fuel switching in Solvay project is presented.

- Natural gas also contributes to the mitigation of greenhouse gases emissions as it is less carbon intensive when compared to other fossil fuels, like fuel oil.

- Additionaly, the transportation of natural gas to the site is safer and more environmentally friendly than fuel oil because it avoids the use of road trucks carrying fuel oil.

- The project also contributes to sustainable development because it made natural gas available in the region of the project activity. In spite of Solvay Elclor being located in one of the most economically developed regions of the country, natural gas was not available there before the project. This was one of the main barriers for project to become real. With the project implementation, natural gas was made available in the region and other users were able to benefit from this fact.

Table 1 – Emissions reductions of criteria air pollutants

Pollutants	**Emissions before project* [kg/h]**	**Forecasted Emissions after project** [kg/h]**	**Emissions Reductions [%]**
SO_2	171,36	0,0043	99,99%
CO	42,98	5,12	88,09%

(*) considering the equivalent use of 68,000 t/year of fuel oil (maximum capacity of the boilers)
(**) data calculated through the stoichiometry of combustion.

The project activity is part of a larger project, the expansion of VCM production capacity. This larger project will increase the operational production capacity of the VCM plant from 150,000 t(VCM)/year to 240,000 tVCM/year. In spite of the production capacity increase, the modifications introduced by the project resulted in a more environmentally efficient installation, with important improvements, such as, steam requirements remained unchanged, process atmospheric emissions became almost zero, chloride residues in the waste water were reduced by increasing process efficiency and waste water and solid residues generation were reduced.

A.3. Project participants:

Table 2 – Parties involved in the project activity

Name of party involved	Private and/or public entities	Party involved wish to be project participant?
Brazil (host)	Private entity: Solvay Indupa do Brasil S.A.	NO

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil

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

São Paulo

A.4.1.3. City/Town/Community etc:

Santo André

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

Project activity is located at:

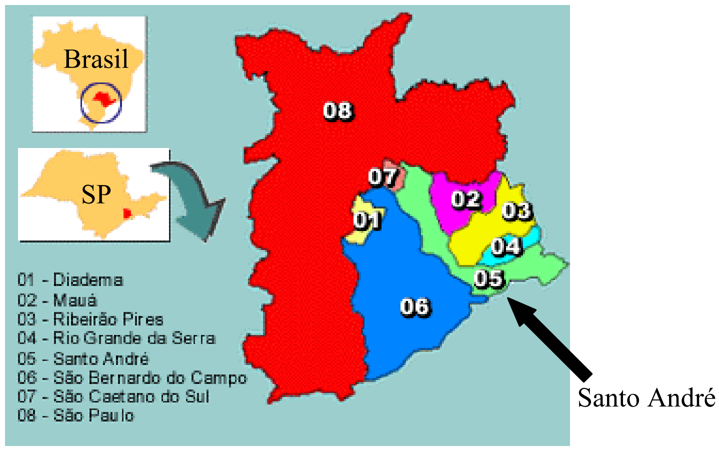
Solvay Indupa do Brasil S/A
km 38 da Estrada de Ferro Santos a Jundiaí, s/nº
Vila Elclor – Santo André – SP – Brasil
Zip Code 09154-900

Phone: +55 +11 4439-8645
Fax: +55 +11 4439-8515

Latitude	Longitude	Altitude
23°45'48" S	46°22'28" W	750 m

Please, refer to Figure 1.

Figure 1 – Location of Santo André



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

Solvay project falls under scope number 4 – manufacturing industries.

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

Technology employed by the project is conventional. There are no major changes when compared with other installations that use natural gas in bolers and furnaces.

The project consists of three phases:

- First phase, currently implemented: Boiler GN-2201/A and Boiler GN-2201/B (operation start-up happened in 15/11/2004).

- Second phase, under implementation: EDC Furnace P581 (to be in service by the end of 2005).

- Third phase, in the future: EDC Furnace P81/A and EDC Furnace P81/B (to be in service by the end of 2006).

<u>Boilers</u>

The boilers included in the project activity are presented in Tables 3 and 4. The two boilers produce steam to supply the thermal energy demands of the plant and also to drive two steam turbines: one of the turbines operates continuously and the other one is a stand-by turbine that operates when grid electricity supply fails and/or during peak hours. The conversion of the installation to burn natural gas consisted of the substitution of the fuel burners in the boilers, construction of the internal natural gas pipeline and revamping of field instrumentation.

Due to the project activity, the local natural gas company built a new pipeline to bring natural gas to the site and region. Solvay did not use any natural gas before the project activity (the chemical processes do not use any natural gas). The only use of natural gas at the site is to attend energy demands. As natural gas is supplied through pipeline, no in site storage is required.

The two boilers GN2201/A and GN2201/B normally burn other complementary fuels, together with the main fuel, either fuel oil or natural gas. This situation existed before the project activity, when the boilers used fuel oil, and remained after the project implementation, with the boilers using natural gas.

The complementary fuels are process streams derived from other sectors at Solvay Elclor site and they are used on an intermitent basis that depends on process conditions controlled by plant operations. The average contribution of the complementary fuels in the total energy input of the boilers is around 6%, in energy basis. The natural gas substituted only the fuel oil, and not the complementary fuels.

The use of complementary fuels did/does not lead to an incentive for fuel switching, as they could be used both with fuel oil and natural gas.

Also, it does not affect the emissions reductions calculations. As further explained in Section B.2, the calculation of emissions reductions is based on the emission factors, the monitored quantity of natural gas consumed during each year of the crediting period and on the calculation of the quantity of fuel oil that would be used in the baseline scenario.

- The emissions factors are not affected by the use of complementary fuels. They are fixed and determined by the IPCC.

- *Q_NG* is a monitored variable, measured directly from the quantity of natural gas used. The measurement of natural gas is not affected by the use of complementary fuels as it is independent from the complementary fuels.

- *Q_FO* is calculated from *Q_NG* (measured) and the efficiencies *η_FO* and *η_NG*. This is the point in which the use of complementary fuels could affect emissions calculations. There are two possible approaches to avoid this problem: (1) complementary fuels are not used when variables are measured to calculate efficiencies *η_FO* and *η_NG*; or (2) complementary fuels are converted, on energy basis, to natural gas and fuel oil equivalents, for efficiency calculations purposes. In this manner, the influence of complementary fuels does not affect the calculation of efficiencies and emissions reductions.

Table 3 – Boiler GN-2201/A

Boiler GN-2201/A	
Manufacturer	CBC Indústrias Pesadas S/A
Year of installation	Manufactured in 1969 – Installed in 1971
Expected lifetime	After substitution of external and internal structure and part of the superheater tubes, in 2002, the expected lifetime of the boiler was increased in 30 years, i.e., until 2032. No fuel switching was considered at that time.
Fuel used	Fuel oil (baseline scenario) Natural gas (project scenario) Complementary fuels from process streams (both scenarios)
Type	Water tube
Nominal steam production rate	62,000 kg/h
Steam conditions	80 kgf/cm^2 – 460°C
Nominal thermal efficiency	Fuel oil: 87,5% Natural gas: 90,2%
Project start-up	15 November 2004

Table 4 – Boiler GN-2201/B

Boiler GN-2201/B	
Manufacturer	CBC Indústrias Pesadas S/A
Year of installation	Manufactured in 1969 – Installed in 1971
Expected lifetime	After substitution of external and internal structure, in 2002, the expected lifetime of the boiler was increased in 30 years, i.e., until 2032. No fuel switching was considered at that time.
Fuel used (originally)	Fuel oil (baseline scenario) Natural gas (project scenario) Complementary fuels from process streams (both scenarios)
Type	Water tube
Nominal steam production rate	62,000 kg/h
Steam conditions	80 kgf/cm^2 – 460°C
Nominal thermal efficiency	Fuel oil: 87,5% Natural gas: 90,2%
Project start-up	15 November 2004

EDC Cracking Furnaces

The EDC cracking furnaces involved in the project activity are presented in Tables 5, 6 and 7. The production of VCM at Solvay is made through the pyrolysis of EDC. The product is heated in the pyrolysis EDC furnace to reach 500°C, when EDC is transformed into VCM and HCl. There are three EDC cracking furnaces at the site. The two existing furnaces P81/A and P81/B are vertical tubes type and have three burners each one. They will be retrofitted in the future phase of the project. With the expansion of the VCM plant, a new furnace, P581, had to be installed. In principle, the furnace would be a fuel oil furnace. The decision of switching fuel oil to natural gas was taken during the VCM expansion project implementation. P581 is a standard natural gas furnace with horizontal tubes and 64 burners low-nox type.

Table 5 – EDC Furnace P581

EDC Furnace P581	
Manufacturer	Petro-Chem Development Co., INC
Year of installation	Manufactured in 2004 – Installed in 2005
Expected lifetime	30 years, i.e., untill 2035
Fuel used	Fuel oil (baseline scenario) Natural gas (project scenario)
Type	Horizontal tube, double row double fire offset, convective
Nominal capacity	140,000 t(VCM)/year
Nominal energy consumption rate	2.8 GJ(fuel)/t(VCM)
Project start-up	End of 2005

Table 6 – EDC Furnace P81/A

EDC Furnace P81/A	
Manufacturer	Heurtey
Year of installation	1971
Expected lifetime	After retrofitting, in 2002, the expected lifetime of the furnace was increased in 25 years, i.e., untill 2027. No fuel switching was considered at that time.
Fuel used	Fuel oil (baseline scenario) Natural gas (project scenario)
Type	Vertical tubes: 2 vertical coils with 32 tubes in the radiation zone and 2 horizontal coils in the convection zone
Nominal Capacity	80,000 t(VCM)/year
Nominal energy consumption rate	2.4 GJ(fuel)/t(VCM)
Project start-up	Furnace to be converted in the end of 2006

Table 7 – EDC Furnace P81/B

EDC Furnace P81/B	
Manufacturer	Heurtey
Year of installation	1971
Expected lifetime	After retrofitting, in 1996, the expected lifetime of the furnace was increased in 25 years, i.e., untill 2021. No fuel switching was considered at that time.
Fuel used	Fuel oil (baseline scenario) Natural gas (project scenario)
Type	Vertical tubes: 2 vertical coils with 32 tubes in the radiation zone and 2 horizontal coils in the convection zone
Nominal Capacity	80,000 t(VCM)/year
Nominal energy consumption rate	2.4 GJ(fuel)/t(VCM)
Project start-up	Furnace to be converted in the end of 2006

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The emission reductions from Solvay project will be achieved through using natural gas, a fuel with lower carbon emission factor, than the fuel previously used (fuel oil). In fact, natural gas is the less carbon intensive from among all fossil fuels. The emissions reductions for Solvay project rely on this fact.

Project emissions reductions will be calculated through approved methodology AM0008. According to the methodology, project emissions are the emissions of CO_2, N_2O and CH_4 derived from natural gas burning. Leakage is CH_4 and CO_2 emissions in natural gas production and transportation. Baseline emissions are the emissions of CO_2, N_2O and CH_4 derived from the continued use of fuel oil.

In the absence of the CDM incentives the project activity would likely not happen and the emissions would be greater than that of the project scenario, because fuel oil would be used instead of natural gas. The additionality assessment conducted in Section B.3 presents with further details the additionality of the project.

There were/are no national and/or sectoral policies and circumstances that influence the decisions or impose obligations to the proposed project activity. The use of fuel oil and natural gas are not restricted nor demanded by any Brazilian and/or State legislation. Also, no sectoral policies incentive the use of natural gas or disincentive the use of fuel oil. Therefore, no sectoral policies and circumstances would make the project activity preferred, rather than the baseline scenario. The only national circumstance that foments the new technology is the participation of Brazil in the Kyoto Protocol, which allows the project to benefit from the CDM incentives.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

Table 8 accounts for the estimated amount of emissions reduction based on the forecasted natural gas consumption. The crediting period is of 10 years, starting in 15/nov/2004.

Table 8 – Estimated emission reductions

Years	Annual estimation of emission reductions [tCO_2]
2004 (15/11/2004 – 31/12/2004)	4,009.80
2005	32,078.42
2006	38,550.80
2007	44,342.24
2008	44,342.24
2009	44,342.24
2010	44,342.24
2011	44,342.24
2012	44,342.24
2013	44,342.24
2014 (1/1/2014 – 14/11/2014)	38,799.46
Total estimated reductions (tCO_2eq)	423,834.14
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tCO_2eq)	42,383.41

A.4.5. Public funding of the project activity:

The project has been developed on equity basis. Solvay has implemented the project without any public funding or other sources of debt.

SECTION B. Application of a baseline methodology

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

AM0008 – "Industrial fuel switching from coal and petroleum fuels to natural gas without extension of capacity and lifetime of the facility".

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

AM0008 is subject to the conditions listed below. The project activity meets all of them.

1. The project activity is to switch the industrial fuel currently used in some element processes of a facility from coal and/or petroleum fuels that would otherwise continue to be used during the crediting period, to natural gas.

   Solvay project is to switch fuel oil to natural gas.

   Fuel oil was used in Boilers GN-2201/A and GN-2201/B to produce steam. After the project the boilers were retrofitted to use natural gas. Other complementary fuels were used in the boilers before the project implementation and remained to be used after the project. The natural gas, however, substituted only the fuel oil used.

   Fuel oil is currently used in EDC Furnace P81/A and EDC Furnace P81/B, that will be retrofitted in a future phase of the project.

   Fuel oil would be used in the new EDC Furnace P581 to produce process heat. EDC Furnace P581 will be in service by the end of 2005 and originally would burn fuel oil, as stated in the environmental license of the project. The license was requested by Solvay and issued by CETESB when the decision of switching fuels was not in place. With the CDM project, the furnace was re-designed to use natural gas.

2. The local regulations/programs do not constrain the facility from using coal/petroleum fuels.

   In fact, there are/were no regulations and programs that constrain the facility from using fuel oil, nor policies that foment the use of natural gas instead of other fossil fuels.

3. Use of coal and/or petroleum fuels is less expensive than natural gas per unit of energy in the country and sector.

   Natural gas prices have been higher than fuel oil prices, including at the time when the decision of implementing the project was undertaken. The historical prices of natural gas and fuel oil are presented in Figure 2 in Section B.3.

4. The facility would not have major efficiency improvements during the crediting period.

   In fact, no major efficiency improvements will happen to the facility during the crediting period. The project is fuel switching only. There is a minor efficiency difference between fuel oil and natural gas combustion, as expected in any project of fuel switching. This difference cannot be considered a major efficiency improvement. Please, refer to Table 9.

5. The project activity does not increase the capacity of final outputs and lifetime of the existing facility during the crediting period (i.e. this methodology is applicable up to the end of the lifetime of existing facility if shorter than crediting period).

   As presented in Table 9, the project activity does not increase the lifetime nor the capacity of the existing facilities. The expected operational lifetime and capacity of the boilers and furnaces have not been/will not be altered with the fuel switching project.

Table 9 – Expected lifetime, capacity and efficiency of the equipment

Boiler	Year of installation	Expected lifetime before and after the project	Capacity before and after the project	Efficiencies before and after the project
Boiler GN2201/A	1971	2032	62,000 kg(steam)/h	Fuel oil: 319.3 t(steam)/TJ(fuel) Natural gas: 326.4 t(steam)/TJ(fuel)
Boiler GN2201/B	1971	2032	62,000 kg(steam)/h	Fuel oil: 319.3 t(steam)/TJ(fuel) Natural gas: 326.4 t(steam)/TJ(fuel)
EDC Cracking Furnace P581	2005	2035	140,000 t(VCM)/year	Fuel oil: 357.1 t(VCM) /TJ(fuel) Natural gas: 357.1 t(VCM) /TJ(fuel)
EDC Cracking Furnace P81/A	1971	2027	80,000 t(VCM)/year	Fuel oil: 415.1 t(VCM) /TJ(fuel) Natural gas: 415.1 t(VCM) /TJ(fuel)
EDC Cracking Furnace P81/B	1971	2021	80,000 t(VCM)/year	Fuel oil: 415.1 t(VCM) /TJ(fuel) Natural gas: 415.1 t(VCM) /TJ(fuel)

GN-2201/A and GN-2201/B were installed in 1971. In 2002, after a complete revision and substitution of some parts, their operational lifetime was increased in 30 years, until 2032. No fuel switching was considered at that time and after the retrofitting both boilers still operated with fuel oil. The fuel switching project did not increase the expected operational lifetime of the boilers.

Furnaces P81/A and P81/B were installed in 1971. P81/A was retrofitted in 2002 and P81/B in 1996. No fuel switching was considered at that times and after the retrofitting, their expected operational lifetime was increased in 25 years. Therefore, P81/A can operate until 2027 and P81/B until 2021. The fuel switching project, to be implemented in the end of 2006, will not change their operational lifetime.

Furnace P581 expected lifetime was not increased because of the project activity. The furnace would operate untill 2035 in the absence of the project activity.

6. The proposed project activity is defined as fuel switching applied to element processes and does not result in integrated process change, except for possible associated changes in other energy use (such as electricity for coal processing) outside the affected element processes, which shall (could) be treated as leakage.

   In fact, project activity will not result in integrated process change. It is a simple substitution of fuel.

B.2.	**Description of how the methodology is applied in the context of the project activity:**

The calculation of project emissions, baseline emissions and leakage is performed independently for each one of process elements in the project activity, i.e., Boiler GN-2201/A, Boiler GN-2201/B, EDC Furnace P581, EDC Furnace P81/A and EDC Furnace P81/B in the following manner:

Baseline Emissions

Annual baseline emissions *BE*, in [tCO_2], during each year of the crediting period, are calculated according to AM0008:

$$BE_y = \sum_i Q\_F_{i,y} \cdot \left(EF\_F_i\_CO_{2,y} + EF\_F_i\_CH_4 \cdot GWP\_CH_4 + EF\_F_i\_N_2O \cdot GWP\_N_2O \right)$$

In the context of the project activity it becomes:

$$BE = Q\_FO \cdot \left(EF\_FO\_CO_2 + EF\_FO\_CH_4 \cdot GWP\_CH_4 + EF\_FO\_N_2O \cdot GWP\_N_2O \right)$$

Where:

Q_FO is the estimated quantity of fuel oil used in the baseline scenario, in each year of the crediting period, measured in [TJ]. *Q_FO* is estimated from the efficiency of each equipment and from the consumption of natural gas, measured during the crediting period. The suffix *y*, in the original equation, will be omitted for the sake of simplification.

In order to ensure that the useful heat needed is common for each element process, both in the project and baseline scenarios, Q_FO is linked with the consumption of natural gas in the project scenario through the following equation:

$$Q\_FO \cdot \eta\_FO = Q\_NG \cdot \eta\_NG \Rightarrow Q\_FO = Q\_NG \cdot \frac{\eta\_NG}{\eta\_FO}$$

This equation is necessary to obtain Q_FO which is a baseline scenario variable that cannot be measured directly.

η_FO and η_NG are the efficiencies for fuel oil and natural gas use, respectively.

In the case of boilers, η_FO and η_NG are calculated as the quotient of steam produced, in [t], per fuel consumed, in [TJ]. The result is in [t/TJ]:

$$\eta\_FO = \frac{Q\_ST}{Q\_FO}$$

$$\eta\_NG = \frac{Q\_ST}{Q\_NG}$$

where,

Q_ST in [t], Q_FO in [TJ] and Q_NG in [TJ] are, respectively, the quantities of steam produced, fuel oil and natural gas consumed. These quantities are to be measured for *ex ante* fuel oil and *ex post* natural gas efficiencies determination.

In the case of furnaces, η_FO and η_NG are calculated as the quotient of VCM produced, in [t], per fuel consumed, in [TJ]. The result is in [t/TJ]:

$$\eta\_FO = \frac{Q\_VC}{Q\_FO}$$

$$\eta\_NG = \frac{Q\_VC}{Q\_NG}$$

where,

Q_VC in [t], Q_FO in [TJ] and Q_NG in [TJ] are, respectively, the quantities of VCM produced, fuel oil and natural gas consumed. These quantities are to be measured for *ex ante* fuel oil and *ex post* natural gas efficiencies determination.

For both cases (boilers and furnaces), η_FO is determined once, before fuel switching, and η_NG is determined once at the early stage of each crediting period. The methodology states that, as appropriate, η_FO and η_NG should be regarded as functions of the load factor. In the case of Solvay project, the efficiencies of the boilers and furnaces do not vary significantly as functions of the load factor and the equipment operate continuosly, with minor changes in load factor. Hence, the efficiencies used in the project will be the average values, observed during normal operation.

The following paragraphs present the efficiencies for each element process. In the calculations, LHV for fuel oil is 40,151 kJ/kg and LHV for natural gas is 47,952 kJ/kg.

Boiler GN-2201/A and Boiler GN-2201/B

Fuel oil: the calculation is based on historical consumption of the boilers.

η_FO = 319.3 t/TJ
Q_FO = 0.003132 TJ (78.00 kg)
Q_ST = 1 t of steam

Natural gas: the calculation is based on the operation of the boilers after the fuel switch.

η_NG = 326.4 t/TJ
Q_NG = 0.002657 TJ (63.90 kg)
Q_ST = 1 t of steam

EDC Cracking Furnaces P81/A and P81/B

Fuel oil: the calculation is based on historical consumption of the existing furnaces.

η_FO = 415.1 t/TJ
Q_FO = 0.002409 TJ (60.00 kg)
Q_VC = 1 t of VCM

Natural gas: as the furnaces have not been switched to natural gas yet, it is assumed that the efficiency will not change in comparision to the current situation. Design efficiencies indicate that the installation will likely not have major efficiencies improvements due to the fuel switching project. This value need to be monitored and re-calculated during the crediting period.

η_NG = 415.1 t/TJ

EDC Cracking Furnaces P581

As this is a new furnace, design efficiencies are used. This value need to be monitored and re-calculated during the crediting period..

$\eta\_FO = \eta\_NG$ = 357.1 t/TJ

$EF\_FO\_CO_2$ is CO_2 equivalent emission factor per unit of energy of fuel oil in [tCO_2/TJ]. In the case of Solvay project, the baseline fuel is fuel oil and the emission factor for fuel oil will be considered constant over the crediting period. IPCC default values will be used, since no other reference is available. $EF\_FO\_CO_2$ is obtained from the following equation, as recommended by the IPCC in the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories":

$$EF\_FO\_CO_2 = \frac{44}{12} \cdot OXID \cdot EF = \frac{44}{12} \cdot 0.99 \cdot 21.1 = 76.59 \quad tCO_2/TJ$$

$EF\_FO\_CH_4$ is the IPCC default CH_4 emission factor of fuel oil associated with fuel combustion, measured in [tCH_4/TJ]. $EF\_FO\_CH_4$ is obtained from the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 3 – Reference Manual, Section 1.4.2.1, Table 1-7, Energy Industries, Oil", where $EF\_FO\_CH_4$ = 3 kg/TJ = 0.003 tCH_4/TJ.

$EF\_FO\_N_2O$ is the IPCC default N_2O emission factor of fuel oil associated with fuel combustion, measured in [tN_2O/TJ]. $EF\_FO\_N_2O$ is obtained from the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 3 – Reference Manual, Section 1.4.2.2, Table 1-8, Energy Industries, Oil", where $EF\_FO\_N_2O$ = 0.6 kg/TJ = 0.0006 tN_2O/TJ.

GWP_CH_4 is the global warming potential of CH_4 set by the IPCC in the "Climate Change 1995: The Science of Climate Change, Table 4, p. 22, 1996" as GWP_CH_4 = 21 tCO_2/tCH_4.

GWP_N_2O is the global warming potential of N_2O set by the IPCC in the "Climate Change 1995: The Science of Climate Change, Table 4, p. 22, 1996" as GWP_N_2O = 310 tCO_2/tN_2O.

After all, baseline emissions become:

$$BE = Q\_FO \cdot (76.59 + 0.003 \cdot 21 + 0.0006 \cdot 310) = 76.84 \cdot \frac{\eta\_NG}{\eta\_FO} \cdot Q\_NG \quad [tCO_2]$$

Project Emissions

Annual project emissions PE, in [tCO_2], during each year of the crediting period is expressed as, according to AM0008:

$$PE_y = \sum_i Q\_NG_{i,y} \cdot (EF\_NG\_CO_2 + EF\_NG\_CH_4 \cdot GWP\_CH_4 + EF\_NG\_N_2O \cdot GWP\_N_2O)$$

In the context of the project activity it becomes:

$$PE = Q\_NG \cdot (EF\_NG\_CO_2 + EF\_NG\_CH_4 \cdot GWP\_CH_4 + EF\_NG\_N_2O \cdot GWP\_N_2O)$$

where:

Q_NG is the quantity of natural gas used in the project scenario, in each year of the crediting period, for replacing *Q_FO* quantity of fuel oil used in the baseline scenario, measured in [TJ]. In the case of Solvay project, *Q_NG* is monitored in each year of the crediting period.

$EF\_NG\_CO_2$ is the IPCC default CO_2 emission factor per unit of natural gas associated with fuel combustion, in [tCO_2/TJ]. It is obtained from the following equation, as recommended by the IPCC in the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories":

$$EF\_NG\_CO_2 = \frac{44}{12} \cdot OXID \cdot EF = \frac{44}{12} \cdot 0.995 \cdot 15.3 = 55.82 \quad tCO_2/TJ$$

$EF\_NG\_CH_4$ is the IPCC default CH_4 emission factor of natural gas associated with fuel combustion, measured in [tCH_4/TJ]. It is obtained from the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 3 – Reference Manual, Section 1.4.2.1, Table 1-7, Energy Industries, Natural Gas", where $EF\_NG\_CH_4$ = 1 kg/TJ = 0.001 tCH_4/TJ.

$EF\_NG\_N_2O$ is the IPCC default N_2O emission factor of natural gas associated with fuel combustion, measured in [tN_2O/TJ]. It is obtained from the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 3 – Reference Manual, Section 1.4.2.2, Table 1-8, Energy Industries, Natural Gas", where $EF\_NG\_CH_4$ = 0.1 kg/TJ = 0.0001 tN_2O/TJ.

After all, project emissions become:

$$PE = Q\_NG \cdot (55.82 + 0.001 \cdot 21 + 0.0001 \cdot 310) = 55.87 \cdot Q\_NG \quad [tCO_2]$$

Leakage

AM0008 considers two sources of leakage: fugitive CH_4 emissions from fuel production and CO_2 emissions from fuel transportation. In Solvay project, following the guidance of AM0008, the annual leakage *LE* is expressed as:

$$LE = (Q\_NG \cdot FE\_NG\_CH_4 - Q\_FO \cdot FE\_FO\_CH_4) \cdot GWP\_CH_4 \\ + Q\_NG \cdot EF\_TF\_NG - Q\_FO \cdot EF\_TF\_FO$$

$FE\_NG\_CH_4$ and $FE\_FO\_CH_4$ are the IPCC default CH_4 emission factor of CH_4 fugitive emissions associated with natural gas and fuel oil production and transportation, in [tCH_4/TJ].

FE_NG_CH₄ = 118 kgCH₄/TJ = 0.118 tCH₄/TJ, as presented in the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 3 – Reference Manual, Section 1.8.5, Table 1-58, Natural gas processing, transport and distribution".

FE_FO_CH₄ = 0. Fugitive emissions of CH_4 associated with fuel oil production and transportation will be considered zero. The reason is the lack of specific CH_4 emission factors for the production of fuel oil. This is conservative.

EF_TF_NG and *EF_TF_FO* are CO_2 emission factors for the transportation of natural gas and fuel oil.

EF_TF_NG = 0. Natural gas is transported through pipelines, hence no emissions of CO_2 are attributed due to its transportation. Fugitive emissions of CH_4 are considered in $FE\_NG\_CH_4$.

EF_TF_FO = 0. Fuel oil would be transported through road trucks in the baseline and emissions of CO_2 would occur due to fossil fuel consumption. However, these emissions will not be considered. This is conservative.

Therefore,

$$LE = Q\_NG \cdot 0.118 \cdot 21 = 2.48 \cdot Q\_NG \qquad [tCO_2]$$

Emission Reductions

The annual emission reduction *ER* in each year of the project activity is expressed as

$$ER = BE - PE - LE \qquad [tCO_2]$$

From previous equations:

$$ER = 76.84 \cdot \frac{\eta\_NG}{\eta\_FO} \cdot Q\_NG - 55.87 \cdot Q\_NG - 2.48 \cdot Q\_NG$$

Table 10 provides for the key sources of data used.

Table 10 – Data used to determine the baseline scenario

Data used	Source
$EF\_FO\_CO_2$ = 76.59 tCO_2/TJ	Fixed value from IPCC
$EF\_FO\_CH_4$ = 0.003 tCH_4/TJ	Fixed value from IPCC
$EF\_FO\_ N_2O$ = 0.0006 tN_2O/TJ	Fixed value from IPCC
GWP_CH_4 = 21 tCO_2/tCH_4	Fixed value from IPCC
GWP_N_2O = 310 tCO_2/tN_2O	Fixed value from IPCC
$EF\_NG\_CO_2$ = 55.82 tCO_2/TJ	Fixed value from IPCC
$EF\_NG\_CH_4$ = 0.001 tCH_4/TJ	Fixed value from IPCC
$EF\_NG\_N_2O$ = 0.0001 tCH_4/TJ	Fixed value from IPCC
$FE\_NG\_CH_4$ = 0.118 tCH_4/TJ	Fixed value from IPCC
$FE\_FO\_CH_4$ = 0	Oil production CH_4 emissions will be disregarded. This is conservative.
EF_TF_NG = 0	Transport emissions are zero.
EF_TF_FO = 0	Transport CO_2 emissions will be disregarded. This is conservative.

B.3. 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:

Anthropogenic emissions of GHG are reduced below those that would have occurred in the absence of the project activity because, without the incentives of the CDM, the mostlikely scenario would be the continued use of fuel oil in the facility.

Project summary

In 2001, in order to expand the VCM plant at that site, Solvay had to install a new dichloroethane (EDC) cracking furnace to meet the increasing necessity of processing capacity. The situation, at that time, would oblige Solvay to install the new furnace using fuel oil. Natural gas was 14 km distant from the site. Solvay required the environmental license considering the use of fuel oil in the furnace and the state environmental agency (Cetesb) issued the installation license in 8 November 2002. Among several technical requirements, Cetesb demanded the installation, in the new fuel oil EDC cracking furnace, of a local exhausting system and atmospheric emissions control, based on the best available technology.

The technical alternatives for Solvay to attend Cetesb requirements were end-of-pipe treatment of flue gases, with the installation of specific control equipment, or fuel switching of the furnace, from fuel oil to natural gas. Both the installation of the control equipment and fuel switching would imply in project changes, requiring a new approval from the company board. The installation of the control equipment had the advantage of being cheaper than changing the furnace to natural gas. Fuel switching would imply in a major project change, especially considering that natural gas was not available at the site.

During the project implementation, Solvay decided to use this opportunity to push its strategic orientation of using natural gas at the site. Some points that motivated the choice were the avoided operation and maintenance costs in the atmospheric emissions control equipment, the better operational performance achieved by the natural gas fueled EDC cracking furnaces, the capacity development in natural gas fueled EDC cracking furnace construction and operation inside the Solvay Group, and the benefits that Solvay could take because of the incentives of the CDM carbon credits from the fuel switch.

Solvay resumed the contacts with the local natural gas company, Comgas, during the last quarter of 2002 to discuss the installation of the natural gas pipeline, necessary to bring the natural gas to the site. The first response obtained from the natural gas company was unfavourable to Solvay, though. A new 14 km natural gas pipeline would be required and Comgas argued that the volume of gas consumed was not high enough to justify the investments by themselves. Hence, if Solvay decided to use the natural gas, they would have to build the new pipeline on their own.

Solvay had two fuel oil boilers in the same site and, also according to Comgas, if the two boilers were retrofitted to burn natural gas, the resultant volume of natural gas consumed would make feasible the construction of the 14 km pipeline with no necessity of Solvay investment. Since the cost of investing in a new pipeline was too high for Solvay to deal with, retrofitting the existing two boilers was the only option that would make possible the use of natural gas in the site. Of course, the original scope of the project did not consider the boilers retrofit and would demand additional investments from Solvay and another change in project scope.

Solvay final decision was the option for the natural gas and this is the project activity herein proposed. The original project scope changed from the installation of the new EDC cracking furnace with fuel oil to the installation of the new cracking furnace with natural gas and the conversion of the two existing boilers and two existing furnaces from fuel oil to natural gas.

The previous knowledge that Solvay Group had about the carbon market, the Kyoto Protocol and the possibility of getting financial incentives from the commercialization of the carbon credits contributed decisively in supporting the option for the natural gas. Solvay Group, as a European company, had already been involved with the discussions about Climate Change, the Kyoto Protocol and its demands and impacts on countries and companies economies. At that time, Solvay Group knew that their business would be affected by the requirements of the Kyoto Protocol and quantified emissions reductions imposed.

Considering the opportunity of switching from fuel oil to natural gas, and in view of the Kyoto Protocol demands and opportunities, Solvay decided to look for Ecoinvest with the objective of better understanding the Clean Development Mechanism and the possibility of having a fuel switch project as an eligible activity under this mechanism. The objective was to improve the attractiveness of natural gas option in the decision process for that specific project. In 16 December 2002, Solvay and Ecoinvest had their first meeting to discuss the subject.

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

(a) Evidence that the starting date of the CDM project activity falls between 1 January 2000 and the date of the registration of a first CDM project activity, i.e., 18 November 2004.

The CDM project activity was first considered by Solvay in the end of year 2002, due to the VCM plant expansion. The issuance of the installation license by Cetesb, for the VCM project, happened in 8 November 2002. Solvay and Ecoinvest had their first meeting to discuss the subject in 16 December 2002. The starting date of the project activity was 8 August 2003 (when design beginned) and operation started in 15 November 2004. The license, evidences of the contacts with Comgas and Ecoinvest are available at the project site.

(b) Evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity.

Solvay is a European company that has broad knowledge about the climate change discussions and the Kyoto Protocol. Inside the European Community, Solvay has participated intensively in the discussions about the Kyoto Protocol and its impacts on countries and companies economies.

Specifically for this project activity, the first meeting between Ecoinvest and Solvay happened in 16 December 2002, as soon as Solvay obtained the installation license from Cetesb. The purpose of the meeting was to evaluate the participation of this specific project activity in the Clean Development Mechanism, in order to improve the benefits of changing the original scope of the project.

The original project (VCM expansion project), that did not include fuel switching, would not stop in the absence of the CDM. As evidenced in the environmental license, the original project was designed with fuel oil furnace (P581) and no fuel switching in the boilers (GN2201/A and B) and other furnaces (P81/A and B). This would be the mostlikely situation in the absence of the CDM. The CDM was an important factor that contributed to the decision of switching fuels.

Therefore, since the beginning of the evaluation of fuel oil substitution in the site, Solvay considered the benefits from the Clean Development Mechanism.

Regulations/programs related to the project activity and its altenatives

There were three alternatives to the project activity:

(1) Install P581 (new furnace) with fuel oil and keep the existing boilers and furnaces as they were.

(2) Install P581 with natural gas and keep the existing boilers and furnaces with fuel oil.

(3) Install P581 with natural gas and retrofit the existing boilers and furnaces to burn natural gas.

The alternatives are shown in Table 11.

Table 11 – Alternatives to the project activity

	Alternatives		
Scope by Solvay	**(1)** **Fuel oil cracking furnaces and boilers**	**(2)** **Natural gas P581 only**	**(3)** **Natural gas cracking furnaces and boilers**
EDC cracking furnace design change	NO	YES	YES
Boilers retrofit	NO	NO	YES
Emissions control – EDC cracking furnace	YES	NO	NO
Natural gas pipeline	NO	YES	NO
Natural gas auxiliaries	NO	YES	YES

The three alternatives were consistent with current laws and regulations and no legislation made anyone of the options mandatory/preferred. Thus, the decision of Solvay in choosing the natural gas was not forced nor restricted by any legal requirement and the proposed project activity is not the only alternative amongst the ones considered by Solvay that is in compliance with all regulations that must be followed.

Prices of natural gas versus fuel oil

Natural gas prices have been higher than fuel oil prices, including at the time when the decision of implementing the project was undertaken. The historical prices of natural gas and fuel oil were presented, in Figure 2. It is important to note that fuel oil prices are volatile and the historical trend shows that they have been lower than natural gas prices in Brazil.

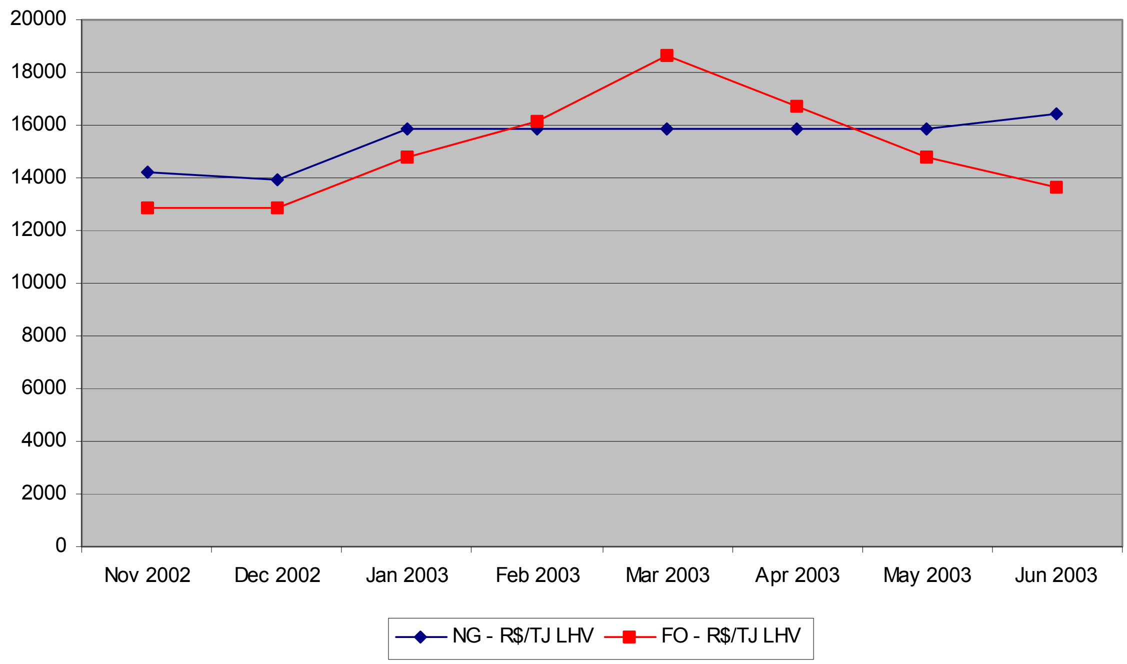


Figure 2 – Prices of natural gas compared with fuel oil

Other barriers

Besides fuel prices, there were and there still are many uncertainties regarding natural gas market development in Brazil, vis-à-vis the well developed and established fuel oil market. In 2002, ANP[1] (*Agência Nacional do Petróleo* – Brazilian regulatory agency for petroleum and natural gas) nominated some barriers faced for the development of natural gas markets in Brazil:

[1] Agência Nacional do Petróleo – ANP. **Panorama da Indústria do Gás Natural no Brasil**. July/2002. Available at www.anp.gov.br.

1. Competition between natural gas and fuel oil – The reduced price of fuel oil, in especial of the most heavy oils, may represent a barrier to the introduction of natural gas, as the two fuels compete between each other.

2. Petrobras, the company that historically has the monopoly of the oil and gas production in Brazil, is the greatest operator of the sector. In its strategic decisions the company seeks to preserve its markets, jeopardizing the development of other players and companies and the establishment of a real free market. It is legally impossible to split Petrobras or to oblige it to sell its participation in other companies.

3. Natural gas taxes – The existence of taxes applied succesively to the several stages of the natural gas chain in addition to the different taxes applied in the different States where the natural gas pipeline goes through, represents another problem to the market.

4. Regulatory uncertainties – there are limits and gaps in the regulatory framework established by Law 9478/97 and other related legislation that create uncertainties in the responsabilities and possibilities of the regulatory agency (ANP) to regulate the market. Examples given by ANP were the indefinition about free access to the grid to other companies and the limits between the Federal regulatory agency and State regulatory agencies responsabilities. This represents the so-called regulatory risks of the natural gas market in Brazil.

5. The environmental licesing of the natural gas infrastructure also represents a barrier to the development of a broad natural gas grid. The process of licensing in Brazil is frequently complex and requires some time to be completed, what increases the time between planning a new pipeline and operating it.

All of those aspects created a scenario in 2002 in which the development of a solid and secure natural gas market was perceived with caution by Solvay.

The choice for natural gas implied important changes and additional costs in the project scope, besides facing an uncertain scenario regarding natural gas markets and prices definition. These changes represented barriers for the project to happen in the absence of the incentives of the CDM.

Other than market barriers, the project activity faced problems with:

1. Design changes – including: furnace design change because of the substitution for natural gas, addition of natural gas auxiliary equipments and addition of boilers and furnaces retrofitting in the project scope. Design changes, specially in the middle of an investment process in which decisions have already been taken, face severe barriers to happen because of investment capital ear marking and project schedule. Project design has been developed since 2001 and the option for natural gas had happened almost at the end of the project development, in the end of 2002. Purchase order of the furnace was placed in February 2004. Hence, the option for natural gas demanded a major change in the project scope, which is faced as a significant barrier in the internal decision process, involving the company board.

2. Pipeline installation – uncertainties about natural gas pipeline installation. The non existence of natural gas pipeline near the site was a huge barrier that almost avoided the project to happen. At a first moment, when Solvay first contacted the natural gas company, Solvay had to built, on its own, the pipeline, because the consumption of natural gas was not high enough to justify natural gas company investment.

   Solvay was the first and largest consumer of natural gas in the region, functioning as an anchor consumer that would allow, in the future, other small consumers to benefit from natural gas availability. Only after the decision of boilers retrofitting, the natural gas company signalized with the possibility to build, at its expenses, the natural gas pipeline. Considering the huge investment costs in the natural gas pipeline construction, if Solvay had to bear it, the fuel oil substitution by natural gas would probably not be approved.

   Natural gas pipeline installation was not an easy task due to difficulties in routing the pipeline through several cities and environmental protection areas. Despite the great effort expended on obtaining regulatory and environmental authorities approvals, the pipeline construction was developed accordingly.

NPV Analysis

The economic investment analysis, using the net present value (NPV) of the project, was conducted. Please, refer to the Annex 5 for detailed information about the cash flow analisys and NPV calculation. The analysis was made for the three alternatives identified before. The results of the analysis are:

Alternative 1 – Fuel oil cracking furnaces and boilers

This is the original situation at the site, used as the reference scenario in the cash flow analysis. The cash flow analysis for the other two alternatives is in reference to this scenario.

Alternative 2 – Natural gas P581 only

NPV (without CERs) = – R$ 6,682,742.72
NPV (with CERs) = – R$ 6,334,767.85

Alternative 3 – Natural gas cracking furnaces and boilers

NPV (without CERs) = – R$ 1,413,552.64
NPV (with CERs) = + R$ 442,447.78

From the analysis of the results one concludes that:

- Alternative 2 is not a realistic and credible scenario, as the NPV is highly negative, in comparison to the other alternatives.

- Alternative 3 has a negative NPV without the CERs and a positive NPV with the CERs. It shows that the impact of the CDM revenues was important for the project to be chosen. Therefore, as the NPV of the project (Alternative 3) without the CERs is negative, project is additional.

- Alternative 1 remains as the baseline scenario as this would be the scenario in the absence of the project activity.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

Project boundary encompasses Boiler GN-2201/A, Boiler GN-2201/B, EDC Furnace P581, EDC Furnace P81/A and EDC Furnace P81/B.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of baseline completion: 23/08/2005.

Contact information:

Ecoinvest Carbon
Rua Padre João Manoel, 222 – Cerqueira Cezar
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Zip 01411-000

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Fax: +55 +11 3063-9069

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:

Starting date of the project activity: 8/8/2003.

The starting date corresponds to the date when Solvay started the design of the project. The project first phase started operation in 15/11/2004, when natural gas started to be used in the boilers.

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

Expected operational lifetime of the project activity 30 years and 0 months.

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

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:

Starting date of the first crediting period: 15/11/2004.

C.2.2.2. Length:

The length of the crediting period is 10 years and 0 months.

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

AM0008 – "Industrial fuel switching from coal and petroleum fuels to natural gas without extension of capacity and lifetime of the facility".

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

Approved monitoring methodology AM0008 is subject to the same conditions addressed in Section B.1.1, please refer to that section.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. Q_NG	*Quantity of natural gas consumed in each year of the project activity*	*Monitored in the project activity from field instruments and purchasing receipts of the local natural gas company*	*TJ*	*M*	*Monthly*	*100%*	*Electronic and paper*	-
2. EF_NG_CO_2	*CO_2 emission factor of natural gas combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCO_2/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
3. EF_NG_CH_4	*CH_4 emission factor of natural gas combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCH_4/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
4. EF_NG_N_2O	*N_2O emission factor of natural gas combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tN_2O/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
5 GWP_CH_4.	*Global Warming Potential for CH_4*	*IPCC in the "Climate Change 1995: The Science of Climate Change"*	*tCO_2/tCH_4*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
6. GWP_N_2O	*Global Warming Potential for N_2O*	*IPCC in the "Climate Change 1995: The Science of Climate Change"*	*tCO_2/tN_2O*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Project emissions are calculated as:

$$PE = Q\_NG \cdot \left(EF\_NG\_CO_2 + EF\_NG\_CH_4 \cdot GWP\_CH_4 + EF\_NG\_N_2O \cdot GWP\_N_2O \right) = 55.87 \cdot Q\_NG$$

Please, refer to Section B.2 for further information.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
7. Q_FO	*Amount of fuel oil that would be consumed in the baseline, for each year of the project activity. Q_FO is estimated from Q_NG during the crediting period and measured only once, before project starting for η_FO calculation*	*Calculated by means of efficiencies and natural gas consumption. For η_FO calculation, Q_FO is measured in the project site, through the purchasing receipts of the fuel oil supplier and/or through local field instruments*	*TJ*	*C, M*	*Monthly*	*100%*	*Electronic*	-
8. η_FO	*Fuel oil efficiency*	*Calculated from monitored variables Q_FO, Q_ST and Q_VC*	*t/TJ*	*C*	*Once, before project starting*	*100%*	*Electronic*	-
9. η_NG	*Natural gas efficiency*	*Calculated from monitored variables Q_NG, Q_ST and Q_VC*	*t/TJ*	*C*	*Once, at early stage of each crediting period*	*100%*	*Electronic*	-
10. Q_ST	*Quantity of steam monitored for efficiency calculation*	*Monitored in the project activity from local field instruments*	*t*	*M*	*Once, before project starting for η_FO and at early stage of each crediting period for η_NG*	*100%*	*Electronic*	-

11. Q_VC	*Quantity of VCM monitored for efficiency calculation*	*Monitored in the project activity from local field instruments*	*t*	*M*	*Once, before project starting for η_FO and at early stage of each crediting period for η_NG*	*100%*	*Electronic*	-
12. EF_FO_CO_2	*CO_2 emission factor of fuel oil combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCO_2/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
13. EF_FO_CH_4	*CH_4 emission factor of fuel oil combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCH_4/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-
14. EF_FO_N_2O	*N_2O emission factor of fuel oil combustion*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tN_2O/TJ*	*E (Fixed parameter)*	*Once, at validation*	*100%*	*Electronic*	-

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Baseline emissions are calculated as:

$$BE = Q\_FO \cdot (EF\_FO\_CO_2 + EF\_FO\_CH_4 \cdot GWP\_CH_4 + EF\_FO\_N_2O \cdot GWP\_N_2O) = 76.84 \cdot \frac{\eta\_NG}{\eta\_FO} \cdot Q\_NG$$

Please, refer to Section B.2 for further information.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated ©, estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

Not applicable.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated © or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
15. $FE\_NG\_CH_4$	*CH_4 emission factor of fugitive emissions associated with natural gas*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCH_4/TJ*	*E (Fixed parameter)*	*Once, at validation.*	*100%*	*Electronic*	-
16. $FE\_FO\_CH_4$	*CH_4 emission factor of fugitive emissions associated with fuel oil*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCH_4/TJ*	*E (Fixed parameter)*	*Once, at validation.*	*100%*	*Electronic*	-
17. EF_TF_NG	*CO_2 emission factor for the transportation of natural gas*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCO_2/TJ*	*E (Fixed parameter)*	*Once, at validation.*	*100%*	*Electronic*	-
18. EF_TF_FO	*CO_2 emission factor for the transportation of fuel oil*	*"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories"*	*tCO_2/TJ*	*E (Fixed parameter)*	*Once, at validation.*	*100%*	*Electronic*	-

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Leakage is calculated as:

$$LE = (Q\_NG \cdot FE\_NG\_CH_4 - Q\_FO \cdot FE\_FO\_CH_4) \cdot GWP\_CH_4 + Q\_NG \cdot EF\_TF\_NG - Q\_FO \cdot EF\_TF\_FO = 2.48 \cdot Q\_NG$$

Please, refer to Section B.2 for further information.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Emissions reductions from the project activity are calculated as:

$$ER = BE - PE - LE = \left(76.84 \cdot \frac{\eta\_NG}{\eta\_FO} - 58.35\right) \cdot Q\_NG$$

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1	*Low*	*The natural gas consumed is monitored in normal plant operations that already has QA/QC procedures in place. Purchasing receipts of the local natural gas company and field instruments can be used to cross check measurements.*
10	*Low*	*The steam produced is monitored in normal plant operations that already has QA/QC procedures in place. Field instruments and historical production rates can be used to cross check measurements.*
11	*Low*	*The VCM produced is monitored in normal plant operations that already has QA/QC procedures in place. This is one of the main process streams in the plant. Sales receipts and field instruments can be used to cross check measurements.*
2, 3, 4, 5, 6, 12, 13, 14, 15, 16, 17, 18	*Low*	*QA/QC procedures are not necessary since these parameters are fixed, obtained from the IPCC.*
7, 8, 9	*Low*	*These variables and parameters are calculated from monitored variables, therefore, QA/QC procedures are derived from the monitored variables.*

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

Project operator and manager is Solvay Indupa do Brasil S.A.. Solvay has in place, due to company policies, engineering best practices and ISO9000 certification, a complete set of maintenance and operations procedures, which include the monitoring of process variables, instruments calibration and quality control. For this reason, no major changes in monitoring and QA/QC procedures will be required for the CDM project activity related variables and parameters.

D.5 Name of person/entity determining the monitoring methodology:

Contact information:

Ecoinvest Carbon
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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Annual project emissions *PE*, in [tCO_2], during each year of the crediting period is expressed as:

$$PE = 55.87 \cdot Q\_NG \quad [tCO_2]$$

Please, refer to Section B.2 for further details.

The estimated consumption of natural gas, in [TJ], and corresponding project emissions, in [tCO_2], during the first crediting period, are presented in Table 12.

Table 12 – Estimated project emissions

Year	Boiler GN2201/A		Boiler GN2201/B		EDC Furnace P581		EDC Furnace P81/A		EDC Furnace P81/B		Total	
	Q_NG [TJ]	PE [tCO_2]	Q_NG [TJ]	PE [tCO_2]	Q_NG [TJ]	PE [tCO_2]	Q_NG [TJ]	PE [tCO_2]	Q_NG [TJ]	PE [tCO_2]	Q_NG [TJ]	PE [tCO_2]
2004*	99.31	5,548.44	99.31	5,548.44	-	-	-	-	-	-	198.61	11,096.88
2005	794.46	44,387.50	794.46	44,387.50	-	-	-	-	-	-	1,588.91	88,775.00
2006	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	-	-	-	-	1,938.91	108,330.03
2007	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2008	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2009	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2010	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2011	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2012	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2013	794.46	44,387.50	794.46	44,387.50	350.00	19,555.03	156.59	8,748.86	156.59	8,748.86	2,252.09	125,827.74
2014**	695.15	38,839.06	695.15	38,839.06	306.25	17,110.65	137.02	7,655.25	137.02	7,655.25	1,970.58	110,099.27
Total	7,944.57	443,875.0 0	7,944.57	443,875.0 0	3,106.25	173,551	1,233.14	68,897.25	1,233.14	68,897.25	21,461.6 6	1,199,095.3

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

The average amount of natural gas consumption in Nm^3 and tonnes can be obtained by using the lower heating value, *LHV* = 47,952 kJ/kg, and density, *d* = 0.79 kg/Nm^3. The estimated consumption for the boilers and furnace results:

Boiler GN2201/A:	16,567.75 t/year	20,971,840 Nm^3
Boiler GN2201/B:	16,567.75 t/year	20,971,840 Nm^3
EDC Furnace P581:	8,097.29 t/year	10,249,730 Nm^3
EDC Furnace P81/A:	3,214.51 t/year	4,069,000 Nm^3
EDC Furnace P81/B:	3,214.51 t/year	4,069,000 Nm^3
Total:	55,945.70 t/year	70,817,340 Nm^3

E.2. Estimated leakage:

Annual leakage *LE*, in [tCO_2], during each year of the crediting period is expressed as

$$LE = 2.48 \cdot Q\_NG \qquad [tCO_2]$$

Please, refer to Section B.2 for further details.

The estimated consumption of natural gas, in [TJ], and corresponding leakage, in [tCO_2], during the first crediting period, are presented in Table 13.

Table 13 – Estimated leakage

Year	Boiler GN2201/A		Boiler GN2201/B		EDC Furnace P581		EDC Furnace P81/A		EDC Furnace P81/B		Total	
	Q_NG [TJ]	*LE* [tCO_2]	*Q_NG* [TJ]	*LE* [tCO_2]	*Q_NG* [TJ]	*LE* [tCO_2]	*Q_NG* [TJ]	*LE* [tCO_2]	*Q_NG* [TJ]	*LE* [tCO_2]	*Q_NG* [TJ]	*LE* [tCO_2]
2004*	99.31	246.08	99.31	246.08	-	-	-	-	-	-	198.61	492.17
2005	794.46	1,968.66	794.46	1,968.66	-	-	-	-	-	-	1,588.91	3,937.33
2006	794.46	1,968.66	794.46	1,968.66	350.00	867.30	-	-	-	-	1,938.91	4,804.63
2007	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2008	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2009	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2010	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2011	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2012	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2013	794.46	1,968.66	794.46	1,968.66	350.00	867.30	156.59	388.03	156.59	388.03	2,252.09	5,580.68
2014**	695.15	1,722.58	695.15	1,722.58	306.25	758.89	137.02	339.52	137.02	339.52	1,970.58	4,883.10
Total	7,944.57	19,686.64	7,944.57	19,686.64	3,106.25	7,697.29	1,233.14	3,055.71	1,233.14	3,055.71	21,461.66	53,182.00

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

E.3. The sum of E.1 and E.2 representing the project activity emissions:

From the summation of emissions in Tables 11 and 12, project activity emissions, in [tCO_2], are calculated and presented in Table 14.

Table 14 – Estimated emissions from the project activity plus leakage

Year	Boiler GN2201/A		Boiler GN2201/B		EDC Furnace P581		EDC Furnace P81/A		EDC Furnace P81/B		Total	
	Q_NG [TJ]	*PE + LE* [tCO_2]	*Q_NG* [TJ]	*PE + LE* [tCO_2]	*Q_NG* [TJ]	*PE + LE* [tCO_2]	*Q_NG* [TJ]	*PE + LE* [tCO_2]	*Q_NG* [TJ]	*PE + LE* [tCO_2]	*Q_NG* [TJ]	*PE + LE* [tCO_2]
2004*	99.31	5,794.52	99.31	5,794.52	-	-	-	-	-	-	198.61	11,589.04
2005	794.46	46,356.16	794.46	46,356.16	-	-	-	-	-	-	1,588.91	92,712.33
2006	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	-	-	-	-	1,938.91	113,134.65
2007	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2008	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2009	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2010	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2011	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2012	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2013	794.46	46,356.16	794.46	46,356.16	350.00	20,422.33	156.59	9,136.88	156.59	9,136.88	2,252.09	131,408.42
2014**	695.15	40,561.64	695.15	40,561.64	306.25	17,869.53	137.02	7,994.77	137.02	7,994.77	1,970.58	114,982.37
Total	7,944.57	463,561.65	7,944.57	463,561.65	3,106.25	181,248.13	1,233.14	71,952.96	1,233.14	71,952.96	21,461.66	1,252,277.3

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Annual baseline emissions *BE*, in [tCO_2], during each year of the crediting period is expressed as:

$$BE = 76.84 \cdot \frac{\eta\_NG}{\eta\_FO} \cdot Q\_NG \ [tCO_2]$$

Please, refer to Section B.2 for further details.

The estimated consumption of natural gas, in [TJ], and corresponding baseline emissions, in [tCO_2], during the first crediting period, are presented in Table 15.

Table 15 – Estimated baseline emissions

Year	Boiler GN2201/A		Boiler GN2201/B		EDC Furnace P581		EDC Furnace P81/A		EDC Furnace P81/B		Total	
	Q_NG [TJ]	*BE* [tCO_2]	*Q_NG* [TJ]	*BE* [tCO_2]	*Q_NG* [TJ]	*BE* [tCO_2]	*Q_NG* [TJ]	*BE* [tCO_2]	*Q_NG* [TJ]	*BE* [tCO_2]	*Q_NG* [TJ]	*BE* [tCO_2]
2004*	99.31	7,799.42	99.31	7,799.42	-	-	-	-	-	-	198.61	15,598.84
2005	794.46	62,395.38	794.46	62,395.38	-	-	-	-	-	-	1,588.91	124,790.75
2006	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	-	-	-	-	1,938.91	151,685.45
2007	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2008	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2009	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2010	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2011	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2012	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2013	794.46	62,395.38	794.46	62,395.38	350.00	26,894.70	156.59	12,032.60	156.59	12,032.60	2,252.09	175,750.66
2014**	695.15	54,595.95	695.15	54,595.95	306.25	23,532.86	137.02	10,528.53	137.02	10,528.53	1,970.58	153,781.83
Total	7,944.57	623,953.75	7,944.57	623,953.75	3,106.25	238,690.46	1,233.14	94,756.76	1,233.14	94,756.76	21,461.66	1,676,111.5

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

The estimated amount of fuel oil consumption in tonnes can be obtained by using the following values for the lower heating value, *LHV* = 40,151 kJ/kg. The estimated consumption for the boilers and furnace results:

Boiler GN2201/A:	20,223.55 t/year
Boiler GN2201/B:	20,223.55 t/year
EDC Furnace P581:	9,670.53 t/year
EDC Furnace P81/A:	3,839.06 t/year
EDC Furnace P81/B:	3,839.06 t/year
Total:	67,907.52 t/year

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Table 16 – Estimated project emissions reductions

Year	ER (tCO_2)					
	Boiler GN2201/A	Boiler GN2201/B	EDC Furnace P581	EDC Furnace P81/A	EDC Furnace P81/B	Total
2004*	2,004.90	2,004.90	-	-	-	4,009.80
2005	16,039.21	16,039.21	-	-	-	32,078.42
2006	16,039.21	16,039.21	6,472.38	-	-	38,550.80
2007	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2008	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2009	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2010	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2011	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2012	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2013	16,039.21	16,039.21	6,472.38	2,895.72	2,895.72	44,342.24
2014**	14,034.31	14,034.31	5,663.33	2,533.76	2,533.76	38,799.46
Total	**160,392.11**	**160,392.11**	**57,442.33**	**22,803.80**	**22,803.80**	**423,834.14**
Annual Average	**16,039.21**	**16,039.21**	**5,744.23**	**2,280.38**	**2,280.38**	**42,383.41**

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

E.6. Table providing values obtained when applying formulae above:

Table 17 – Estimated PE, BE, LE and ER

Year	Estimation of project activity emissions [tCO_2]	Estimation of baseline emissions [tCO_2]	Estimation of leakage emissions [tCO_2]	Estimation of emissions reductions [tCO_2]
2004*	11,096.88	15,598.84	492.17	4,009.80
2005	88,775.00	124,790.75	3,937.33	32,078.42
2006	108,330.03	151,685.45	4,804.63	38,550.80
2007	125,827.74	175,750.66	5,580.68	44,342.24
2008	125,827.74	175,750.66	5,580.68	44,342.24
2009	125,827.74	175,750.66	5,580.68	44,342.24
2010	125,827.74	175,750.66	5,580.68	44,342.24
2011	125,827.74	175,750.66	5,580.68	44,342.24
2012	125,827.74	175,750.66	5,580.68	44,342.24
2013	125,827.74	175,750.66	5,580.68	44,342.24
2014**	110,099.27	153,781.83	4,883.10	38,799.46
Total	**1,199,095.35**	**1,676,111.49**	**53,182.00**	**423,834.14**

* 15/11/2004 – 31/12/2004
** 1/1/2014 – 14/11/2014

SECTION F. Environmental impacts

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

Solvay obtained two environmental licenses from the State environmental agency, CETESB: one for the fuel switching in the boilers and another one for the furnace installation (included in the license of the VCM plant expansion).

For the boilers, CETESB required the development of the so-called MCE (Project Characterization Document – *Memorial de Caracterização do Empreendimento*) to issue the license. The MCE is a simplified document that characterizes the projects in terms of its environmental impacts. It is required to verify if the project activity needs to carry out a more detailed study (RAP – Preliminary Environmental Report – *Relatório Ambiental Preliminar*) to obtain the license. As the fuel switching in the boilers did not present significant environmental impacts, the RAP was not necessary. The MCE and the license are available for further consultation with Solvay and with CETESB.

The furnace license is included in the VCM expansion project license. In this case, besides the MCE, CETESB required further analisys of the project through the RAP. The RAP is a simplified environmental impact assessment to verify if the project activity needs to carry out the EIA/RIMA (Environmental Impact Assessment/Environmental Impact Report – *Estudo de Impacto Ambiental/Relatório de Impacto Ambiental*) to obtain the license. The EIA/RIMA was not necessary as the project activity would not bring major impacts. The MCE, the RAP and the license are available for further consultation with Solvay and with CETESB. The RAP and MCE were developed taking into consideration fuel oil as the primary energy source to the furnace. As stated before, the final decision was to switch from fuel oil to natural gas, what reduces environmental impact.

F.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:

No significant environmental impacts are expected for this project activity. The non requirement of the EIA/RIMA by the State environmental agency confirms this fact. The verification of project atmospheric emissions, wastewater generation and solid residues final disposal was approved by the environmental agency as of the issuance of the license. Also, emergency plans and safety programs were developed and implemented.

Actually, some benefits can be observed after project implementation, as presented in Section A.2.

SECTION G. Stakeholders' comments

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

Brazilian legislation requests the public announcement and invitation for comments during the environmental licensing process. The public announcement and public comments invitation were made in the local State oficial journal (*Diário Oficial do Estado*) and in the regional newspaper. No objections and comments were raised about the project. Evidence is available with Solvay.

Additionally, the Brazilian Designated National Authority for the CDM requires the compulsory invitation of selected stakeholders to comment the PDD sent to validation in order to provide the letter of approval.

G.2. Summary of the comments received:

No comment was received during the local stakeholders' call for comments during the process to obtain the environmental license.

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

No comment was received during the local stakeholders' call for comments during the process to obtain the environmental license.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The project is being developed on equity basis. Solvay has implemented the project without public funding or other source of debt.

Annex 3

BASELINE INFORMATION

All baseline information was presented in Section B. Please, refer to that section.

Annex 4

MONITORING PLAN

All monitoring information was presented in Section D. Please, refer to that section.

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Annex 5

CASH FLOW ANALYSIS

Discount rate =	25.00%	
CER Price =	6.50	US$/tCO2
Dolar rate =	3.00	R$/US$
Taxes =	34.00%	

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Natural gas price (R$/TJ)		15,503.55	15,503.55	15,503.55	15,503.55	15,503.55	15,503.55	15,503.55	15,503.55	15,503.55	15,503.55
Fuel oil price (R$/TJ)		15,054.50	15,054.50	15,054.50	15,054.50	15,054.50	15,054.50	15,054.50	15,054.50	15,054.50	15,054.50
Natural gas consumption (TJ/year)											
GN2201/A		794.46	794.46	794.46	794.46	794.46	794.46	794.46	794.46	794.46	695.15
GN2201/B		794.46	794.46	794.46	794.46	794.46	794.46	794.46	794.46	794.46	695.15
P581		0.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	306.25
P81/A		0.00	0.00	156.59	156.59	156.59	156.59	156.59	156.59	156.59	137.02
P81/B		0.00	0.00	156.59	156.59	156.59	156.59	156.59	156.59	156.59	137.02
Fuel oil consumption (TJ/year)											
GN2201/A		812.00	812.00	812.00	812.00	812.00	812.00	812.00	812.00	812.00	710.50
GN2201/B		812.00	812.00	812.00	812.00	812.00	812.00	812.00	812.00	812.00	710.50
P581		0.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	306.25
P81/A		0.00	0.00	156.59	156.59	156.59	156.59	156.59	156.59	156.59	137.02
P81/B		0.00	0.00	156.59	156.59	156.59	156.59	156.59	156.59	156.59	137.02
CERs (tCO2)											
GN2201/A		16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	14,034.31
GN2201/B		16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	16,039.21	14,034.31
P581		0.00	6,472.38	6,472.38	6,472.38	6,472.38	6,472.38	6,472.38	6,472.38	6,472.38	5,663.33
P81/A		0.00	0.00	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,533.76
P81/B		0.00	0.00	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,895.72	2,533.76

Alternative 2 - Only P581 using natural gas	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2.1 - Delta Investment											
Investment savings - natural gas furnace	5,800,000.00										
Investment savings - treatment of flue gases of fuel oil furnaces	2,700,000.00										
Natural gas auxiliaries	(500,000.00)										
Conversion of boilers to natural gas	0										
Natural gas pipeline	(12,000,000.00)										
DELTA INVESTMENT	(4,000,000.00)										
2.2 - Additional expenses/savings due to natural gas, in comparison with the reference											
Natural gas expenses	0.00	0.00	(157,168.25)	(157,168.25)	(157,168.25)	(157,168.25)	(157,168.25)	(157,168.25)	(157,168.25)	(157,168.25)	(137,522.22)
Extra fee for low consumption of natural gas	0.00	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)	(930,000.00)
Savings with O&M - natural gas furnace	0.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00
Savings with O&M - natural gas boilers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DELTA OPERATING MARGIN	0.00	(630,000.00)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(767,522.22)
DELTA DEPRECIATION	0.00	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)
BASE FOR PROFIT TAXES (EBIT)	0.00	(1,030,000.00)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,167,522.22)
2.3 - Taxes											
TAXES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET INCOME = EBIT - TAXES	0.00	(1,030,000.00)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,187,168.25)	(1,167,522.22)
DELTA CASH FLOW = INVEST + DEPRECIATION + NET INCOME (ALT 2)	(4,000,000.00)	(630,000.00)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(787,168.25)	(767,522.22)
Net Present Value without CERs	(6,682,742.72)										
2.4 - CERs revenues	0.00	0.00	126,211.31	126,211.31	126,211.31	126,211.31	126,211.31	126,211.31	126,211.31	126,211.31	110,434.90
DELTA OPERATING MARGIN	0.00	(630,000.00)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(657,087.32)
DELTA DEPRECIATION	0.00	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)	(400,000.00)
BASE FOR PROFIT TAXES (EBIT)	0.00	(1,030,000.00)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,057,087.32)
2.5 - Taxes											
TAXES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET INCOME = EBIT - TAXES	0.00	(1,030,000.00)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,060,956.93)	(1,057,087.32)
DELTA CASH FLOW = INVEST + DEPRECIATION + NET INCOME (ALT 2)	(4,000,000.00)	(630,000.00)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(660,956.93)	(657,087.32)
Net Present Value with CERs	(6,334,767.85)										

Alternative 3 - All equipment using natural gas	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3.1 - Delta Investment											
Investment savings - natural gas furnace	5,800,000.00										
Investment savings - treatment of flue gases of fuel oil furnaces	2,700,000.00										
Natural gas auxiliaries	(2,800,000.00)										
Conversion of boilers to natural gas	(9,000,000)										
Natural gas pipeline	0.00										
DELTA INVESTMENT	(3,300,000.00)										
3.2 - Additional expenses/savings due to natural gas, in comparison with the reference											
Natural gas expenses	0.00	(185,429.49)	(342,597.73)	(483,230.89)	(483,230.89)	(483,230.89)	(483,230.89)	(483,230.89)	(483,230.89)	(483,230.89)	(422,827.03)
Extra fee for low consumption of natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Savings with O&M - natural gas furnace	0.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00
Savings with O&M - natural gas boilers	0.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00	720,000.00
DELTA OPERATING MARGIN	0.00	834,570.51	677,402.27	536,769.11	536,769.11	536,769.11	536,769.11	536,769.11	536,769.11	536,769.11	597,172.97
DELTA DEPRECIATION	0.00	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)
BASE FOR PROFIT TAXES (EBIT)	0.00	504,570.51	347,402.27	206,769.11	206,769.11	206,769.11	206,769.11	206,769.11	206,769.11	206,769.11	267,172.97
3.3 - Taxes											
TAXES	0.00	(171,553.97)	(118,116.77)	(70,301.50)	(70,301.50)	(70,301.50)	(70,301.50)	(70,301.50)	(70,301.50)	(70,301.50)	(90,838.81)
NET INCOME = EBIT - TAXES	0.00	333,016.54	229,285.50	136,467.61	136,467.61	136,467.61	136,467.61	136,467.61	136,467.61	136,467.61	176,334.16
DELTA CASH FLOW = INVEST + DEPRECIATION + NET INCOME (ALT 3)	(3,300,000.00)	663,016.54	559,285.50	466,467.61	466,467.61	466,467.61	466,467.61	466,467.61	466,467.61	466,467.61	506,334.16
Net Present Value without CERs	(1,413,552.64)										
3.4 - CERs revenues	0.00	625,529.22	751,740.54	864,673.63	864,673.63	864,673.63	864,673.63	864,673.63	864,673.63	864,673.63	756,589.42
DELTA OPERATING MARGIN	0.00	1,460,099.74	1,429,142.80	1,401,442.73	1,401,442.73	1,401,442.73	1,401,442.73	1,401,442.73	1,401,442.73	1,401,442.73	1,353,762.39
DELTA DEPRECIATION	0.00	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)	(330,000.00)
BASE FOR PROFIT TAXES (EBIT)	0.00	1,130,099.74	1,099,142.80	1,071,442.73	1,071,442.73	1,071,442.73	1,071,442.73	1,071,442.73	1,071,442.73	1,071,442.73	1,023,762.39
3.5 - Taxes											
TAXES	0.00	(384,233.91)	(373,708.55)	(364,290.53)	(364,290.53)	(364,290.53)	(364,290.53)	(364,290.53)	(364,290.53)	(364,290.53)	(348,079.21)
NET INCOME = EBIT - TAXES	0.00	745,865.83	725,434.25	707,152.20	707,152.20	707,152.20	707,152.20	707,152.20	707,152.20	707,152.20	675,683.18
DELTA CASH FLOW = INVEST + DEPRECIATION + NET INCOME (ALT 2)	(3,300,000.00)	1,075,865.83	1,055,434.25	1,037,152.20	1,037,152.20	1,037,152.20	1,037,152.20	1,037,152.20	1,037,152.20	1,037,152.20	1,005,683.18
Net Present Value with CERs	442,447.78										