JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Sofia District Heating Project
Version 3, 22/10/2007

A.2. Description of the project:

Background

District heating (DH) is the dominant form of space heating in major cities in Bulgaria. DH, compared with other forms of energy, is the most economical way to provide heat to the population in highly urbanized areas. The sector generated approximately 11 GWh of heat energy and 1.8 GWh of electricity in 2004 and represented about 25% of the energy consumption in the country. About 80% of this energy came from natural gas with other sources being coal (12%) and heavy fuel oil (8%).

The price of electricity is relevant for the District Heating Companies (DHCs) that use combined heat and power (CHP) boilers. These companies sell their electricity to the national grid while the heat is sold to domestic and industrial consumers. In 2002, according to the Energy and Energy Efficiency Law, the national power grid has to purchase electricity generated in the CHP plants at preferential rates of around US$ 43/MWh, which is close to the electricity tariffs. This policy was in place to use CHPs to meet peak electricity demand and assist the DH sector by allowing them to generate revenues from the sale of electricity. The contribution of CHPs to the generation of electricity is, however, limited. Installed capacity for electricity generation by CHP plants is about 540 MW compared to a total installed capacity of 11,000 MW. The CHP plants fully recover their costs on the electricity generation and often cross-subsidize the DH operations. The level of cross-subsidization depends on the condition of the CHP plants and the fuel used. Cross-subsidy is seen as a temporary phenomenon and is expected to be phased out as the DH sector becomes self sustainable.

While the DH sector has been going through a difficult time, actions taken by the Government are helping the sector to make a turn-around. Since 2000, there have been changes, including: tariff increases, which are helping to improve the financial situation of the DHCs; elimination of disconnections from the DH system; an increase in demand-side measures through metering of consumption, and some rehabilitation of sub-stations. To support the turn-around and place the sector on a sustainable footing, the DHCs and the Government have to continue to address the key issues in the sector.

The Sofia DH sources are:

- Two combined heat and power (CHP) plants which generated 3,840 GWh of heat per year in 2003;
- Two large heat only boiler (HOB) which generated 1,680 GWh of heat per year in 2003 and;
- Seven small isolated heating plants which produced 480 GWh of heat per year in 2003

Table 1. Sofia Energy Production Capacity

Plant	MWth	MWel
CHP Sofia east	2014	186
CHP Sofia	1320	75
HP Luilin	607.6	0
HP Zemliane	607.6	0
HOB Hadji Dimitar	63.36	0
HOB Suha reka	35.5	0
HOB Levski	54.6	0
HOB Orlandovzi	4.6	0
HOB Ovcha kupel 1	54.6	0
HOB Ovcha kupel 2	54.6	0
HOB Injstroy"	19.8	0

The Sofia DH system which is fuelled by gas and heavy fuel supplies heat to approximately 368,000 apartments that are connected to the DH system. The total length of the DH network is 900 km and there are 15,768 substations.

Description of the project

The aim of the project is to rehabilitate the DH system in the city of Sofia by replacing 60 km of pipelines (7%) and 7,000 substations. So far 6808 substations have been replaced. However, 10000 substation instead of 7000 will be replaced as unit price per substation has proven be lower than estimated. The main part of the project has been implemented and pre-insulated pipes, modern ball and butterfly valves, compensators and thermal insulation have been installed. Some substations will still be replaced in 2007 and 2008. The substations which transfer heat to individual buildings have been upgraded to include new heat exchangers and pumps, together with modern control and monitoring equipment leading to considerable decrease of specific heat consumption.

The project has converted Sofia DH network to a variable flow and allow groups of consumers to automatically regulate their heat consumption and also strengthen the connections between the four zones of Sofia to integrate the DH network and to optimize the heat supply. The goal of the project is to reduce heat losses and improve efficiency of the network so energy consumption and hence CO_2 emissions are correspondingly reduced up to around 15 % in comparison with baseline scenario.

The majority of heating goes to residential buildings, which are mostly high-rise apartment complexes. Each residential building contains one or more substations that distribute hot water to individual radiators within flats. Older substations are mostly “direct”, and bleed hot water directly from the main distribution network into the building. Newer buildings use “indirect” substations, which use a secondary circulation network and pump, and a heat exchanger connected to the primary distribution network.

Equipments supplied under the project are accompanied with manual for installation, operation and maintenance. In addition, the operational staff undergoes training course, carried out by the respective Supplier. The warranty period of the supplied equipment is as follows:

- substations – 5 years
- frequency converters – 3 years
- valves – 5 years
- compensators – 5 years
- pre-insulated pipes – 5 years

The maintenance of the substations is carried out by Toplofikacia staff, trained by the Suppliers, and with certificate for passed examination. Requirement for the Suppliers of frequency converters is, e.g. to have service in Sofia and to carry out the warranty and post-warranty services.

This project was positively pre-determined by TŰV SŰD in 2004. However, initial verification revealed some mistakes in the implementation of the Monitoring Plan leading to the need to revise the documentation and re-determine the project[1].

The project was originally bundled with similar Pernik project. Projects have now been separated into two independent projects for re-determination due to the facts that projects have been implemented by different project entities and project characteristics are slightly different e.g. with differing implementation timetables. Project is to be re-determined under JI Track 1 subject to relevant eligibility criteria expected to be met in Bulgaria.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to e considered as project participant (Yes/No)
Bulgaria	Toplofikacia Sofia	No
To be determined	IBRD as a Trustee for Prototype Carbon Fund (PCF)	Yes

A.4. Technical description of the project:

A.4.1. Location of the project:

The project is located in Sofia in Bulgaria.

Figure 1. Map of Bulgaria

[1] A joint initial verification for Sofia DH and Pernik DH projects was completed in September 2005. Verifier raised questions regarding the monitoring database (Tracking database) for Pernik leading to revisions of the database and requirement to have the documentation re-determined before a periodic verification of emission reductions could take place. Determinator reviewed the database and documentation model for Pernik and Sofia in and issued a report in November 2006 requesting updating of the project documentation. The documentation has now been revised including PDD and Monitoring Plan and Monitoring database/Tracking database.

A.4.1.1. Host Party(ies):

Bulgaria is the host party. Bulgaria ratified the Kyoto Protocol to the UNFCCC on July 17, 2002.

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

Region of Sofia

A.4.1.3. City/Town/Community etc.:

Sofia

Sofia is the capital and the largest city in Bulgaria which is located in western Bulgaria.

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

The project is located in Sofia managed by the Sofia District Heating Company, also referred to as Toplofikacia Sofia (TS), a municipal and government owned company. TS distributes hot water to four separated distribution networks – Sofia, Sofia East, Zemliane, and Luilin.

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

The project belongs to sectoral scope 2, Energy Distribution. The measures that have been implemented as a result of the project include[2]:

1. **Replacement of piping:** Network rehabilitation involving the replacement of approximately 60 km of transmission pipelines (7% of the total pipeline network) and over-ground thermal insulation have been implemented in order to reduce losses. All pipelines that were replaced were old foam-concrete types that had become increasingly difficult to maintain. The pipes are spread throughout the city within all four of the major distribution networks. Some improved interconnection between the Sofia and Sofia East networks, where limited interconnection existed will be implemented.

2. **Replacement of substations:** 6808 substations have been replaced (total of 15,768 substations), and approximately 3000 will still be replaced as part of the project. A total of 10000 substation, for which financing is currently provided, will be replaced. These substations were a mix of direct substations that directly use the hot water from Sofia DH and older indirect substations that are due for replacement.

3. **Variable-speed pumping:** The current strategy of using constant-flow pumps to disperse hot water through the primary distribution network has been improved by adding variable flow pumping. Savings of in pumping electricity is approximately 26%.

The combination of the measures identified above has resulted in aggregate savings of input fuel (gas and heavy fuel oil) to the CHPs and boilers, and electricity used by the primary distribution pumps.

[2] There has been some delays and implementation is still partly ongoing

Table 2. Measures implemented by the project.

Component		Total target	Implemented by mid 2007	2002	2003	2004	2005	2006	2007
Pipeline trace	km	95.5	91.5	0	36	37.5	2	1	15
Substations	No	11675[3]	8620	1097	2314	2182	439	625	1963
Frequency converters	No	28	28	0	0	4	5	5	14
Heat insulation/over ground pipeline	km	16	16	0	0	14	2	0	0
Compensators and valves	No	2500	1960	0	0	160	555	645	600

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

The emission reductions would be achieved through (i) reductions in heat and water losses in the pipeline distribution system; (ii) improved interconnectivity among the four zones in Sofia DH transmission system; (iii) improved heat exchangers and better control systems at substations; and (iv) lower grid electricity consumption due to the installation of variable-frequency pumps.

All four efficiency gains lead to lower consumption of fossil fuels and thus lower CO_2 emissions. The main impact comes from the component (iii), i.e. replacement of substations.

The financial situation of the TS deteriorated steadily in the end of the 1990s. Main factors affecting TS were (i) loss of sales due to voluntary disconnections by customers, (ii) low domestic tariff that were below the unit cost of heat production, (iii) low bill collection rates and (iv) rising operation expenses, including fuel costs. Given the financial constraints of the TS, rehabilitation of the network was not affordable, which has led to an increase in heat losses. In the absence of the project, the DHC would have not been able to raise the required capital to improve the energy efficiency, and thus the proposed project would not be implemented in the absence of the JI component due to the investment and institutional barriers as described in B.1.

A.4.3.1. Estimated amount of emission reductions over the crediting period:

The estimated amount of emission reduction over the crediting period of 2008-2012 is 1,337,926 t CO_2e. The estimated amount of emission reduction over the period of 2004-2007 is 836,132 CO_2e planned to be transferred as AAUs before the first commitment period.

[3] *This is the number of the substations, which are identified, as subject to replacement and in case that financing is provided this would be the number of the substations replaced under the project. Currently, 10 000 will replaced

Table 3. Emission reductions in 2004-2007

	Years
Length of the period prior to 2008	4
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2004	146,585
2005	238,977
2006	250,660
2007	199,910
Total estimated emission reductions over the period prior to 2008 (tonnes of CO_2 equivalent)	836,132
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	209,033

Table 4. Emission reductions in 2008-2012

	Years
Length of the crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	267,510
2009	267,274
2010	267,205
2011	267,956
2012	267,981
Total estimated emission reductions over the period prior to 2008 (tonnes of CO_2 equivalent)	1,337,926
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	267,585

A.5. Project approval by the Parties involved:

Ministry of Environment and Water as an authorized representative of the Republic of Bulgaria approved the project in 2004.

A number of Parties involved may need to provide Letters of Approval and added to the list of Parties involved at a later stage since the receiver of the ERUs is a multilateral Fund consisting of multiple participants.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

Baseline methodology

A baseline study for Sofia DH project was conducted in 2004[4]. No approved CDM baseline methodology existed at the time the project was designed. The different approaches considered when establishing the baseline methodology were taken from the Modalities and Procedure for Clean Development Mechanism[5], which offers guidance in selection of project specific baseline approaches. Baseline is determined based on existing actual or historical emissions. Below follows a description and justification of the baseline methodology chosen.

The chosen approach is in compliance with the current Guidance on criteria for baseline setting by Joint Implementation Supervisory Committee.

Identification of alternatives and determination of the baseline

The financial situation of TS deteriorated steadily in the end of the 1990s due to (i) loss of sales due to voluntary disconnections by customers; (ii) low domestic tariffs that are below the unit cost of heat production; (iii) low bill collection rates; and (iv) rising operating expenses, including fuel costs.

DH systems have been supply-driven providing no opportunity for the consumer to control consumption or maintain temperatures at individual comfort levels. This inflexible technical design has led to residential consumers preferring to fully or partially be disconnected from the DH system and benefit from the free-rider effect, in which they would be able to receive heat from hot water pipes running through the apartment or through common walls with neighboring apartments using DH services.

In spite of increased price of electricity, residential tariffs still did not cover the operating costs as tariffs were close to the cost of production. The residential tariffs have not kept pace with costs due to affordability considerations for consumers. Pls. see also section A.2. for additional discussion concerning the state of DN sector in Bulgaria.

The operating revenues of TS before the subsidies were almost stagnant at around BGN (Bulgarian lev) 240 million whereas operations and maintenance expenses increased from BGN 220 million in 1999 to BGN 287 million in 2001. The operating deficit was partly covered through subsidies from the central government.

Several scenarios were considered in the baseline study covering the alternative sources of heat for consumers such as electricity, natural gas and individual heating systems using solid or liquid fuels. All such means of heating would result in higher cost for consumers and will require much higher infrastructure investments than those needed to rehabilitate and upgrade the existing DH system.

There are no specific legal requirements related to the project, especially regarding the rehabilitation of DH network and substations. The project has been established in full compliance with the elaborated

[4] Nexant, 2004, Baseline Study Bulgaria Sofia Pernik District Heating Project.
[5] Modalities and Procedures for Clean Development Mechanism as defined in Article 12 of the Kyoto Protocol, FCCC/KP/CMP/2005/8/Add.1

energy strategy by the Council of Ministers of Republic Bulgaria and approved by the National Assembly.

Thus, only two plausible and credible alternatives which dominated other scenarios were listed as candidate to the baseline:

- the continuation of the current operation and maintenance practices,
- the implementation of the project activity in the business-as-usual conditions (without the JI component).

Given the financial state of TS, the company would have not been able to raise the required capital to rehabilitate the DH system. Therefore the baseline scenario that represent the most plausible and credible scenario was the continuation with the business-as-usual operation of the DH system for the foreseeable future with no changes to the operational capacity of the system with minimum maintenance (based on historical observed business-as-usual maintenance) in order to keep the system operational.

The baseline over the life of the project was expected to remain unchanged over the duration of the project. The baseline for the project was estimated using correlation between heat production, electricity production and fuel use by Nexant in 2004. Historical annual data for 3 years and monthly plant data for a 12 month period was used to conduct a regression analysis and develop the necessary regression models to estimate the fuel used in the DH plants. In order to calculate heat production in baseline case, reduction of losses of pipeline and substation replacement has also been taken into account.

The monitoring plan and tracking database, however, allow for adjustment of the correlation if any major changes will occur within the project boundary as discussed in the section D.

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

Investment barrier faced by the Project

The project is financed by International Bank of Reconstruction and Development (IBRD), European Bank for Reconstruction and Development (EBRD), Kozloduy International Decommissioning Support Fund (KIDS, an EU grant) and emission reduction purchase of the Prototype Carbon Fund.

The company requested a loan from IBRD and EBRD in 1999. However, the Government of Bulgaria was not able to provide the State guarantee required for a Bank loan from IBRD and EBRD since the financial viability of the enterprise would be jeopardized if the entire investments were to be financed through debt. As mentioned earlier in B.1, the financial situation of TS deteriorated steadily at the time of the investment decision. Given its financial state, the TS would not have been able to raise the required capital needed to rehabilitate the DH system. KIDS and the carbon revenues were necessary leverage to provide a guarantee and thus contributed to alleviate the financial barrier that would not have been possible to overcome.

The Project was not a common practice

The use of external sources of financing for investment in the rehabilitation of the DH systems was not a common practice in Bulgaria at the time of the investment decision for the project. As discussed above, the heat tariffs were insufficient to even compensate current operating expenditure of DH companies and did not allow the implementation of the mid-term and long-term investment in the DH rehabilitation in particular using the debt financing. In addition, the system of state subsidize was not providing sufficient resources and incentives to the DH companies for such investments.

It can be therefore concluded that the proposed JI project is additional to what would occur otherwise.

B.3. Description of how the definition of the project boundary is applied to the project:

The project boundary for Sofia DH encompasses the entire DH system including the 2 CHP plants, the 2 large heat-only-boilers, and 7 small heat-only-boilers (HOB), the transmission system and distribution up to and including substations. In effect, the boundary encompasses all the emission sources that will be impacted by the project. The emissions from the gas supply pipeline are ignored and it is assumed that these emissions would not be change from baseline to project.

Table 5. Sources of emissions

	Source	Gas[6]		Justification/Explanation
Project	Emissions from heat and power production due to natural gas consumption	CO_2	Included	The main source or project emissions
	Emissions from heat and power production due to heavy fuel oil consumption	CO_2	Included	Insignificant source for emissions. Included should there be changes in the future.
	Emissions from BAU pipeline replacement	CO_2	Included	The way project is designed emissions are added to project scenario due to expected BAU pipeline replacement (pls. see figure 4).
	Emissions from pump replacement	CO_2	Included	Reduced emissions from the grid due to lower electricity consumption deducted from the project emissions (pls. see figure 4).
Baseline	Emissions from heat and power production due to natural consumption	CO_2	Included	The main source of baseline emissions.
	Emissions from heat and power production due to heavy fuel oil consumption	CO_2	Included	Minor source of baseline emissions.

[6] CH4 and N2O emissions from heat and power production are in fact calculated in Tracking database. They are, however, insignificant.

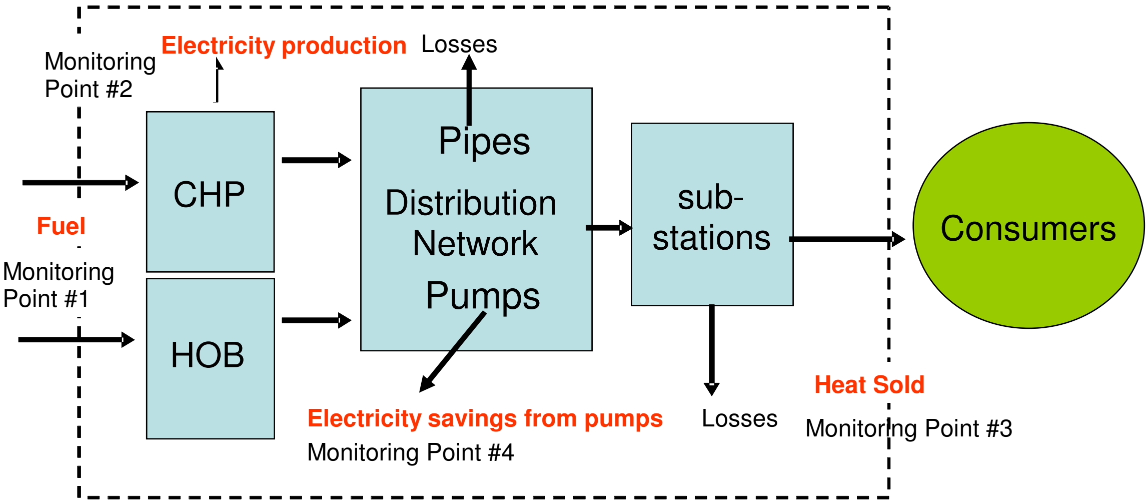


Figure 2: Sofia DH project boundary and main monitoring points.

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

A baseline study was conducted and finalized in 16/01/2004 by Anand Subiah in Nexant and updated by Sari Siitonen Poyry Energy in 31/05/2007.

Nexant, Inc
1030 15th street, NW 750
Washington D.C 20005

Nexant and Poyry Energy are not project participants.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

Official starting data of the project was October 1 2003.

C.2. Expected operational lifetime of the project:

The operational lifetime of the project is 25 years.

C.3. Length of the crediting period:

The crediting period is 5 years, 01/01/2008-31/12/2012 for ERUs
In addition, ERs generated 01/01/2004-31/12/2007 will be transferred as AAUs.

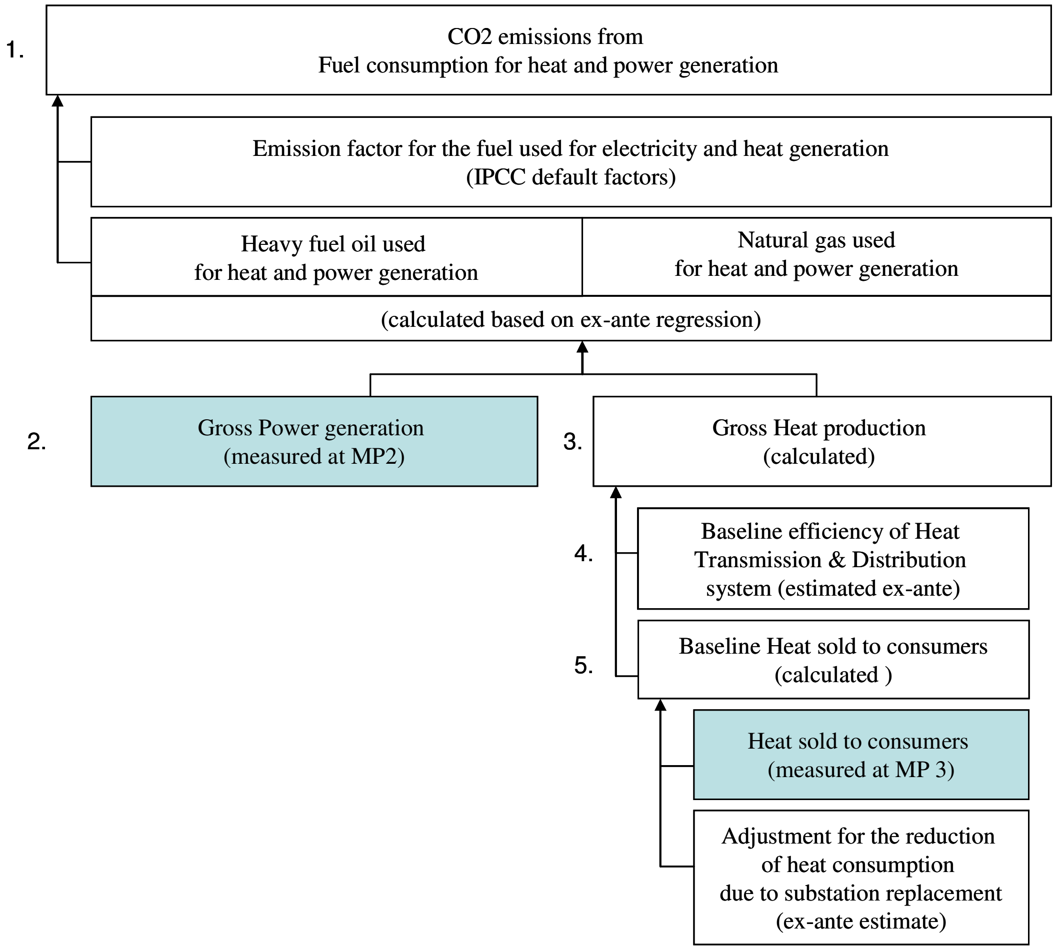
SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

There were no approved monitoring methodologies available at the time project was designed. The monitoring plan describes the methodology that has been developed for this project.[7] The monitoring plan describes how the emission reductions are estimated and monitored and how the baseline and project emissions are calculated. A Tracking Database (Excel-based workbook) has been developed to monitor and calculate emissions for the project and baseline scenario and to calculate the emission reductions. Baseline is monitored *ex-post.*

The following figure provides an algorithm of the monitoring of the emissions in the baseline scenario.

Figure 3. Algorithm of the monitoring and calculation of the baseline emissions.



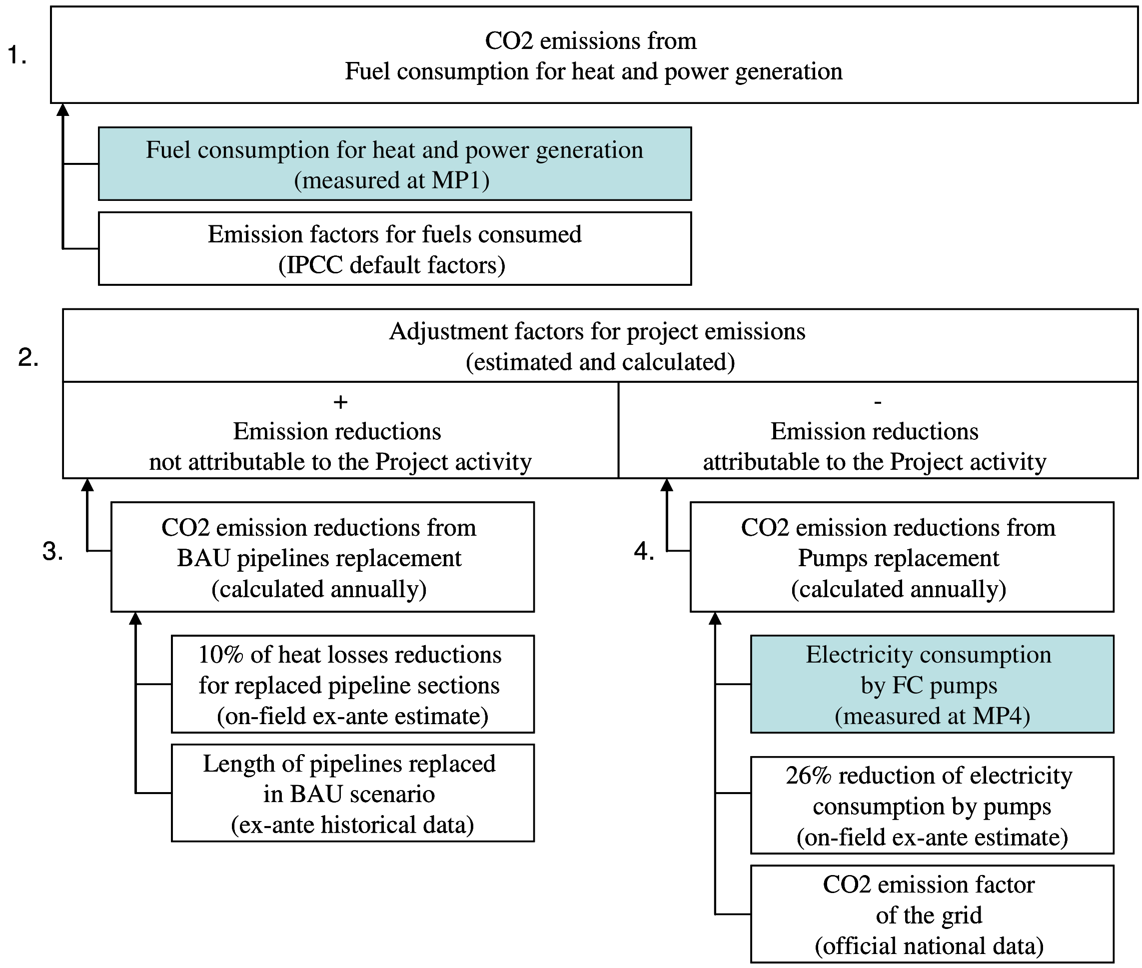
The baseline emissions are due to the fuel consumption for gross heat and power generation necessary to provide a required amount of heat to the consumers taking into account heat losses. These emissions are calculated based on the ex-post measured amount of heat sold to consumers, adjusted to take into account two parameters impacted by the project activity:

[7] The original calculation model (Tracking database) was developed in January 2004 by Nexant and PDD was positively pre-determined by TÜV. The calculation of the project emission was structured in a way where emission reductions from expected infrastructure improvement is added to the project emission, to reduce the total emission reductions from the project, since the expected infrastructure improvements would have happened without the project. Also, reductions from electricity savings due to frequency controlled pumps are subtracted from the project emissions. The Monitoring plan and the Tracking Database were updated in May 2007 by Pöyry Energy.

- the historical level of losses in the heat distribution system, and
- the level of specific heat consumption (kWh/m^3 of living space per year), which was reduced due to the introduction of the new substations by the project. [8]

The following figure reflects the algorithm of project emission reductions monitoring and calculation.

Figure 4. Algorithm of project emission monitoring and calculation. [9]



The project emissions are also due to the fuel consumption for gross heat and power generation. These emissions are calculated based on the ex-post monitored fuel consumption (Step 1 in the figure). Two adjustments are applied to the amount of the project emissions (Step 2 in the figure):

- First (Step 3), to take into account the emission reductions that would be generated anyway in the business-as-usual scenario (baseline) and are not attributable to the project activity. These emissions reductions will be achieved through continuation of the historical maintenance & repair practices. The replacement of 5 km of pipelines per year in the baseline will reduce heat losses from the replaced sections by 10%. The correspondent emission reductions are estimated using ex-ante historical data and are added to the project emissions.

[8] No other measures are taken to reduce specific heat consumption, e.g. heat meters were installed in apartments before the implementation of the project.

[9] Emission reductions not attributable to project activity refer to adjustment factor in terms of heat losses reduction due to the replacement of the pipes in continuation of the historical maintenance & repair practices.

- Second (Step 4), the replacement of the old pumps by the frequency controlled (FC) pumps in the project allows to reduce the electricity consumption by the district heating distribution system. The emissions reduction will be achieved due to the project via lower electricity generation by the regional power plants. The correspondent emission reductions are deducted from the total project emissions.

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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
P1	Natural Gas consumption	TS	Million m^3	M	Monthly	100%	Electronic	Gas consumption is measured by meters monthly.
P2	Heavy Fuel Oil consumption	TS	Tonne	M	Monthly	100%	Electronic	Fuel consumption at each HOB is measured by gauge readings monthly.
P3	Emission factor, natural gas	Revised 1996 IPCC Guidelines for National GHG Inventories	gCO_2/MJ		Annual	100%	Electronic	
P4	Emission factor, heavy fuel oil	Revised 1996 IPCC Guidelines for National GHG Inventories	gCO_2/MJ		Annual	100%	Electronic	
P5	Electricity consumed in frequency controlled pumps	TS	MWh	M	Monthly	100%	Electronic	Electricity consumption is measured by meters installed at each pump.
P6	Electricity grid CO_2 emission	www.moew.goverment.bg	Kg CO_2/MWh		Annual	100%	Electronic	

	factor							
P7	Adjustment factor for infrastructure improvement	Kalkum B, 2000. District Heating Strategy and Action Plan. Sofia, Bulgaria	Scalar	E	Annual	100%	Electronic	The reduction of heat losses in the distribution system due to the pipeline replacement was established ex-ante by the independent study

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

$$PE_y = PEF_y + II_y - ES_y \qquad (1)$$

Where:

PE_y	Total project emissions in year y (tCO_2e).
PEF_y	project emissions in year y resulting from the fossil fuel combustion for gross heat and power generation by the DH system (tCO_2e).
II_y	emission reductions in year y due to the replacement of the heat transmission and distribution pipes in continuation of the historical maintenance & repair practices (tCO_2e). These emissions reductions are not attributable to the project activity as they will be implemented anyway.
ES_y	emission reductions in year y due to the reduced grid electricity consumption by the frequency controlled pumps replacing the old pumps (tCO_2e).

Fossil fuel combustion for gross heat and power generation

$$PEF_y = \sum_{i=1,2} (Fuel\_Use_{i,y} * EF_i) \qquad (2)$$

Where:

PEF_y	project emissions in year *y* resulting from the fossil fuel combustion for gross heat and power generation by the DH system (tCO_2e).
$Fuel\_Use_{i,y}$	fuel *i* used in year *y* for gross heat and power generation (MJ). The fuel type 1 is a heavy fuel oil and the fuel type 2 is the natural gas.
EF_i	emission factor of the fuel *i* from the Revised 1996 IPCC Guidelines for National GHG Inventories (gCO_2e/MJ).

Replacement of pipes in continuation of historic maintenance & repair practices

$$II_y = PEF_y * AF_{II,y} \quad (3)$$

Where:

II_y	emission reductions in year *y* due to the replacement of the heat transmission and distribution pipes in continuation of the historical maintenance & repair practices (tCO_2e). These emissions reductions are not attributable to the project activity as they will be implemented anyway.
PEF_y	project emissions in year *y* resulting from the fossil fuel combustion for gross heat and power generation by the DH system (tCO_2e).
$AF_{II,y}$	adjustment factor in terms of heat losses reduction due to the replacement of the pipes in continuation of the historical maintenance & repair practices.

Adjustment factor for heat losses reduction due to pipes replacement in continuation of historic practices

$$AF_{II,y} = 0.1 * \sum_{y=1}^{Y} Pipes_{replaced,BAU,y} / Total\_lenght \quad (4)$$

Where:

$AF_{II,y}$	adjustment factor in terms of heat losses reduction due to the replacement of the pipes in continuation of the historical maintenance & repair practices.
0.1	share of heat losses reduced for each section of replaced heat pipes, estimated at 10% in the study District Heating Strategy and Action Plan. (Kalkum B, 2000. Sofia, Bulgaria).
$Pipes_{replaced,BAU,y}$	total length of heat pipes replaced from the start of the project in year *y* in continuation of historic practices (km). The estimated replacement of pipe per year without the project is 5 km/year.

Total_lengh Total length of pipes in operation equal to 900 km.

Adjustment factor for reduced grid electricity consumption by the new frequency controlled pumps

$$ES_y = El\_cons_y * \Delta Eff_{FCP} * EF_{CO2\_grid,y} \quad (5)$$

Where:

$ES_{,y}$ emission reductions in year *y* due to the reduced grid electricity consumption by the frequency controlled pumps replacing the old pumps (tCO_2e). These emissions reductions are directly attributable to the project activity. Due to the expected reduction of the carbon intensity of the grid power generation in the coming years, the contribution of this factor on the total emission reduction by the project will be slightly lower.

El_cons electricity consumption from the national grid by frequency controlled pumps in year *y* (MWh).

ΔEff_{FCP} share of electricity consumption reduced due to the installation of frequency controlled pumps. Based on the ex-ante monitored data, the pumps are 26% more energy efficient than the old pumps.

$EF_{CO2\_grid,y}$ Emission factor of the electricity generation by the grid power plants in year *y* ($kgCO_2$/MWh).

Insignificant project emissions: The replacement of the old direct substations by the project with new indirect substations will lead to the marginal increase of electricity consumption since the old direct substations are hydrostatic and do not have an electric pump or electronic controls that the new substations employ. At the same time, the replacement of old indirect substations by new indirect substations will lead to the reduction of electricity consumption due to the installed variable flow pumping. In comparison to the electricity savings due to the installation of variable flow pumping, the possible increase of electricity consumption related to the substation replacements is likely to be insignificant and will not be taken into account in the calculations.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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
B1	Natural Gas consumption	TS	Million m^3	C	Monthly	100%	Electronic	
B2	Heavy Fuel Oil consumption	TS	Tonne	C	Monthly	100%	Electronic	
B3	Emission factor, natural gas	Revised 1996 IPCC Guidelines for National GHG Inventories	gCO_2/MJ		Annual	100%	Electronic	
B4	Emission factor, heavy fuel oil	Revised 1996 IPCC Guidelines for National GHG Inventories	gCO_2/MJ		Annual	100%	Electronic	
B5	Electricity production	TS	MWh	M	Monthly	100%	Electronic	Electricity production are metered and read by TS.
B6	Baseline heat production	TS	MWh	C	Monthly	100%	Electronic	Calculated based on baseline heat sold by dividing heat sold by transmission and distribution losses.

B7	Baseline Heat sold	TS	MWh	M	Monthly	100%	Electronic	Heat meters are installed at the substations in each district are read monthly and adjusted by Adjustment factor due to savings of new substations in residential sector.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

$$BE_y = \sum_{i=1.2.} (Fuel\_cons_{BL,i,y} * EF_i) \qquad (6)$$

Where:

BE_y Total baseline emissions in year y (tCO_2e) .

$Fuel\_cons_{BL,i,y}$ consumption of fuel i in year y for gross heat and power generation by the DH system in the baseline (MJ). The fuel type 1 is a heavy fuel oil and the fuel type 2 is the natural gas.

EF_i emission factor of the fuel i from the Revised 1996 IPCC Guidelines for National GHG Inventories (gCO_2e/MJ).

Baseline natural gas consumption for gross heat and power generation

$$Fuel\_cons\_NG_y = (0.147 * El\_gen\_gross_y) + (0.119 * Heat\_gen\_gross_y) + 919.92 \qquad (7)$$

Where:

$Fuel\_cons\_NG_y$	natural gas consumption in year *y* to generate heat and power in the baseline. It is calculated using a correlation between the heat and power generation and fuel consumption (1000 Nm^3). The correlation has been developed by Nexant in 2004[10] and is based on the historical data.
$El\_gen\_gross_y$	Gross power generation in year *y* (MWh). The amount of electricity generation is not impacted by the project activity.
$Heat\_gen\_gross_y$	Gross heat generation in year *y* (MWh).

Baseline heavy fuel oil consumption for gross heat and power generation

$$Fuel\_cons\_HFO_y = \left(9.86 * 10^{-3} * El\_gen\_gross_y\right) + \left(5.73 * 10^{-3} * Heat\_gen\_gross_y\right) - 914.68 \qquad (8)$$

Where:

$Fuel\_cons\_HFO_y$	heavy fuel oil consumption in year *y* to generate heat and power in the baseline. It is calculated using a correlation between the heat and power generation and fuel consumption (tonnes). The correlation has been developed by Nexant in 2004 and is based on the historical data.
$El\_gen\_gross_y$	Gross power generation in year *y* (MWh). The amount of electricity generation is not impacted by the project activity.
$Heat\_gen\_gross_y$	Gross heat generation in year *y* (MWh).

Gross heat generation in the baseline scenario

$$Heat\_gen\_gross_y = Heat\_sold_{BL,y} / Eff_{transm\_distrib} \qquad (9)$$

Where:

$Heat\_gen\_gross_y$	Gross heat generation in year *y* (MWh).
$Heat\_sold_{BL,y}$	baseline heat sold to the consumers in year *y* (MWh).
$Eff_{transm\_distrib}$	Efficiency of heat transmission and distribution system in the baseline expressed by a share of gross heat production supplied to the consumers. The estimation of the district heating transmission and distribution efficiency is based on data from 1999-2002.[11]

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[10] Nexant, 2004, Baseline Study Bulgaria Sofia Pernik District Heating Project.

District heating transmission & distribution efficiency

$$If \quad Heat\_sold_{BL,y} \leq 800GWh \quad : \quad Eff_{transm\_distrib} = 8.5E^{-10} * (Heat\_sold_{BL,y})^3 - 2.02E^{-06} * (Heat\_sold_{BL,y})^2 + 0.0016 * (Heat\_sold_{BL,y}) + 0.45 \quad (10.1)$$

$$If \quad Heat\_sold_{BL,y} \succ 800GWh \quad : \quad Eff_{transm\_distrib} = 0.872 \quad (10.2)$$

Where:

$Heat\_sold_{BL,y}$	baseline heat sold to the consumers in year *y* (MWh).
$Eff_{transm\_distrib}$	efficiency of heat transmission and distribution system in the baseline expressed by a share of gross heat production supplied to the consumers. The estimation of the district heating transmission and distribution efficiency is based on data from 1999-2002.

The efficiency of district heating transmission and distribution depends on the throughput of the system estimated based on the amount of heat sold as it is represented on the figure 5. The relationship between these two parameters as developed by Pöyry Energy has a satisfactory high correlation factor ($R^2 = 0.935$).

[11] Pöyry Energy Oy, 2007, Explanation Note, Baseline Model and Monitoring Database Revision of Sofia and Pernik District Heating Projects – SOFIA

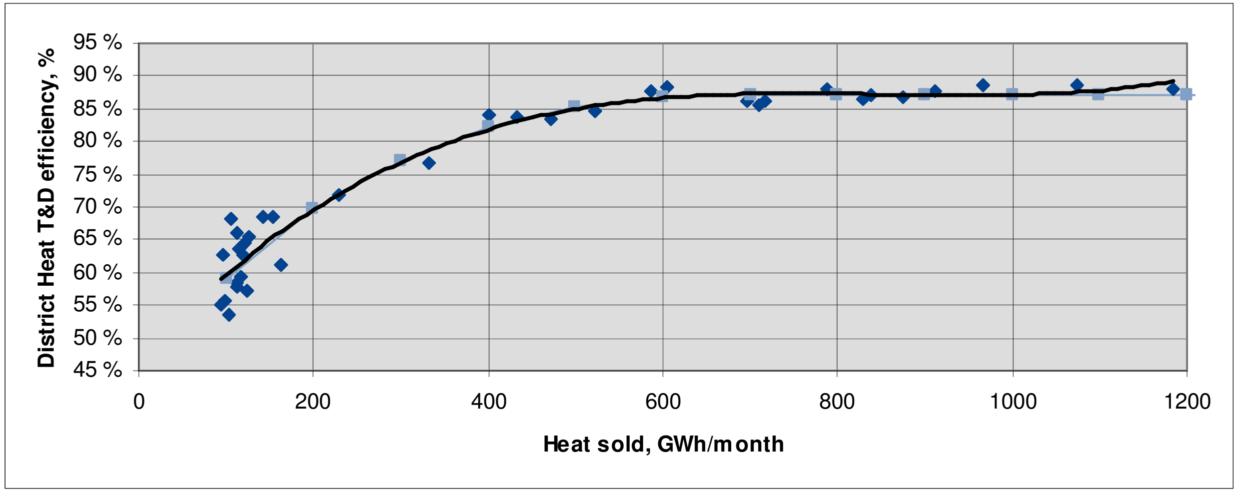

Figure 5 - Historical relationship between Heat Sold and Transmission & Distribution Efficiency.

Baseline heat sold to the consumers

$$Heat\_sold_{BL,y} = Heat\_sold_{measured,y} * \Delta Eff_{substation} \quad (11)$$

Where:

$Heat\_sold_{BL,y}$	baseline heat sold to the consumers in year y (MWh).
$Heat\_sold_{measured,y}$	Heat sold to the consumers in year y, measured during the project implementation (MWh)
$\Delta Eff_{substation}$	adjustment factor that takes into account the monitored reduction of specific heat consumption by residential consumers due to the installation

of indirect substations by the project (%). More detailed information of the calculation of the adjustment factor is included in the Annex 2.

Events or trigger that could impact the correlations used to calculate the baseline emissions

Certain events, or triggers, can be substantial enough to warrant an adjustment of the correlations (7) and (8) used to calculate the baseline consumption of natural gas and heavy fuel oil for gross heat and power generation. Such triggers are assumed to be significant events that take place outside of the scope of the present project. It is assumed that these changes would have taken place irrespective of this project, and thus the baseline must be modified to reflect these changes. The monitoring plan incorporates adjustment factors for changes in plant efficiency and these are used in conjunction with the correlation equations to adjust the baseline and project case. This adjustment ensures that major changes to the TS plant system are accounted and emission reductions are calculated only for the investment project related interventions. This also ensures that no revisions are needed to the monitoring plan. Triggers could include:

1. Significant rehabilitation of the existing heat generation facilities or new heat and/or electricity generation capacity at Sofia.

2. Very significant changes to the loading of the TS DH system (system plant load drops below 40%). These changes, whether due to huge changes is customer base or customer energy use, would change the operating plant characteristics and would require an adjustment to the baseline.

The likely impacts of these triggers and the changes that may be required to the baseline and monitoring plan are shown in table below.

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Table 6. Likely Impact of Triggers

Triggers	Likely Impact on the correlations (7) & (8)	Impact on Monitoring Plan
Significant rehabilitation of the existing heat generation facilities or addition of new CHP plants to the DHC Sofia system.	This can significantly alter the correlation between fuel use and electricity and heat generation. The baseline correlations developed may no longer be applicable and new correlations will have to be developed to redefine the baseline.	The monitoring plan will not need to be changed since the measuring points will remain the same. The baseline correlation equations incorporate a factor that accounts for plant efficiency and this corrects for any change that may be necessary. Thus no changes will need to be made to the monitoring plan or the baseline correlations other than the efficiency of the rehabilitated or new facilities, which needs to be input once in the MP model.
Very significant changes to the loading of the TS DH plant system (system plant load drops below 40%)	Very significant changes in plant operating conditions, whether due to huge changes is the customer base or customer energy use, may change the operating plant characteristics to the point that the correlation equations developed using historical data may not apply, requiring new correlations to be developed.	The monitoring plan will not need to be changed since the measuring points will remain the same. The baseline correlation equations incorporate a factor that accounts for plant efficiency and this corrects for any change that may be necessary. Thus no changes will need to be made to the monitoring plan or the baseline correlations.

In addition, rehabilitation projects at apartment level impacting specific heat consumption could trigger the need to revise the relevant part the baseline. This can monitored via change of specific heat consumption during verification stage, i.e. should specific heat consumption considerably decrease after the full implementation of the project.

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	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

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D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

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D.1.3. Treatment of leakage in the monitoring plan:

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	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

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

DH customers who switch from electric heating to DH will reduce their draw on grid power and thereby reduce emissions from the marginal plant on the Bulgarian national grid. The customer surveys done in the baseline study have not clearly determined that customer decisions to reconnect to DH are influenced by the installation of new substations. To the extent that such reconnections to DH are attributable to the project, there will be a positive leakage impact. However, given that many customers are already reconnected to DH due in large part due to the new tariff regulations, the leakage impacts from the additional customers reconnecting to the DH system are likely to be relatively insignificant, and are not attributed to the project.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

$$ER_y = BE_y - PE_y \qquad (12)$$

ER_y emissions reductions from the project in year y (tCO_2e)

BE_y baseline emissions in year y (tCO_2e)

PE_y project emissions in year y (tCO_2e)

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

An Environmental Assessment (EA) was completed in 1997 which was part of the feasibility study for the rehabilitation of the Sofia DH system. Remedial measures to address environmental concerns raised in the EA were incorporated in the Environmental Management Plan, which was completed in late 2001.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
P1Natural gas consumption	Low	Commercial reading and invoicing of the consumed monthly quantity natural gas is performed according to the devices installed and owned by Bulgargas EAD (seller). Flow meters are also installed by Toplofikacia Sofia AD in order to have control. Consumed quantity natural gas is read monthly from the commercial flow meters and statements are prepared and signed by representatives of Toplofikacia Sofia and Bulgargas. On the basis of monthly statements a general monthly statement is made for the consumed quantity natural gas and signed by both sides. The general monthly statement is stored in Department of Exploitation and Repair Activities.
P2 Heavy fuel oil consumption	Medium	All data is read from instruments for input, output, temperature and levels in the tanks and entered in respective journals kept with the engineers on duty, foremen of the shifts of the heat sources boiler shops and production and technical departments (PTDs). Reports from the PTDs for fuel input and output for 24 hours are received in the territorial dispatching system (TDS) of Toplofikacia Sofia. The chiefs of the boiler shops and PTDs make an inventory of fired fuel oil and take stock of the available fuel quantities monthly. Monthly reports are signed by the directors of the corresponding district heating region and they represent a document for the available fuel oil quantities and the monthly fuel consumption for the previous month for each plant. The same are sent for summarization and storage in Operation and Maintenance Division in the headquarters of Toplofikacia Sofia AD.
P5 Electricity consumed in frequency controlled pumps	Low	The measurement of consumed electricity from frequency converter motors is carried out by means of measurement system. It includes measurement transformers, electric meter, secondary circuit measurement, terminals and fuses. A comparison will be made for the quantity of measured electricity through the energy balance based on all flows.
B5 Electricity production	Low	Electricity meters at the CHP and HOB plants are read by TS monthly by Committee represented by Toplofikacia Sofia EAD and National Electricity Company which prepares the Protocol. At the end of the month a summarized monthly statement is prepared and approved by the Executive Directors of both companies.

B7 Baseline Heat sold	Low	Heat meters are installed in substations under the art.5 from the Measurement Law. Measurement devices are verified by authorized laboratories with eligibility certificates according to the “Regulation for measurement devices, subjected to metrological control”. The data from the heat meters are contained in the heat meters memory for a period of 36 months. At the beginning of each month technician, in the presence of the representative of the apartment house, as per the requirements of the Energy Law, records the heat meter data by a hand-held terminal. A server with software for heat meter data processing is installed in each DH region. The final data are prepared in the table form and handed over to the computational center of Toplofikacia Sofia for invoicing of heat sold. After review of the invoiced heat energy of the consumers, the printing lists with invoices in due diligence are signed by the directors of respective DH regions. The primary data are stored in the technical departments of each DH region, and the final data in Commercial Department of Toplofikacia Sofia AD. Heat sold is further adjusted by savings due to new substations in residential sector.

Bulgarian regulations require that all measurement equipment should be calibrated at regular intervals according to specified standards. The calibrations are undertaken either by government organisations or in some cases by private companies. Heat meters are calibrated based on national requirement every two years.

QUALITY ASSURANCE SYSTEM

“Toplofikacia Sofia”AD has not taken steps for certification under ISO 9001 – quality assurance system due to lack of financial resources. However the company controls the quality of heat produced and the supplied services. The indicators used have been approved and are monitored by the State committee for energy and water regulation (SCEWR) and comprise an integral part of the licenses for heat production and transmission obtained by the company.

Heat supply quality indicators

Quality of heat energy – no uniform state and European standards exist. Quality is regulated by means of various major technical indicators. The values of those indicators are specific and are subject to monitoring by means of modern technical devices for automated control and communication. Any deviations from the regulated values represent violations of the quality indicators. The aggregate consumer time for supply of heat with deteriorated quality determines the general indicator for quality of heat energy.

Continuous heat supply – the indicators for continuity are determined for a certain period of time – heating season and calendar year according to the registered data of “Toplofikacia Sofia”AD. To this end, an official register of heat cuts is kept, comprising accurate records of the date and time by hours and minutes of the cut substations, with their identification numbers and by capacity, number of affected consumers, as well as the causes for the cuts.

Quality of commercial services – The commercial relations between "Toplofikacia Sofia"AD and its consumers are divided in two types: such related to connection conditions, and other related to heat supply. The quality indicators related to both types of relations refer to availability and observance of certain rules, observance of regulated timeframes for response and taking of action on submitted requests, applications, claims, terms for correction of omitted mistakes etc.

Norms for the quality of heat energy

"Toplofikacia Sofia"AD is obliged to supply heat with guaranteed parameters, according to process features of the equipment and the applied modes of operation in the district heating network. The value of guaranteed parameters (temperatures, pressures, flows) shall be set forth in the general conditions for sale of heat or in the written contracts with consumers.

Quality of commercial services

The indicators for the quality of commercial services are regulated in written rules for performance of work and deadlines for implementation of certain activities related to data submission, taking measures for removal of mistakes and omissions etc. The company has prepared and publicly announced regulations for connection of producers and consumers of Heat energy to the district heating network and enters in a register the filed application and refusals for connecting. The rules on operational performance include a regulation on the steps to be taken in case of disconnection and re-connection of heat supply for overdue bills, as well as measures for provision of special services to socially vulnerable consumers.

Internal audits

Working group has been appointed by an order of the executive director for internal control of activities related to implementation of the monitoring plan. The working group checks-up submitted and summarized data from the monthly reports, compares them with the primary data and prepares the annual report. The following comparisons are being made:

- Vertical check-up - comparison of monthly data with data from previous years (it is valid for all data);
- Horizontal check-up – comparison of primary data from measuring devices, installed at heat source inlet/outlet, and data from individual measuring devices at equipment inlet/outlet;
- Comparison of technological data with accounting data;

Deviations are analyzed, as well as possibilities for improvement of the results.

Environmental Management System

"Toplofikacia Sofia"AD has taken steps to introduce an environmental management system (EMS) in compliance with international standard ISO 14001:2004, which is the main among the range of acknowledged but not mandatory environmental standards and guidelines. Formally the company has not been certified under ISO 14001 (due to lack of financial resources), but the staff has been trained how to draft the required documents in compliance with the requirements, and is ready to submit them to the relevant certifying authority. Most of the requirements of ISO 14001 coincide with the procedures on the integrated permits (IP) for the 4 major heat sources of the company that have been issued by the Ministry of Environment and Water, and that are mandatory.

The major driver for the EMS is the environmental policy of the company. It is determined and regularly revised by the top management of the company ensuring that the policy:

- Is compatible with the nature, scope and environmental impact of the activities, products and services of the company included in the EMS;
- Includes the obligation to comply with the applicable legal and other requirements applicable for the company, and related to the environment;
- Includes an obligation for continuous upgrading for pollution prevention;
- Provides a framework for presenting and considering the environmental goals and objectives;
- Is documented, implemented and sustained;
- Has been communicated to all persons working at the company or on behalf of it.

The company carried out a preliminary Environmental Review to identify and assess the actions, processes, products and services provided by the heat sources of the company, as described in EMS, and their impact on the environment. Certain categories of main activities and processes have been identified in the Environmental Review Report. Flow diagrams have been prepared, the environmental have been identified taking into account their input and output elements (both foreseen and unforeseen).

The top management of the company has determined the positions and responsibilities in the organization that would allow the full implementation of the environmental policy and the EMS. A responsible person has been assigned by internal order ("Company environmental director" – CED), who regardless of other duties has determined the positions, responsibilities and authorities for:

- Setting up, implementation and maintenance of EMS at each site of the company falling within the scope of EMS, in compliance with ISO 14001 requirements;
- Reporting to top management on the performance of EMS in view of reviewing and proposing improvements.

A panel of environmental specialists, engineers, experts from the central administration and the heat regions of the company assist the CED. By another internal order, at each of the four main heat sources in the four heat regions Sofia", "Sofia Iztok", "Zemlyane" and "Liulin" one Plant director on environment (PDE) has been designated. The top management of Toplofikacia Sofia AD secures efficient distribution of responsibilities among various levels and positions in order to maintain the efficiency of the EMS.

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

Management and Operations Responsibility

All the data to be monitored, collected and recorded is already being monitored and recorded by plant operating personnel on a routine basis. Indeed, much of the data needed for this project is being gathered on a daily basis. However, for the project monitoring plan, the data from all the individual DH plants that comprise the Sofia DH System will have to be summed up and recorded on a monthly basis in the Tracking Database. Calculation will be done early following year as some annual parameters are needed for ER calculation. Individual plants report the data electronically to the head office and summarize it to the system level on a monthly basis. The recording of data is done at the TS head office where the staff prepares daily, weekly, and monthly management reports. Individual plants report the data electronically to head office and summarize it to the system level on a monthly basis.

Tracking Database Data Entry

The TS will be responsible for ensuring that all required information is collected each month as well as annually and input into the Tracking Database. The Tracking Database will use the monthly data to calculate the project model GHG impacts. After the baseline and project models have been calculated by the Tracking Database, the resulting GHG emissions reductions will be calculated as the difference of the two values. The result is the monthly carbon dioxide emission reduction due to project impacts. The monthly results will be aggregated annually. The Tracking Database will output the project results, including monthly reductions of carbon dioxide equivalents, which will be periodically sent for verification throughout the lifetime of the project.

The following parameters must be monitored also on annual basis, and the results are input into the Tracking Database (i) annual Heat Sold, (ii) Heat Consumption of Residential Sector, (iii) reduction of heat consumption (%) in residential sector, and (iv) Adjustment Factor in order calculate Baseline Heat Sold.

Table 7. Monitoring responsibilities in District Heating Region (DHR).

Official position	**Role**	**Summarized and other information**
Director DHR	Responsible for Annual report data submission in the headquarters.	Director DHR.
Deputy Director of Heat Source	Responsible for monitoring activities implementation and reporting on operational data	Here is included the control implementation for envisaged procedures for documentation, measurement and reading as well.
Deputy Director of District Heating Network	Responsible for monitoring activity implementation and reporting on substations data.	Here is included as well the control implementation for envisaged procedures for documentation, measurement and reading as well.
Chief of department “Production technological”	Responsible for the current implementation of batch reading procedures for monitoring purposes. Responsible for furnish documentary evidence of repair, emergency and installation works, related to emission sources. Responsible to take tests and analyses in the frame of the site, for current reading of measurement devices	Here is included as well information organization for monitoring purposes for repair and maintenance activities, related to the emissions. Provide information to the territorial dispatch service in the headquarters every 24 hours.
Head of boiler workshop	Responsible for the primary documentation and documents submission to the monitoring system archive.	Including organization of control measurements.
Chief of department “Accounting”	Bear a whole responsibility for the accounting trial balance, related with monitoring indicators.	Including for insurance of stock-taking accuracy of warehouse inventory.
Head of workshop “Control, instrumentation and automation”	Responsible for the condition of measuring devices in the heat source and furnish documentary evidence for their status.	

Table 8. Monitoring responsibilities in the headquarters of "Toplofikacia Sofia" AD.

Official position	**Role**	**Summarized and other information**
Executive Director	Responsible for Annual Report presentation to PCF	
Deputy Executive Director "Maintenance and repair activity"	Responsible for the whole implementation of monitoring activities and reporting	Here is included the control implementation for envisaged pro-cedures for documentation, measurement and reading as well
Chief of department "Maintenance and repair activity"	Responsible for gathering, storage and summary of monthly information related to the consumed fuel quantities and produced heat energy in the company.	Summarize the data for monthly quantities fuel and prepare summarized monthly certificate for them. Summarize the data for heat energy monthly production.
Chief of department "Electricity economy and water consumption"	Responsible for gathering, storage and summary of data for monthly production and purchase of electricity for the company.	Summarize the data for electricity production and purchase of electricity energy.
Chief "Territorial dispatch service"	Responsible for receiving and recording of daily information related to the operational process.	
Director Commercial directorate	Responsible for data processing for heat energy billing and print out of the invoices. Responsible for data storage.	Control data reliability.
Chief of department "Planning"	Responsible for summarized monthly statements with the operational indicators of the company.	
Chief Accountant	Bear the whole responsibility for the accounting trial balance, related to monitoring indicators	Including for insurance of stock-taking accuracy of warehouse inventory
Chief of department "Metrological control"	Responsible for testing and control the status of the measuring devices	

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

The monitoring plan was established by Anand Subiah in Nexant and updated by Sari Siitonen, Poyry Energy in 2007.
Nexant and Poyry Energy are not project participants.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

The estimated project emissions are:

Table 9a: Project emissions in 2004-2007.

Year	Project Emissions, CO_2e tonnes
2004	1,494,653
2005	1,501,731
2006	1,496,805
2007	1,482,678
Total	5,975,867

Table 9b: Project emissions in 2008-2012.

Year	Project Emissions, CO_2e tonnes
2008	1,471,063
2009	1,476,299
2010	1,478,791
2011	1,480,472
2012	1,482,886
Total	7,389,512

E.2. Estimated leakage:

There is no leakage identified for the project.

E.3. The sum of E.1. and E.2.:

See E.1.

E.4. Estimated baseline emissions:

The estimated baseline emissions are:

Table 10a: Baseline emissions in 2004-2007.

Year	Baseline Emissions, CO_2e tonnes
2004	1,641,238
2005	1,740,708
2006	1,747,465
2007	1,682,588
Total	6,811,999

Table 10b: Baseline emissions in 2008-2012.

Year	Baseline Emissions, CO_2e tonnes
2008	1,738,573
2009	1,743,574
2010	1,745,996
2011	1,748,428
2012	1,750,867
Total	8,727,438

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

The total emission reduction from the project is 836,132 tonnes CO_2e for the years 2004-2007 and 1,337,926 tonnes CO_2e for the years 2008 – 2012. Annual data is provided in section E.6.

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

Table 11a: Summary

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2004	1,494,653	0	1,641,238	146,585
2005	1,501,731	0	1,740,708	238,977
2006	1,496,805	0	1,747,465	250,660
2007	1,482,678	0	1,682,588	199,910
Total tonnes of CO_2 equivalent)	5,975,867	0	6,811,999	836,132

Table 11b: Summary

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2008	1,471,063	0	1,738,573	267,510
2009	1,476,299	0	1,743,574	267,274
2010	1,478,791	0	1,745,996	267,205
2011	1,480,472	0	1,748,428	267,956
2012	1,482,886	0	1,750,867	267,981
Total tonnes of CO_2 equivalent)	7,389,512	0	8,727,438	1,337,926

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

An Environmental Assessment (EA) was completed by the World Bank in June 1997 as part of the feasibility study for the rehabilitation of the Sofia DH project. The project was classified as Category B according the IBRD's Operational Policy on Environmental Assessment which indicates that the impacts were site specific and do not affect the environment in a significant manner. The environmental issues were related to construction activities and include dust, noise, minor traffic disruptions, and handling of hazardous waste.

The project's environmental benefits include fuel savings due to network efficiency gains; a reduction in the DHCs' water consumption as a result of the rehabilitation program.

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

Not applicable.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

The environmental issues related to the project were made public through the Environmental Management Plan (EMP). The EMP was published in local newspapers and also was placed in he WB's website. Public meetings were also held to discuss the EMPs. In these meetings, no concerns about the environment were raised.

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Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

Baseline emissions (parameter 8 in table 9) are calculated based on actual heat sold (5) measured at substation level. Measured heat sold in residential sector is adjusted by historical losses in network (see equation 9) and also adjusted by reduction of losses due to substation replacement (-15.65 % in 2006, see table 10) in residential sector. Baseline fuel consumption (7) is further calculated based on historical correlation between energy produced in baseline case and natural gas and heavy fuel oil consumption (see equation 7). Baseline CO2 emissions are calculated utilizing IPCC conversion factor of 56.1 and 77.37 kg CO2/GJ for natural gas and oil, respectively. Project emissions are calculated based on fuel consumption (1 and 2). Caloric value of fuels is provided by the project entity. Emissions related to BAU pipeline replacement are added to project emissions based on chosen approach (pls. see equation 3).

Additional detailed information is provided in this section for Adjustment factor calculation needed for Baseline heat sold (B5) calculation, i.e. how substation replacement reduction of specific heat consumption due to the project is monitored. Source for the methodology is Pöyry Energy Report 60K05788.01.Q010 to EBRD, September 25, 2006: Preliminary methodology for Monitoring and Verification of Energy Efficiency Measures, Annex 5. Methodology has been developed for specific substation monitoring and adjustment factor for ER monitoring is calculated based on reduction of normalized specific heat consumption.

Table 9. Tracking database results for 2004- 2006.

Year	Project						Baseline		Emission reductions tCO2e
	Nat. Gas Mil. m3	Hvy. Fuel Oil (Tons)	Total GJ	Elec. Prod MWh	Heat Sold MWh	Emissions tCO2e	Baseline Fuel, GJ	Emissions tCO2e	
No.	1	2	3	4	5	6	7	8	9
2004	772	19,049	26,467,565	875,655	4,517,358	1,494,653	29,031,086	1,641,238	146,585
2005	776	20,325	26,649,002	790,150	4,763,387	1,501,731	30,766,917	1,740,708	238,977
2006	777	19,673	26,665,743	798,636	4,649,566	1,496,805	30,886,864	1,747,465	250,660

Heating Values of Fuels are provided by the Toplofikacia Sofia:

Natural Gas	33.3	MJ/m3
Heavy Fuel Oil	39.8	MJ/kg

Table 13. Calculation of the adjustment factor for modification of the specific heat consumption.

Degree days of the normal year	2767						
Year		**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Adjustment factor: Increase (+) / Decrease (-) compared to the level of the year 2001	%		-0.66%	-9.70%	-7.75%	-12.62%	-15.65%
Make-up water consumption, t/a	t/a	3340087	3085219	2930008	1936805	1779502	1862597
to level of 2001	%		*-7.63%*	*-12.28%*	*-42.01%*	*-46.72%*	*-44.24%*
annual change	%		*-7.63%*	*-5.03%*	*-33.90%*	*-8.12%*	*4.67%*
Heat output to DH network (DH water), MWh	MWh/a	6022145	5446848	5927565	5349652	5554315	5500165
DH consumption (DH water), MWh	MWh/a	5039220	4572834	4979502	4481932	4728994	4620043
Heat losses in DH network (DH water), MWh	MWh/a	982925	874014	948063	867720	825321	880122
Heat losses in DH network (DH water)	%	16.32%	16.05%	15.99%	16.22%	14.86%	16.00%
Average temp. of heat carrier (DH water)	degC	59	57	59	60	62	62
Degree days		2787	2509	3053	2566	2855	2840
Average outdoor temperature degC	degC	10.4	10.7	10.2	10.6	n.a	n.a
Heat (DH) consumption of residential consumers, MWh	MWh/a	4049331	3699928	3966863	3542191	3705291	3609089
Entire space heated volume for residential consumers	1000m3	61486	61665	61964	62402	63134	63976
Specific heat consumption inc. DHW (residential)	kWh/m3,a	65.86	60.00	64.02	56.76	58.69	56.41
DH consumption for space heating	MWh/a	3308303	3022841	3240927	2893970	3027223	2948626
Estimated DH consumption for DHW preparation, MWh	MWh/a	741028	677087	725936	648221	678068	660463
Estimated DH consumption for DHW preparation, %	%	18.30%	18.30%	18.30%	18.30%	18.30%	18.30%
Adjusted heat consumption in respect of a normal year inc. DHW	MWh	4025709	4010887	3663364	3768994	3612089	3533401
Adjusted specific heat consumption in respect of a normal year inc. DHW	kWh/m3,a	65.47	65.04	59.12	60.40	57.21	55.23

Substations are replaced only in residential sector. As not all heat is sold to residential sector, the total heat sold is taken proportionally into account when calculating annually Adjustment factor. Calculation is included Tracking Database.

Annex 3

MONITORING PLAN

Please see Section D of the PDD.