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

Prototype Carbon Fund

ANDIJAN DISTRICT HEATING PROJECT

Draft PDD (only Sections A-E and relevant Annexes)

for demonstrating
New baseline and monitoring methodology for district heating rehabilitation reducing use of in house devices

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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Andijan District Heating Project

A.2. Description of the project activity:

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The existing heating network of the City of Andijan (Uzbekistan) is in extremely poor condition, inefficient and provides unreliable heating services to its customers. The project includes the reconstruction of the boilerhouses, the distribution network and the distribution in the building, including heat and hot water metering equipment. The Project will finance the reconstruction of an initial eight cellular nano-regions over 3 years, representing approximately 35% of the area now served by the existing Andijan district heating company (ADHC). Every nano-region will provide heat for about 25 buildings, or 70'000 m^2, including sanitary hot water. Over 21 years, the newly established district heating company NEWCO will implement the remaining fourteen cellular regions required to complete the reconstruction of the heating network in Andijan. NEWCO will finance its partial investment program with a combination of Uzbek equity (provided by the Government of the Republic of Uzbekistan (RoU)), grant funds, the proceeds from the sale of Certified Emissions Reductions (CERs) and a loan by the European Bank for Reconstruction and Development (EBRD).

This project demonstrates evident contribution to sustainable development. As a result of this project, great improvement will be made to the quality of service delivered to the consumer. Heat will be available throughout the heating season and hot water available throughout the year on a reliable basis.
In addition to improvements in the way services are delivered, consumers will be given the ability to control their use of energy. Individually metered heat and hot water combined with installation of devices that will enable regulation of consumption usage will provide consumers with the proper incentives to seek demand side efficiency. However emission reductions from demand side energy efficiency measures will not be claimed contributing to the conservativeness of the approach.

Introduction of new technologies and installation of modern equipment including heat and hot water metering allows: (i) to increase energy efficiency and safe fuel and heating for the population of Andijan; (ii) to reduce the expenditures for heat and hot water production; (iii) to change existing subsidized tariff policy; (iv) to reduce pollutant emissions into the atmosphere; (v) to reduce CO_2 emissions. Besides, the project implementation will considerably improve living standards of the population in Andijan and will strongly contribute to the local technical capacity building and facilitate the replication of the project.

Combined, these measures will significantly reduce energy consumption and improve the local environment.

This project delivers significant transition impact through the introduction of the private sector management of a public utility and is the first in the EBRD designed to utilize the Clean Development Mechanism of the Kyoto Protocol as a co-financing source.

At the moment, a feasibility study has been finalized and the private sector management is currently being established.

A.3. Project participants:

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- The Republic of Uzbekistan is the Project Sponsor.
- The Andijan Regional Khokimiyat is the Project Implementing Agency.
- The newly established district heating company NEWCO [Hamkor Issyklyk Taminot Servise (HITS)], based in Andijan, is the project operator.
- The European Bank for Reconstruction and Development (EBRD) will provide debt financing.
- The Prototype Carbon Fund (PCF) will purchase the greenhouse gas emission reductions on behalf of its Participants (private sector corporations and Annex I governments – see PCF annual report and PCF website at http://www.prototypecarbonfund.org.
- The contact point for this CDM project is the World Bank (International Bank for Reconstruction and Development, IBRD) in its role as Trustee of the PCF.

Detailed contact information is contained in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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A.4.1.1. Host Party(ies):

>>
Uzbekistan

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

>>
Andijan Province

A.4.1.3. City/Town/Community etc:

>>
Andijan City

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

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The project is located in Andijan, Uzbekistan. Andijan is the administrative center of the province of Andijan, which is situated in the eastern part of the Fergana Valley, on the Andijan-Say River (see map below). The Fergana valley is divided among Uzbekistan, Tajikistan, and Kyrgystan. The province of Andijan covers an area of 4 200 square kilometres. The climate is typically continental with extreme differences between winter and summer temperatures. The population of the Andijan province is 1’899’000, the city of Andijan has approximately 330’000 inhabitants (year 2000). This province has the highest population density in Uzbekistan (more than 400 inhabitants per square kilometers).

Figure 1: Location of the city of Andijan in Uzbekistan[1]

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

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1. Energy industries (renewable - / non-renewable sources)
2. Energy distribution

A new category might be introduced: “Energy efficiency, district heating system reconstruction”

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

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The project includes the reconstruction of the district heating system’s boilerhouses, the distribution network and the distribution in the buildings, including the installation of heat and hot water metering equipment. The technology to be implemented is state of the art and proven. Its implementation brings a significant reduction in local pollutants emission and contributes to the betterment of the local environment. The Andijan project is the first major district heating system reconstruction project in Uzbekistan since the independence from the Soviet Union in 1991. Its successful implementation will strongly contribute to the local technical capacity building and facilitate the replication of the project.

[1] Adapted from http://www.advantour.com/uzbekistan/information/map.htm

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:

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At present, the Andijan District Heating Company (ADHC) provides unreliable heating services to the residents with a very inefficient district heating system fueled by mazut (heavy fuel oil with high sulfur content) and natural gas. The residents use additional individual heaters and hot water boilers fueled by both natural gas and electricity to increase winter room temperatures and to produce hot tap water.

The project foresees the step-wise implementation of a new efficient District Heating System (DHS), replacing the existing DHS and the individual heaters in units of about 70'000 m^2 of heated area, called "nano-regions", to provide room heating and hot tap water. The project reduces the consumption of oil and natural gas in the DHS and the consumption of natural gas and electricity for individual heaters in the apartments and leads to a net reduction of the related CO_2-emissions.

The barrier analysis of the alternative future scenarios shows that in the absence of the proposed project activity, the non-availability of domestic equipment for district heating systems and the high investment risk would prevent the district heating system reconstruction project from implementation.

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

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254’000 tons of CO_2 in years 1 to 7 of the project (cumulative, until 2012, 8 nano-regions) and
1.2 million tons of CO_2 in years 1 to 21 of the project (cumulative, until 2026, 21 nano-regions).
See Section E.

A.4.5. Public funding of the project activity:

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The newly established district heating company NEWCO will finance its investment program with a combination of Uzbek equity (provided by the Government of RoU), grant funds (provided by the Government of Switzerland), an international loan (provided by the EBRD), and, at a later stage, the proceeds from the sale of Certified Emissions Reductions (CERs) and the revenues from the sale of heat services to its customers (cf. Annex 2 on public funding).

SECTION B. Application of a baseline methodology

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

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Baseline methodology for district heating rehabilitation, possibly reducing use of in house devices

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

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Given the limited data availability in the heating sector of Uzbekistan, the non-existence of agreed standardized baselines, the importance of economic and non-economic barriers in investment decisions in

the district heating sector in Andijan, a barrier analysis of all plausible baseline scenarios is deemed as the most suitable baseline method for the present project.

The following aspects make the methodology particularly applicable:

- The project replaces an existing deteriorated district heating system (DHS), and its customers use individual heaters to complement the DHS heating services and heat demand.
- There is sufficient information available about local conditions that impact the operation, use and development of the DHS and about technical and investment alternatives to the existing DHS. Because of the limited availability of official data, extensive use of on site determination of key parameters by international experts was made.
- The decision on the future of the DHS system is made on the basis of financial considerations taking into account barriers to investment and operation of the current and any future system configuration
- The project does not result in any significant leakage of CO_2 emissions or an increase of non-CO_2 emissions. Project proponents claim only reductions of CO_2 emissions.

The existing ADHC-System has a boilerhouse capacity that is larger than the capacity of the new system. E.g., the largest of the old DHS-Micro-Regions, called "RK-2", has an installed (name plate) capacity of 3*58MW = 174 MW. It serves a heated area of 488'000 m^2. This results in *356 kW* installed capacity per 1000 m^2 heated area. (Data source: Site visit, interview with ADHC chief engineer)
With the project activity: One nano-region is served by a total boilerhouse-capacity of 18.2 MW. Each nano-region covers a heated area of 70'000 m^2. This results in *260 kW* installed capacity per 1000 m^2 heated area, which is only 73% of the boilerhouse capacity of the existing system. (Data source: Econoler Feasibility Study, Draft Final Report, p. 49.) In addition, the capacity of the in house devices that are replaced with the project activity further adds to the total capacity of the baseline scenario.
With this, the total (name plate) capacity of heat sources does not increase but decreases with the project implementation and the second applicability criteria (no capacity increase) is fulfilled.

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

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Overview

The baseline methodology includes the following steps:

Table 1: Outline of new baseline methodology and its reference to consolidated methodologies.

Step	Section in NMB
1. Identification of practical alternatives to the projects technology	Section B.2.
2. Determination of the baseline technology	Section B.2.
3. Definition of emission factors for saved fuels	Section B.2.
4. Definition of emission factors for saved electricity (ACM0002, average)	Section B.2.
5. Determination of emission factors for heating technologies	Section B.2.
6. Emission reductions calculation and projection	Section B.2.
7. Additionality test (Additionality tools)	Section B.3.

The methodology does not support emission reductions from demand side measures, and such emission reductions are not claimed by the project, although they are likely to be promoted by it, making the emission reduction calculation conservative.

1 Identification of practical alternatives to the projects technology

The following Table provides a list of plausible alternatives to the project activity that are available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity, i.e. heating services to consumers connected to the district heating system (DHS).

	Alternatives	Fuel used
1.	Current DHS only: status quo maintained with minimal fixes and repair.	Heavy fuel oils, natural gas, electricity
2.	Current DHS only: reconstruction of the existing distribution system, layout and boilerhouses remain unaltered	Heavy fuel oil and national gas
3.	Current DHS only: reconstruction of the existing boilerhouses, layout and distribution system remain unaltered	Heavy fuel oil
4.	New DHS according to the EBRD Project: new layout in nano-regions with new boilerhouses and distribution system	Light fuel oil
5.	New DHS according to the EBRD Project (same as 4). In addition to the DHS, solar thermal heaters are installed on rooftops in order to generate sanitary hot water.	Light fuel oil 91% Solar energy 9%
6.	New DHS according to the EBRD Project (same as 4). *This alternative is the proposed project activity not under taken as a CDM project activity.*	Light fuel oil 50% Natural gas 50%
7.	New DHS according to the EBRD Project (same as 4).	Heavy fuel oil
8.	New DHS according to the EBRD Project (same as 4).	Coal
9.	New DHS according to the EBRD Project (same as 4).	Natural gas
10	Construction of individual, independent heating systems for each apartment block. No DHS is necessary apart from service and control tasks to be provided for the individual apartment block boilers/ systems	Light fuel oil
11	Installation of individual electric heaters and electric boilers in all apartments. No hot water network is necessary	Electricity
12	Installation of individual natural gas fuelled heaters and boilers in all apartments. No hot water network is necessary	Natural gas
13	Current DHS (same as 1) combined with existing individual electric heaters (as in 11.) and existing individual natural gas fuelled heaters (as in 12.). No investment. *This alternative is the continuation of the current situation.*	Heavy fuel oils, natural gas, electricity

Table 2: List of plausible alternatives to the CDM project technology

2 Determination of the baseline scenario

Prices for heat services and fossil fuels are currently highly subsidized and far from world market prices. Tariff and price reforms have been planned for several years, but the outcome and the timing of price changes is highly uncertain. Temporary shortages and blackouts in the supply of natural gas and power are quite common in Andijan. Furthermore the investment climate is difficult, and so is access to finance for private investors. Commercial loans are hardly available, and interest rates for commercial loans are very high. Under such circumstances a barrier analysis (option 2 of the baseline methodology) is more appropriate to determine the baseline scenario than an investment analysis.

In the following, a list of relevant barriers is given:

1. **Investment barrier: no local commercial funding**
Debt funding is not available for mayor DHS rehabilitation activities.
The following factors have to be taken into account for an evaluation of the possibility of the existing DH company ADHC to finance major investments to rehabilitate or reconstruct the existing district heating system:

- There is no domestic production of suitable equipment in Uzbekistan for the reconstruction, such as large boilers, pre-insulated pipes, etc. All key equipment has to be imported for which hard currency is necessary.
- Net foreign direct investments for Uzbekistan are very low. They fell from (low level) USD 167 million in 1997 to USD 73 million in 2000 (or about 1.1% of GDP). This is a clear indication of the high risks that potential investors face in Uzbekistan, which make them reluctant to investments. (Source: EBRD Uzbekistan Economic Brief 2002])
- Another measure of investment risks are the credit rating and other investment indicators by rating organizations. Uzbekistan is not included in the list of the countries rated by Moody's, Fitch and the world competitiveness yearbook of IMD[2)], in contrast e.g. to the Baltic countries. This indicates that Uzbekistan is not a viable investment country for international investors and that the perceived investment risks are very high.
- The Director of the World Bank Regional Office in Uzbekistan said that the World Bank will not invest into any projects in the district heating sector in Uzbekistan in the next 3 to 4 years, because the risks would be far to high.
- The Government of Uzbekistan is short of hard currency which is a mandatory prerequisite for imports (underlined by the fact that the local currency SUM is not freely convertible)
- The present operator of the district heating system in Andijan, ADHC, spends more money than it earns. The feasibility study[3] concludes: "The district heating plant suffers a structural profitability gap; the situation dramatically worsened during the last years." This has been confirmed from the ADHC financial director during the international expert's site visit 2002. According to the chief engineer of ADHC[4], the duration of the heating season in the large boilerhouse RK-1 has been shortened in recent years from five to three months in order to save fuel costs, because of the precarious financial situation of ADHC. Figure 2 shows the increase in the gap between total expenses and total income. The profitability gap results from an increase in cost and the parallel decrease in payment from consumers (because they receive insufficient heating services) and the reduction of subsidies from the central government.
- Even if (hypothetically) a loan from a local commercial bank would be available, the bank would ask for 120% collateral (e.g. in new equipment and existing assets), which ADHC in its current financial situation does not have.

From this, the existing DH company ADHC is not in a position to finance major investments for system reconstruction on a commercial basis.

Development: Although structural reforms in several sectors of Uzbekistan are underway and the potential for economic growth is promising (Source: EBRD, Uzbekistan Country Profile May 2002), there has been little reform success so far. The Uzbek economy is still state controlled, and it is safe to say that

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2) see: www.moodys.com; www.fitchratings.com; www.imd.ch

[3] Econoler Development – Socageth, *Andijan District Heating Improvement Project. Feasibility Study & Project Preparation.* Draft Final Report. Brussels, June 2001.

[4] Interview with ADHC chief engineer of April 11, 2002.

Uzbekistan's investment climate will, for the 7 years to come, not allow for commercial financing of larger investment projects, in particular in the municipal services sector (with typically longer pay-back periods). After seven years, the key factors determining the baseline will be checked and adapted, if needed.
Impact: This barrier prevents the implementation of all alternatives that include a significant investment in new district heating systems or heating systems for apartment blocks, i.e. alternatives 2 to 10. The investment in new individual electric or natural gas fuelled heaters is prevented only to a certain degree by the barrier, as wealthier consumers are in a position to purchase such new individual in house devices. (See overview of barriers in Table 3 below).

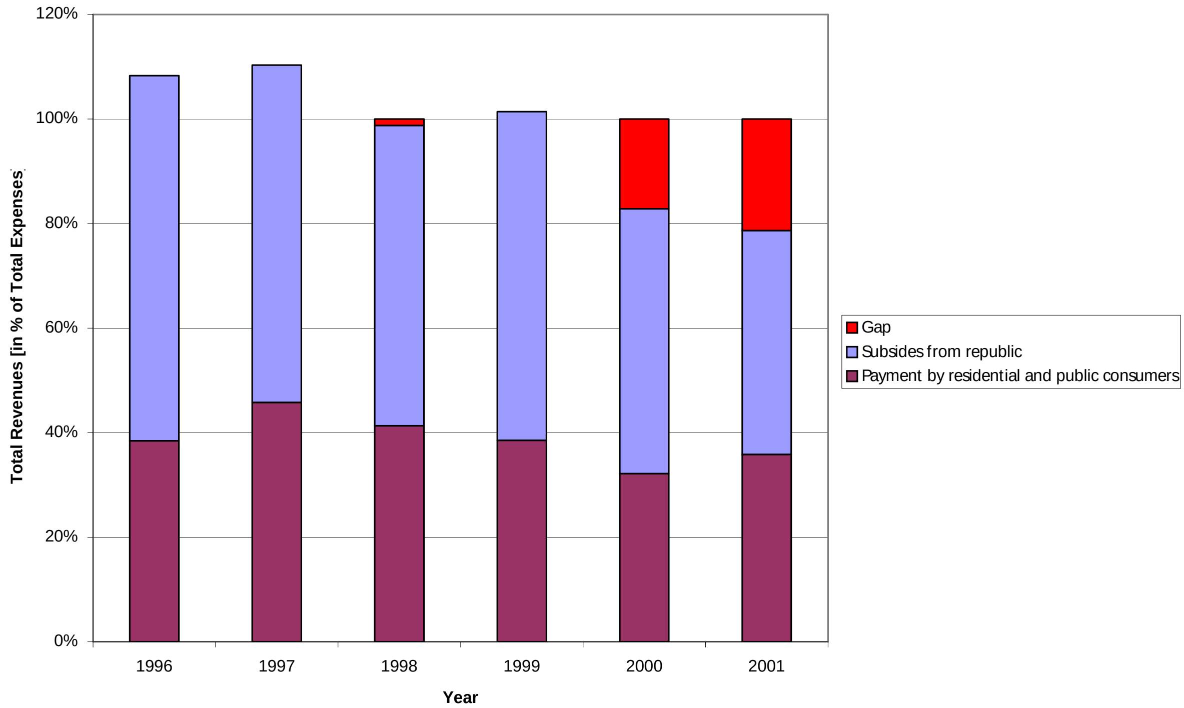

Figure 2: Development of total revenues of ADHC (payments from consumers and subsidies) compared to the total expenses (source ADHC).

2. **Technological barrier:** availability of **DHS equipment**
There is no domestic production of suitable equipment in Uzbekistan for the reconstruction, such as large boilers, pre-insulated pipes, etc. From this follows that the proposed project activities involves high risks due to the non-availability ("low" market share) of new technology for DHS rehabilitation in Uzbekistan that the baseline technology (continuation of old DHS and individual heaters) does not face.

Impact: This barrier prevents the implementation of all alternatives that include a significant investment in new technology for the district or block-wide heating systems, i.e. alternatives 2 to 10. (See overview of barriers in Table 3 below).

3. Technological barrier: availability of natural gas

Uzbekistan is rich in natural gas, taking the place of third largest natural gas producer in the CIS countries and one of the top-ten world producers. It has managed to boost gas production from 45 billion Nm3 in 1992 to almost 60 billion Nm3 in 1999. However, most of the gas fields are in the western part of Uzbekistan, whereas Andijan is located in the easternmost portion. A main pipeline transports gas from the gas fields in the west to the eastern part of Uzbekistan through Tajikistan and then to Andijan. The gas pipeline is in substandard condition and is unable to deliver year-round sufficient quantities to satisfy demand of all customers in a reliable way, including the large needs of industries in the Fergana valley and the district heating network of Andijan. Furthermore, incidents where gas was stolen by individuals, or withheld by Tajikistan in exchange for water resources, have occurred and may further contribute to the gas shortage.

Many residents reported that natural gas supply in Andijan is weak or ceasing in the coldest months of the year. Natural gas consumption by residents is not metered, but calculated according to norms and billed per head and by the size of the apartment.

Impact: This barrier prevents the implementation of all alternatives that would significantly increase the demand for natural gas in Andijan, i.e. the new DHS fuelled 100% by natural gas (A9) and heating by using 100% individual natural gas heaters (A12) are not feasible (See overview of barriers in Table 3 below).

4. **Technological barrier: availability of electricity**

Power generation in Uzbekistan has declined since 1992 (about 11%), with 43 Terawatthours (TWh) produced in 1999. During this period, the country has changed from a net exporter to a net importer of electricity, as consumption has remained stable. Uzbekistan is part of the United Central Asia Power System (CAPS)[5)]. Uzbekistan has seasonal arrangements with Kyrgyzstan and Kazakhstan for importing and exporting energy and water. In summer, Kyrgyzstan supplies Uzbekistan with electricity from the excess power from its hydroelectrical plants. In winter, Uzbekistan exports natural gas to Kazakhstan and natural gas, fossil fuel and electricity to Kyrgyzstan. In Uzbekistan electricity is inefficiently generated and distributed. Losses occur at all levels and power cuts are frequent in some parts. In addition, the electricity distribution network in large parts of the country, and in particular in Andijan, was not designed to deliver enough energy for widespread household space heating. Households currently use either unsafe home-made electric resistance heaters or expensive imported oil filled heaters. Only the wealthiest consumers have installed electric water heaters.

In Andijan, electricity has become an important energy carrier in households that covers a significant share of the heat demand, due to high subsidies and low consumer prices.
Development: The future development of the availability of electricity will depend on the supply from Uzbekistan's power stations and the capacity of the local distribution network in Andijan City. This may limit availability during cold days in winter. As the current electricity availability in Andijan seems relatively good (based on interviews with residents), there seems to be some room for an additional increase within the present capacity. The local authorities think that the recent reconstruction of the Syrdaruy and Novo-Angren thermal power stations should improve the situation of power availability.

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5) CAPS was built in the Soviet era, connecting the power lines of Kazakhstan, Kyrgyzsyan, Tajikistan, Turkmenistan and Uzbekistan. It includes a 500 kilovolt ring system, which was completed in 1991. There are also 110 kV and 220 kV lines linked these five countries. Uzbekistan is the main contributor to CAPS, generating 51 % of the power the system carriers, while Tajikistan generates 15 %, Kyrgyzstan 14 %, Turkmenistan 11 %, and Kazakhstan 9 %. Balance and synchronization of CAPS is done at the Unified Dispatch Center (IDC) located in Tashkent, Uzbekistan.

However, the capacity of the local power network will not be sufficient to support a fully electricity based heating system in Andijan in the future.

Impact: This barrier prevents the implementation of all alternatives that would significantly increase the demand for electricity in the local grid of Andijan, i.e. heating by using 100% individual electric heaters (A11). (See overview of barriers in Table 3 below).

5. **Technological barrier: limited capacity of existing DHS**

Currently, the services provided by the existing DHS to its customers are insufficient. Due to the very high losses in the network, customers that are located in more remote areas of the distribution network receive only very little heat from the boilerhouses. Also, fuel shortages during cold winterdays leads to a reduction of provided DHS services. On average, the heat provided by the DHS covers only about 22% of the heat demand of consumers. To cover the remaining 78%, consumers use individual in house devices.

Impact: The current DHS with minimal improvements (A1) alone is not sufficient to cover the basic heating needs of consumers and is therefore not a viable alternative. (See overview of barriers in Table 3 below).

6. **Barrier due to prevailing practice**

In Uzbekistan, many cities face similar problems with their outdated DHS from the times of centrally planned economies. The Andijan project is the first major DHS reconstruction project in Uzbekistan since the independence in 1991. In the mean time, a similar EBRD DHS project activity is under consideration in the city of Tashkent, which to-date has not made progress.

Impact: This barrier prevents the implementation of all alternatives that foresee a significant renewal of (part of) the district or block-wise heating systems, i.e. alternatives 2 to 10. (See overview of barriers in Table 3 below).

***Note*: this PDD is meant to illustrate the corresponding new baseline and monitoring methodology. For the final and complete version of the present PDD, the evidence on barriers will be updated and presented into a transparent and easily verifiable documented form. Particular attention will be given to documenting evidences for the uncertainties and temporary limitations/ blackouts in the availability of natural gas and electricity for heating purposes.**

Barrier		Barrier prevents alternative(s) no.:												
		1	2	3	4	5	*6*	7	8	9	10	11	12	13
1.	**Investment barrier**: no local commercial funding. No access to international capital market due to real or perceived risks.		x	x	x	x	*x*	x	x	x	x	(X)	(X)	
2.	**Technological barrier**: availability of **DHS equipment**		x	x	x	x	*x*	x	x	x	x			
3.	**Technological barrier**: availability of **natural gas**									x			x	
4.	**Technological barrier**: availability of **electricity**											x		
5.	**Technological barrier**: **limited capacity** of existing **DHS**	x												
6.	Barrier due to **prevailing practice**		x	x	x	x	*x*	x	x	x	x			
	Result: viable alternative													13

Table 3: Overview of barrier analysis of alternative scenarios (x: barrier prevents project alternative, (x) barrier prevents project alternative up to a certain degree).

Result: Alternative 13, the continuation of the current situation characterized by a mix of DHS heating technology and electric and NG heater technologies, is the only viable alternative under the current socio-economic conditions in Andijan. This alternative is therefore taken as the baseline scenario.

3 Definition of emission factors for saved fuels

Determination of emission factors for baseline district heating system

Data availability for the existing old DHS is rather limited. Although data on fuel consumption (Mazud, NG) is available, heat supply to customers is not metered. Therefore, a systematic and conservative estimate of the overall efficiency of the existing DHS has been made, based on a site visit, interviews with the Chief Technical Engineer of ADHC and customers and based on experience with similar deteriorated DHS in other countries.

The estimate is based on an assessment of the boiler houses and networks “RK 1” and RK 2”, which are planned to be replaced by the new system and which are representative for the situation in the Andijan DHS. The total efficiency of the DHS is composed of the combined efficiencies of the boilerhouse and of the distribution system (losses in network and basement, leakage of water in network). Input parameters include fuel consumption, network water temperatures, amount of boiler feed water and estimates of boiler efficiency and tapped water. Details of the efficiency estimate of the old DHS are provided in Annex 3 (Section A 3.2).

The emission factor for heat supplied to consumers by the old DHS consuming heavy fuel oil (HFO) is:

(1) $$EF_{heat,DHS,HFO} = \frac{1}{\eta_{DHS,HFO}} \cdot EF_{CO2,HFO} \cdot OXID_{HFO} = \frac{1}{0.199} \cdot 0.077367 \cdot 0.99 \text{ tCO}_2\text{/GJ} = 0.384891 \text{ tCO}_2\text{/GJ}$$

And for the old DHS with natural gas (NG):

(2) $$EF_{heat,DHS,NG} = \frac{1}{\eta_{DHS,NG}} \cdot EF_{CO2,NG} \cdot OXID_{NG} = \frac{1}{0.205} \cdot 0.055403 \cdot 0.995 \text{ tCO}_2\text{/GJ} = 0.268907 \text{ tCO}_2\text{/GJ}$$

Data sources: Certificates and data from fuel suppliers, default values from IPCC 1996 (see details in Annex 3, section A 3.2).

For individual natural gas fuelled in house devices, the emission factor for heat supplied to consumers is:

(3) $$EF_{heat,IHD,NG} = \frac{1}{\eta_{IHD,NG}} \cdot EF_{CO2,NG} \cdot OXID_{NG} = \frac{1}{0.9} \cdot 0.055403 \cdot 0.995 \, tCO_2/GJ = 0.061251 \, tCO_2/GJ$$

assuming an efficiency of 90% for individual gas heaters (expert estimate).
It may be assumed that in the future the DHS will further deteriorate, that the efficiencies will further decrease and baseline emissions increase. The conservative assumption is made that the efficiencies and emission factors remain constant.

Determination of emission factors for project activity heat source

The emission factor for heat supplied to consumers by the new rehabilitated DHS consuming furnace oil and natural gas will be calculated ex-post based on actual measurements (see NMM). Assuming an overall system efficiency of 75.7%, the emission factors for furnace oil and natural gas of the new DHS is projected to be:

(4) $$EF_{heat,DHS,LFO,y} = \frac{1}{\eta_{DHS,LFO}} \cdot EF_{CO2,LFO} \cdot OXID_{LFO} = \frac{1}{0.757} \cdot 0.074066 \cdot 0.99 \, tCO_2/GJ = 0.09686 \, tCO_2/GJ$$

(5) $$EF_{heat,DHS,NG,y} = \frac{1}{\eta_{DHS,NG,y}} \cdot EF_{CO2,NG} \cdot OXID_{NG} = \frac{1}{0.757} \cdot 0.055403 \cdot 0.995 \, tCO_2/GJ = 0.072821 \, tCO_2/GJ$$

4 Definition of emission factors for saved electricity

Since the independence of Uzbekistan from the Soviet Union in 1991, the infrastructural basis of the country deteriorated and, to the knowledge of the PDD developers, no new power plants have been built in recent years. Therefore, option (b) of Step 4 is used for the determination of the emission factor for saved electricity. i.e. the baseline emission factor for saved electricity EFel is calculated as the weighted average emission (in tCO2/MWh) of the current generation mix in the (regional) grid.

The latest available data on electricity emission factors for fossil mix in the Uzbek grid dates from 1999[6] (see table below): Around 85 to 89% of the electricity in Uzbekistan is generated based on fossil fuels, with the remaining 11 to 15% produced by hydro power plants. In the past, the share of natural gas for thermal power generation increased from 74,4 in 1990 to 83 % in 1999. Most of the power plants are old, inefficient, and deteriorating, and appropriate maintenance and renewal has not been done. Therefore CO_2-emission factors rose again in the last years, in spite of the increase in the share of natural gas (see Table 4). The CO_2 emission factor per kWh in Table 4 takes into account fuel mix, equipment conditions and level of thermal power station operation.

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[6] Liliya Zavyalova and Axel Michaelowa, National CDM Criteria, Baseline Methodologies and Case Studies for Uzbekistan. HWWA Discussion Paper 126, Hamburg 2001; http://www.hwwa.de/Projects/Res_Programmes/RP/Klimapolitik/HWWA_3062_FSP_Klima_Publikationen.htm

Year	Fossil mix [gCO_2/kWh]	Fossil and hydro mix [gCO_2/kWh]
1990	624.3	559.2
1995	580.8	514.0
1999	620.4	**536.6**

Table 4: Average CO_2-emission factor for fossil power plants and for fossil and hydro plants in Uzbekistan[7].

The share of hydro power in Uzbekistan shows a seasonal pattern. In 2001, the average share of hydro was 11.2%, with 15.3% in summer (April-Sept.) and only 7.5% in winter (Oct.-March). Electric heaters are used predominantly in winter term. To be conservative, the following assumptions are made:

- The (potentially significant) transmission losses in the Uzbek grid are neglected.
- Average annual hydro mix is used.
- An efficiency of 100% for individual electric heaters is assumed.

With this, an average emissions factor, EF_{el}, of 536.6 gCO_2/kWh is calculated and will be used for the first seven-year crediting period.

Development: The development of the energy sector in Uzbekistan and future changes in the national power generation fuel mix will have an impact on the electricity emission factor. In the Monitoring Plan, the electricity emission factors will therefore be adjusted on a regular basis at the beginning of each 7 year crediting period, based on available data of the operators of the power plants and the grid operator.

5 Determination of emission factors for heating technologies

Estimate of heat demand

No measurements or data for building heat demand in Andijan is available. Consumers are billed independently of the amount of heat supplied.

To calculate the heat demand in the existing apartments, a reference building in Andijan was selected, the size, wall thickness and other building data was taken from cross sections of the building or estimated during the site visit. The energy balance calculation of heat demand follows the guidelines of the Association of Swiss Architects and Civil Engineers (SIA)[8] using data for the conditions in Andijan. Input data included the heat insulation properties of the building (e.g. coefficient of heat transition), ventilation, monthly mean temperatures, irradiation, waste heat from additional humans, electric appliances etc., and an estimate of room temperature based on interviews with about 12 residents of representative apartments (see Annex A.3.3).

The interviews corroborated the findings of the feasibility study that apartments near boiler-houses receive enough heat, whereas apartments located far from the boilerhouses and which are connected over longer pipes receive no or insufficient heat. Most apartments with insufficient heat supply from ADHC use either additional stand alone heaters and many use hot water boilers, both fueled by natural gas or electricity. No data on room temperatures is available. Based on the qualitative interviews and

---

[7] The emission factors are based on data of the Ministry of Energy on the calculation and analysis of technical-economical performances (TEP) of thermal power stations in Uzbekistan. Data source: see Footnote [6].

[8] Registered Norm of the Swiss Association for Norms: *SIA Empfehlung 380/1 Energie im Hochbau*. Schweizerischer Ingenieur- und Architektenverein. Publisher: SIA, PO.Box, CH-8039 Zürich, Switzerland; www.sia.ch.

measurements in apartments during the on-site visits by international experts in the year 2002, an average room temperature during heating season of 16°C was estimated.

Average room temperature	Heat energy	Thermal heat hot water	Heat total		Heating period
[°C]	[MJ/m²a]	[MJ/m²a]	[MJ/m²a]	[%]	[d/a]
10	239	60	299	28.2	43
12	368	60	428	40.4	66
14	502	60	562	53.1	89
15	572	60	632	59.7	101
16	642	60	702	66.3	112
18	788	120	908	85.7	135
20	939	120	1059	**100.0**	158

Table 5: Heat demand as a function of room temperature and hot water demand for reference building in Andijan city, results from building energy model.

Based on the model calculation of building heat demand, 16°C correspond to a heat demand of 702 MJ per square meter and year, including (estimated) 60 MJ/m^{2}a of (low) hot water consumption (see Table above).

Therefore, annual heat demand in the baseline case is assumed to be 702 MJ/m^2.

Estimate of contribution of IHD to heat supply
Data on the consumption of natural gas and electricity by DHS customers was not available. The operators of the NG and electricity grids provided some data on overall consumption in Andijan. However, the on-site visit revealed that most of the electricity meters in the buildings seem to be bypassed, and the pressure in the natural gas distribution network is often so low (especially during cold periods) that metering is heavily distorted. As a result, the data from grid operators cannot be used to estimate baseline emissions.

From the measured fuel consumption in the area RK-1 and RK-2 and from the total efficiency of the DHS it results that the old DHS provides only an average of 154 MJ/m^2 per year, which covers only about 22% of the heat demand of 702 MJ/m^2. The gap in demand is covered by both electric and natural gas fuelled in house devices. Based on the site visits and interviews, it is estimated that the electric and NG heaters cover about the same share in the gap, i.e. 274 MJ/m^2 each (702=154+274+274).

Fuel consumption in RK1&RK2, efficiencies and specific emission factor for ADHC

	Fuel consumption		**Efficiency**	**Heat delivered**			**EF_CO2**	**OXID[1)]**	**EF_heat**	**CO2 emission**
	[GJ]	[-]	[-]	[GJ]	[MJ/m2]	[-]	[tCO2/GJ]	[-]	[tCO2/GJ]	[tCO2/yr]
Total fossil fuel	637'252	100%	20.2%	128'968	154.1	100%	0.06498	99.3%	0.3186	41'095
Mazud (HFO)	277'037	43.5%	19.9%	55'130	65.9	42.7%	0.07737	99.0%	0.3849	21'219
Furnace oil (LFO)	1'016	0.2%	19.9%	202	0.2	0.2%	0.07407	99.0%	0.3685	74
Natural gas	359'199	56.4%	20.5%	73'636	88.0	57.1%	0.05540	99.5%	0.2689	19'801
	Power consumption ADHC						**EF_CO2[2)]**			
	[MWh]						[tCO2/MWh]			
Electricity ADHC	7'342						0.5366			3'940
	Sum of heat delivered								**EF_heat**	**Total emission**
				[GJ]	[MJ/m2]				[tCO2/GJ]	[tCO2/yr]
Total ADHC				128'968	**154.1**				**0.3492**	45'035

1) Source: Revised IPCC guidelines 1996, Vol. 3, Table 1-6.

2) Source: Liliya Zavyalova and Axel Michaelowa, National CDM Criteria, Baseline Methodologies and Case Studies for Uzbekistan. HWWA Discussion Paper 126, Hamburg 2001

In house devices

	Fuel consumption		**Efficiency**	**Heat delivered**			**EF_CO2**	**OXID[1)]**	**EF_heat**	**CO2 emission**
	[GJ]		[-]	[GJ]	[MJ/m2]		[tCO2/GJ]	[-]	[tCO2/GJ]	[tCO2/yr]
Natural gas	254'703		90.0%	229'233	**273.9**		0.05540	99.5%	0.0613	14'041
	Power consumption						**EF_CO2[2)]**		**EF_heat**	
	[MWh]			[GJ]	[MJ/m2]		[tCO2/MWh]		[tCO2/GJ]	
Electric heaters	63'676		100%	229'233	**273.9**		0.5366		0.1491	34'168

	Fuel consumption		**Efficiency**	**Heat delivered**					**EF_heat**	**CO2 emission**
	[GJ]			[GJ]	[MJ/m2]				[tCO2/GJ]	[tCO2/yr]
Total heat supplied	1'121'187			587'434	**702.0**				**0.15873**	93'244

heated area RK-1 and RK-2 [1000m2]: 836.8

Table 6: Calculation of baseline technology emission factor.

Table 6 provides an overview of the calculation of the overall emission factor for the baseline scenario, following the equations in steps 3, 4 and 5 in section D.1 in the related new Baseline Methodology. The table combines the contribution of the different heat sources to heat supply with the above derived efficiencies and emission factors. As a result the specific overall emission factor for the baseline scenario, EF_{BLS} amounts to 0.15873 tCO_2 per GJ of heat delivered.

Calculation of the project technology emission factor

The overall project emission factor will be measured ex-post.
Assuming an equal share of furnace oil and natural gas in the fuel mix, average room temperature with the new system of 20° C and 120 MJ/m^2 for hot water, the following table provides a projection for the overall emission factor for the project activity of 0.0859 tCO_2/GJ, following the equations in steps 3, 4 and 5 in section D.1 in the related new Baseline Methodology.

Fuel consumption in 1 nano-region (comparable to RK1&RK2), efficiencies and specific emission factor for NEWCO

	Fuel consumption		Efficiency	Heat delivered			EF_CO2	OXID[1]	EF_heat	CO2 emission
	[GJ]	[-]	[-]	[GJ]	[MJ/m2]	[-]	[tCO2/GJ]	[-]	[tCO2/GJ]	[tCO2/yr]
Total fossil fuel	97'926	100%		74'130	1'059.0	100%	0.06474	99.3%	0.0848	6'289
Furnace oil (LFO)	48'963	50%	75.70%	37'065	529.5	50%	0.07407	99.0%	0.0969	3'590
Natural gas	48'963	50%	75.70%	37'065	529.5	50%	0.05540	99.5%	0.0728	2'699
	Power consumption						**EF_CO2[2]**			
	[MWh]						[tCO2/MWh]			
Electricity NEWCO	140						0.5366			75
	Sum of heat delivered								**EF_heat**	**Total emission**
	[GJ]								[tCO2/GJ]	[tCO2/yr]
Total NEWCO	74'130								**0.0859**	6'365

1) Source: Revised IPCC guidelines 1996, Vol. 3, Table 1-6.

2) Source: Liliya Zavyalova and Axel Michaelowa, National CDM Criteria, Baseline Methodologies and Case Studies for Uzbekistan. HWWA Discussion Paper 126, Hamburg 2001

Heated area of one nano-region [1000m2]: 70.0

Table 7: Calculation of project technology emission factor.

6 Emission reductions calculation and projection

The district heating system rehabilitation project activity mainly reduces carbon dioxide by providing heat to existing district heating customers by means of a rehabilitated and efficient district heating system instead of providing heat to these customers by the old deteriorated inefficient district heating system and the use of individual heaters (in house devices) fuelled by natural gas and electricity identified as the baseline scenario.

The emission reduction ER_y (in tCO_2) by the project activity during a given year y is the difference in the specific overall emission factor of the baseline EF_{BLS} and of the project activity EF_{PA}, multiplied by the actual energy $HEAT_{PA\_BLS\text{-}HH,y}$ delivered to the *baseline customers* (customers connected to the DHS before and after project implementation) by the CDM project[9] in year y. The latter part is to ensure that an increase in coverage (compared with the baseline) by the improved DHS is not included in ER calculations.

(6) $$ER_y = (EF_{BLS} - EF_{PA,y}) \cdot HEAT_{PA\_BLS-HH,y}$$

where

$HEAT_{PA\_BLS\text{-}HH,y}$ is the amount of heat (in GJ) delivered in year y to *baseline customers* that

(a) are physically connected to a rehabilitated (part) of the DHS in the year y, and

(b) were physically connected to the old district heating system before the start of the project activity.

(Only heat delivered to consumers fulfilling both conditions (a) and (b) is considered in $HEAT_{PA\_BLS\text{-}HH,y}$.)

For emission reduction estimate see Section E below.

Step 7 of the methodology (additionality test) is provided in Section B.3 below.

[9] This calculation of emission reductions (ER) follows Meth Panel recommendation to the Executive Board on NM0046 (p. 3, Section A.I.c."Others").

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:

The district heating system rehabilitation project activity mainly reduces carbon dioxide by providing heat to existing district heating customers by means of a rehabilitated and efficient district heating system instead of providing heat to these customers by the old deteriorated inefficient district heating system and the use of individual heaters (in house devices) fuelled by natural gas and electricity identified as the baseline scenario.

7 Additionality test

In this section the approved *additionality tool* is applied. The outcome of the barrier analysis to determine the baseline technology is already a strong indicator for the additionality of the project. In the following Steps 0 to 5 refer to the related Sections in the *additionality tool*.
In order to be conservative, both Investment and Barrier Analysis are carried out.

Step 0: Preliminary screening (starting date of PA)
Step 0 is not applicable: Crediting period starts only after the registration of the project activity.

Step 1: Identification of alternatives to the project activity

Sub-step 1a: Define alternatives to the project activity
Table 2 (in Section B.2 above) provides a list of plausible alternatives to the project activity that are available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity, i.e. heating services to consumers connected to the district heating system (DHS).

Sub-step 1b: Enforcement of applicable laws and regulations
All alternatives are in line with current applicable laws and regulations. The current district heating system's high air pollution level surpasses the relevant national threshold value. Therefore, ADHC pais a (very small) air pollution tax.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method
The investment comparison analysis is used (Option II).

Sub-step 2b –Option II: Apply investment comparison analysis
The total unit cost of delivered heat (USD/GJ) is selected as financial indicator.

Sub-step 2c: Calculation and comparison of financial indicators
Here, the total unit cost of delivered heat (USD/GJ) is calculated, following equations (1) to (3) in the NMB. Annex 3 provides an overview on assumptions made and on intermediate results. All relevant costs (investment, O&M, fuels, management) are included, capital recovery duration is 21 years.

The results of the analysis of total unit cost per unit of heat supplied for the 13 identified alternatives are provided in the ranked list below. The table provides data for different discount rates applied and for the

use of local fuel prices, as paid currently in Andijan. For the sensitivity analysis, also results based on world market prices are given.

Investment analysis: Total cost per unit of heat supplied		5% discount rate on investments		15% discount rate on investments		25% discount rate on investments	
Rank	Alternative	USD/ GJ (local fuel prices)	USD/ GJ (world market fuel prices)	USD/ GJ (local fuel prices)	USD/ GJ (world market fuel prices)	USD/ GJ (local fuel prices)	USD/ GJ (world market fuel prices)
1	A13 Current DHS + NG + electr. heaters in aps.	2.01	10.13	**2.01**	10.13	2.01	10.13
2	A11 New electric heaters in apartments	2.40	13.92	**3.10**	14.63	3.92	15.45
3	A12 New NG heaters in appartments	2.54	5.43	**4.71**	7.60	7.25	10.13
4	A1 Current DHS with minimal improvements	5.33	16.70	**5.33**	16.70	5.33	16.70
5	A3 Current DHS with new boiler houses	4.65	12.71	**5.41**	13.47	6.30	14.36
6	A2 Current DHS with new distribution network	5.10	9.11	**6.91**	10.92	9.03	13.03
7	A9 New DHS with natural gas	3.85	7.38	**7.17**	10.70	11.05	14.58
8	A10 Individual heating boilers per block	5.00	8.62	**7.69**	11.31	10.83	14.45
9	*A6 New DHS with LFO and natural gas (PA without CDM)*	*4.63*	*8.80*	***7.95***	*12.13*	*11.83*	*16.01*
10	A7 New DHS with heavy fuel oil (HFO)	4.47	7.45	**7.98**	10.96	12.09	15.07
11	A8 New DHS with coal	4.63	8.08	**8.43**	11.88	12.86	16.31
12	A4 New DHS with light fuel oil (LFO)	5.42	10.23	**8.74**	13.56	12.62	17.44
13	A5 New DHS with LFO & solar in summer	7.36	11.61	**12.96**	17.21	19.50	23.75

Table 8: Result of analysis of total cost per unit of heat supplied for alternatives.

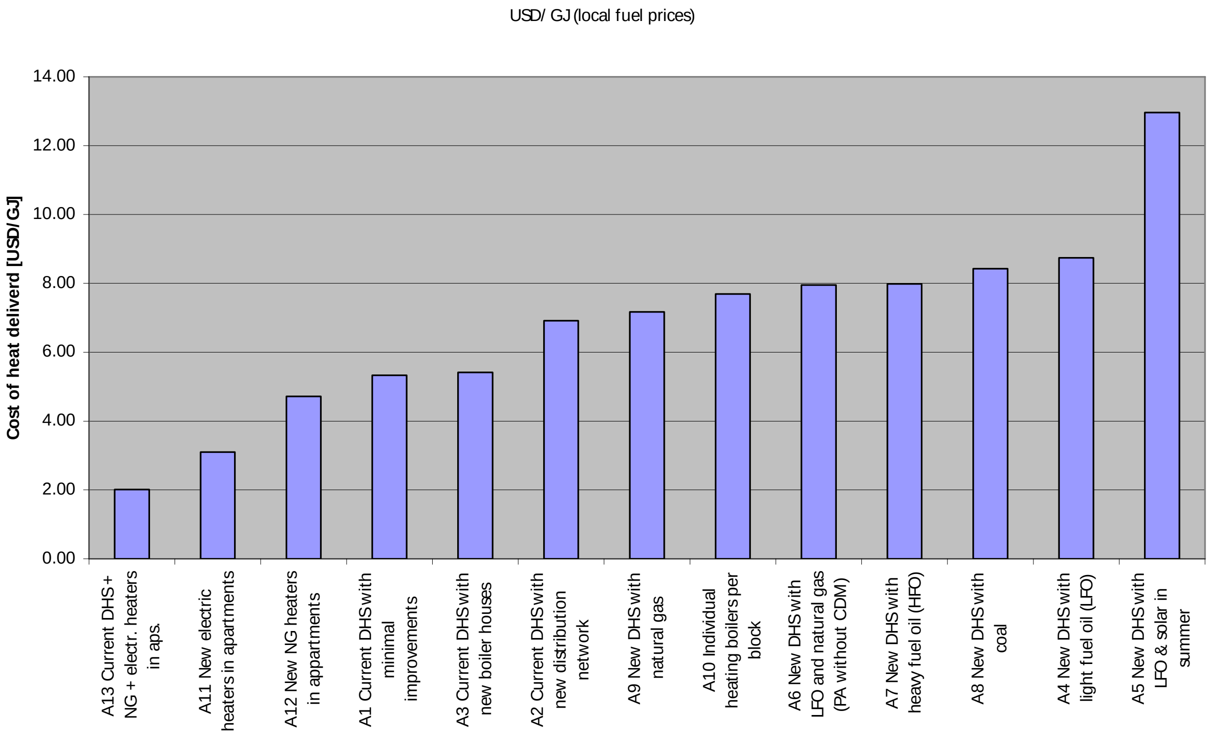

Figure 3: Total costs per unit of heat delivered for project alternatives for local fuel prices at 15% discount rate

The investment comparison analysis should realistically simulate the choice of heating technologies and heating services of the relevant decision takers being (i) the DHS operators/investors and (ii) the DHS

consumers. Both of them have to make their investment decisions based on the local fuel prices and on the local conditions for commercial loans:

Fuel prices: fuel prices may change and may converge to world market levels with the development of a country. At present, there is no sign that this convergence will take place in Uzbeksitan in the years to come. However, fuel price level in Andijan are part of the parameters monitored for the baseline determination.

Conditions for loans (interest rate, pay back, grace period): The *additionality tool* specifies that, in calculating the financial indicator, the project's risks can be included through the cash flow pattern. In the present analysis, the interest rate includes a risk premium. A measure of investment risks are the credit rating and other investment indicators by rating organizations. Uzbekistan is not included in the list of the countries rated by Moody's, Fitch and the world competitiveness yearbook of IMD[10], in contrast e.g. to the Baltic countries. This indicates that Uzbekistan is not a viable investment country for international investors and that the perceived investment risks are very high. The commercial banking sector in Uzbekistan is very weak, commercial loans are rarely available. If they were available, commercial interest rates would exceed 25% for infrastructure projects in Andijan. The selected interest rate of 15% for the analysis is therefore rather conservative.

Total unit cost of delivered heat of the district heating system (alternatives 1-9, 13) reflect the production cost per GJ borne by the DHS operators. For the current DHS, tariffs for consumers are lower, as the DH operator receives significant subsidies for operation and DHS services are billed according to a norm and not according to the heat supplied.

Result: It follows from Table 8 that alternative 6, the proposed project activity not undertaken as a CDM project activity, is not the alternative with the best financial indicator, but on the 9^{th} rank (at local fuel prices and 15% discount rate). Alternative 13, the continuation of the current mix of district and individual heating systems involves no investments and has the lowest cost of heat supplied.
The proposed project activity (A6) is not the most financially attractive alternative.

Sub-step 2d: Sensitivity analysis
The key factors determining the results of the levelized cost analysis are (i) fuel prices and (ii) interest rates.
It follows from Table 8 that alternative 6, the proposed project activity not undertaken as a CDM project activity, is not the alternative with the best financial indicator, for any combination of the two factors. Assuming hypothetically world market fuel prices and a 5% discount rate, the proposed project activity (A6, 8.80 USD/GJ) is still not the most financially attractive alternative.

Result: Step 2 of the *additionality tool* is satisfied.

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[10] see: www.moodys.com; www.fitchratings.com; www.imd.ch .

Step 3: Barrier analysis

Sub-step 3a
Identify barriers that would prevent the implementation of the type of the proposed project activity:
Table 2 (in Section B.2 above) provides a list of plausible alternatives to the project activity that are available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity, i.e. heating services to consumers connected to the district heating system (DHS). Barriers include:

- Investment barrier: no local commercial funding. No access to international capital market due to real or perceived risks.
- Technological barrier: availability of DHS equipment
- Technological barrier: availability of natural gas, availability of electricity
- Technological barrier: limited capacity of existing DHS
- Barrier due to prevailing practice

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

See results of baseline determination (step 2) in Table 3 in Section B.2 above:
Barriers 1, 2 and 6 prevent the implementation of the type of proposed project activity from being carried out if the project activity was not registered as a CDM activity.
Alternative 13 (continuation of current practice) is a viable alternative that does not face any of the barriers identified.

Result: Step 3 of the *additionality tool* is satisfied.

Step 4. Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity
In Uzbekistan, many cities face similar problems with their outdated DHS from the times of centrally planned economies. The Andijan project is the first major DHS reconstruction project in Uzbekistan since the independence in 1991.

In the mean time, a similar project activity is considered in the city of Tashkent with CDM. This activity has not made any significant progress is therefore not included in the analysis.
No other similar activities in Uzbekistan implemented without CDM are known to the PDD developers.

Sub-step 4b: Discuss any similar options that are occurring
No other similar activities in Uzbekistan implemented without CDM are known to the PDD developers.

Result: Step 4 of the *additionality tool* is satisfied.

Step 5. Impact of CDM registration

The hard-currency revenues from the CERs allow for an adequate cashflow to cover the debt service for the EBRD loan. This was a relevant factor for EBRD when deciding on the loan.

Evidence for this is given in the EBRD document BDS 01-114 of 6 November 2001 "Andijan District Heating Programme" that served as a basis for the approval of the loan by the EBRD board of directors (confidential):

- "Securing co-financing in the form of grants and sale of CERs" is one of the "Conditions of Effectiveness" (Section 2 "Key Terms and Conditions").
- "Participation in carbon markets" is mentioned under section 3 "Rationale for Bank's involvement": "The Project would build capacity and skills in Uzbekistan and the Bank for CDM transactions, which can lead to additional energy efficiency investments"

With the availability of hard-currency funding for the supply of international equipment, barriers 1, 2 and 6 are lifted, and the project activity (alternative 6) becomes a viable option under CDM registration.

Result: Steps 2 to 5 of the additionality tool are satisfied. Therefore the project activity is additional.

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

>>
The project boundary applied to the CDM project activity includes the emissions resulting from the consumption of fossil fuels (furnace oil, natural gas) in the district heating system (DHS) as well as from the consumption of electricity in the DHS, related to the heating services from the rehabilitated DHS provided to the DHS' existing customer base. I.e. heating services to consumers that
(a) are physically connected to a rehabilitated (part) of the DHS in the year *y*, and
(b) were physically connected to the old district heating system before the start of the project activity.

Fuel production and transportation as well as production and installation of equipment is outside of the boundaries, since their contribution to overall emission may be neglected.
Power generation is outside the boundaries, but contributes as an indirect emission to the overall baseline and project emissions.

The methodology addresses only CO_2 emissions from heating or power generation activities related to the DHS customers. The methodology does not support claims of emission reductions from other sources or other greenhouse gases.

The methodology does only claim emission reductions related to the improvement of district heating services to its existing customer base. Potential heating services to new customers that have not been connected to the DHS before the start of the project activity are not considered in the calculation of project emissions and of emission reductions.

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:

>>
December 2004.
Jürg Füssler, Ernst Basler + Partners Ltd. (EBP) [with contributions from Robert Sigrist (EBP), Roland Henseler (EBP), Liliya Zavyalova (Uzbekistan), Johannes Heister (PCF), Junji Nakanishi (PCF) and Klaus Oppermann (PCF)]. Contact: juerg.fuessler@ebp.ch, Zollikerstr. 65, CH-8702 Zollikon, Switzerland, Tel: +41 1 395 11 11, Fax +41 1 395 12 34.
Ernst Basler + Partners Ltd. is not a project participant.

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:

>>
Expected 2006 [to be confirmed].

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

>>
At least 21 years

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

C.2.1. Renewable crediting period

A 21 years crediting period is chosen, renewed every seven years.

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

>>
Expected 2006

C.2.1.2. Length of the first crediting period:

>>
Seven years.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
n.a.

C.2.2.2. Length:

>>
n.a.

SECTION D. Application of a monitoring methodology and plan

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

>>
Monitoring methodology for district heating rehabilitation, possibly reducing use of in house devices

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

>>

The monitoring methodology is appropriate because it focuses on data which is measurable and minimizes the number of variables which has to be estimated. This is of particular importance in circumstances of limited availability of data on the relevant heating sector.

The project does not result in any significant leakage of CO_2 emissions or an increase of non-CO_2 emissions. Project proponents claim only reductions of CO_2 emissions.

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	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.	$F_{LFO,DHS}$	Operator: LFO consumption in new DHS (sum of all boilers)	t	m	Monthly	100%	Electronic	Recorded from main fuel meters and documented by fuel purchasing records
2.	NCV_{LFO}	Fuel supplier: LFO net calorific value	GJ/t	m	Annually	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
3.	$EF_{CO2,LFO}$	Fuel supplier: LFO CO_2 emission factor	tCO_2/GJ	m	Annually	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
4.	$OXID_{LFO}$	Operator: LFO oxidation factor	-	m	Annually	100%	Electronic	If no local data available, a conservative value of 100.0% can be used as default.
5.	$F_{NG,DHS}$	Operator: fossil fuel(s) *i* consumption in new DHS (sum of all boilers)	Nm^3	m	Monthly	100%	Electronic	Recorded from main fuel meters and documented by fuel purchasing records
6.	NCV_{NG}	Fuel supplier: NG net calorific value	MJ/Nm^3	m	Annually	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
7.	$EF_{CO2,NG}$	Fuel supplier: NG CO_2 emission factor	tCO_2/GJ	m	Annually	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
8.	$OXID_{NG}$	Operator: NG	-	m	Annually	100%	Electronic	If no local data available, a

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	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
		oxidation factor						conservative value of 100.0% can be used as default.
9.	$ELEC_{DHS\_PA,y}$	Operator: electricity consumption new DHS	MWh	m	Monthly	100%	Electronic	Recorded from main electricity meters and documented by electricity purchasing records
10.	$HEAT_{Boiler}$	Operator: boiler heat output to network	GJ	m	Monthly	100%	Electronic	As measured by the difference in temperature between water entering and exiting the boilers and by the amount of water; data used for cross-checking only.
11.	$HEAT_{PA\_BLS\text{-}HH,y}$	Operator: heat delivered in year *y* to consumers that are connected to the new DHS and that have been connected to the old DHS before the start of the project activity	GJ	m	Monthly	100%	Electronic	As measured by the difference between water entering and exiting the Apartments and the temperature and amount of hot tap water supplied

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

>>

Formula are provided in steps 3, 4, and 5 in Section B.2. above. They are repeated here for convenience:

Determination of emission factors for project activity heat source

(7) $$EF_{heat,DHS,LFO,y} = \frac{1}{\eta_{DHS,LFO}} \cdot EF_{CO2,LFO} \cdot OXID_{LFO}$$

(8) $$EF_{heat,DHS,NG,y} = \frac{1}{\eta_{DHS,NG,y}} \cdot EF_{CO2,NG} \cdot OXID_{NG}$$

These factors will be determined *ex-post* based on monitoring.

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	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
12.	$F_{HFO,DHS}$	Operator: HFO consumption in old DHS	t	m	Monthly in period before project activity start	100%	Electronic	DHS: Recorded from main fuel meters and documented by fuel purchasing records
13.	NCV_{HFO}	Fuel supplier: HFO net calorific value	GJ/t	m	Annually in period before project activity start	100%	Electronic	More frequent if change of supplier or origin (each time supplier/origin is changed). If no local data available, IPPC values can be used as default.
14.	$EF_{CO2,HFO}$	Fuel supplier: HFO	tCO_2/GJ	m	Annually	100%	Electronic	More frequent if change of supplier

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	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
		CO_2 emission factor			in period before project activity start			or origin (each time supplier/origin is changed). If no local data available, IPPC values can be used as default.
15.	$OXID_{HFO}$	Operator: fossil fuel(s) *i* oxidation factor	-	m	Annually in period before project activity start	100%	Electronic	If no local data available, IPPC values can be used as default.
16.	$F_{LFO,DHS}$	Operator: LFO consumption in old DHS (sum of all boilers)	t	m	Monthly in period before project activity start	100%	Electronic	DHS: Recorded from main fuel meters and documented by fuel purchasing records
17.	NCV_{LFO}	Fuel supplier: LFO net calorific value	GJ/t	m	Annually in period before project activity start	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
18.	$EF_{CO2,LFO}$	Fuel supplier: LFO CO_2 emission factor	tCO_2/GJ	m	Annually in period before project activity start	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
19.	$OXID_{LFO}$	Operator: LFO	-	m	Annually	100%	Electronic	If no local data available, IPPC

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	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
		oxidation factor			in period before project activity start			values can be used as default.
20.	$F_{NG,DHS}$	Operator: NG consumption in old DHS (sum of all boilers)	Nm^3	m	Monthly in period before project activity start	100%	Electronic	DHS: Recorded from main fuel meters and documented by fuel purchasing records
21.	NCV_{NG}	Fuel supplier: NG net calorific value	MJ/Nm^3	m	Annually in period before project activity start	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
22.	$EF_{CO2,NG}$	Fuel supplier: NG CO_2 emission factor	tCO_2/GJ	m	Annually in period before project activity start	100%	Electronic	More frequent if change of supplier or origin. If no local data available, IPPC values can be used as default.
23.	$OXID_{NG}$	Operator: NG oxidation factor	-	m	Annually in period before project activity start	100%	Electronic	If no local data available, IPPC values can be used as default.
24.	$F_{NG,IHD}$	Expert estimate:	Nm^3	e	Annually	100%	Electronic	IHD: Expert estimate (See steps 3

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	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
		NG consumption in individual heaters (IHD)			in period before project activity start			and 5 in Section B.2.)
25.	$ELEC_{DHS\_BLS}$	Operator: electricity consumption old DHS	MWh	m	Monthly in period before project activity start	100%	Electronic	Recorded from main electricity meters and documented by electricity purchasing records
26.	$\eta_{i,DHS}$	Expert estimate based on site visit: overall DHS specific system efficiency	-	m/e	Once before project activity start	Representative samples of network	Electronic	Option used: old DHS efficiency is estimated because data on heat supplied is not available. Overall DHS specific system efficiency of old system is conservatively estimated based on available data and measurements on efficiencies of boiler, network insulation, network leakage etc. See steps 3 and 5 in Section B.2.
27.	$\eta_{NG,IHD}$	Expert estimate based on site visit: Specific efficiency of individual heater using NG (IHD)	-	e	Once before project activity start	Sample	Electronic	See definition in Step 3 in Section D.1. in related NMB.
28.	$HEAT_{el}$	Expert estimate based on site visit: amount of heat	MWh	m/e	Annually in period before	Sample	Electronic	Estimated based on electricity consumption pattern (summer vs. winter), random surveys in

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	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
		produced by individual electric heaters (IHD) that compensate for insufficient DHS heating services[11]			project activity start			consumer's apartments, sales data of individual electric heaters etc. See steps 3 and 5 in Section B.2.

[11]) Only IHD that compensate insufficient DHS services are counted. Heat produced by electric IHDs that are not affected by the rehabilitation of the DHS (e.g. that are in rooms that will receive no heat services from the rehabilitated DHS) are not included.

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	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
29.	EF_{el}	Option (b): published study[12] on grid emission factors in Uzbekistan	tCO_2/MWh	c	At the beginning of each crediting period	Option (b): all power plants, including renewables, nuclear, etc.	electronic	See Step 4 in Section B.2.
30.	$COST_{HFO,y}$	Fuel supplier: cost of HFO;average market price in year y	USD/t	m	At the beginning of each crediting period	samples	electronic	Price as documented by official price list of supplier or other official statistics. All fuels used in DHS and IHD as well as electricity for heating have to be considered.
31.	$COST_{LFO,y}$	Fuel supplier: cost of LFO;average market price in year y	USD/t	m	At the beginning of each crediting period	samples	electronic	Price as documented by official price list of supplier or other official statistics. All fuels used in DHS and IHD as well as electricity for heating have to be considered.
32.	$COST_{NG,y}$	Fuel supplier: cost of NG; average market price in year y	USD/ 1000Nm3	m	At the beginning of each crediting period	samples	electronic	Price as documented by official price list of supplier or other official statistics. All fuels used in DHS and IHD as well as electricity for heating have to be considered.
33.	$COST_{el,y}$	Fuel supplier: cost of electricity for heating; official price in year y	USD/MWh	m	At the beginning of each crediting period	samples	electronic	Price as documented by official price list of supplier or other official statistics. All fuels used in DHS and IHD as well as electricity for heating have to be considered.

[12] Liliya Zavyalova and Axel Michaelowa, National CDM Criteria, Baseline Methodologies and Case Studies for Uzbekistan. HWWA Discussion Paper 126, Hamburg 2001;
http://www.hwwa.de/Projects/Res_Programmes/RP/Klimapolitik/HWWA_3062_FSP_Klima_Publikationen.htm

The specific emission factor of the baseline technology is determined before the start of the project activity on the basis of fuel use / efficiency / performance data of heating systems over two or more heating season or through the use of IPCC default data and estimates as indicated in Table D.2.1.3. The recording frequency is also indicated in Table D.2.1.3. Data may be adjusted for climatic variations using heating degree days or an equivalent measure.

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

>>

Formula are provided in steps 3, 4, and 5 in Section B.2. above. They are repeated here for convenience:

Determination of emission factors for baseline district heating system

The emission factor for heat supplied to consumers by the old DHS consuming heavy fuel oil (HFO) is:

(9) $$EF_{heat,DHS,HFO} = \frac{1}{\eta_{DHS,HFO}} \cdot EF_{CO2,HFO} \cdot OXID_{HFO} = \frac{1}{0.199} \cdot 0.077367 \cdot 0.99 \text{ tCO}_2\text{/GJ} = 0.384891 \text{ tCO}_2\text{/GJ}$$

And for the old DHS with natural gas (NG):

(10) $$EF_{heat,DHS,NG} = \frac{1}{\eta_{DHS,NG}} \cdot EF_{CO2,NG} \cdot OXID_{NG} = \frac{1}{0.205} \cdot 0.055403 \cdot 0.995 \text{ tCO}_2\text{/GJ} = 0.268907 \text{ tCO}_2\text{/GJ}$$

Data sources: Certificates and data from fuel suppliers, default values from IPCC 1996 (see details in Annex 3, section A 3.2).

For individual natural gas fuelled in house devices, the emission factor for heat supplied to consumers is:

(11) $$EF_{heat,IHD,NG} = \frac{1}{\eta_{IHD,NG}} \cdot EF_{CO2,NG} \cdot OXID_{NG} = \frac{1}{0.9} \cdot 0.055403 \cdot 0.995 \text{ tCO}_2\text{/GJ} = 0.061251 \text{ tCO}_2\text{/GJ}$$

assuming an efficiency of 90% for individual gas heaters (expert estimate).
It can be assumed that in the future the DHS will further deteriorate, that the efficiencies will further decrease and baseline emissions increase. The conservative assumption is made that the efficiencies and emission factors remain constant.

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

Option not used.

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 (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

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

>>

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 (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Leakage is not relevant in the case of the Andijan project. It can be assumed that leakage can only be of small dimension and that emissions outside the projects boundary cannot be measured in the case of the Andijan project.

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

>>

Not applicable. Leakage is not considered. See section D.2.3.

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.)

>>

Formula is provided in step 6 in Section B.2. above. It is repeated here for convenience:

Emission reductions calculation and projection

The district heating system rehabilitation project activity mainly reduces carbon dioxide by providing heat to existing district heating customers by means of a rehabilitated and efficient district heating system instead of providing heat to these customers by the old deteriorated inefficient district heating system and the use of individual heaters (in house devices) fuelled by natural gas and electricity identified as the baseline scenario.

The emission reduction ER_y (in tCO_2) by the project activity during a given year y is the difference in the specific overall emission factor of the baseline EF_{BLS} and of the project activity EF_{PA}, multiplied by the actual energy $HEAT_{PA\_BLS-HH,y}$ delivered to the baseline households by the CDM project[13] in year y. The latter part is to ensure that an increase in coverage (compared with the baseline) by the improved DHS is not included in ER calculations.

(12) $$ER_y = (EF_{BLS} - EF_{PA,y}) \cdot HEAT_{PA\_BLS-HH,y}$$

where

$HEAT_{PA\_BLS-HH,y}$ is the amount of heat (in GJ) delivered in year y to consumers that

(a) are physically connected to a rehabilitated (part) of the DHS in the year y, and

(b) were physically connected to the old district heating system before the start of the project activity.

(Only heat delivered to consumers fulfilling both conditions (a) and (b) is considered in $HEAT_{PA\_BLS-HH,y}$.)

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.
D.2.1.1.- 1, 5	Low	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
D.2.1.1.- 2 to 4, 6 to 8	Low	Data should be documented. No QC/QA if IPCC default values are used.
D.2.1.1.- 9 to 11	Low	Meters should be subject to a regular maintenance and testing regime to ensure accuracy.
D.2.1.3.- 12, 16, 20, 24	Low to Medium	Meters should be subject to a regular maintenance and testing regime to ensure accuracy.
D.2.1.3.- 13 to 15, 17 to 19, 21 to 23	Low to Medium	Data should be documented. No QC/QA if IPCC default values are used.
D.2.1.3.- 25	Medium to High	Data should be documented. No QC/QA if IPCC default values are used.
D.2.1.3.- 26, 27	Medium	Data/estimates should be documented.
D.2.1.3.- 28	Medium to High	Data/assumptions/estimates should be documented.
D.2.1.3.- 29	Low to Medium	Option (a): see monitoring methodology ACM0002; Option (b) document data/ assumptions/ estimates /sources

[13] This calculation of emission reductions (ER) follows Meth Panel recommendation to the Executive Board on NM0046 (p. 3, Section A.I.c."Others").

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

>>

The operator of the rehabilitated DHS, NEWCO, will be responsible for the monitoring.

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

>>

Jürg Füssler, Ernst Basler + Partners Ltd. {with contributions from Robert Sigrist (EBP), Roland Henseler (EBP), Liliya Zavyalova (Uzbekistan), Johannes Heister (PCF), Junji Nakanishi (PCF) and Klaus Oppermann (PCF)]. Contact: juerg.fuessler@ebp.ch, Zollikerstr. 65, CH-8702 Zollikon, Switzerland, Tel: +41 1 395 11 11, Fax +41 1 395 12 34.

Ernst Basler + Partners Ltd. is not a project participant.

SECTION E. Estimation of GHG emissions by sources

Assumptions: The following assumptions on the project activity were made when estimating emission reductions:

- The project consists of a total of 21 nano-regions that are implemented gradually over 21 years in 12 sub-projects, with up to three new nano-regions rehabilitated per year, as described in Table 9.
- Overall system efficiency of rehabilitated DHS is 75.7% (step 3 in Section B.2)
- Assumed is an equal share of furnace oil and natural gas in the fuel mix, average room temperature with the new system of 20° C and 120 MJ/m^2 for hot water, resulting in a total of 1059 MJ/m^2 heating services delivered (step 6 in Section B.2)
- Each nano-region covers 70'000 m^2 of heated area.

Result: The calculation of the estimated emission reductions is provided in Table 9 below.
The project results in estimated annual savings of about 5'400 tCO2 per nano-region, and in *cumulative* savings of

- 254’000 tons of CO_2 in years 1 to 7 of the project (until 2012, 8 nano-regions) and
- 1.2 million tons of CO_2 in years 1 to 21 of the project (until 2026, 21 nano-regions).

E.1. Estimate of GHG emissions by sources:

>>
Specific project emissions (per GJ of heat provided to customers):
Total project emissions from fossil fuel use and power consumption in new DHS: 0.0858 tCO2/GJ
For details see Table 7 in section B.2.

E.2. Estimated leakage:

>>
0

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

>>
Total project activity emissions: 0.08583 tCO2/GJ

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

>>
Specific basleine emissions (per GJ of heat provided to customers by DHS and IHD):
Total baseline emissions: 0.15873 tCO2/GJ
For details see Table 6 in section B.2.

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

>>
Specific emission reductions of the project activity: 0.0729 tCO2/GJ

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

>>

Andijan district heating project: estimate of annual emission reductions

		1	2	3	4	5	6	7	8	9	10
	Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Heating service provided											
No of new nano-regions operational	[-]	2	3	3	0	0	0	0	0	0	1
No of nano-regions operational	[-]	2	5	8	8	8	8	8	8	8	9
Area heated by PA	[1000m2]	140	350	560	560	560	560	560	560	560	630
PA heat supply to existing consumers	[MJ/m2]	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059
PA heat supply to existing consumers	[GJ]	148'260	370'650	593'040	593'040	593'040	593'040	593'040	593'040	593'040	667'170
Emission factors											
Overall EF baseline	[tCO2/GJ]	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873
Overall EF project activity	[tCO2/GJ]	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586
Difference EF (BLS - PA)	[tCO2/GJ]	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287
Emission reduction											
Annual emission reduction	[tCO2]	**10'804**	**27'011**	**43'217**	**43'217**	**43'217**	**43'217**	**43'217**	**43'217**	**43'217**	**48'620**
Kummulative emission reduction	[tCO2]	10'804	37'815	81'033	124'250	167'468	210'685	253'903	297'120	340'337	388'957

Continued

		11	12	13	14	15	16	17	18	19	20	21
	Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Heating service provided												
No of new nano-regions operational	[-]	0	1	0	1	0	2	1	2	1	2	2
No of nano-regions operational	[-]	9	10	10	11	11	13	14	16	17	19	21
Area heated by PA	[1000m2]	630	700	700	770	770	910	980	1'120	1'190	1'330	1'470
PA heat supply to existing consumers	[MJ/m2]	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059	1'059
PA heat supply to existing consumers	[GJ]	667'170	741'300	741'300	815'430	815'430	963'690	1'037'820	1'186'080	1'260'210	1'408'470	1'556'730
Emission factors												
Overall EF baseline	[tCO2/GJ]	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873	0.15873
Overall EF project activity	[tCO2/GJ]	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586	0.08586
Difference EF (BLS - PA)	[tCO2/GJ]	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287	0.07287
Emission reduction												
Annual emission reduction	[tCO2]	**48'620**	**54'022**	**54'022**	**59'424**	**59'424**	**70'228**	**75'631**	**86'435**	**91'837**	**102'641**	**113'446**
Kummulative emission reduction	[tCO2]	437'577	491'599	545'620	605'044	664'468	734'697	810'327	896'762	988'599	1'091'241	1'204'687

Table 9: Estimate of emission reduction over the first 21 years of the project activity (PA).

SECTION F. Environmental impacts

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

>>

Not required for demonstrating NMB and NMM.

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:

>>

Not required for demonstrating NMB and NMM.

SECTION G. Stakeholders' comments

>>

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

>> Not required for demonstrating NMB and NMM.

G.2. Summary of the comments received:

>> Not required for demonstrating NMB and NMM.

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

>> Not required for demonstrating NMB and NMM.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The new district heating operator NEWCO will finance its investment program with a combination of Uzbek equity (provided by the Government of RoU), grant funds (provided by Government of Switzerland), the proceeds from the sale of Certified Emissions Reductions (CERs) and an EBRD loan.

The public funding of the Andijan project does not result in a diversion of official development assistance and is separate from and is not counted towards the financial obligations of Parties included in Annex I of the Kyoto Protocol, as no ODA is used to purchase emission reductions from the project activity.

Annex 3

BASELINE INFORMATION

A 3.1 Details of investment comparison analysis

The investment comparison analysis in Sub-step 2b of the additionality tool follows equations (1) to (3) in Section D.1 of the related new baseline methodology.
The following tables provide an overview on assumptions made and on intermediate results.

Fuel prices

	HFO	LFO for ADHC	LFO for residen-tial consumers	Kerosene	Coal	NG	Electricity for private consumers	Electricity for ADHC	Solar energy
Local fuel price UZS per ton (NG per 1000m3)	19'139	50'222	62'778	52'428	6'062	7'140	-	-	
F-X UZS/USD 2001:	844.07	844.07	844.07	844.07	844.07	844.07			
Local fuel price USD per ton:	23	59	74	62	7.2	8			
World market fuel price USD per ton	110	210	210	230	45	98			
calorific value GJ/t (NG:per 1000m3)	40.95	42.50	42.50	43.08	15.53	34.54			
Local fuel priceUSD/ GJ	**0.55**	**1.40**	**1.75**	**1.44**	**0.46**	**0.24**	**1.55**	**2.67**	**0.00**
World market fuel price USD/ GJ	**2.69**	**4.94**	**4.94**	**5.34**	**2.90**	**2.84**	**12.50**	**8.33**	**0.00**

Sources:

Local price source: local suppliers information obtained at site visit, prices for 2001. No local indication for coal prices: Indian and Eastern Europe prices as published by the International Energy Agency (IEA)

World market prices:average of 1985 - 2001 energy prices published by the IEA. Energy prices follow no obvious trend over this period, average was taken to eliminate fluctuation

Non fuel cost

		Total water and chemicals cost [USD / GJ]	Operations & Maintenance for boiler (-house) [USD / GJ]	O&M for network [USD / GJ]	Overhead & office [USD / GJ]	**Total non fuel costs [USD / GJ]**
A 1	Current DHS with minimal improvements	0.106	1.88	0.81	0.74	**3.54**
A 2	Current DHS with new distribution network	0.023	1.88	0.07	0.74	**2.72**
A 3	Current DHS with new boiler houses	0.106	0.17	0.81	0.74	**1.82**
A 4	New DHS with light fuel oil (LFO)	0.023	0.17	0.07	0.03	**0.29**
A 5	New DHS with LFO & solar thermal heaters in summer	0.023	0.13	0.06	0.03	**0.24**
A 6	New DHS with LFO and natural gas	0.023	0.17	0.07	0.03	**0.29**
A 7	New DHS with heavy fuel oil (HFO)	0.023	0.17	0.07	0.03	**0.29**
A 8	New DHS with coal	0.023	0.17	0.07	0.03	**0.29**
A 9	New DHS with natural gas	0.023	0.17	0.07	0.03	**0.29**
A 10	Individual heating boilers per block	0.023	0.34	0.02	0.03	**0.41**
A 11	New electric heaters in apartments	0.000	0.08	0.00	0.00	**0.08**
A 12	New NG heaters in appartments	0.000	0.17	0.00	0.00	**0.17**
A 13	Current DHS + NG + electr. Heaters in aps.	0.023	0.51	0.18	0.16	**0.88**

Investment cost

		Boiler (-house) or heater [USD]	Network and customer building [USD]	Private management company [USD]	Solar thermal heaters [USD]	Total investment [USD]	Life time [a]	Discount rate [%]	Capital recovery amount [USD]	Energy produced per nano region [GJ/a]	Capital recovery amount [USD/GJ]	Discount rate [%]	Capital recovery amount [USD]	Energy produced per nano region [GJ/a]
A 1	Current DHS with minimal improvements	0	0	0	0	0			0	74'130	0.00		0	74'130
A 2	Current DHS with new distribution network	0	1'667'740	0	0	1'667'740	21	5%	130'077	74'130	1.75	15%	264'198	74'130
A 3	Current DHS with new boiler houses	701'170	0	0	0	701'170	21	5%	54'689	74'130	0.74	15%	111'077	74'130
A 4	New DHS with light fuel oil (LFO)	876'463	2'084'675	101'136	0	3'062'274	21	5%	238'845	74'130	3.22	15%	485'116	74'130
A 5	New DHS with LFO & solar thermal heaters in summer	876'463	2'084'675	101'136	2'100'000	5'162'274	21	5%	402'637	74'130	5.43	15%	817'791	74'130
A 6	New DHS with LFO and natural gas	876'463	2'084'675	101'136	0	3'062'274	21	5%	238'845	74'130	3.22	15%	485'116	74'130
A 7	New DHS with heavy fuel oil (HFO)	1'051'756	2'084'675	101'136	0	3'237'567	21	5%	252'518	74'130	3.41	15%	512'885	74'130
A 8	New DHS with coal	1'314'695	2'084'675	101'136	0	3'500'506	21	5%	273'026	74'130	3.68	15%	554'539	74'130
A 9	New DHS with natural gas	876'463	2'084'675	101'136	0	3'062'274	21	5%	238'845	74'130	3.22	15%	485'116	74'130
A 10	Individual heating boilers per block	1'752'926	625'403	101'136	0	2'479'465	21	5%	193'389	74'130	2.61	15%	392'789	74'130
A 11	New electric heaters in apartments	650'000	0	0	0	650'000	21	5%	50'697	74'130	0.68	15%	102'971	74'130
A 12	New NG heaters in appartments	2'000'000	0	0	0	2'000'000	21	5%	155'992	74'130	2.10	15%	316'834	74'130
A 13	Current DHS + NG + electr. Heaters in aps.	0	0	0	0	0	21	5%	0	74'130	0.00	15%	0	74'130

Total cost composition (USD/GJ)		Local fuel cost (USD/ GJ)	World market fuel cost	Water & chemical cost	Office and overhead cost	Maintenance and operations cost	Investment cost at 5% discount rate	Investment cost at 15% discount rate	Investment cost at 25% discount rate
A 1	Current DHS with minimal improvements	1.79	13.16	0.11	0.74	2.69	0.00	0.00	0.00
A 2	Current DHS with new distribution network	0.63	4.64	0.02	0.74	1.95	1.75	3.56	5.68
A 3	Current DHS with new boiler houses	2.09	10.15	0.11	0.74	0.97	0.74	1.50	2.39
A 4	New DHS with light fuel oil (LFO)	1.90	6.72	0.02	0.03	0.24	3.22	6.54	10.42
A 5	New DHS with LFO & solar in summer	1.68	5.94	0.02	0.03	0.19	5.43	11.03	17.57
A 6	New DHS with LFO and natural gas	1.12	5.29	0.02	0.03	0.24	3.22	6.54	10.42
A 7	New DHS with heavy fuel oil (HFO)	0.77	3.75	0.02	0.03	0.24	3.41	6.92	11.02
A 8	New DHS with coal	0.66	4.10	0.02	0.03	0.24	3.68	7.48	11.92
A 9	New DHS with natural gas	0.33	3.86	0.02	0.03	0.24	3.22	6.54	10.42
A 10	Individual heating boilers per block	1.98	5.60	0.02	0.03	0.36	2.61	5.30	8.44
A 11	New electric heaters in apartments	1.63	13.15	0.00	0.00	0.08	0.68	1.39	2.21
A 12	New NG heaters in appartments	0.27	3.16	0.00	0.00	0.17	2.10	4.27	6.81
A 13	Current DHS + NG + electr. Heaters in aps.	1.14	9.26	0.02	0.16	0.69	0.00	0.00	0.00

		5% discount rate on investments		15% discount rate on investments		25% discount rate on investments	
Total cost		**Total cost in USD/ GJ (local fuel prices)**	**Total cost in USD/ GJ (world market fuel prices)**	**Total cost in USD/ GJ (local fuel prices)**	**Total cost in USD/ GJ (world market fuel prices)**	**Total cost in USD/ GJ (local fuel prices)**	**Total cost in USD/ GJ (world market fuel prices)**
A 1	Current DHS with minimal improvements	5.33	16.70	**5.33**	16.70	5.33	16.70
A 2	Current DHS with new distribution network	5.10	9.11	**6.91**	10.92	9.03	13.03
A 3	Current DHS with new boiler houses	4.65	12.71	**5.41**	13.47	6.30	14.36
A 4	New DHS with light fuel oil (LFO)	5.42	10.23	**8.74**	13.56	12.62	17.44
A 5	New DHS with LFO & solar in summer	7.36	11.61	**12.96**	17.21	19.50	23.75
A 6	New DHS with LFO and natural gas	4.63	8.80	**7.95**	12.13	11.83	16.01
A 7	New DHS with heavy fuel oil (HFO)	4.47	7.45	**7.98**	10.96	12.09	15.07
A 8	New DHS with coal	4.63	8.08	**8.43**	11.88	12.86	16.31
A 9	New DHS with natural gas	3.85	7.38	**7.17**	10.70	11.05	14.58
A 10	Individual heating boilers per block	5.00	8.62	**7.69**	11.31	10.83	14.45
A 11	New electric heaters in apartments	2.40	13.92	**3.10**	14.63	3.92	15.45
A 12	New NG heaters in appartments	2.54	5.43	**4.71**	7.60	7.25	10.13
A 13	Current DHS + NG + electr. Heaters in aps.	2.01	10.13	**2.01**	10.13	2.01	10.13

A 3.2 Details of determination of efficiencies of heat sources

Old ADHC district heating system (baseline):

Fuel consumption of ADHC

Consumption data provided from ADHC chief engineer

Figures include fuel used for own heat demand

Year		Mazud (HFO)			Furnace oil (LFO)			Kerosene			Coal			NG			Total fuel Heating value
		[t]	[GJ]	[%]	[t]	[GJ]	[%]	[t]	[GJ]	[%]	[t]	[GJ]	[%]	[1000 m	[GJ]	[%]	[GJ]
2001	RK-1	2'056	84'166	41.3%		0	0.0%		0	0.0%		0	0.0%	3'464	119'622	58.7%	203'788
2001	RK-2	4'485	183'647	48.6%	12	501	0.1%		0	0.0%		0	0.0%	5'612	193'832	51.3%	377'980
2001	Total City A.	8'345	341'702	40.4%	372	15'813	1.9%	111	4'795	0.6%		0	0.0%	14'008	483'793	57.2%	846'103
2001	Total Region A.	11'263	461'185	41.4%	1'437	61'067	5.5%	332	14'312	1.3%	677	10'521	0.9%	16'390	566'043	50.9%	1'113'127
2000	RK-1	3'493	143'028	45.4%		0	0.0%		0	0.0%		0	0.0%	4'987	172'236	54.6%	315'263
2000	RK-2	3'498	143'232	37.9%	36	1'530	0.4%		0	0.0%		0	0.0%	6'738	232'710	61.6%	377'472
2000	Total City A.	9'104	372'764	37.4%	558	23'730	2.4%	194	8'345	0.8%		0	0.0%	17'145	592'149	59.4%	996'988
2000	Total Region A.	11'721	479'922	37.3%	2'030	86'267	6.7%	592	25'505	2.0%	920	14'290	1.1%	19'695	680'205	52.9%	1'286'189
Average 2000-01 of Sum RK-1&RK2			277'037	43.5%		1'016	0.2%		0	0.0%		0	0.0%		359'199	56.4%	637'252

Net calorific values of fuels available in Andijan

	1	2	3	4	5	7	8
	Calorific value	Calorific value	Density at 20°	Viscosity	Sulfur	Emission factor	
	[GCal/t]	[GJ/t]	[kg/m3]	[CT]	[%]	[tC/TJ]	[tCO2/GJ]
Mazud (HFO)	9.780	40.947	962	4.1 (at 80°)	3.50	21.1	77'367
Furnace oil (LFO)	10.150	42.496	815	15.0	0.88	20.2	74'067
Kerosene	10.290	43.082	787		0.20	19.6	71'867
Coal (high quality lignite)	3.710	15.533				27.6	101'200
	[Gcal/1000m3]	[GJ/1000m3]					
Natural Gas	8.249	34.537	0.7240			15.11	55'403

Remarks to columns:

1-5 Sources: Certificates and data from suppliers (oil products: AO Nefteproduct; coal: AO Ugol, NG: Andijan Oblgas/Uzbeknieftiegaz)

7 Sources: NG: GHG Emission Reduction, Manual for Project Setting, for Central Asia, Almaty, 2000; Others: IPCC Rev. 1996 Guidelines, Vol. 3 p. I.13; Furnace oil: IPCC factor for LFO is used

efficiency distribution $_{leak}$

	boiler feed water	temperature feeding water average value	loss fraction outgoing pipe	outgoing temperature average value	loss fraction return pipe	return pipe temperature average value	loss fraction tapping	tapping temperature average value
	[m³/a]	[°C]	[%]	[°C]	[%]	[°C]	[%]	[°C]
RK1	668'159	15	25	75	25	40	50	60
RK2	1'130'000	15	25	75	25	40	50	60
Andijan City	2'085'131	15	25	75	25	40	50	60

	output boiler house	loss leakage outgoing	loss leakage return	loss tapping	contribution tapping to hot water supply	total loss	4 efficiency distribution leak
	[GJ/a]	[GJ/a]	[GJ/a]	[GJ/a]	[% of tapping]	[GJ/a]	[%]
RK1	231'239	41'964	17'485	62'946	20	109'805	**53**
RK2	275'392	70'970	29'571	106'454	20	185'704	**33**
Andijan City	713'424	130'957	54'565	196'435	20	342'670	**52**

Efficiency distribution$_{leak}$ describes how the leakage of hot water in the network (and the correspondent losses heat) affect the efficiency of heat distribution.

efficiency distribution $_{total}$

	1 effi. Network [1)] thermal	2 effi. Basement [2)] thermal	3 = 1*2 effi. distribution thermal	4 effi. distribution leak	5 =3*4 effi. distribution total
	[%]	[%]	[%]	[%]	[%]
RK-1	81.5	83.4	68.0	52.5	**35.7**
RK-2	81.5	83.4	68.0	32.6	**22.1**
Andijan City	81.5	83.4	68.0	52.0	35.3
Weighted average RK1&RK2					28.0

[1)] Calculated based on reference network Microrayon-3

[2)] Calcualted based on reference building

Efficiency distribution$_{total}$ (column 5) combines the different elements that reduce the efficiency of the distribution system (network and piping). It includes thermal losses through sub-optimally insulated network (column 1) and basement pipes (column 2) and the losses through leaking hot water (column 4).

efficiency total

	6 efficiency boilerhouse [3)]	5 effi. distribution total	7 = 6*5 efficiency total
	[%]	[%]	[%]
Mazud+LFO	71	28.0	**19.9**
NG	73	28.0	**20.5**
Total (weighted) efficiency RK-1 and RK-2			20.2

[3)] Estimate by ADHC chief engineer (exhaust temperature approx. 350°C)

Efficiency total combines the efficiency of the boilerhouse with the total distribution efficiency.

New NEWCO district heating system (project activity):

Efficiency new project boilers (NEWCO)

	Winter	Summer	Weighted mean
total efficiency	84%	53%	**75.7%**
Heat delivered	74%	26%	

Assumptions: Based on Econoler data for new project., exeptions:
Distribution efficiency winter 93%, not 95% (too optimistic)
Heat delivered: own estimates, based on current service level

A 3.3 Model input data for determination of heat demand

Energiebilanz nach SIA 380/1								
Obj.:	Andijan District Heating		**Auftrag:**	202051				
Ort:	Andijan							
Var.:	**IST-Zustand + Warmwasser**							
Pos.	Daten	Abk.	Wert	Einheit				
A	**Benutzung**							
1	Raumlufttemperatur	ti	16	°C	effektiv:		**16**	
1b	Heizgrenze	tgr	12	°C	effektiv:		**12**	
2	Temperatur Estrich	td	6	°C	effektiv:			
3	Temperatur Keller	tk	1	°C	effektiv:		**1**	
4	Temperatur Erdreich tiefer als 2m	te	8	°C	effektiv:			
4a	Temperatur Erdreich bis 2m Tiefe	te2	6	°C	effektiv:			
5	Personenzahl	P	128	Pers	effektiv:		**128**	
6	Nutzungszeit	hp	12	h/Tag	effektiv:		**12**	
7	Elektrizitätsverbrauch	Ee	65	MJ/m2a	effektiv:		**65**	
8	Reduktionsfaktor Elektrizität	fe	**0.8**	-				
9	Luftwechsel Zone 1	n	3.00	1/h	effektiv:		**3.00**	
9a	Zone 2	n	3.00	1/h	effektiv:			
9b	Zone 3	n	3.00	1/h	effektiv:			
9c	Zone 4	n	3.00	1/h	effektiv:			
B	**Klimadaten**					**Klimastation**		
10	Höhe über Meer	-	**450**	m		Fergana Valley		
11	Länge der Heizperiode	HT	112	Tage/a				
12	Heizgradtage	HGT	1643	K Tag/a				
13	Globalstrahlung horizontal	GH	858	MJ/m2a				
14	Globalstrahlung Süd	GS	1076	MJ/m2a				
15	Globalstrahlung Ost	GO	501	MJ/m2a				
16	Globalstrahlung West	GW	544	MJ/m2a				
17	Globalstrahlung Nord	GN	252	MJ/m2a				
C	**Volumen, Flächen, k-Werte**							
18	Energiebezugsfläche	EBF	**2114**	m2				
19	Beheiztes Volumen netto Zone 1	V	**6131**	m3				
19a	Zone 2	V	**0**	m3				
19b	Zone 3	V	**0**	m3				
19c	Zone 4	V	**0**	m3	**D**	**k-Werte**		
20	Dach inkl. horizontale Fenster gegen aussen	Ad	**529**	m2	kd	**0.9**	W/m2K	33
21	Dach gegen Estrich		**0**	m2		**0**	W/m2K	34
22	Wand inkl. Fenster gegen aussen	Aw	**1230**	m2	kw	**1.2**	W/m2K	35
23	Wand gegen unbeheizt		**585**	m2		**1.7**	W/m2K	36
24	Wand gegen Erdreich tiefer als 2m		**0**	m2		**0**	W/m2K	37
24a	Wand gegen Erdreich bis 2m Tiefe		**0**	m2		**0**	W/m2K	37a
24b	Wand gegen beheizt		**0**	m2		**0**	W/m2K	37b
24c	Türen und Tore		**0**	m2		**0**	W/m2K	37c
25	Boden gegen aussen	Ab	**0**	m2	kb	**0**	W/m2K	38
26	Boden gegen unbeheizt		**529**	m2		**0.8**	W/m2K	39
27	Boden gegen Erdreich		**0**	m2		**0**	W/m2K	40
28	Fenster horizontal	Af	**0**	m2	kf	**0**	W/m2K	41
29	Fenster Süd		**0**	m2		**0**	W/m2K	42
30	Fenster Ost		**160**	m2		**5.2**	W/m2K	43
31	Fenster West		**160**	m2		**5.2**	W/m2K	44
32	Fenster Nord		**0**	m2		**0**	W/m2K	45
32a	Fenster beschattet		**0**	m2		**0**	W/m2K	45a
	Total Fensterfläche		319.2	m2				
	Fensterfläche/EBF		0.15	-				
D	**g, f**							
46	g-Wert Fenster	g	**0.8**	-				
47	Glasanteil Fenster	fr	**0.75**	-				
48	Beschattung u. Verschmutzung	fb	**0.7**	-				
	Gebäudetyp							
I	EFH							
II	MFH		**x**					
II	Heime							
III	Schule							
III	Verwaltung							
IV	Industrie, Lager, Werkstätten							
V	Spezielle Bauten							

Annex 4

MONITORING PLAN

See separate document "Andijan District Heating Project – Monitoring Plan"

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