JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM FOR SMALL-SCALE PROJECTS
Version 01.1 - in effect as of: 27 October 2006

CONTENTS

Annexes

SECTION A. General description of the small-scale project

A.1. Title of the small-scale project:

Cogeneration and Utilization of Waste Heat at Uman Greenhouse Combinate

Project pertains to the sectoral scope #1 “Energy industries (renewable/non-renewable sources)”, Group I

SSC JI PDD version number: 02.5

Data of Completion: 11th of November, 2010.

A.2. Description of the small-scale project:

The project is aimed at reducing greenhouse gases emissions from natural gas combustion and grid electricity consumption at Uman Greenhouse Combinate (UGC), located in Cherkasy oblast, Ukraine.

UGC is one of the biggest producers of fresh vegetables in Ukraine representing up to 7 % share of the market. Its main products are tomatoes and cucumbers cultivated in the Company’s greenhouses, which are located in three places: Uman, Talne, and Khrystynivka (for simplification purposes, the Company’s greenhouses sites in Uman are called “Uman”, those in Talne – “Talne”, site in Khrystynivka is not included in the Project boundaries). The total greenhouses area of the company in 2006, when the decision about the project implementation was made, was 18.3 hm^2, which allowed production of 8162 tonnes of tomatoes and cucumbers per annum. The products of the company are produced and packed at UGS and then distributed through Ukrainian supermarket retail chains, up to 40% are exported.

According to UGC development plan in 2012 the production capacity is to be increased to reach 24500 tonnes of vegetables. It involves enlargement of the greenhouses area for 27.3 hm^2 to reach 45.6 hm^2 of total UGC greenhouses area in 2012. This will increase overall energy demand of the Enterprise (see Table A 2-1. UGC development plan).

Table A 2-1. UGC development plan figures.

	2006	2007	2008	2009	2010	2011	2012
Total greenhouses area, hm^2	18.3	24.0	28.3	33.5	35.6	35.6	45.6
Production, tonnes	8162	10617	13856	17000	19000	19000	24500
Electricity demand, MWh	4.8	4.93	10	27	31	31	39.7
Heat demand, GJ	643144	781322	913359	1073954	1131067	1131067	1438130

Electricity is used for operational activities and for additional lighting in greenhouses. Natural gas is combusted for the purposes of heating and to enrich the air within the greenhouses with CO_2 in order to increase the plants’ bioproductivity.

Before project implementation heat energy was generated by water boilers with natural gas combustion to satisfy UGC’s demand in heat. Electricity demand has been covered by purchasing electricity from the national grid as there were no electricity generating capacities on site.

The baseline scenario was assumed as continuation of the current practice of purchasing electricity from national power grid and producing heat by natural gas combustion in water boilers.

The JI project activity involves installation of:

- three Caterpillar G3520C cogeneration units in Uman to produce heat, electricity and CO_2 for the plants in the greenhouses;
- two heat utilizers TUV-16 to utilize the waste heat at the Talne Gas Compressor Station "Talne", a part of Ukrtransgas Affiliated Company Naftogaz of Ukraine, which is located 1.5 km away from UGS's greenhouses in Talne.

The anthropogenic emissions of GHGs will be reduced by the proposed JI project through offsetting the use of state grid electricity and displacing the heat produced by gas-fired water boilers.

Substituting the carbon-intensive national grid electricity produced by traditional power plants with electricity locally generated by gas-fired cogeneration units leads to GHGs emission reductions and will also avoid electricity transportation losses during the delivery to the Enterprise. Generated heat will be directed for heating the greenhouses of the company, which will offset the heat previously produced by natural gas-fired water boilers. CO_2 produced by cogeneration units and purified in exhaust gases' purification system would be enough to satisfy the CO_2 demand for greenhouse air enrichment in Uman, therefore, it will substitute the CO_2 previously generated in boilers.

Besides, the energy utilized at Gas Compressor Station "Talne" will be used to heat the company's Talne greenhouses, offsetting the heat previously produced by natural gas combustion.

The overall project investments are UAH 38.6 million financed by the bank loan and UGC internal investment. The decision on the project implementation was made in the beginning of 2006. While the decision-making the JI component was assumed as significant incentive to launch the project. The project investment period began in December 2006 and its operational phase started in November 2009. Without JI revenues the project activity could not have happened as it would be prevented by number of financial, organizational, technological and other barriers (further described in Section B).

The implementation of the project activity will be socially and environmentally beneficial. Two of the cogeneration units installed will be equipped with the system for exhaust gases purification, which will lead to overall decrease in the air pollution on the site and improve health and safety conditions for the UGC workers. Heat utilizers will reduce the heat pollution currently caused by Talne Gas Compressor Station and affecting the local ecosystem by changing its microclimate and impacting the local biodiversity.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as a project participant (Yes/No)
Party A: Ukraine (Host Party)	• Legal entity A1: Private-Rent Agricultural Enterprise "Uman Greenhouse Combinate" (UGC)	No
Party B: Germany	• Legal entity B1: RWE Power AG	No

UGC is one of the biggest Ukrainian producers of fresh vegetables. Its principal activity is production of tomatoes and cucumbers, which are cultivated in the company's greenhouses, located in three places: Uman, Talne, and Khrystynivka in Cherkassy oblast of Ukraine.

RWE Power AG with an installed capacity of over 42000 MW and over 20 million customers is the third largest electricity and sixth largest gas supplier in Europe. In 2008, with 66 000 employees RWE generated some 49 billion Euro in external revenue. RWE invests in GHG emission reduction projects to generate carbon certificates that RWE can use as a part of its carbon mitigation activities. RWE has been working for more than 6 years on climate protection projects worldwide.

A.4. Technical description of the small-scale project:

A.4.1. Location of the small-scale project:

Location of the project – 26 Derevianko st., Uman, Cherkasy oblast, 20300 Ukraine

Fig. A 4-1. Map of Ukraine indicating the region of the project implementation

A.4.1.1. Host Party(ies):

Ukraine

Article 5 of the Kyoto Protocol requires 'Annex 1 Parties to having in place, no later than 2007, national systems for the estimation of greenhouse gas emissions by sources and removal by sinks.' National Inventory System of Ukraine was created by Government Decision "Procedure of the Functioning National System of the Estimation of Anthropogenic Emissions by Sources and Removals by Sinks of GHG not Controlled by the Montreal Protocol" (21.04.06, №554).

According to Article 7 of the Kyoto Protocol Ukraine have submitted annual greenhouse gas inventories on a regular basis. First National Inventory report was submitted on 20th of February, 2004. The last one was submitted on 25th of May, 2009. Ukraine has also submitted its Fifth National Communication report on 29th of December 2009.

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

Cherkasy oblast

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

Towns Uman, Talne.

A.4.1.4. Detail of physical location, including information allowing the unique identification of the small-scale project:

As it was mentioned before, UGC production facilities are located in Uman, Talne and Khrystynivka.

Only sites in Uman and Talne are included in the project boundary as the project activity does not influence the operation of the site in Khrystynivka

Uman is a town located in the Cherkasy Oblast in central Ukraine at around 48°45′N 30°13′E / 48.75°N 30.217°E / 48.75; 30.217, and serves as the administrative center of the Umanskyi Raion. The UGC main production facilities as well as administrative buildings are located in Uman. Greenhouses area there was 14.85 hm^2 in 2006 and is to be increased to reach 22.45 hm^2 by 2012. It consists of four divisions, for simplification, they are further referred to as "project site in Uman".

Talne is a town in Cherkasy Oblast, located 38 kilometers to the Northern-East from Uman.The UGC greenhouses area there was 2.3 hm^2 in 2006, and was planned to be enlarged to 22.0 hm^2. The project site in Talne lies 1.5 km away from Gas Compressor Station "Talne", a part of Ukrtransgas – the Affiliated Company of the Naftogaz of Ukraine. The existence of large scale heat waste there was a key condition for the project idea occurrence.

A.4.2. Small-scale project type(s) and category(ies):

The small scale project conforms to the type (ii): Energy efficiency improvement project activities, and category F.Supply-side energy efficiency improvements – generation.

A.4.3. Technology(ies) to be employed, or measures, operations or actions to be implemented by the small-scale project:

General information about UGC production cycle

The UGC production cycle includes following stages: plants cultivation, harvesting, products packing, storage, distribution and sale (Fig. A 4-2). The most specific stage which requires the highest energy input is plants cultivation. Many environmental indicators inside and outside of greenhouses have to be taken into consideration. The most important of them are variations in temperature, humidity, wind speed etc. These parameters are inter alia monitored by the computer greenhouse environmental control system Priva Integro, sending signals determining the energy input.

UGC employs two types of greenhouses, which differ by their efficiency, heating and lightening needs. The greenhouses of the first type, further referred to as "old greenhouses", were build in 70s-80s of XX century and have the highest net heating requirements. Greenhouses of the second type, further referred to as "new greenhouses", were constructed in 90s and later, and are more efficient in terms of heating needs, but require permanent lightening (for the area of each type of the greenhouses refer to table A 4-1).

Energy demand of the Enterprise is determined by the weather conditions and technical characteristics of the greenhouses employed. It is comprised of heating, illumination and CO_2 supply for greenhouse air enrichment needs.

Greenhouses are heated to maintain the optimal temperature levels for plants development, which lies in the range 18-22 °C for tomatoes and 16-22 °C for cucumbers depending on the daytime. The average optimal temperature inside the greenhouses is 20 °C. For UGC climate zone greenhouses heating season proceed from the middle of September till the middle of May. Amount of heat that needs to be supplied per 1 hm^2 has been estimated taking into account difference in temperatures outside and inside of the greenhouses, heat conduction of the greenhouses (depending on enclosure material), air infiltration (determined by construction specifics, joint packing etc.), greenhouse surface area, and wind speed. For calculation formulae refer to Section E. Estimated UGC heat demand of the project sites is in the following table A 4-1.

Table A 4-1. UGC heat demand.

Uman	2006	2007	2008	2009	2010	2011	2012
Greenhouse area, hm^2	14,9	10,9	15,2	20,4	22,5	22,5	22,5
New greenhouses	4,0	4,0	8,3	13,5	16,3	16,3	16,3
Old greenhouses	10,9	6,9	6,9	6,9	6,2	6,2	6,2
Heat demand, GJ	545408	388759	518296	675848	731880	731880	731880
Talne							
Greenhouse area, hm^2	2,3	12,0	12,0	12,0	12,0	12,0	22,0
New greenhouses	0,5	10,2	10,2	10,2	10,2	10,2	20,2
Old greenhouses	1,8	1,8	1,8	1,8	1,8	1,8	1,8
Heat demand, GJ	85554	377764	377764	377764	377764	377764	679011

Old greenhouses are illuminated when the length of the day falls, while new greenhouses have to be illuminated constantly. Electricity consumption is determined based on total installed capacity of appliances; its levels according to UGC development plans are in table A 2-1.

Plants consume large amounts of CO_2 during their lifetime, high concentration of CO_2 in greenhouses increase their bioproductivity and consequently the vegetable yields. Therefore, CO_2 has to be constantly supplied to the greenhouses. During the heating season the CO_2, which occur as a result of heat generation, is used; and in summer time natural gas is combusted exclusively for these needs. CO_2 demand is estimated based on monthly natural gas consumption rates per one hm^2, provided by the Enterprise. These amounts are equal for both scenarios; therefore, they are not accounted.

Fig. A 4-2 UGC production cycle.

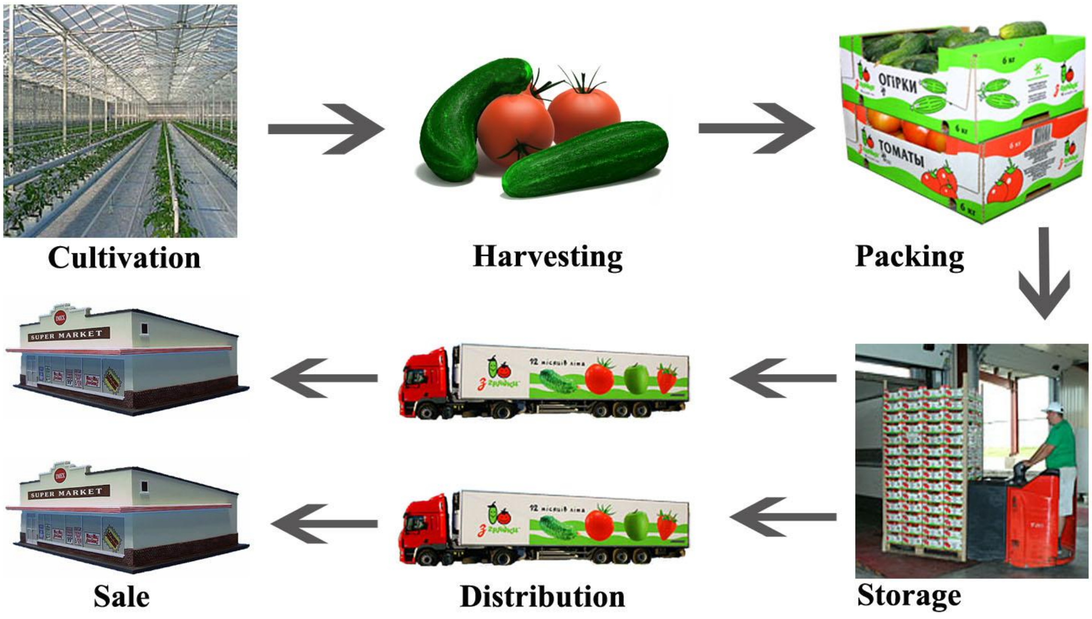

Fig. A 4-3 Two types of greenhouses employed at UGC.

Technologies to be employed by the project

The project uses the state-of-the-art technologies, which will result in a significantly better performance than commonly used technologies in Ukraine (natural gas fired boilers for heat generation and generation of electricity by power stations of national grid).

The proposed JI project activity comprises the increase in the efficiency of energy carrier consumption resulting from the two project interventions:

- Installation of three cogeneration units "Caterpillar G3520C" with "FRERK" exhaust-heat modules for combined heat and power generation in Uman.
- Installation of two heat utilizers TUV-16 for the utilization of waste heat from natural gas combustion at Talne Gas Compressor Station "Talne", a part of Ukrtransgas – the Affiliate of Naftogaz of Ukraine.

Technologies that were implemented by the proposed project are not likely to be substituted by other or more efficient technologies within the project period as they were specially developed for the needs of UGC.

Cogeneration units

Cogeneration unit consists of a natural-gas powered reciprocating engine generator set, three-flow heat utilization module, switchgear and controls. First flow of heat utilization module uses the heat of jacket water, oil cooler and air-cooled turborefrigerator - Stage 1; separate secondary flow of air-cooled turborefrigerator - Stage 2 is equipped with thermostat and pump; and third flow – the consumer water flow – is combined with the common plate heat exchanger, which collects the utilized heat and transfers it to consumer water flow. Nominal technical characteristics are in the table A 4-2 below.

Generator sets #1 and #2 are equipped with exhaust gases purification system ECO2Pro type 64 produced by Steuler Anlagenbau GmbH&Co.KG. In addition to three-flow heat utilization module generator set #3 is equipped with exhaust gases heat utilizer, directing the utilized heat to the common plate heat exchanger of the three-flow heat utilization module. Exhaust gases are purified by the catalyst installed for this set. Technical information is presented in tables A 4-3 and A 4-4 below.

Fig. A 4-4 Gas generator set Caterpillar G3520C.

Table A 4-2. Technical characteristics of gas generator set Caterpillar G3520C

Parameter	Nominal value
Manufacturer	Caterpillar
Fuel type	Natural gas
Fuel system	Low pressure
Cooling type	Two stage aftercooler, JW + O/C + A/C 1 combined
Electrical efficiency, %	40.6
Heat efficiency, %	42.98
Combined efficiency, %	83.3
Fuel Consumption: 100% load 75% load 50% load	 8.88 9.13 9.54
Power rating, ekW	2000
Heat output rate, kW	2287
Emissions NOx (5% O2), mg/Nm^3 CO (5% O2), mg/Nm^3 THC (total) (5% O2), mg/Nm^3 NMHC (5% O2), mg/Nm^3 CO2 (5% O2), mg/Nm^3 Exhaust O2 (dry)	 500 981 2633 395 208587 9.4

Table A 4-3. Exhaust gases purification system ECO2Pro type 64

Parameter	Nominal value
Manufacturer	Steuler Anlagenbau GmbH&Co.KG
System input: NO_x (NO_2), dry (5% O_2), mg/Nm^3 NO:NO_2 proportion CO, dry (5% O_2), mg/Nm^3 CO_2, % O_2, % H_2O NMHC, humid (5% O_2), mg/Nm^3 Dust Exhaust gases temperature (100% load, 1 unit), C° Exhaust gases volume (100% load, 1 unit, 0 C°, 101,3 kPa), Nm^3/year	 max 500 90:10 max 981 5 9.5 7 max 395 <10 450 9.275
System output: NO_x, ppm N_{ox}, ppm C_2H_4, PPB NH_3, mg/Nm3 CO, ppm CO_2 output temperature, C° Carbamide concentration, % Carbamide use, l/year	 10-15 30 <450 <5 <10 120 40 5.5

Table A 4-4. Exhaust gases purification catalyst

Parameter	Before	After
NO_x, (5% O_2) mg/Nm^3	500	500
CO, (5% O_2) mg/Nm^3	970	450

Heat utilizers

Heat-utilizer TUV-16 is a vertical water-tube double-drum boiler with forced water circulation working under positive pressure. TUV-16 is mounted behind the gas compressor unit and makes up a cogeneration system with it.

TUV-16 consists of:

- convection bank module;
- joining gas conduit with compensators, maintenance access hole, control and cut-off valves;
- extra exhaust pipes with manual registers;
- tubing within heat-utilizer;
- electrical equipment and control panel.

Technical characteristics of heat-utilizers TUV-16 are presented in the table A 4-5.

The utilized heat in the form of hot water is transported to UGC greenhouses through the 1.5 km long isolated pipeline.

Table A 4-5. Technical characteristics of heat utilizers TUV-16.

Parameter	Nominal value
Manufacturer	STE “Ukrpromenergo”
Heat output rate, kW	16000
Efficiency, %	79,5
Gas-compressor unit exhaust gases temperature, °C Input Output	 480 100
Temperature of water, °C Input Output	 70 115
Water pump capacity (2 pumps), kW	90
Dimensions, mm	6150x4600

As it was mentioned above, before project implementation natural gas fired boilers were installed at UGC, thus extensive initial trainings of the personnel were conducted to ensure proper operating and maintenance of the cogeneration units in Uman and heat-utilizers in Talne. The trainings have been provided by technical consultant of Power Units Department of Zeppelin Ukraine LLC on December 18th, 2009. According to the Act on Conducting the Trainings boiler-house manager, electrical engineers, cogeneration units’ operators have successfully passed the training course on general principles of functioning and the rules of operation of the installed equipment as well as were acquainted with the specific characteristics of the CHPs and safety regulation.

Due to the installation of the above mentioned equipment one gas-fired water boiler KVNm in Uman will have to be dismantled. Table A 4-6 contains its technical characteristics.

Table A 4-6. Technical characteristics of gas-fired water boiler KVNm dismantled.

Parameter	Nominal value
Manufacturer	
Heat output rate, kW	1160
Efficiency, %	98
Natural gas consumption rate, m^3/hour	120±2,5
Temperature of water, °C Input Output	 95 55
Temperature of exhaust gases, °C	60
Emissions NO_x, mg/m^3 CO, mg/m^3	 250 130

Implementation schedule:

The decision to launch the project was made in the beginning of 2006.

Investment stage started in December 2006, when the contract on the project design for heat utilization has been concluded, and lasted till May 2009.

Operation phase began in November 2009, when three Caterpillar G3520C cogeneration units in Uman were put into operation. In December 2009 one heat-utilizer TUV-16 started to operate, the other TUV-16 is expected to put into operation in 2011.

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

Reduction of GHG emissions under the JI project in comparison with the baseline scenario is ensured by the following:

1. Overall increase in the efficiency of energy carrier use due to the combined heat and power generation;
2. On site electricity generation which has lower emission factor than electricity produced by the power plants of the national electricity grid and also leads to the decrease in electricity transmission losses;
3. Waste heat utilization to cover part of the Enterprise’s heat demand which eliminates the need for natural gas combustion.

Subtotal estimated reductions of CO_{2e} emissions under the JI project during 2009-2012 are **148 913 tonnes** CO_{2e}**,** subtotal estimated reductions of CO_{2e} emissions during 2013-2020 are **467 988** tonnes CO_{2e}. Total CO_{2e} emission reductions during 2009-2020 are **616 901** tonnes CO_{2e}.

The proposed JI project activity faced significant barriers to its implementation, including technological, organizational and financial barriers. In 2006 the prevailing practice in Ukraine was heat generation by nonrenewable fuel combustion and purchase of electricity from national power grid. Even though in 2005 the Cogeneration Act was adopted by Ukrainian Parliament it was not effective enough to create enabling environment for cogeneration projects in Ukraine. Experts point out the contradictions of this law with existing legislation, including tax laws, as reasons for its poor effect[1]. In 2006 waste heat utilization at gas compressor stations was not a common practice as well. In 2004 State Company "Ukrtransgas" reported the launch of a pilot cogeneration project at Bogorodchany Gas Compressor Station No. 21, Ivano-Frankivsk oblast. The experience gained there was meant to be spread to other Ukrainian gas compressor stations.

Overall, without being registered as a JI project, the project scenario would be prevented by the above mentioned barriers as well as lower NPV of the project activity compared to the equipment costs and operation expenses under the baseline scenario.

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

	Years
Length of the crediting period	12
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2009	7853
2010	40781
2011	41780
2012	58499
Subtotal 2009-2012 (tonnes of CO_2 equivalent)	148913
Annual average of estimated emission reductions over the first commitment period (tonnes of CO_2 equivalent)	47025
2013	58499
2014	58499
2015	58499
2016	58499
2017	58499
2018	58499
2019	58499
2020	58499
Subtotal 2013-2020 (tonnes of CO_2 equivalent)	467988
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	616901
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	55245

[1] Volodymyr Smelik, Vladyslav Smelik and Dmytro Sakharuk. Investing in cogeneration for Ukraine – how to develop projects successfully. Cogeneration and On-Site Power Production. http://www.cospp.com/display_article/346780/122/CRTIS/none/none/1/Investing-in-cogeneration-for-Ukraine-%E2%80%94-how-to-develop-projects-successfully/

A.4.5. Confirmation that the proposed small-scale project is not a debundled component of a larger project:

The proposed project is not a debundled component of a larger project as UGC is not a project participant to a JI SSC project with a publicly available determination in accordance with paragraph 34 of the JI guidelines and there are no JI projects within 1 km of the project boundary of the proposed project at the closest point.

A.5. Project approval by the Parties involved:

The Project Idea Note had been submitted for review of the National Environmental Investment Agency of Ukraine. The National Environmental Investment Agency issued a Letter of Endorsement # 516/23/7 from 15th of May, 2009 for the project providing its support for further development of proposed joint implementation project. In accordance with the "Requirements for the Joint Implementation Projects preparation" approved by National Environmental Investment Agency of Ukraine (Order #33 from 25th of June, 2008) to receive a Letter of Approval for the JI project the project proponent should provide to the National Environmental Investment Agency of Ukraine the final determination report of the proposed project along with project design documentation and the copy of Letter of Endorsement.

The final PDD will be sent along with the determination report to the National Environmental Investment Agency pursuing the Letter of Approval (LoA), which usually is expected within 30 days after PDD submission.

SECTION B. Baseline

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

The baseline is the scenario that reasonably represents the anthropogenic emissions by sources or anthropogenic removals by sinks of greenhouse gases that would occur in the absence of the project[2].

Feasible options are combined into alternative baseline scenarios. Each aggregated scenario is evaluated to determine which one faced the least barriers to implementation at the time when the project activity was planned and which one was the most financially attractive thus being the baseline scenario.

The baseline scenario justified in part B.2 stipulates that industrial plant (UGC) continues to operate with equipment replacement as needed with no change in equipment efficiency (the frozen-efficiency scenario). For the proposed JI project owner it means satisfying electricity demand by purchasing energy from the national grid, and covering production process' heating needs by natural gas combustion in water boilers. To satisfy the growing demand for heat due to UGC enlargement plans 2 new boilers of the similar performance as the newest ones at the Enterprise would need to be installed.

Indication and description of the approach chosen regarding baseline setting

In line with Guidelines on criteria for baseline setting and monitoring (Version 2, adopted JISC 18 meeting in October, 2009) a JI specific approach with combination of approved CDM methodologies was used for the proposed project baseline and monitoring setting.

Justification of the baseline chosen was performed using the alternatives to the project activity proposed by the following methodologies: Approved baseline methodology AM0014 "Natural gas-based package cogeneration" (Version 04) (for site in Uman) and Approved consolidated baseline and monitoring methodology ACM0012 "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" (Version 03.2) (for site in Talne)[3].

Basic assumptions of the baseline methodology in the context of project activity are the following:

- Heat generation by the cogeneration units Caterpillar G3520C and heat-utulizers TUV-16 within the project activity refers to heat generation by natural-gas fired boilers in the baseline.
- Electricity generation by the cogeneration units in the project scenario will substitute electricity generation by the power plants of national grid in the baseline.
- Heat energy and electricity demand of the Enterprise in the baseline and project scenarios is equal.

Baseline emissions are proportional to the amount of baseline fuel consumption that is offset by heat and electricity supplied by the natural gas cogeneration system.

Due to the similar nature of the effect resulting from the employment of heat-exchange technology, namely the substitution of the heat energy, which in the absence of the project activity would have to be

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[2] FCCC/KP/CMP/2005/8/Add.2

[3] The Approved consolidated baseline and monitoring methodology ACM0012 "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" (Version 03.2) is refered to for baseline alternatives only.

produced by natural gas-fired water boilers, the similar approach for baseline emissions calculation as in the Approved baseline methodology AM0014 "Natural gas-based package cogeneration" (Version 04) for this technology was used.

Table B-1 illustrates why the Approved baseline methodology AM0014 "Natural gas-based package cogeneration" (Version 04) can be applied to the proposed JI project and points out the adaptations required to incorporate the project specifics.

Additionality analysis was performed using the latest version of the Tool for demonstration and assessment of additionality (Version 05.2).

Table B-1. Applicability of the Approved baseline methodology AM0014 "Natural gas-based package cogeneration" (Version 04) for the proposed JI project activity

AM0014 Applicability	Project activity characteristics
The electricity and heat requirement of the consuming facility is generated in separate systems (i.e. electricity and heat in the baseline cannot be generated in another cogeneration facility) in the absence of the project activity;	***Full correspondence***. In the absence of project activity electricity is purchased from national grid and heat is produced by natural gas combustion in water boilers.
The cogeneration system is either third party cogeneration systems, i.e. not owned or operated by the consuming facility that receives the heat and electricity from project cogeneration systems or the cogeneration system is owned by the industrial user (henceforth referred to as self-owned) that consumes the heat and electricity from project cogeneration systems;	***Full correspondence***. In the case of the proposed JI project activity the cogeneration system is self-owned.
The cogeneration system provides all or a part of the electricity and or heat demand of the consuming facility;	***Full correspondence***. Cogeneration system covers the electricity demand of the facility and provides part of the required heat energy.
No excess electricity is supplied to the power grid and no excess heat from the cogeneration system is provided to another user;	***Adaptation required.*** Excess electricity is to be supplied to national grid.
In the case project activity displaces electricity from fossil fuel based, dedicated power plant(s), methodology can only claim reductions from only that fraction of displaced electricity from the baseline dedicated power plant(s), for which it can be demonstrated that project activity led to reduction in generation of baseline dedicated power plant (s).	***N/A.*** Standardized emission factors are used.

Application of the approach chosen

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

In considering options for heat and electricity supply and the ongoing management of the facility, UGC and its investors sought reliability, regular supply, simplicity of operation and minimal capital outlay.

Options for project site in Uman[4]

1. Project owner continues to operate with equipment replacement as needed with no change in equipment efficiency (The frozen-efficiency scenario).
2. Project owner continues to operate with improved efficiency new equipment at the time of equipment replacement using a less carbon intensive fuel.
3. Project owner upgrades the thermal energy generating equipment and therefore increases the efficiency of boiler(s) immediately.
4. The heat and or electricity demand of the project owner is reduced through improvements in end-use efficiency.
5. Installation of a cogeneration system owned by the project owner.
6. Installation of a package cogeneration system owned by a company other than the project owner.
7. Installation of a cogeneration system by a third party.

Options for project site in Talne[5]**:**

1. On-site or off-site existing/new renewable energy based cogeneration plant;
2. On-site or off-site existing/new fossil fuel based cogeneration plant;
3. An existing or new fossil fuel based boilers;
4. An existing or new renewable energy based boilers;
5. Any other source such as district heat;
6. Other heat generation technologies (e.g. heat pump or solar energy);
7. Steam/Process heat generation from waste energy, but with lower efficiency;
8. Cogeneration with waste energy, but at a lower efficiency;
9. Implementation of the project activity without ERU revenue.

All of the options are consistent with current Ukrainian legislation. Their feasibility analysis follows:

<u>Options for site in Uman</u>

1. **Project owner continues to operate with equipment replacement as needed with no change in equipment efficiency (The frozen-efficiency scenario).**
The efficiency of the water boilers already installed at the Enterprise is relatively high (95% compared to 90% proposed by the AM0014 methodology in order to maintain conservativeness), and the equipment itself is rather new (assembled in 2001 and later). Therefore, the frozen efficiency scenario in the absence of the JI mechanism would be the most likely.

2. **Project owner continues to operate with improved efficiency new equipment at the time of equipment replacement using a less carbon intensive fuel.**
In 2006 all of the boilers at UGS were natural-gas fired. All the necessary infrastructure was in place and the system was optimized. In January, 2006 natural gas price for UGC was UAH 490.6 without VAT, and in February, 2006, Government of Ukraine has adopted the maximum gas price level for industrial users till 2010. According to Resolution # 128 of Cabinet of Ministers of Ukraine[6] from 9th of February

[4] In agreement with the approved baseline methodology AM0014 “Natural gas-based package cogeneration” (Version 04)；

[5] In line with approved consolidated baseline and monitoring methodology ACM0012 “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” (Version 03.2).

[6] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=128-2006-%EF

2006 the gas price should not exceed USD 110[7] per 1000 m^3 of natural gas. This decision was followed by Resolution #176 of National Electricity Regulation Commission[8] from 16 of February, 2006 stating that natural gas price for industrial users would not exceed UAH 548. Thus, natural gas was regarded as a reliable energy source with stable prices, guaranteed by Ukrainian government. Overall, situation at the beginning of 2006 has favored the continuation of natural gas use.

Less carbon intensive than natural gas fuels are, for example, biomass, biomass pellets or biogas. Taking biomass as an alternative would require installation of biomass-fired boilers, special infrastructure development (large territory for storage facilities, proper inflammation control etc.), logistics setting (ensuring timely biomass delivery etc.), high transportation costs, hiring additional staff for maintenance, their training, ensuring straw quality control etc. Using biomass pellets as an alternative fuel, in addition to the requirements described, was also facing the constrained availability of pellets on the market – up to 90% of the pellets produced in Ukraine are exported to European countries[9]. Opting for biogas would not require the boilers replacement, but additional equipment such as methane tanks, biogas purification and enrichment systems would need to be installed. Similarly to other biomass fuels, using biogas imposed establishment of storage places, logistics setting and hiring trained specialists, biogas substrate production or purchase costs. Overall, the realization of this option was prevented by economical, financial and technological barriers.

3. **Project owner upgrades the thermal energy generating equipment and therefore increases the efficiency of boiler(s) immediately.**
The efficiency increase potential of the UGC water boilers in 2006 was to large extent already realized. Efficiency of the operating boilers is 94% and higher. In case the existing boilers are replaced by more efficient ones (maximum efficiency of the offered boilers at the market is 96%) the total natural gas economy would be 250 thousand m^3 annually which is not enough to cover the cost of boilers replacement.

4. **The heat and or electricity demand of the project owner is reduced through improvements in end-use efficiency.**
Major heat demand of the Enterprise is constituted by the heating needs of the greenhouses, which are the systems with fixed heating requirements and limited potential for the end-use efficiency increase. More to it, this potential was to large extent realized already in the course of an end-use energy efficiency program which has been successfully implemented at the Enterprise. The program included inter alia: automatized climate control system installation, thermoinsulation, joint packing, heating units' distribution optimization etc. Therefore, it could not be considered as reliable option to reduce the energy consumption at the Enterprise.

5. **Installation of a cogeneration system owned by the project owner.** It is understood that in this option the project owner buys the equipment and installs it by his own. The obstacles for this option include lack of the experience and *"know-how"* of the UGC technical personnel for installation and startup, as well as the maintenance of cogeneration systems. This imposed high technological risk which could prevent the project from realization.

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7 Exchange rate in 2006:1 USD = 5.05 UAH

8 Resolution #176 "On adoption of the natural gas price maximum level industrial users" of National Electricity Regulation Commission from 16 of February, 2006 http://ukrgazenergo.ua/ua/kompany/normatively/index.shtml

9 D&P Consult. Ukrainian pellets market overview, 2009.

6. **Installation of a package cogeneration system owned by a company other than the project owner.** If a cogeneration system were owned by a company other than the UGC, and this company was responsible for installation, running and maintenance of the system, and was selling the heat and electricity produced to the UGC, the technological barriers would be much lower. However, such business scheme is not common in Ukraine and there were no companies offering this kind of partnership to UGC at the time when the decision about the project implementation was made.

7. **Installation of a cogeneration system by a third party.** This option is the realization of the project activity without ERU revenue. In the case of cogeneration system installation by a third party, responsible for fitting-up and periodic maintenance of the system, leaving its operation to UGC specialists, the technological and *"know-how"* risks described earlier are also reduced. It also includes the UGC ownership of the produced energy.

Options for site in Talne

1. On-site or off-site existing/new fossil fuel based cogeneration plant.
This option includes installation of natural gas cogeneration units similar to those chosen for Uman with heat rating 2.29 MW. To cover the heat demand increase of the site in Talne the installation of 38 cogeneration units is required. Provided that there is no need in electricity generation for this site as its demand is covered by the electricity produced in Uman, this option is clearly economically unattractive.

2. On-site or off-site existing/new renewable energy based cogeneration plant.
In this option the cogeneration units are the same as in previous one, but the fuel is biogas. It increases overall investment needed for cogeneration units' purchase and installation by the expenses related to biogas production. It is also clearly economically unattractive.

3. An existing or new fossil fuel based boilers.
The efficiency of the natural gas fired water boilers already installed at the Enterprise was relatively high (94% and higher) and the equipment itself was rather new (assembled in 2001 and later). The growing heat demand of the site in Talne could be satisfied by installation of the 2 new water-boilers of the similar performance as the latest purchased by the Enterprise. It faced no barriers.

4. An existing or new renewable energy based boilers.
In 2006 all of the boilers at UGS were natural-gas fired. All the necessary infrastructure was in place and the system was optimized. In January, 2006 natural gas price for UGC was UAH 490.6 without VAT and in February, 2006, Government of Ukraine has adopted the maximum gas price level for industrial users till 2010. According to Resolution # 128 of Cabinet of Ministers of Ukraine[10] from 9th of February 2006 the gas price should not exceed USD 110 per 1000 m^3 of natural gas. This decision was followed by Resolution #176 of National Electricity Regulation Commission[11] from 16 of February, 2006 stating that natural gas price for industrial users would not exceed UAH 548. Thus, natural gas was regarded as a reliable energy source with stable prices, guaranteed by Ukrainian government. Overall, situation at the beginning of 2006 has favored the continuation of natural gas use.

In addition, considering, for example, biomass as a possible renewable fuel, taking this alternative would also require investments in new equipment purchase, special infrastructure development (storage facilities, proper inflammation control etc.) and logistics setting (ensuring timely biomass delivery etc.). Consequently, this option was prevented by economical, financial and technological barriers.

[10] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=128-2006-%EF

[11] Resolution #176 "On adoption of the natural gas price maximum level industrial users" of National Electricity Regulation Commission from 16 of February, 2006 http://ukrgazenergo.ua/ua/kompany/normatively/index.shtml

5. Any other source such as district heat.
District heat could not be considered an option for UGC site in Talne due to its high heat demand. Another way could be the end-use efficiency increase, but for greenhouses in Talne this potential was to large extent realized already: 94% of the greenhouse area in Talne is to be covered by highly efficient new greenhouses by 2012. The rest 6% represent type-2 greenhouses (see section A 4) are of improved energy efficiency. End-use energy efficiency improvements in Talne included inter alia automatized climate control system installation, thermoinsulation, joint packing, heating units distribution optimization etc. Therefore this could not be considered as reliable option to reduce the energy consumption at the Enterprise.

6. Other heat generation technologies (e.g. heat pump or solar energy).
There are no successful examples of employing heat pumps or solar energy at the scale comparable to the proposed project activity in Talne. Maximum available capacity of a heat pumps offered in Ukrainian market is 60 KW with maximum output temperature of water up to 65 °C[12]. Heat pumps cannot be used as an independent heat supplier[13]. Also due to the lack of technical knowledge and experience of dealing with this new for Ukraine technology performance failure risks are very high. Regarding solar energy situation is similar: no success stories of large scale heliosystems use, preventive technological barriers, high equipment costs and also requirements for additional territory for solar collectors installation. Overall, for UGC in 2006 this option was unrealistic.

7. Steam/Process heat generation from waste energy, but with lower efficiency.
Due to the fact that the heat utilizer TUV-16 is “one of its kind” specially developed for the proposed JI project activity (see Common practice analysis for more details) lower efficiency analogues did not exist. Hence, this option was not possible.

8. Cogeneration with waste energy, but at a lower efficiency.
Since combined heat and power generation itself was proved to be not rational for the site in Talne this option is not discussed (see option 1).

Conclusion
The above analysis identifies the following feasible alternatives to the proposed project activity:

Site in Uman: Option 1.
Site in Talne: Option 3.

When aggregated together there were three alternative scenarios which could be realized by UGC in the beginning of 2006:

1. *The continuation of the current practice (Options 1 in Uman; and 3 in Talne);*
2. *Implementation of the project activity without ERU revenue;*
3. *Implementation of the project activity with ERU revenue.*

Therefore, the baseline scenario is Alternative 1, which supposes that Project owner continues the current practice: the Enterprise consumes electricity supplied from the national grid; all of the heat required is produced by natural gas combustion in water boilers.

Baseline scenario presumes heat generation by natural gas fired boilers and electricity supply from the national grid, which is in line with national and sectoral policies and circumstances. Natural gas accounts

[12] http://teplonasos.com/fighter1330ua.html

[13] http://www.actahort.org/members/showpdf?booknrarnr=245_30

for 52-58% of fuel, which is used for heat generation by boilers in Ukraine[14]. Using natural gas fired boilers with efficiency from 94% up to 98% (that is relatively high in comparison with 90% proposed by the AM14000 methodology) is totally in line with national energy policy. The other important issue, which should be taken into consideration, is environmental pollution. Natural gas is the less carbon intensive fuel[15] among the commonly used fuels for heat energy generation in Ukraine[14]. As Ukraine has a surplus in electricity generation[16], its supply from the national grid to satisfy the Enterprise's demand totally corresponds with sectoral circumstances.

The establishment of the baseline is carried out with taking into account the mandatory laws and regulations.

For calculation of GHG emissions due to natural gas combustion and electricity consumption actual data and predicted figures have been used.

Key information and data used to establish the baseline scenario (variables, parameters, data sources, etc.) is provided below in tabular form (See also Sections D and E).

Data and parameters not monitored

Data/Parameter	***CHOR***
Data unit	GJ
Description	Cogeneration system heat output rate
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Technical specifications of cogeneration units
Value of data applied (for ex ante calculations/determinations)	8.25
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	***CEC***
Data unit	MW
Description	Cogeneration system electricity capacity
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Technical specifications of cogeneration units
Value of data applied	2

[14] Overview of Heating Sector in Ukraine // Center for Social and Economic Research, Kyiv, 2007, by Anna Tsarenko.

[15] *1996 IPCC Guidelines for National Greenhouse Gas Inventories*: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF). http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1wb1.pdf

[16] Overview of Electricity Market in Ukraine// Center for Social and Economic Research, Kyiv, 2008, by Viachaslau Herasimovich, Anna Tsarenko.

(for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	***UHOR***
Data unit	MW
Description	Heat utilizators capacity
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Technical specifications of heat utilizers
Value of data applied (for ex ante calculations/determinations)	16
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	e_b
Data unit	
Description	Industrial boiler efficiency (fraction, lower heating basis)
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Technical specifications of water boilers, average efficiency
Value of data applied (for ex ante calculations/determinations)	0.95
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	GWP_{CH4}
Data unit	tCO_2/tCH_4
Description	Global warming potential of CH4 valid for the commitment period.
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	2007 IPCC Fourth Assessment Report, WG1, Chapter 2, Table 2.14
Value of data applied	21

(for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data / Parameter	***EF_{NG}***
Data unit	*kg CO_2/GJ*
Description	CO_2 emission factor for natural gas combustion
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF). CEF has been converted to CO_2 emission factor through multiplying CEF by 44/12 and carbon oxidation factor 1.
Value of data applied (for ex ante calculations/determinations)	*56.1*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	***MLR***
Data unit	kg CH_4/GJ natural gas energy consumption
Description	Methane Leakage Rate in natural gas production, processing, transport and distribution
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1, Table 1-61 referring to Rabchuk et al (1991).
Value of data applied (for ex ante calculations/determinations)	*0.558*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data/Parameter	***$EF_{red\_elec\ grid}$***
Data unit	tCO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	“Ukraine - Assessment of new calculation of CEF” by TUV SUD Industrie Service GmbH (17.08.2007). See Annex 4 for details.
Value of data applied (for ex ante calculations/determinations)	*0.896*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data/Parameter	***$EF_{prod\_elec\ grid}$***
Data unit	tCO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	“Ukraine - Assessment of new calculation of CEF” by TUV SUD Industrie Service GmbH (17.08.2007). See Annex 4 for details.
Value of data applied (for ex ante calculations/determinations)	*0.807*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data and parameters monitored

Data/Parameter	***NCV_{ng}***
Data unit	GJ/1000 m^3
Description	Net calorific value for natural gas
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Supplier documentation
Value of data applied (for ex ante calculations/determinations)	The lowest value of natural gas NCV was applied for ex ante calculations
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be)	

applied	
Any comment	

Data / Parameter	$\boldsymbol{V_{NG}}$
Data unit	m^3
Description	Volume of natural gas consumed by cogeneration units
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial gas flow metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial metering of NG consumption and payment for it: - accuracy of gas flow meter is 0.02%; -once a year gas flow meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***CEP***
Data unit	MWh
Description	Cogeneration electricity generation
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial electricity metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Megacon Controls Ltd: - accuracy of electricity meter is 0.5%.
Any comment	

Data / Parameter	$\boldsymbol{CEO_{EG}}$
Data unit	MWh
Description	Cogeneration electricity supplied to electricity grid
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial electricity metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and	Conservative

procedures (to be) applied	
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial metering of electricity flow: - accuracy of electricity flow meter is 0.5%; -once a year electricity flow meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***CHO***
Data unit	Gkal
Description	Cogeneration heat supplied to industrial plant
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial heat metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial heat metering: - accuracy of heat meter is 0.02%; -once a year heat meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***HEHO***
Data unit	Gkal
Description	Heat exchangers heat supplied to industrial plant
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial heat metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial heat metering: - accuracy of heat meter is 0.5%; -once every four years heat meter is certified by state authorized laboratory.
Any comment	

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

The proposed project activity foresees combined heat and electricity generation by three Caterpillar G3520C cogeneration units in Uman and waste heat utilization by two heat utilizers TUV-16 in Talne. Generated heat energy will be used for covering heat energy demand of UGC's greenhouses in Uman and Talne. Electricity demand of the greenhouses in Uman will be covered by CHPs' produced electricity, and surplus amounts electricity will be purchased to the national grid.

Under the baseline scenario Project owner continues the current practice: the Enterprise consumes electricity supplied from the national grid; all of the heat required is produced by natural gas combustion in water boilers. The establishment of the baseline is carried out with taking into account the mandatory laws and regulations.

The GHGs emissions in the project scenario will be reduced in comparison with the baseline scenario by following:

1. Overall increase in the efficiency of energy carrier use due to the combined heat and power generation;
2. On site electricity generation which has lower emission factor than electricity produced by the power plants of the national electricity grid and also leads to the decrease in electricity transmission losses;
3. Waste heat utilization to cover part of the Enterprise's heat demand which eliminates the need for natural gas combustion.

In order to demonstrate the additionality of the proposed project activity the investment, barrier and common practice analyses were used.

Step 2: Investment analysis

To demonstrate that the proposed project activity was not the most financially attractive the investment comparison analysis was performed (Option II, sub-step 2a of the Tool for demonstration and assessment of additionality (Version 05.2). The indicator chosen is net present value (NPV).

Financial calculations have shown that for the project scenario without ERU sales net present value (NPV) of the project scenario was UAH 9 million greater than the same indicator in the baseline scenario, while NPV of project scenario with ERU sales was more than UAH 10 million lower. Thus, the project scenario without revenues from ERUs sale is not the most financially favorable. .

The key assumptions, which were taken into consideration, are the following:

1. The assessment period is not limited to the proposed crediting period of the JI activity 2009-2020, but extended to 23 years reflecting the substantial period of expected operation of the installed equipment (2006-2029).
2. The cost of financing expenditures (i.e. loan interest payment) is not included in the calculation of the project NPV.
3. Liquidating value of the assets was assumed at the level of 20% of their initial value. It was adjusted for the inflation level for the period 2010-2029 and added to the revenues as per 2029.
4. It was used 1.103 inflation index, that was average for 2003-2005.
5. All input values are used with VAT excluded.

6. UGC revenues from sources other than the ones occurring due to the project activity were not included in the calculation, because it was assumed that they remain equal for both scenarios.

In calculation of net present value the costs of main equipment (cogeneration units, heat utilizers), componentry (controls, valves, sensors etc.) and operational costs (natural gas cost, electricity cost, heat costs, expenses for maintenance and consumables) were taken into account.

Table B 2-1. Main equipment cost

Equipment	Cost without VAT, UAH	Year of purchase
Three cogeneration units with exhaust gases purification system	20 496 408	2008-2009
Heat utilizer #1	5 163 422	2006-2009
Heat utilizer #2	5 163 422	2010-2011

Total capital expenditures for project scenario are about 38.6 million UAH.

The parameters used in the financial analysis are based on the figures available to UGC at the time of decision making about the project implementation (in the beginning of 2006) and are detailed in table B 2-2 below.

Table B 2-2. Parameters used in financial analysis

Data	Value	Source of data
Natural Gas Price (UAH/1000 m3)	490,6	2006 figures, provided by the Enterprise
Electricity Price (UAH/MWh)	286	2006 figures, provided by the Enterprise
Heat Price (UAH/GCal)	90	Tentative price, provided by the Enterprise
Discount Rate	16.4 %	Loan rate in UAH as for January 2006
ERU Price (UAH)	100	Market data
Inflation index	1.103	Average inflation index for 2003-2005

The amount of electricity consumed in project scenario was taken equal to the electricity demand of the Enterprise and it was assumed that the rest of the electricity generated would be sold to the grid.

Results of NPV calculation are presented in the table B 2-3.

Table B 2-3. Net present values and capital expenditures for baseline and project scenario

	NPV (UAH) till 2029, with 16.4 % discount rate
Baseline scenario	-181 152 426
Project scenario	-190 337 956
Project scenario with ERUs sales	-172 912 693

The project scenario without additional revenues from emission reduction units sale was not the most financially attractive scenario. Overall, Project ERUs' revenues provide the Enterprise with necessary additional incentive for the project activities' execution.

10% fluctuations to the key prices (natural gas cost, electricity cost and heat costs) were applied in the sensitivity analysis. Although 10% increase in electricity prices would result in increase of NPV of the baseline scenario over NPV of the project scenario, but the difference is not significant (even less than

1% of NPV Baseline) and the other results of prices fluctuations showed that the baseline scenario is financially preferable.

Thus, sensitivity analysis confirms that baseline scenario is more financially favorable than the project one.

Table B 2-4. Sensitivity analysis results.

Natural gas price change	**-10%**	**No change**	**10%**
NPV Baseline	-172 889 305	-181 152 426	-189 415 546
NPV Project	-185 539 279	-190 337 956	-195 136 633
NPV Project with ERU	-168 114 016	-172 912 693	-177 711 370
Electricity sale price change	**-10%**	**No change**	**10%**
Electricity purchase price change	**-10%**	**No change**	**10%**
NPV Baseline	-171 500 309	-181 152 426	-190 804 542
NPV Project	-190 791 786	-190 337 956	-189 884 125
NPV Project with ERU	-173 366 523	-172 912 693	-172 458 862
Heat price change	**-10%**	**No change**	**10%**
NPV Baseline	-181 152 426	-181 152 426	-181 152 426
NPV Project	-181 458 261	-190 337 956	-199 217 651
NPV Project with ERU	-164 032 998	-172 912 693	-181 792 388

Step 3: Barrier analysis

Sub-step 3a: Identify barriers that would prevent the implementation of the proposed project activity.

In addition to financial barriers analyzed before, the project faced significant technological, organizational and prevailing practice barriers. Technological barriers included lack of skilled and properly trained personnel to operate and maintain the cogeneration units in Uman and heat-utilizers in Talne. For UGC the technological barriers existing for cogeneration in Ukraine are even more serious due to the need to ensure exhaust gases purity to be able to supply the part of them – the pure CO_2 – to the greenhouses. It makes cogeneration units with air purification equipment unique installations in Ukraine.

The heat-utilizers installed by UGC at Gas Compressor Station “Talne” are the “first of its kind”: they are the only 16 MW capable heat-utilizers installed at gas compressor station in Ukraine. Another project of this type was realized in Novopskovsk, Luhansk oblast, where two 8MW capable heat-utilizers were mounted at gas compressor station operated by Donbastransgas. This allows stating the existence of the barrier due to prevailing practice. Finally, this project intervention faces serious organizational barrier: Gas Compressor Station “Talne”, a part of Ukrtransgas – the affiliated company of Naftogaz of Ukraine, is a strategic entity with limited access. Installation of heat utilizers there, their operation and maintenance raises a number of legal, organizational and financial issues that need to be overcame in order to make the heat utilization possible.

Additionally, power generation projects have to obtain the license for power generation activity, which is reported as one of the serious administrative barriers for the business development in Ukraine. According to the study[17] provided by the International Financial Corporation, around 64% of the companies that are subject to obtain permits or licenses considered the licensing process as a difficult one.

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

The barriers identified do not exist for the baseline scenario which is the continuation of the current practice of purchasing national grid electricity and heat generation by natural gas consumption in gas-fired water boilers.

Step 4: Common practice analysis

Sub-step 4a: Analyze other alternatives similar to the proposed project activity.

According to the information obtained from Ukrainian Greenhouse Association, cogeneration is not common for greenhouse complexes in Ukraine. Prevailing practice is heat generation by non-renewable fuel combustion and purchase of electricity from national power grid. Heat generation in gas fired boilers is common practice in Ukraine given the easy availability of gas, its relatively low price in recent years and the need for high quality, reliable heat. In addition, natural gas combustion in boilers produces CO_2 of sufficient purity which allows its direct supplying to the greenhouses with no need for introduction of any emission purification systems.

Even though in 2005 the Cogeneration Act was adopted by Ukrainian Parliament it was not effective enough to create enabling environment for cogeneration projects in Ukraine. Experts point out the contradictions of this law with existing legislation, including tax laws, as reasons for its poor effect[18]. The first cogeneration projects were implemented in Ukraine after 2005, In September 2009, there were eleven cogeneration units in Ukraine, qualified by the National Agency of Ukraine for Efficient Use of Energy Resources[19]. None of them are at agricultural enterprises or in Cherkasy oblast.

In 2006 waste heat utilization at gas compressor stations was not common practice in Ukraine either. In 2004 State Company “Ukrtransgas” reported the plan to launch pilot cogeneration project at Bogorodchany Gas Compressor Station No. 21, Ivano-Frankivsk oblast. The experience gained there was meant to be spread to other approximately 80 Ukrainian gas compressor stations. This project was planned to be realized within the scope of Ukrainian Energy Efficiency Program (CMU Resolution #148 from 5.02.1997) and Ukrainian Program for the Support to Non-traditional and Renewable Energy Sources, and Small-scale Hydro- and Heat energy (CMU Resolution #1505 from 31.12.1997) [20]. Although the construction of 30 MW CHP plant for gas turbines waste heat utilization at Bogorodchany Gas Compressor Station No. 21 was reported to start in 2005 by American Company ContourGlobal[21], however, the project has not been executed and never reached the construction phase.
As it was mentioned in barrier analysis another project involving heat-utilizers installation was realized in Novopskovsk, Luhansk oblast, at Gas Compressor Station operated by Donbastransgas, a part of

[17] International Financial Corporation. 2005. Business environment in Ukraine.

[18] http://www.cospp.com/display_article/346780/122/CRTIS/none/none/1/Investing-in-cogeneration-for-Ukraine-%E2%80%94-how-to-develop-projects-successfully/

[19] List of cogeneration units meeting qualification reguirements. National Agency of Ukraine for Efficient Use of Energy Resources http://naer.gov.ua/?p=616

[20] Ukrainian Construction and Architecture Committee, Technical Council, Decision from 03.08.2005, No. 37 http://www.uapravo.net/data/base18/ukr18282.htm

[21] http://www.contourglobal.com/bogorodchany.html

Ukrtransgas Affiliated Company Naftogaz of Ukraine. However, the capacity of heat utilizers installed there is twice lower than in the proposed JI project activity. Thus, the project at Talne Gas compressor station is unique and therefore additional.

Conclusion

The chosen project scenario faced significant financial, technological, organizational and prevailing practice barriers which in the absence of JI mechanism would prevent the implementation of the project activity. The impact of revenue from ERU sales in improving the NPV of the project provided UGC with a significant enough incentive to mitigate the abovementioned barriers and implement the project scenario. The project is therefore additional.

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

There are the following sources of GHG emissions related to the proposed baseline and project scenarios:

- All sources of emissions that are not influenced by the projects have been excluded;
- All sources of emissions that are influenced by the projects have been included.

Table B 3-1. Sources of emissions included in consideration or excluded of it.

	Source	**Gas**	**Incl./ Excl.**	**Justification/Explanation**[22]
Baseline	Natural gas combustion for heat generation at water boilers	**CO_2**	**Incl.**	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Fuel consumption at the grid power generation	**CO_2**	**Incl.**	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Natural gas production, processing and distribution leaks	**CH_4**	**Incl.**	**May be a significant emission source**
Project	Natural gas consumption for heat and power generation by cogeneration units	**CO_2**	**Incl.**	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Natural gas production, processing and distribution leaks	**CH_4**	**Incl.**	**May be a significant emission source**

Baseline scenario

The baseline scenario is the continuation of current practice under which the project owner continues to operate with no change in equipment efficiency. The Enterprise consumes electricity supplied from the national grid; all of the heat required is produced by natural gas combustion in water boilers.

Baseline boundary (see Fig. B 3-1. beneath**)** includes water boilers in Uman and in Talne sites (for their technical characteristics refer to table B 3.2.). The only fuel consumed by the Enterprise was natural gas.

[22] According to approved methodology *AM0014 "Natural gas-based package cogeneration" (Version 04)* emissions of CH_4 and N_2O should be included. But due to the fact that they do not exceed 1 per cent of the annual average anthropogenic emissions by sources of GHGs, or an amount of 2,000 tonnes of CO_2 equivalent, they were considered negligible.

Table B 3-2. Technical characteristics of installed boilers (as in 2006)

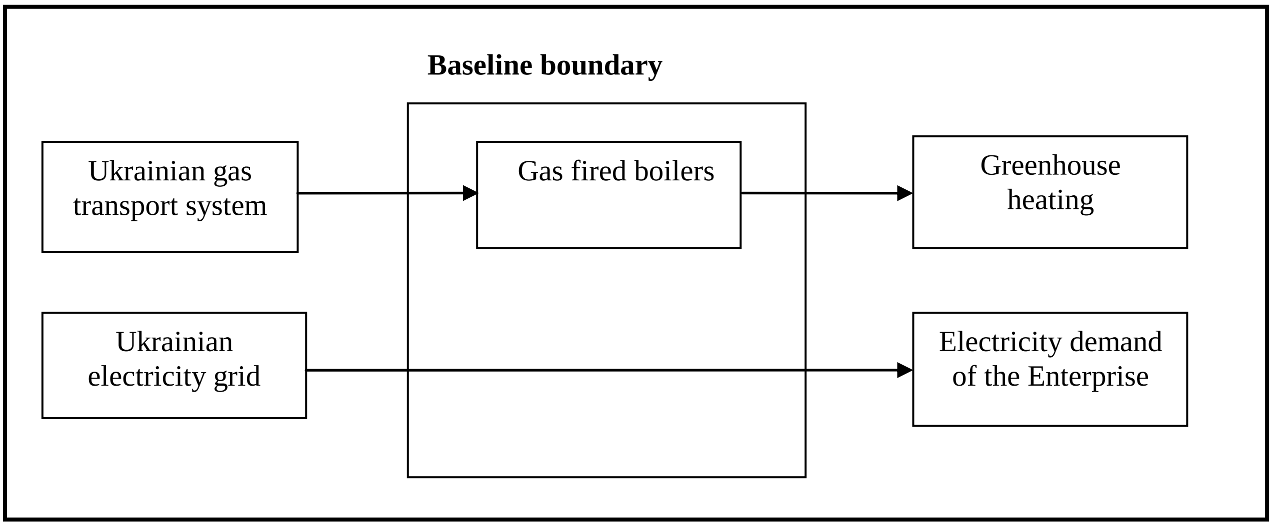
Boiler	Capacity, MW	Efficiency, %	Location
APV-3 #1	8,14	94,75	Uman
APV-3 #2	8,14	94,73	Uman
AV-3M #3	8,13	94,56	Uman
AV-3M #4	8,13	95,03	Uman
AV-3M #5	8,14	94,79	Uman
AV-3M #6	8,14	94,30	Uman
AV-3M #7	8,13	95,50	Uman
AV-3M #1	8,06	95,85	Uman
APV-3 #2	8,09	96,18	Uman
KVNm #1	1,16	98,01	Uman
AV-3M #3	8,13	93,96	Talne
AV-3M #4 (reserved)	7,49	94,51	Talne

In order to meet the growing UGC heat demand and to produce as much heat energy as the heat utilizers in the project scenario do the other two boilers would have to be installed in Talne. It is assumed, that the new boilers would be of the similar performance as the existing ones because of their high efficiency and being a common practice for the Enterprise.

It was estimated that the volumes of CO_2 produced by cogeneration units and purified in exhaust gases purification system are enough to satisfy the CO_2 demand for the supply to greenhouses for inside air enrichment at Uman site. Consequently, operating cogeneration units eliminates the need to burn natural gas to produce CO_2 in summer which leads to GHGs emission reductions. Despite this fact, these reductions were neglected in order to maintain conservativeness.

Project activity does not bring any change to the operation of UGC greenhouses in Khrystynivka, thus, this site cannot be attributed to the project. Such elements as power grid, connection to natural gas supply, Gas Compressor Station “Talne” are closely connected with the project, but are not under control of the project participants; therefore they are not included in the project boundary.

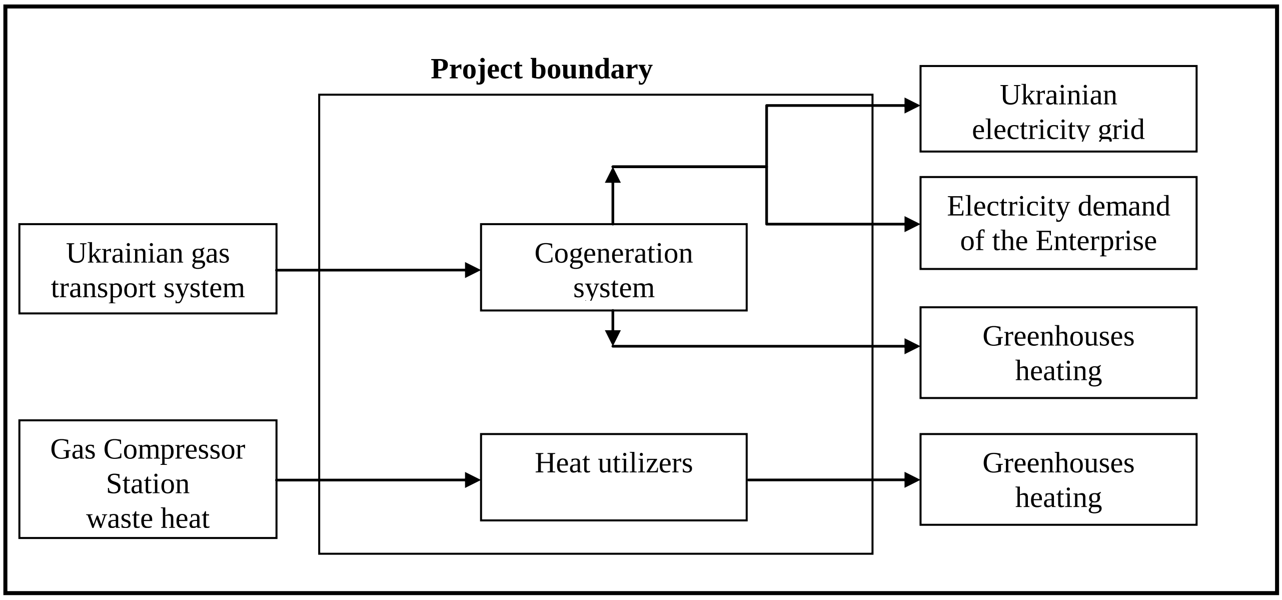
Fig. B 3-1. Baseline scenario boundary.



Project scenario

Project boundary (see Fig. B 3-2. beneath**)** includes operation of three cogeneration units producing heat and electricity, which is used for own needs and the excess of electricity is supplied to national power grid. Waste heat at Gas Compressor Station is utilized by two heat utilizers and used for heating needs (See also Section A for details).

Fig. B 3-2. Project scenario boundary



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

Date: 20th of October, 2010
Kyryl Tomlyak, LLC 'KT-Energy'
15 B/22 Biloruska st.,
Kiev, 04119, Ukraine
Tel/Fax. +(38 044) 493 83 32
ktomlyak@kt-energy.com.ua

LLC 'KT-Energy' is not a participant of this Project.

SECTION C. Duration of the small-scale project / crediting period

C.1. Starting date of the small-scale project:

Starting date of the project is January 24th, 2006, when the decision about project realization has been made. Project investment period started in December 2006 and its operational phase began in November 2009.

C.2. Expected operational lifetime of the small-scale project:

Operational lifetime of the project is 20 years or 240 months.

C.3. Length of the crediting period:

Start of the crediting period for proposed project activity is 1st of November 2009.

End of the first commitment period is 31st of December, 2012.

Thus, the length of the first commitment period: 3 years and 2 months (38 months).

The end of the crediting period is 31st of December, 2020. Thus, the length of the crediting period: 11 years and 2 months (134 months).

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

For monitoring of GHGs emissions a JI specific approach with elements of the approved baseline and monitoring methodology *AM0014 "Natural gas-based package cogeneration" (Version 04)* has been used. Monitoring plan is established in accordance with Host Party regulations, namely in accordance with Decree of Cabinet of Ministers of Ukraine #206 dated 22.02.2006 'On Approval of the Procedure of Drafting, Review, Approval and Implementation of Projects Aimed at Reduction of Anthropogenic Emissions of Greenhouse Gases' and "Requirements for the Joint Implementation Projects preparation" approved by National Environmental Investment Agency of Ukraine (Order #33 from 25th of June, 2008).

Monitoring plan has also been established in accordance with *Appendix B of the JI guidelines* and taking into account *Guidance on criteria for baseline setting and monitoring* developed by JISC. The formulae applied correspond to those proposed by the approved baseline and monitoring methodology *AM0014 "Natural gas-based package cogeneration" (Version 04)*.

The approved baseline and monitoring methodology AM0014 cannot be used in full as it implies no excess electricity to be supplied to the power grid. Since electricity supply to the national grid is foreseen within project boundaries, baseline CO_2 emissions from electricity supply to electricity grid, that are offset by electricity supplied from cogeneration system, should be taken into account. To estimate above mentioned CO_2 emissions cogeneration electricity supply to the national grid will be monitored and multiplied by relevant emission factor for electricity from public supply (For more detail see paragraph on baseline emissions estimation).

Besides, the monitoring methodology AM0014 will be used for the monitoring of the following sources of emissions:

- CO_2 emissions from the combustion of natural gas for heat generation in the baseline and heat and electricity generation in the project;
- CH_4 emissions from natural gas production, processing and distribution leaks.

Monitoring of CH_4 and N_2O emissions from natural gas combustion excluded as they do not exceed 1% of annual average anthropogenic emissions by sources of GHGs, and therefore were considered negligible.

The project involves two different interventions:

1. Installation of three cogeneration units at Site in Uman;
2. Recovery of the waste energy by two heat utilizers installed in Talne.

Due to the similar nature of the effect resulting from the employment of heat-exchange technology, namely the substitution of the heat energy, which in the absence of the project activity would have to be produced by natural gas-fired water boilers, it was decided to use the similar approach for baseline emissions calculation as in the Approved baseline methodology AM0014 "Natural gas-based package cogeneration" (Version 04) for this technology also.

Emission reductions

Emission reductions for the project are estimated as the difference between baseline and project emissions:

$$ER_y = BE_y - PE_y$$

Project emissions
The project emissions are estimated by direct calculation of the natural gas consumption, electricity and heat generation converted in CO_2 emissions. For natural gas combustion, *IPCC* emission factors (EF) have been considered. The Net Calorific Value (NCV) taken is that provided by the Enterprise.

Project emissions comprise the following components:
- Carbon dioxide (CO_2) emissions from natural gas combustion in cogeneration system;
- Methane (CH_4) emissions from leakages at natural gas production, transportation, distribution and consumption.

Each of these is proportional to the natural gas consumption in the cogeneration system, which is monitored. In order to avoid double counting carbon dioxide (CO_2) emissions from energy consumption by heat utilizers are not included because the electricity required is to be produced by cogeneration units. Total project emissions are calculated as follows:

(1) $$PE_y = PE_{cs} + PE_{equiv\ fug},$$

where
PE_y – total project GHG-s emissions, tonnes CO_{2e}/year;
PE_{cs} – project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year;
$PE_{equiv\ fug}$ – project methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year;

Project carbon dioxide emissions from each of the sources are proportional to annual energy consumption of natural gas in cogeneration system which is calculated as follows:

(1.0.) $$AEC_{NG} = V_{NG} \times NCV_{NG}$$

where:
AEC_{NG} – annual energy consumption of natural gas in cogeneration system, GJ/year;
V_{NG} – volume of natural gas consumed by cogeneration units, m^3/year;
NCV_{NG} – natural gas net calorific value, GJ/thousand m^3.

(1.1.) $$PE_{cs} = AEC_{NG} \times EF_{NG},$$

where:
PE_{cs} – project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year;
AEC_{NG} – annual energy consumption of natural gas in cogeneration system, GJ/year;
EF_{NG} – CO_2 emission factor of natural gas (lower heating value basis), tonnes CO_2/GJ.
IPCC default value for EF_{NG} is 0,056 tonnes CO_2/GJ, [*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories:* Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF) CEF has been converted to CO_2 emission factor through multiplying CEF by 44/12 and carbon oxidation factor 1.]

(1.2.) $$PE_{equiv\ fug} = AEC_{NG} \times MLR \times GWP\ (CH_4) \times 10^{-3},$$

where:
PE** **equiv fug – project methane emissions from natural gas production and leakage in transport and distribution, corresponding to consumption of natural gas in cogeneration system, tonnes CO_{2e}/year;
$\boldsymbol{AEC_{NG}}$ – annual energy consumption of natural gas in cogeneration system, GJ/year;
MLR - Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (lower heating value basis), kg CH_4/GJ natural gas energy consumption;
GWP $\boldsymbol{(CH_4)}$ - global warming potential of methane = 21.

Default value for ***MLR*** corresponds to*1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1*[23]*: Eastern Europe and Former USSR – Emission Factors:*
- 0,218 kg CH_4/GJ of methane emissions at natural gas production [Table 1-61, page 1.129.55];
- 0,340 kg CH_4/GJ of methane emissions at natural gas processing, transport, and distribution [Table 1-61, page 1.129];

Baseline emissions
As the baseline scenario is the continuation of practice before implementation of the Project, the specific baseline energy consumptions have been calculated ex ante. In line with *AM0014 (Version 4)*, baseline emissions are those emissions associated with the generation of heat and electricity that are offset by the output of the cogeneration system. Same approach was applied for the heat utilizers. The CO_2 emissions were then calculated by applying same EFs as used for project emissions estimation. For electricity emission factors the *Global Carbon B.V. "Standardized emission factors for Ukrainian electricity grid"* are to be used (see Annex 4).

Baseline emissions are those emissions associated with the generation of heat and electricity that are offset by the output of the cogeneration system and heat utilizers.
Baseline emissions comprise three components:

- CO_2 emissions corresponding to the combustion of natural gas that would have been used if the cogeneration system did not provide heat to the plant;
- CH_4 emissions from natural gas production and leaks in the transport and distribution pipeline supplying the plant and leaks in the gas distribution piping within the plant, associated with the natural gas consumption;
- CO_2 emissions associated with the electricity that would have to be purchased from the power grid if the cogeneration system did not provide electricity to the plant.

The baseline emissions for the first four emission sources listed above are proportional to the amount of natural gas consumption in the plant that is offset by heat supplied by the natural gas cogeneration system and heat utilizers. Each can be represented as the product of an emission factor and energy consumption, which depends on the heat output of the cogeneration system.

The consumption of the natural gas in the baseline for the supply of heat is determined as follows:

$$(2.0) \qquad ABEC_{BF} = (CHO / e_b + HEHO / e_b)*4.1868,$$

where
$\boldsymbol{ABEC_{BF}}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
CHO – cogeneration heat supplied to industrial plant, Gkal/h;

[23] *1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1.* http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref10.pdf

HEHO – heat-exchanger heat supplied to industrial plant, Gkal/h;
e_b – boiler efficiency.

Total baseline scenario GHGs emissions are estimated using the formula below:

(2) $$BE_y = BE_{th} + BE_{th\ equiv\ fug} + BE_{elec\ grid} + BE_{elec\ own},$$

where
BE_y – total baseline GHG-s emissions, tonnes CO_{2e}/year;
BE_{th} – baseline CO_2 emissions from combustion of baseline fuel for heat supply, tonnes CO_2/year;
$BE_{th\ equiv\ fug}$ – baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year;
$BE_{elec\ own}$ – baseline emissions of CO2 from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year.
$BE_{elec\ grid}$ – baseline emissions of CO2 from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year.

(2.1.) $$BE_{th} = ABEC_{BF} \times EF_{BF},$$

where:
BE_{th} – baseline CO_2 emissions from combustion of baseline fuel for heat supply, tonnes CO_{2e}/year;
$ABEC_{BF}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
EF_{BF} - CO_2 emission factor of the fuel used to generate heat, tonnes CO_2/GJ.
IPCC default value for EF_{NG} is 0,056 tonnes CO_2/GJ, [*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF). CEF has been converted to CO_2 emission factor through multiplying CEF by 44/12 and carbon oxidation factor 1.]

(2.2.) $$BE_{th\ equiv\ fug} = ABEC_{BF} \times MLR \times GWP\ (CH_4) \times 10^{-3},$$

where:
$BE_{th\ equiv\ fug}$ – baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO2e/year;
$ABEC_{BF}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
MLR - Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (lower heating value basis), kg CH_4/GJ natural gas energy consumption;
$GWP\ (CH_4)$ - global warming potential of methane = 21.

Default value for ***MLR*** corresponds to*1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1*[24]*: Eastern Europe and Former USSR – Emission Factors:*
- 0,218 kg CH_4/GJ of methane emissions at natural gas production [Table 1-61, page 1.129.55];
- 0,340 kg CH_4/GJ of methane emissions at natural gas processing, transport, and distribution [Table 1-61, page 1.129];

[24]*1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1.* http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref10.pdf

(2.3.) $BE_{elec\ grid} = CEO_{EG} \times EF_{prod\_elec\ grid} \times 10^{-3}$,

where:
$BE_{elec\ grid}$ – baseline emissions of CO_2 from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year;
CEO_{EG} – cogeneration electricity supplied to electricity grid, MWh;
$EF_{prod\_elec\ grid}$ – baseline CO_2 emissions factor for electricity from public supply, kg CO_2/MWh. [*Carbon B.V. "Standardized emission factors for Ukrainian electricity grid"* are to be used (see Annex 4)].

(2.4.) $BE_{elec\ own} = CEO_{IP} \times EF_{red\_elec\ grid} \times 10^{-3}$,

where:
$BE_{elec\ own}$ – baseline emissions of CO_2 from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year;
CEO_{IP} – cogeneration electricity supplied to industrial plant, MWh;
$EF_{red\_elec\ grid}$ – baseline CO_2 emissions factor for electricity from public supply, kg CO_2/MWh [*Carbon B.V. "Standardized emission factors for Ukrainian electricity grid"* are to be used (see Annex 4)].

In case $CEO_{EG} = 0$, $CEO_{IP} = CEP$;
In case $CEO_{EG} > 0$, $CEO_{IP} = CEP - CEO_{EG}$,

where:
CEO_{EG} – cogeneration electricity supplied to electricity grid, MWh;
CEO_{IP} – cogeneration electricity supplied to industrial plant, MWh;
CEP – cogeneration electricity generation, MWh.

Table D 1-1. Data to be collected in order to monitor baseline and project emissions

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)
CEP Cogeneration electricity generation	Electricity meter	MWh	m	Daily	100%	Electronic (spreadsheet)
CEO_{EG} Cogeneration electricity supplied to electricity grid	Electricity meter	MWh	m	Daily	100%	Electronic (spreadsheet)
CHO Cogeneration heat supplied to industrial plant	Heat meter after cogeneration unit	Gkal	m	Daily	100%	Electronic (spreadsheet)
HEHO Heat-exchange boiler heat supplied to industrial plant	Heat meter after heat-exchange boiler	Gkal	m	Daily	100%	Electronic (spreadsheet)

VNG Volume of natural gas consumed by cogeneration units	Commercial gas flow meter	m3	m	Daily	100%	Electronic (spreadsheet)
NCV_{NG} Natural gas net calorific value	Supplier	GJ/thousand m3	m	Daily	100%	Electronic (spreadsheet)

In order to ensure accurate collecting and archiving of the monitoring data the special Monitoring Procedure was introduced at the Enterprise. According to the Procedure, all the necessary data will be collected by the UGC Department for Technical Modernization and will be kept for two years after the last transfer of ERUs for the project. The Head of the Department for Technical Modernization of the UGC is responsible for the performance of monitoring data required, LLC 'KT-Energy' is responsible for the calculations of emission reductions based on monitoring data that is provided by the Enterprise.

At the Enterprise Automated electricity metering system is incorporated, it collects and saves data on electricity export to the national grid. Besides, all metering equipment (except electricity meter for cogeneration electricity generation) has initial memory that saves data for the whole period of its functioning. Thus, double archiving of data will be provided. To ensure double archiving of data on cogeneration electricity generation, every month the data will be duplicated and saved on the computer of the Head of the Department for Technical Modernization.

Within the project activity polluters' emissions into the atmosphere are expected. The gases emitted from the cogeneration system are monitored and reported in compliance with the requirements of the State environmental monitoring service of the Committee on natural resources in Cherkasy oblast through official quarterly statistical form 2-tp (air) *Data on protection of atmospheric air*, which contains information on amounts of trapped and neutralized atmospheric pollutants, itemized emissions of specific pollutants, number of emission sources, measures on reduction of emissions into the atmosphere, emissions from particular groups of pollution sources. The forms 2-tp (air) *Data on protection of atmospheric air* has being archived at the Enterprise for at least two years since the last transfer of the ERUs for the project.

D.2. Data to be monitored:

The tables below identify data to be collected for monitoring of the emissions in the project and baseline scenarios.

Data and parameters not monitored

Data/Parameter	e_b
Data unit	
Description	Industrial boiler efficiency (fraction, lower heating basis)
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Technical specifications of water boilers, average efficiency
Value of data applied (for ex ante calculations/determinations)	0.95
Justification of the choice of data or description of measurement methods and procedures (to be) applied	

QA/QC procedures (to be) applied	
Any comment	

Data/Parameter	***GWP** $_{CH4}$*
Data unit	tCO_2/tCH_4
Description	Global warming potential of CH4 valid for the commitment period.
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	2007 IPCC Fourth Assessment Report, WG1, Chapter 2, Table 2.14
Value of data applied (for ex ante calculations/determinations)	21
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures (to be) applied	
Any comment	

Data / Parameter	EF_{NG}
Data unit	*kg* CO_2*/GJ*
Description	CO_2 emission factor for natural gas combustion
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF). CEF has been converted to CO_2 emission factor through multiplying CEF by 44/12 and carbon oxidation factor 1.
Value of data applied (for ex ante calculations/determinations)	*56.1*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	***MLR***
Data unit	kg CH_4/GJ natural gas energy consumption
Description	Methane Leakage Rate in natural gas production, processing, transport and distribution
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1, Table 1-61 referring to Rabchuk et al (1991).
Value of data applied (for ex ante	*0.558*

calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data/Parameter	$EF_{red\_elec\ grid}$
Data unit	tCO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	"Ukraine - Assessment of new calculation of CEF" by TUV SUD Industrie Service GmbH (17.08.2007). See Annex 4 for details.
Value of data applied (for ex ante calculations/determinations)	*0.896*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data/Parameter	$EF_{prod\_elec\ grid}$
Data unit	tCO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid
Time of determination/monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	"Ukraine - Assessment of new calculation of CEF" by TUV SUD Industrie Service GmbH (17.08.2007). See Annex 4 for details.
Value of data applied (for ex ante calculations/determinations)	*0.807*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

All fixed data and parameters are already available.

Data and parameters monitored

Data / Parameter	***NCV_{NG}***
Data unit	GJ/1000 m^3
Description	Net calorific value for natural gas
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Supplier documentation
Value of data applied (for ex ante calculations/determinations)	The lowest value of natural gas NCV was applied for ex ante calculations
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	***V_{NG}***
Data unit	m^3
Description	Volume of natural gas consumed by cogeneration units
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial gas flow metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial metering of NG consumption and payment for it: - accuracy of gas flow meter is 0.02%; -once every two years gas flow meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***CEP***
Data unit	MWh
Description	Cogeneration electricity generation
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial electricity metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative

QA / QC procedures (to be) applied	Quality of measurement is ensured by Megacon Controls Ltd: - accuracy of electricity meter is 0.5%.
Any comment	

Data / Parameter	***CEO_{EG}***
Data unit	MWh
Description	Cogeneration electricity supplied to electricity grid
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial electricity metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial metering of electricity flow: - accuracy of electricity flow meter is 0.5%; -once a year electricity flow meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***CHO***
Data unit	Gkal
Description	Cogeneration heat supplied to industrial plant
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial heat metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial heat metering: - accuracy of heat meter is 0.02%; -once every four years heat meter is certified by state authorized laboratory.
Any comment	

Data / Parameter	***HEHO***
Data unit	Gkal
Description	Heat exchangers heat supplied to industrial plant
Time of determination/monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Commercial heat metering at the Enterprise
Value of data applied (for ex ante calculations/determinations)	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Quality of measurement is ensured by Ukrainian standards applied for commercial heat metering: - accuracy of heat meter is 0.5%; -once every four years heat meter is certified by state authorized laboratory.
Any comment	

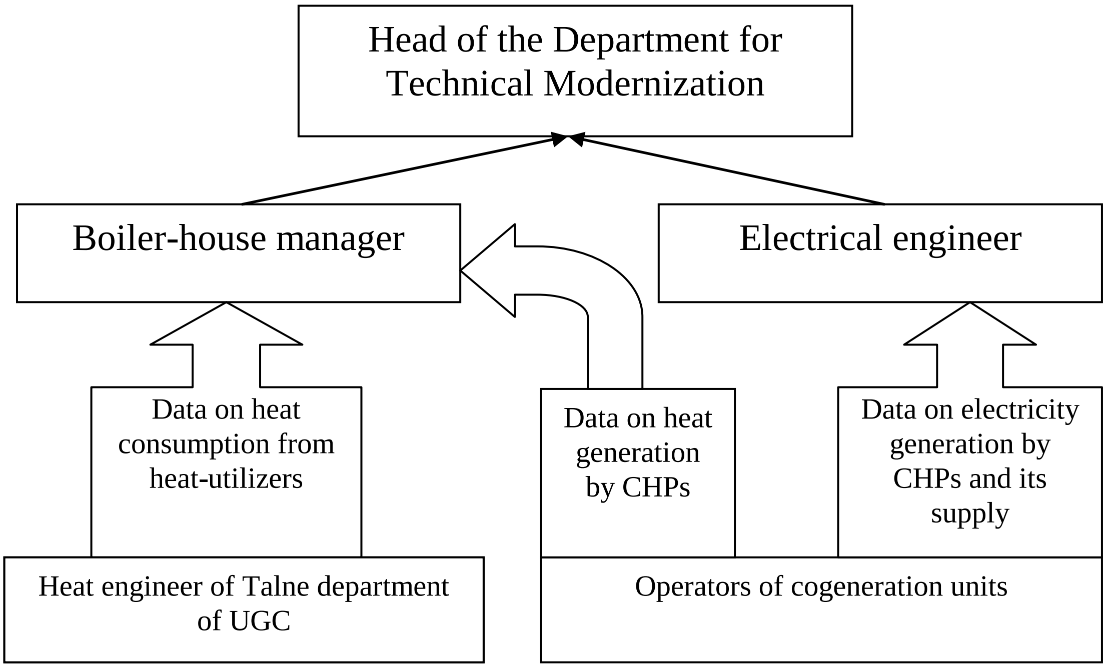
D.3. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

Data	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
V_{NG} Natural gas consumed by cogeneration units	*low*	*Devices used:* Gas flow meter. *Quality of measurement is ensured by Ukrainian standards applied for commercial metering of NG consumption and payment for it:* *- accuracy of gas flow meter is 0.02%;* *- once every two years gas flow meter is certified by state authorized laboratory.*
NCV_{NG} Natural gas net calorific value	*low*	*Supplier's data*
CEP Cogeneration electricity generation	*low*	*Devices used:* Terberg Power Orginizer. *Quality of measurement is ensured by Megacon Controls Ltd:* *- accuracy of electricity meter is 0.5%.*
CEO_{EG} Cogeneration electricity supplied to electricity grid	*low*	*Devices used:* Electricity meter after cogeneration unit. *Quality of measurement is ensured by Ukrainian standards applied for commercial metering of electricity flow:* *- accuracy of electricity flow meter is 0.5%;* *- once a year electricity flow meter is certified by state authorized laboratory.*

CHO Cogeneration heat supplied to industrial plant	*low*	*Devices used:* Heat meter after cogeneration. *Quality of measurement is ensured by Ukrainian standards applied for general metering of heat:* *- accuracy of the heat meter is 0.02%;* *- once every four years the heat meter is certified by state authorized laboratory.*
HEHO Heat-exchange boiler heat supplied to industrial plant	*low*	*Devices used:* Heat meter after heat-exchange boiler. *Quality of measurement is ensured by Ukrainian standards applied for commercial metering of heat:* *- accuracy of the heat meter is 0.5%;* *- once every four years the heat meter is certified by state authorized laboratory.*

D.4. Brief description of the operational and management structure that will be applied in implementing the monitoring plan:

In order to ensure accurate recording of the monitoring data the special Monitoring Procedure was introduced at the Enterprise. According to the Procedure, all the necessary data will be collected by the UGC Department for Technical Modernization. The management structure is on the chart below.



Monitoring data will be daily recorded by the operators of cogeneration units and heat engineer of Talne department respectively. On the basis of the data recorded boiler-house manager and electrical engineer will give monthly reports to the Head of the Department of Technical Modernization, who is responsible for the performance of monitoring data to LLC 'KT-Energy'.

LLC "KT-Energy" is responsible for the calculations of emission reductions based on monitoring data, which is provided by the Enterprise.

D.5. Name of person(s)/entity(ies) establishing the monitoring plan:

Date: 20th of October, 2010
Kyryl Tomlyak, LLC 'KT-Energy'
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LLC 'KT-Energy' is not a participant of this Project.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions and formulae used in the estimation:

The following assumptions were taken into account while estimating the project emissions:
- natural gas consumption for combined heat and power generation in 2009-2012 is estimated based on cogeneration unit energy consumption rate, which is 9.54 GJ/MWh;
- the electricity produced in Uman will be transported through power grid to other UGC sites (Talne and Khrystynivka) and will cover the electricity demand of the Enterprise. Therefore, CO_2 emissions from electricity consumption by heat-utilizers (90 kW water pump) are not included in the project emissions in order to avoid double counting;
- cogeneration units will operate 7000 hours annually.

CO_2 demand was calculated based on monthly natural gas consumption rates per hm^2, provided by the Enterprise (see table 1 in s2). CO_2 produced by cogeneration units and purified in exhaust gases purification system would be enough to satisfy the CO_2 demand for greenhouse air enrichment in Uman, therefore, it will substitute the CO_2 previously generated in boilers, leading to emission reductions (see table E-1). However, because the natural gas consumption for this purpose cannot be monitored directly, it was assumed that CO_2 generation is equal in both scenarios in order to maintain conservativeness.

Table E-1. CO_2 for Greenhouses Air Enrichment Demand and Supply in the Project Scenario for Site in Uman (May-August).

Years	CO_2 demand, tonnes	CO_2 supply by cogeneration units, tonnes
2009	0	0
2010	1831	5041
2011	1831	5041
2012	1831	5041
2013	1831	5041
2014	1831	5041
2015	1831	5041
2016	1831	5041
2017	1831	5041
2018	1831	5041
2019	1831	5041
2020	1831	5041
Total	20141	55451

Baseline and project scenario CO_2 generation and consumption levels at the site in Talne are equal; therefore they are not included in the calculation. Project emissions comprise the following components:

- Carbon dioxide (CO_2) emissions from natural gas combustion in cogeneration system;
- Methane (CH_4) emissions from leakages at natural gas production, transportation, distribution and consumption.

(1) $$PE_y = PE_{cs} + PE_{equiv\ fug},$$

where
PE_y – total project GHG-s emissions, tonnes CO_{2e}/year;
PE_{cs} – project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year;

***PE** $_{equiv\ fug}$* – project methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year;

Project carbon dioxide emissions from each of the sources are proportional to annual energy consumption of natural gas in cogeneration system which is calculated as follows:

(1.0.) $$AEC_{NG} = CEC \times AOH_{CS} \times FCR_{NG},$$

where:
AEC_{NG} – annual energy consumption of natural gas in cogeneration system, GJ/year;
CEC **–** cogeneration electricity capacity, MW
AOH_{CS} – annual operating hours of cogeneration system, hours per year;
FCR_{NG} – cogeneration system fuel consumption rate, GJ/MWh.

(1.1.) $$PE_{cs} = AEC_{NG} \times EF_{NG},$$

where:
PE_{cs} – project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year;
AEC_{NG} – annual energy consumption of natural gas in cogeneration system, GJ/year;
EF_{NG} – CO_2 emission factor of natural gas (lower heating value basis), tonnes CO_2/GJ.
IPCC default value for EF_{NG} is 0,056 tonnes CO_2/GJ, [*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF). CEF has been converted to CO_2 emission factor through multiplying CEF by 44/12 and carbon oxidation factor 1.]

(1.2.) $$PE_{equiv\ fug} = AEC_{NG} \times MLR \times GWP(CH_4) \times 10^{-3},$$

where:
$PE_{equiv\ fug}$ – project methane emissions from natural gas production and leakage in transport and distribution, corresponding to consumption of natural gas in cogeneration system, tonnes CO_{2e}/year;
AEC_{NG} – annual energy consumption of natural gas in cogeneration system, GJ/year;
MLR **-** Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (lower heating value basis), kg CH_4/GJ natural gas energy consumption;
$GWP(CH_4)$ **-** global warming potential of methane = 21.

Default value for ***MLR*** corresponds to*1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1*[25]*: Eastern Europe and Fromer USSR – Emission Factors:.*
- 0,218 kg CH_4/GJ of methane emissions at natural gas production [Table 1-61, page 1.129.55];
- 0,340 kg CH_4/GJ of methane emissions at natural gas processing, transport, and distribution [Table 1-61, page 1.129];

[25]*1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1.* http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref10.pdf

Years	Project emissions		
	CO_2 emissions from natural gas combustion by cogeneration system, tonnes CO_2/year	Methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year	Total project emissions, tonnes CO_{2e}/year
2009	4368	914	5282
2010	20886	4370	25256
2011	20886	4370	25256
2012	20886	4370	25256
Subtotal over the period 2009-2012	**67026**	**14024**	**81050**
2013	20886	4370	25256
2014	20886	4370	25256
2015	20886	4370	25256
2016	20886	4370	25256
2017	20886	4370	25256
2018	20886	4370	25256
2019	20886	4370	25256
2020	20886	4370	25256
Subtotal over the period 2013-2020	**167088**	**34960**	**202048**
Total over the period 2009-2020	**234114**	**48984**	**283098**

E.2. Estimated leakage and formulae used in the estimation, if applicable:

The leakages under the project were taken equal to zero.

E.3. Sum of E.1. and E.2.:

Due to the fact that no leakage is expected during the project activity the sum of E.1 and E.2 equals E.1

E.4. Estimated baseline emissions and formulae used in the estimation:

The following conservative assumptions were taken into account while estimating baseline emissions:

- start of operation is 1st of November 2009;
- cogeneration system annual operation for heat generation – 5808 hours (1464 hours in 2009); annual operation for power generation - 7000 hours (1464 hours in 2009);
- average efficiency of the installed boilers at UGC is 95%;
- heat and electricity demand in the baseline and project scenarios are equal.

Baseline emissions are estimated using the approach proposed by the approved methodology *AM0014 “Natural gas-based package cogeneration” (Version 04)*. In accordance with it, baseline emissions are those emissions associated with the generation of heat and electricity that are offset by the output of the cogeneration system. Due to the fact that the heat supplied by the heat utilizers also substitutes the heat which in the absence of the project activity would have been produced by industrial boilers, it is reasonable to apply the same approach for heat-exchange technology also.

Baseline emissions comprise three components:

- CO_2 emissions corresponding to the combustion of natural gas that would have been used to generate heat for satisfying UGC's demand in the absence of proposed project activity;
- CH_4 emissions from natural gas production and leaks in the transport and distribution pipeline supplying the plant and leaks in the gas distribution piping within the plant, associated with the natural gas consumption;
- CO_2 emissions associated with the electricity that would have to be purchased from the power grid if the cogeneration system did not provide electricity to the plant.

The baseline emissions for the first three emission sources listed above are proportional to the amount of natural gas consumption in the plant that is offset by heat supplied by the natural gas cogeneration system. Each can be represented as the product of an emissions factor and energy consumption, which depends on the heat output of the cogeneration system.
The consumption of the natural gas in the baseline for the supply of heat is determined as follows:

(2.0a) $$ABEC_{BF} = CHOR \times AOH_{CS} / e_b + \sum UHOR / e_b,$$

where
$ABEC_{BF}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
$CHOR$ – cogeneration system heat output rate, GJ/h;
AOH_{CS} – annual operating hours, h/year;
$UHOR$ – monthly heat utilizers heat output, GJ;
e_b – boiler efficiency.

$CHOR$ was determined from the technical specification of cogeneration units. The value of AOH_{CS} was taken equal to 7000; $UHOR$ was estimated based on the heat demand of the project site in Talne.

(2.0b) $$UHOR = HD - HS,$$

where
$UHOR$ – monthly heat utilizers heat output rate, GJ;
HD - heat demand of the greenhouse site in Talne, GJ;
HS - heat supply from natural gas combustion for greenhouses air enrichment with CO_2 in Talne, GJ.

Heat demand of the greenhouses was calculated using the following formula:
(2.0c) $$HD = S_{GH} \times C_{surf} \times C_{inf} \times C_{wind} \times C_{hc} \times (t_{inside} - t_{outside})^{26},$$

where
HD - heat demand of the greenhouse site, GJ/hour;
S_{GH} – greenhouses area of the site, hm^2;
C_{surf} – surface coefficient for the particular greenhouse type;
C_{inf} – infiltration coefficient for the particular greenhouse type;
C_{wind} – wind-speed coefficient for the greenhouse location;
C_{hc} – heat conduction coefficient for the particular greenhouse type, kJ/($m^2 \cdot °C$);
t_{inside} – optimal temperature maintained inside the greenhouses, which is 20 °C;
$t_{outside}$ – temperature outside the greenhouses, °C.

[26] Shyshko G.G. Greenhouses and Greenhouse Complexes. Reference book, Kyiv, 1993.

Input data was obtained from the Enterprise. See tables E 4-1a and E 4-1b for the value of coefficients applied, Annex 2 Table 2 for the average monthly temperatures in the region.

Table E 4-1a. Greenhouses' heat demand coefficients for new greenhouses.

Coefficient	Value	Justification
C_{surf}	1.2	For new greenhouses area 4.05 hm^2 and its surface area 4.9 hm^2
C_{inf}	1.1	For greenhouses covered with single plastic film
C_{wind} (for 5 m/s)	1	For wind speed 5 m/s
C_{hc}, , kkal/(m^2*°C)	5	For double plastic cover of greenhouses

Table E 4-1b. Greenhouses' heat demand coefficients for old greenhouses.

Coefficient	Value	Justification
C_{surf}	1.2	For old greenhouses area 12.65 hm^2 and its surface area 15.2 hm^2
C_{inf}	1.3	For greenhouses with glass cover
C_{wind} (for 5 m/s)	1	For wind speed 5 m/s
C_{hc}, , kkal/(m^2*°C)	5.5	For glass cover with metal frame bars of greenhouses

(2.0d) $$HS = ABEC_{BF\_CO2} \times NCV_{NG} \times e_b,$$

where
$ABEC_{BF\_CO2}$ - annual energy consumption for CO_2 supply for air enrichment within the greenhouses at baseline plant, GJ/year;
NCV_{NG} – natural gas net calorific value, GJ/thousand m^3;
e_b – boiler efficiency.

The baseline consumption of the natural gas for the supply of heat is determined as follows:

(2.0e) $$ABEC_{BF\_CO2} = \sum FCR \times DOH_b \times S_{GH} \times Days\,,$$

where
$ABEC_{BF\_CO2}$ - annual energy consumption for CO_2 supply for air enrichment within the greenhouses at baseline plant, GJ/year;
FCR – fuel consumption rate for CO_2 generation, GJ/h·hm^2;
DOH_b – daily operating hours of the boilers generating CO_2, h/day (corresponds to the average photoperiod in the particular month);
S_{GH} – greenhouses area, hm^2;
$Days$ – number of days in the month.

FCR was provided by the Enterprise – practically determined rates developed taking into account plant's vegetation specifics, heat dumping capacity in summer, ventilation intensity etc (input data provided in Annex 2, Table 1).

Total baseline scenario GHGs emissions are estimated using the formula below:

(2) $$BE_y = BE_{th} + BE_{th\ equiv\ fug} + BE_{elec\ own} + BE_{elec\ grid}\,,$$

where

BE_y – total baseline GHG-s emissions, tonnes CO2e/year;
BE_{th} – baseline CO2e emissions from combustion of baseline fuel for heat supply, tonnes CO2/year;
$BE_{th\ equiv\ fug}$ – baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO2e/year;
$BE_{elec\ own}$ – baseline emissions of CO2 from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year;
$BE_{elec\ grid}$ – baseline emissions of CO2 from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year.

(2.1.) $$BE_{th} = ABEC_{BF} \times EF_{BF},$$
where:
BE_{th} – baseline CO2 emissions from combustion of baseline fuel for heat supply, tonnes CO2e/year;
$ABEC_{BF}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
EF_{BF} - CO2 emission factor of the fuel used to generate heat, tonnes CO2/GJ.

(2.2.) $$BE_{th\ equiv\ fug} = ABEC_{BF} \times MLR \times GWP\ (CH_4) \times 10^{-3},$$
where:
$BE_{th\ equiv\ fug}$ – baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO2e/year;
$ABEC_{BF}$ - annual energy consumption for heat supply at baseline plant, GJ/year;
MLR - Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (lower heating value basis), kg CH4/GJ natural gas energy consumption;
$GWP\ (CH_4)$ - global warming potential of methane = 21.

(2.3.) $$BE_{elec\ own} = CEO_{IP} \times EF_{red\_elec\ grid} \times 10^{-3},$$
where:
$BE_{elec\ own}$ – baseline emissions of CO_2 from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year;
CEO_{IP} – cogeneration electricity supplied to industrial plant, MWh;
$EF_{red\_elec\ grid}$ – baseline CO_2 emissions factor for electricity from public supply, kg CO_2/MWh [*Carbon B.V. "Standardized emission factors for Ukrainian electricity grid"* are to be used (see Annex 4)].

(2.4.) $$BE_{elec\ grid} = CEO_{EG} \times EF_{prod\_elec\ grid} \times 10^{-3},$$
where:
$BE_{elec\ grid}$ – baseline emissions of CO_2 from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year;
CEO_{EG} – cogeneration electricity supplied to electricity grid, MWh;
$EF_{prod\_elec\ grid}$ – baseline CO_2 emissions factor for electricity from public supply, kg CO_2/MWh. [*Carbon B.V. "Standardized emission factors for Ukrainian electricity grid"* are to be used (see Annex 4)]..

Years	Baseline emissions				
	CO_2 emissions from combustion of baseline fuel for heat supply, tonnes CO_2/year	CH_4 emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year	CO_2 emissions from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year.	CO_2 emissions from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year.	Total baseline emissions, tonnes CO_{2e}
2009	4669	977	4032	3457	13135
2010	24299	5085	27776	8877	66037
2011	25125	5257	27776	8877	66037
2012	38311	8017	35571	1856	83755
Subtotal over the period 2009-2012	**92404**	**19336**	**95155**	**23067**	**229963**
2013	38311	8017	35571	1856	83775
2014	38311	8017	35571	1856	83775
2015	38311	8017	35571	1856	83775
2016	38311	8017	35571	1856	83775
2017	38311	8017	35571	1856	83775
2018	38311	8017	35571	1856	83775
2019	38311	8017	35571	1856	83775
2020	38311	8017	35571	1856	83775
Subtotal over the period 2013-2020	**306488**	**64136**	**284568**	**14848**	**670040**
Total over the period 2009-2020	**398892**	**83472**	**379723**	**37915**	**900003**

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

Years	Baseline emissions, tonnes of CO_{2e}	Project emissions, tonnes of CO_{2e}	Emission reductions, tonnes of CO_{2e}
2009	13135	5282	7853
2010	66037	25256	40781
2011	66037	25256	41780
2012	83755	25256	58499
Subtotal over the period 2009-2012	**229963**	**81050**	**148913**
2013	83775	25256	58499
2014	83775	25256	58499
2015	83775	25256	58499
2016	83775	25256	58499
2017	83775	25256	58499
2018	83775	25256	58499
2019	83775	25256	58499

2020	83775	25256	58499
Subtotal over the period 2013-2020	**670040**	**202048**	**467988**
Total over the period 2009-2020	**900003**	**283098**	**616901**

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2009	5282	0	13135	7853
2010	25256	0	66037	40781
2011	25256	0	67036	41780
2012	25256	0	83755	58499
Subtotal over the period 2009-2012 (tonnes of CO_2 equivalent)	81050	0	229963	148913
2013	25256	0	83775	58499
2014	25256	0	83775	58499
2015	25256	0	83775	58499
2016	25256	0	83775	58499
2017	25256	0	83775	58499
2018	25256	0	83775	58499
2019	25256	0	83775	58499
2020	25256	0	83775	58499
Subtotal over the period 2013-2020 (tonnes of CO_2 equivalent)	202048	0	670040	467988
Total (tonnes of CO_2 equivalent)	283098	0	900003	616901

SECTION F. Environmental impacts

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

The project has been subject to a formal environmental impact assessment (EIA) undertaken in accordance with the applicable legislation and regulations of Ukraine. These include: the Laws of Ukraine "On Protection of Environment", "On Ecological Expertise", "On Protection of Atmospheric Air", "On Ensuring Sanitary and Epidemic Welfare of the Population", and "On Local Councils and Local Government", as well as the applicable Water Code, Land Code, and Forest Code.

Before the start of the project implementation the Enterprise received all the required conclusions of the state ecological expertise. Permit #7110800000-45 on Polluting Substances' Emissions into the Atmospheric Air by Stationary Sources has been issued to UGC by State Department for Environmental Protection in Chercasy Oblast. It is valid from August 14th, 2009, until August 15th, 2014. Also the License # 469980 has been issued to the UGC by the National Electricity Regulatory Commission of Ukraine on October 29th, 2009. The License is valid from October 29th, 2009, until October 28th, 2012.

Main environmental impacts of the project are caused be exhaust gases emitted by cogeneration system; NOx, CO, THC, HC (non-methane). They are subjects to regulation by existing Ukrainian legislation. The gases emitted from the cogeneration system are monitored and reported in compliance with the requirements of the State environmental monitoring service of the Committee on natural resources in Cherkasy oblast through official quaterly statistical form 2-tp (air) *Data on protection of atmospheric air*, which contains information on amounts of trapped and neutralized atmospheric pollutants, itemized emissions of specific pollutants, number of emission sources, measures on reduction of emissions into the atmosphere, emissions from particular groups of pollution sources. Two of the cogeneration units installed will be equipped with the system for exhaust gases purification, which will lead to overall decrease in the air pollution on the site and improve health and safety conditions for the UGC workers in comparison to baseline scenario.

According to the EIA, only local environmental impact can be stated, thus no transboundary environmental effects are expected.

Toxic waste of the Enterprise including the waste related to the project activity (used engine oil, oil containers etc.) is utilized by "Dobrobut Eco-Ukraina", which has all the necessary state licenses.

Heat-utilizers will reduce the heat pollution currently caused by Talne Gas Compressor Station and affecting the local ecosystem by changing its microclimate and impacting the local biodiversity.

Project territory does not belong to natural reserve territory. There are no fauna and flora species mentioned on Red Lists present on the area of the project location. The project will be located totally within the land boundary of the Enterprise territory and will not require any additional land. Cogeneration units and heat utilizers are not water pollution source.

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

Overall environmental impacts of project scenario in comparison with baseline scenario will be positive

SECTION G. Stakeholders' comments

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

No stakeholder consultation process for the JI projects is required by the Host Party. Stakeholder comments will be collected after the publication of this document on UNFCCC web-page during the determination procedure.

However, at the stage of EIA of the project the statement of intention and the statement of environmental implications have been published in local newspaper. No stakeholder comments were received.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

See Section B.

Table 1. Natural gas consumption for CO2 generation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Natural gas consumption for CO2 generation rate, per 1 hectare m3/hour	50	60	70	80	90	30	30	30	50	70	60	50
Generation of CO2 per day, hours	6	7	9	10	11	12	12	12	11	9	7	6
Days	31	28	31	30	31	30	31	31	30	31	30	31
Monthly natural gas consumption, m3, per 1 hectare	9300	11760	19530	24000	30690	10800	11160	11160	16500	19530	12600	9300

Table 2. Average monthly temperatures in Cherkasy[27]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Average monthly temperature, ^{0}C	-5,8	-5,6	-0,4	7,6	14,9	17,8	20	19,3	14	7,2	1,4	-3,5
Difference between temperatures (with necessary t = 20 ^{0}C)	25,8	25,6	20,4	12,4	5,1	2,2	0,0	0,7	6,0	12,8	18,6	23,5
Days	31	28	31	30	31	30	31	31	30	31	30	31
Hours	744	672	744	720	744	720	744	744	720	744	720	744

[27] Shyshko G.G. Greenhouses and Greenhouse Complexes. Reference book., Kyiv, 1993.

Annex 3

INVESTMENT ANALYSIS

The analysis, in the form of net present value aggregated costs calculation and comparison, is given in the attached Excel file “Uman_NPV”.

Annex 4

CARBON EMISSION FACTOR FOR UKRAINIAN NATIONAL ELECTRICITY GRID

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Ukraine - Assessment of new calculation of CEF

Introduction

Many Joint Implementation (JI) projects have an impact on the CO_2 emissions of the regional or national electricity grid. Given the fact that in most Economies in Transition an integrated electricity grid exists, a standardized baseline should be used to estimate the amount of CO_2 emission reductions on the national grid.

The Ukraine is one of the major JI host countries where many grid related projects have been developed or will be implemented. In order to enhance the project development and reliability in emission reductions from the Ukraine a standardized and common agreed grid factor expressing the carbondioxid density per kWh is crucial.

Objective

Global Carbon B.V. is one of the pioneers developing JI projects in Ukraine who has developed a baseline approach for determining the Ukrainian grid factor. The approach is implied from the approved CDM methodology ACM0002.

The team of Carbon Management Service (CMS) of TÜV SÜD Industrie Service GmbH with its accredited certification body "Climate and Energy" has been ordered to verify the developed approach and the calculated grid factor.

Once an approach is agreed it should be used for calculating the grid by using current available data served from the Ukraine Ministry for Fuel and Energy. Such annual grid factor shall be used as a binding grid factor for JI projects developed in the Ukraine.

Scope

The baseline approach to which this confirmation is referring is attached. The confirmation includes the inherent approach if the algorithms are developed reasonable and from a technical point of view correct. Furthermore the verified the

Date: 17.08.2007

Our reference: IS-USC-MUC/

This document consists of 4 Pages

Page 1 of 4

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The test results refer exclusively to the units under test.

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Our reference/Date: IS-USC-MUC/ / 17.08.2007

Industrie Service

origin of the data. The team consists of:

- Werner Betzenbichler (Head of the certification Body "Climate and Energy"),
- Thomas Kleiser (Head of division JI/CDM, GHG-Auditor and Project Manager)
- Markus Knödlseder (GHG-Auditor and Project Manager)

Mr. Kleiser and Betzenbichler assessed the baseline approach and agreed with Global Carbon on the conclusive approach. Mr. Kleiser and Mr. Knödlseder assessed the calculation model whereas Mr. Knödlseder interviewed also Mr. Nikolay Andreevich Borisov, Deputy Director for Strategic Development in Ministry of Fuel and Energy (+380 (44) 2349312 // borisov@mintop.energy.gov.ua) who explained the process of data gathering in the Ukraine. He also confirmed that GlobalCarbon B.V. uses the served data.

Conclusion

The conclusive assessment does not include potential uncertainties that might be occurred in the data gathering process of the ministry. Considering that we confirm that applied data served by Ministry of Fuel and Energy are reliable and correctly used.

Based on submitted calculation method, developed baseline study (see attachment), applied data and written confirmation from Ministry of Fuel and Energy (see attached documents) the team of Carbon Management Service of TÜV SÜD Industrie Service GmbH with its accredited certification body "Climate and Energy" confirms further that developed approach is eligible to determine the Ukrainian electricity grid factor as a standard value for JI project in the Ukraine.

The team recommends updating the calculation annually depending on point of time when national consolidated data are available.

Munich,17/08/2007

Markus Knödlseder

GHG-Auditor and Project Manager

Munich, 17/08/2007

Werner Betzenbichler

Head of the certification Body "Climate and Energy" and Carbon Management Service

Our reference/Date: IS-USC-MUC/ / 17.08.2007

Industrie Service

ANNEX 1 – Calculated emission factors

Weigthed average Simple OM 2003 - 2005

	El. Production	CO2 emissions	Technical Losses	Producing	Reducing
	MWh	tCO2	%	tCO2/MWh	tCO2/MWh
2003	98.214.112	80.846	14,2		
2004	94.330.765	74.518	13,4		
2005	96.526.887	78.203	13,1		
Total	**289.071.764**	**233.567**	**10%**	**0,807**	**0,896**
			Other baselines		
			ERUPT 2006	0,725	0,876
			ERUPT 2012	0,636	0,756
			UA Hydro project	0,915	

Annex 5

FINANCIAL PLAN

Table 1. Project investments.

Cogeneration with exhaust gases purification (3 units), UAH with VAT	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Project design	0	0	0	150 973	0	0
Main equipment cost	0	0	17 237 173	7 358 516	0	0
Installation works	0	0	0	200 000	0	0
Other capital investment	0	0	1 373 361	1 140 902	0	0
Heat-utilizator TUV-16 No.1, UAH with VAT						
Project design	0	370 000	0	0	0	0
Main equipment cost	120 000	3 783 906	2 072 200	220 000	0	0
Installation works	0	466 027	0	0	0	0
Transportation cost	0	221 191	0	0	0	0
Other capital investment	0	2 161 106	0	0	0	0
Heat-utilizator TUV-16 No.2, UAH with VAT						
Project design	0	0	0	0	370 000	0
Main equipment cost	0	0	0	0	2 192 200	4 003 906
Installation works	0	0	0	0	466 027	0
Transportation cost	0	0	0	0	221 191	0
Other capital investment	0	0	0	0	2 161 106	0
Total project investment	120 000	7 002 230	20 682 734	9 070 391	5 410 524	4 003 906
Total in 2006-2011	**46 289 785**					

Table 2. Project funding.

	Total, UAH	Bank loan, UAH	Internal investment, UAH	Internal investment share
Cogeneration with exhaust gases purification (3 units)	27 460 925	17 186 559	10 274 367	37%
Heat-utilizator TUV-16 No.1	9 414 430	7 367 216	2 047 214	22%
Heat-utilizator TUV-16 No.2	9 414 430	0	9 414 430	100%

Table 3. Funding sources.

Financial institution	Amount, USD	Interest rate, %	Contract information
OJSB 'UkrGasBank'	1 049 591	12,0	#11, 25.01.2007
OJSB 'UkrGasBank'	733 619	12,5	#21, 21.03.2008
OJSB 'UkrGasBank'	3 236 141	11,5	#18, 03.03.2008

Table 4. Debt schedule.

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Principal payment, UAH	0	0	0	0	0	7459600	12615428	14644738	7944721
Interest payment, UAH	0	309044	1516421	4944705	4944705	3165565	2108340	861073	64726

Annex 6

ABBREVIATIONS

UGC, The Company The Enterprise	-	Private-Rent Agriculture Enterprise Uman Greenhouse Combinate
NCV	-	Net Calorific Value
NPV	-	Net Present Value
GHG	-	Greenhouse Gases