ANNUAL MONITORING REPORT
of JI PROJECT

"COGENERATION AND UTILIZATION OF WASTE HEAT AT UMAN GREENHOUSE COMBINATE"

for the period from 1st of December, 2009 until 30th of April, 2011

Version 1.2
8th of June 2011

CONTENT

"Cogeneration and Utilization of Waste Heat at Uman Greenhouse Combinate"

SECTION A

A.1 Title of the JI project

Cogeneration and Utilization of Waste Heat at Uman Greenhouse Combinate

A.2 Registration number of the JI project

UA 1000260

A.3 Brief description of the JI 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.

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 are reduced by the project through offsetting the use of state grid electricity and displacing the heat produced by gas-fired water boilers.

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.

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 avoidance of electricity transportation losses during the delivery to the Enterprise. Generated heat is directed for heating the greenhouses of the company, which are offset the heat previously produced by natural gas-fired water boilers.

Approval of the project by Parties involved

National Environmental Investment Agency of Ukraine has issued Letter of Approval #463/23/7 from 2nd of March, 2011. Upon consideration of the project documents and the relevant expert opinions, it was determined that the JI Project complies with the requirements of Article 6 of the Kyoto Protocol to the UN Framework Convention on Climate Change and, therefore, is to be approved as a joint implementation project.

The Federal Republic of Germany as investor country granted its approval of the project activity "Cogeneration and Utilization of Waste Heat at Uman Greenhouse Combinate" within the framework of Joint Implementation. The approval notice concerning the project has been issued by Federal Environment Agency, German Emissions Trading Authority, on 7th of April, 2011.

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A.4 Status of project implementation

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 be put into operation in December 2011.

A.5 Methodology applied to the project activity (incl. version number)

A.5.1. Baseline methodology

In line with Guidelines on criteria for baseline setting and monitoring (Version 2, adopted at 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).

Basic assumptions of the baseline methodology in the context of project activity were 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 fired cogeneration system. Due to the similar nature of the effect resulting from the employment of heat-utilization 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, 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.

A.5.2. Monitoring methodology:

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 was 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

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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 (Version 02) 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).

Monitoring methodology AM0014 was 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.

JI project specific approach was used to estimate baseline CO_2 emissions from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system. To estimate above mentioned CO_2 emissions cogeneration electricity supply to the national grid was monitored and multiplied by relevant emission factor for electricity from public supply.

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

A.6 Deviations and/or revisions of the Monitoring Plan

Monitoring Plan has been revised and following amendments were made:

1. ***Revision:*** In Section D methane emissions from leakages at natural gas production, transportation, distribution and consumption were included in project emissions according to the formulae 4.6, 4.7, 4.8 of the paragraph d, p. 15 of the approved baseline and monitoring methodology AM0014 "Natural gas-based package cogeneration" (Version 04). However, according to the paragraph 2 of the Annex 2 'Calculation of emission reductions or enhancements of net removals' of 'Guidance on criteria for baseline setting and monitoring' (Version 02) emission reductions should be calculated as the difference between the anthropogenic emissions by sources within the project boundary in the baseline scenario and in the project scenario, and then adjusted for the leakage. So, leakage emissions should be calculated separately from project emissions.

Thus, project emissions were calculated according to the formula

$$PE_y = PE_{cs},$$

where

PE_y – total project GHGs emissions during year y, tonnes CO_{2e}/year,

PE_{cs} – project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year.

Leakages emissions were calculated according to the formula

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

where

$LE_{equiv\ fug}$ – leakage emissions from natural gas production and leakage in transport and distribution, corresponding to consumption of natural gas in cogeneration system, tonnes CO_{2e}/year;

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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;
GWP (CH_4) - global warming potential of methane = 21.

Emission reductions were calculated according to the formula

$$ER_y = (BE_y - PE_y) - LE_{equiv\ fug,y}$$

where
ER_y – emission reduction in the year y, tonnes of CO_2e,
BE_y – baseline emissions in the year y, tonnes of CO_2e,
PE_y – project emissions in the year y, tonnes of CO_2e,
$LE_{equiv\ fug,y}$ – leakage emissions in the year y, tonnes of CO_2e.

Justification: 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. According to the paragraph 12 of Guidance on criteria for baseline setting and monitoring (Version 02), the Guidance shall apply to all projects that apply a JI-specific approach, including projects that use selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools. In the determined PDD emissions from leakages due to natural gas production, transport and distribution has been calculated as a part of project emissions as per formulae 4.6, 4.7, 4.8 of the paragraph d, p. 15 of the methodology AM0014 "Natural gas-based package cogeneration" (Version 04). But above mentioned leakages should be estimated separately (according to the paragraph 2 of the Annex 2 'Calculation of emission reductions or enhancements of net removals' of 'Guidance on criteria for baseline setting and monitoring' (Version 02)) as the approved baseline and monitoring methodology AM0014 "Natural gas-based package cogeneration" (Version 04) is not used in its totality. Thus, estimation of leakages separately will improve the accuracy of the monitoring of emission reduction.

2. ***Revision:*** The reference for global warming potential of CH_4 was changed to 1995 IPCC Second Assessment Report, WG1, page 22, Table 4, the value for a period of 100 years.

Justification: Revision to the Monitoring Plan has been made to improve the accuracy of the reference for global warming potential of CH_4. The reference has been changed according to the paragraph 3 of Decision 2/CP.3 COP UNFCCC that states: "global warming potentials used by Parties should be those provided by the Intergovernmental Panel on Climate Change in its Second Assessment Report ("1995 IPCC GWP values") based on the effects of the greenhouse gases over a 100-year time horizon".

3. ***Revision:*** Emission factors for electricity will be monitored and evaluated according to published researches, and as soon as any other developed emission factor of the Ukrainian electricity grid will be approved, appropriate modifications of emission reduction calculations at the stage of monitoring report development will be made.

Emission reduction calculations in the current Monitoring Report are based on default values for emission factors for electricity of Ukrainian grid according to the Order #63 from 15th of April, 2011 of National Environmental Investment Agency of Ukraine 'On the Approval of Specific Parameters of Carbon Dioxide Emissions in 2009', Order #43 from 28th of March, 2011 of National Environmental Investment Agency of Ukraine 'On the Approval of Specific Parameters of Carbon Dioxide Emissions in 2010', Order #75 from 12th of May, 2011 of National Environmental

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Investment Agency of Ukraine 'On the Approval of Specific Parameters of Carbon Dioxide Emissions in 2011'.

Justification: Emission factors for electricity will be monitored to ensure more accurate estimation of emission reductions. The accuracy of data will be improved due to the use of up-to-date researches as they will reflect the latest changes of GHGs emissions from electricity generation in Ukraine. Only properly approved data will be applied to assure the correctness of its use.

In the current Monitoring Report values were set according to the Order #39 from 21st of March, 2011 'On the Approval of the Methodology of Estimation of Specific Carbon Dioxide Emissions from Electricity Generation on Thermal Power Plants and its Consumption' and are recommended by National Environmental Investment Agency of Ukraine for use during preparation of project design documents and annual monitoring reports of JI projects. Calculation of emission factors from electricity is conducted according to actual results of operation of thermal power plants, main electricity networks and energy supply companies. Emission factors are properly approved by Design Focal Point of Ukraine, National Environmental Investment Agency of Ukraine, and thus, will improve applicability and accuracy of data used for estimation of emission reduction.

4. ***Revision:*** Within monitoring of the data at the Enterprise, cross-checking procedures have been developed in detail. Cross-checking procedures were implemented at the Enterprise by Monitoring Procedure and described in Section B.2.3 of the Monitoring Report.

Justification: Cross-checking procedures have been elaborated to ensure double archiving of data monitored and improve its accuracy. Moreover, cross-checking procedures foresee backup estimating and/or metering of monitoring parameters in cases of malfunctioning or any other disruptions in the operation of the equipment.

A.7 Changes since last verification

Not applicable.

A.8 Person(s)/entities responsible for the preparation and submission of the monitoring report

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SECTION B

B.1 Monitoring period

Monitoring start date: 1/12/2009
Monitoring end date: 30/04/2011

B.2 Brief description of the monitoring plan applied

B.2.1 Brief description of the approach 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 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 was not used in full as it implies no excess electricity to be supplied to the power grid. Since electricity supply to the national grid is provided within project boundaries, baseline CO_2 emissions from electricity supply to electricity grid, that are offset by electricity supplied from cogeneration system, were taken into account. To estimate above mentioned CO_2 emissions, cogeneration electricity supply to the national grid was monitored and multiplied by relevant emission factor for electricity from public supply.

B.2.2 Data and parameters not monitored

Table B.2.2-1.

Data/Parameter	Data Unit	Description	Value of data/parameter applied	Source
e_b		Industrial boiler efficiency (fraction, lower heating basis)	0.95	Technical specifications of water boilers, average efficiency
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of CH_4	21	1995 IPCC Second Assessment Report, WG1, page 22, Table 4, the value for a period of 100 years
EF_{NG}	$t\ CO_2/GJ$	CO_2 emission factor for natural gas combustion	0.0561	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors

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				(CEF) converted to CO_2 emissions by multiplying on 44/12.
MLR	kg CH_4/GJ natural gas energy consumption	Methane Leakage Rate in natural gas production, processing, transport and distribution	*0.558*	1996 IPCC Guidelines for National Greenhouse Gas: Reference Manual, Chapter 1, Table 1-61 referring to Rabchuk et al (1991).

B.2.3 Data and parameters monitored

Data collected in order to estimate baseline emissions is presented in the table below.

Table B.2.3-1.1.

Data/Parameter	Data Unit	Description	Value for the period of 1.12.2009-31.12.2009	Value for the period of 1.01.2010-31.12.2010	Value for the period of 1.01.2011-30.04.2011
CHO	Gkal	Cogeneration heat supplied to industrial plant	2 061	21 686	9 540
HEHO	Gkal	Heat exchangers heat supplied to industrial plant	0	35 214	23 317
CEP	MWh	Cogeneration electricity generation	2 982	23 042	12 615
CEO_{EG}	MWh	Cogeneration electricity supplied to electricity grid	745	13 939	7 720

Table B.2.3-1.2.

Data/Parameter	Data Unit	Description	Value	Source
$EF_{red\_elec\ grid,2009}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian grid for projects reducing electricity consumption from the grid for 2009	1237	Order #63 from 15th of April, 2011 of National Environmental Investment Agency of Ukraine
$EF_{red\_elec\ grid,2010}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian grid for projects reducing electricity consumption from the grid for 2010	1225	Order #43 from 28th of March, 2011 of National Environmental Investment Agency of Ukraine
$EF_{red\_elec\ grid,2011}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian	1227	Order #75 from 12th of May, 2011 of National

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		grid for projects reducing electricity consumption from the grid for 2011		Environmental Investment Agency of Ukraine
$EF_{prod\_elec\ grid,2009}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian grid for projects producing electricity to the grid for 2009	1068	Order #63 from 15th of April, 2011 of National Environmental Investment Agency of Ukraine
$EF_{prod\_elec\ grid,2010}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian grid for projects producing electricity to the grid for 2010	1067	Order #43 from 28th of March, 2011 of National Environmental Investment Agency of Ukraine
$EF_{prod\_elec\ grid,2011}$	kg CO_{2e} /MWh	Emission factor for electricity of Ukrainian grid for projects producing electricity to the grid for 2011	1063	Order #75 from 12th of May, 2011 of National Environmental Investment Agency of Ukraine

Data collected in order to estimate leakages is presented in the table below.

Table B.2.3-2.

Data/Parameter	Data Unit	Description	Value for the period of 1.12.2009-31.12.2009	Value for the period of 1.01.2010-31.12.2010	Value for the period of 1.01.2011-30.04.2011
V_{NG}	m^3	Volume of natural gas consumed by cogeneration units (under standard conditions)	643 829	6 177 307	3 452 723
NCV_{NG}	GJ/ $1000m^3$	Net calorific value for natural gas	33.808	33.774	33.760

Data collected in order to estimate project emissions is presented in the table below.

Table B.2.3-3.

Data/Parameter	Data Unit	Description	Value for the period of 1.12.2009-31.12.2009	Value for the period of 1.01.2010-31.12.2010	Value for the period of 1.01.2011-30.04.2011
V_{NG}	m^3	Volume of natural gas consumed by cogeneration units (under standard conditions)	643 829	6 177 307	3 452 723
NCV_{NG}	GJ/ $1000m^3$	Net calorific value for natural gas	33.808	33.774	33.760

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B.3 Collecting and archiving of the monitored data

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 is collected by the UGC Department for Technical Modernization and will be kept for at least two years after the last transfer of ERUs for the project. Deputy Director 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.

Collecting and archiving of data on natural gas consumption

To measure natural gas consumption by cogeneration units gas metering equipment has been installed. Turbine gas meter Actaris TZ 100/G400 serial-№ 2782301006/C together with a corrector B25 serial-№8158 measures total natural gas consumption by all three cogeneration units. The corrector B25 brings the volume of natural gas consumption to standard conditions (Ts=20ºC, Ps=101.325 kPa). Installed corrector is capable to save daily and monthly data during two years. The corrector is connected with a computer of cogeneration units' operators and automatically saves daily and monthly data on a hard disc.

Thus, input data on natural gas consumption are archived and saved in the initial memory of the corrector (during two years) and on the hard disc of the computer of cogeneration units' operators (during at least two years of last transfer of ERUs for the project). In this way double archiving of input data is ensured.

No later than 3^{d} of every month boiler house manager is responsible for performing a report on total natural gas consumption during a previous month to the Deputy Director for Technical Modernization.

Cross-Checking Method for measuring and collecting of natural gas consumption: To ensure accurate measuring of natural gas consumption in cases of any malfunction of turbine gas meter Actaris TZ 100/G400 serial-№ 2782301006/C and corrector B25 serial-№8158, three additional gas meters Actaris FLUXI/TZ 80 serial-№ 2949107001/C, Actaris FLUXI/TZ 80 serial-№ 2949107002/C, Actaris FLUXI/TZ 80 serial-№ 1174907003/B for measuring of natural gas consumption by every cogeneration unit have been installed. Thus, in cases of any disruption of main metering equipment additional natural gas metering equipment would be used to measure natural gas consumption by cogeneration unit.

Collecting and archiving of data on NCV of natural gas

Data on NCV of natural gas is provided by the supplier, Gaysynske line production RPD of "Cherkasytransgas", in the form of monthly certificates on physicochemical parameters of natural gas. The boiler-house manager is responsible for providing of the certificates to the Deputy Director for Technical Modernization along with average monthly value on NCV of natural gas as to the approved form of monthly reports according to the Monitoring Procedure.

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Cross-Checking Method for estimating NCV of natural gas: In cases, when certificates on physicochemical parameters of natural gas cannot be provided by supplier, the value of NCV_{NG}=34 GJ/1000 m^3 as per DBN V.2.5-20-2001 "Gas supply" would be used.

Collecting and archiving of data on heat energy generation by cogeneration units

To measure heat energy generation by cogeneration units heat metering equipment has been installed. Heat energy meter SPT961.1 serial-№14693 measures total heat generation by all three cogeneration units. Installed meter is capable to save daily data during one year and monthly data during two years. Every month daily data on total heat energy generation by cogeneration units is duplicated and archived in printed version.

No later than 3^d of every month boiler house manager is responsible for performing a report on total heat energy generation during a previous month to the Deputy Director for Technical Modernization.

Cross-Checking Method for estimating heat energy generation: In cases of any disruption of metering equipment, heat energy generation by cogeneration units would be estimated on the basis of natural gas consumption and technical characteristics of cogeneration units under Description of Gas Generator Set Caterpillar G3520C.

Collecting and archiving of data on heat energy consumption from heat-exchange boiler

To measure heat energy generation by heat-exchange boiler heat metering equipment has been installed. Heat energy meter SVTU10M(M2) serial-№16298 measures total heat generation by heat-exchange boiler TUV-16. Installed heat meter is capable to save daily and monthly data during two years. Besides, daily data on heat energy consumption is daily recorded in the register "Heat energy consumption from heat-exchange boiler". Thus, double archiving and collecting of data is ensured.

No later than 3^d of every month heat engineer of Talne Department is responsible for performing a report on heat energy consumption from heat-exchange boiler TUV-16 during a previous month to the Deputy Director for Technical Modernization.

Cross-Checking Method for estimating heat energy consumption from heat-exchange boiler: At Talne Department special electronic program is installed to measure input and output temperatures of hot water, which is supplied from heat-exchange boiler. In cases of any disruption of heat energy metering equipment, the quantity of heat energy supplied can be estimated by the formula:

$$Q= (t_1-t_2)\cdot c\cdot\rho\cdot V\cdot T\cdot 10^{-6},$$

where

Q – amount of consumed heat energy, GJ,
t_1 – temperature of input hot water, K,
t_2 – temperature of output hot water, K,
T – period of estimation, hours,
V – heat pump capacity, 400 m^3/hour,
ρ – water density, 1000 kg/m^3,
c – specific heat capacity of water, 4,18 kJ/kg·K.

Collecting and archiving of data on electricity export to the grid

To measure electricity export to the grid by cogeneration units power metering equipment has been installed. Electricity meters CTK3-05Q2T3Mt Energija-9 serial-№50107, CTK3-05Q2T3Mt Energija-9 serial-№50101, CTK3-05Q2T3Mt Energija-9 serial-№49969 and CTK3-05Q2T3Mt Energiia-9 serial-№50099 measures electricity export to the national grid of Ukraine. Installed meters are capable to save daily and monthly data during one year. To ensure archiving of monitoring data during at least two years of last transfer of ERUs for the project, daily data on electricity export is archived on the hard disk of the computer of the Deputy Director for Technical Modernization.

Cross-Checking Method for measuring electricity export to the national grid: Uman Greenhouse Combinate sells electricity to Cherkasyoblenergo, where also Automated electricity metering system is installed to check the quantity of electricity supplied by UTK. According to the agreement between Uman Greenhouse Combinate and Cherkasyoblenergo every month Cherkasyoblenergo provides hourly and daily data on electricity supply to UTK, which will be saved at least two years of last transfer of ERUs for the project, thus double archiving and cross-checking of data are ensured.

Collecting and archiving of data on electricity generation by cogeneration unit

To measure total electricity generation three frequency/voltage guards, Terberg Controls KCVF 594 serial-№15/054, KCVF 594 serial-№15/052, KCVF 594 serial-№15/051 have been incorporated in the control panel of cogeneration units (one frequency/voltage guards per one cogeneration unit). Before frequency/voltage guards' installation they were tested by Megacon Controls Ltd.

Daily data on electricity generation is recorded by the operators of cogeneration units in the register "Electricity generation". Control panel also saves aggregated data on electricity generation from the date of installation of cogeneration units, although daily and monthly data are not available. No later than 3^{d} of every month electrical engineer is responsible for performing a report on electricity generation during a previous month to the Deputy Director for Technical Modernization.

Cross-Checking Method for estimating electricity generation: In cases of any disruption of metering equipment, electricity generation by cogeneration units would be estimated on the basis of natural gas consumption and technical characteristics of cogeneration units under Description of Gas Generator Set Caterpillar G3520C.

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Information on the data collected is presented in the table below.

Data variable	Data unit	Source of data	Type/serial number of monitoring equipment	Measured (m), calculated (c), estimated (e)	Recording frequency	How will the data be archived? (electronic/ paper)
CEP Cogeneration electricity generation	MWh	Electricity meter	KCVF 594 №15/054, KCVF 594 №15/052, KCVF 594 №15/051	m	Daily	Electronic spreadsheet
CEO_{EG} Cogeneration electricity supplied to electricity grid	MWh	Automated electricity metered system	CTK3-05Q2T3Mt Energiia-9 №50107, CTK3-05Q2T3Mt Energiia-9 №50101, CTK3-05Q2T3Mt Energiia-9 № 49969 CTK3-05Q2T3Mt Energiia-9 № 50099	m	Daily	Electronic spreadsheet
CHO Cogeneration heat supplied to industrial plant	Gkal	Heat meter after cogeneration unit	SPT961.1 №14693	m	Daily	Electronic spreadsheet
HEHO Heat-exchange boiler heat supplied to industrial plant	Gkal	Heat meter after heat-exchange boiler	SVTU-10M(M2) №16298	m	Daily	Electronic spreadsheet
VNG Volume of natural gas consumed by cogeneration units	m^3	Commercial gas flow meter	Actaris TZ 100/G400 serial-№ 2782302006/C and corrector B25 serial-№8158	m	Daily	Electronic spreadsheet
NCV_{NG} Natural gas net calorific value	GJ/ 1000 m^3	Supplier	-	m	Daily	Paper

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B.4 Information on monitoring equipment

Data variable	Data unit	Type/serial number of monitoring equipment	Grade of accuracy	Date of last calibration	Date of next calibration
CEP Cogeneration electricity generation	MWh	KCVF 594 №15/054, KCVF 594 №15/052, KCVF 594 №15/051	0.5%	n/a	n/a
CEO_{EG} Cogeneration electricity supplied to electricity grid	MWh	CTK3-05Q2T3Mt Energiia-9 №50107, CTK3-05Q2T3Mt Energiia-9 №50101, CTK3-05Q2T3Mt Energiia-9 № 49969 CTK3-05Q2T3Mt Energiia-9 № 50099	0.5%	05.11.2009 05.11.2009 05.11.2009 05.11.2009	05.11.2013 05.11.2013 05.11.2013 05.11.2013
CHO Cogeneration heat supplied to industrial plant	Gkal	SPT961.1 №14693	0.02%	18.01.2008	18.01.2012
HEHO Heat-exchange boiler heat supplied to industrial plant	Gkal	SVTU-10M(M2) №16298	0.5%	20.01.2010	20.01.2012
VNG Volume of natural gas consumed by cogeneration units	m^3	Actaris TZ 100/G400 serial-№ 2782301006 with corrector B25 serial-№8158	0.02%	28.02.2010	28.02.2012
NCV_{NG} Natural gas net calorific value	GJ/ 1000 m^3	n/a	n/a	n/a	n/a

B.5 Operational and management structure 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 is collected by the UGC Deputy Director for Technical Modernization. The management structure is on the chart below.

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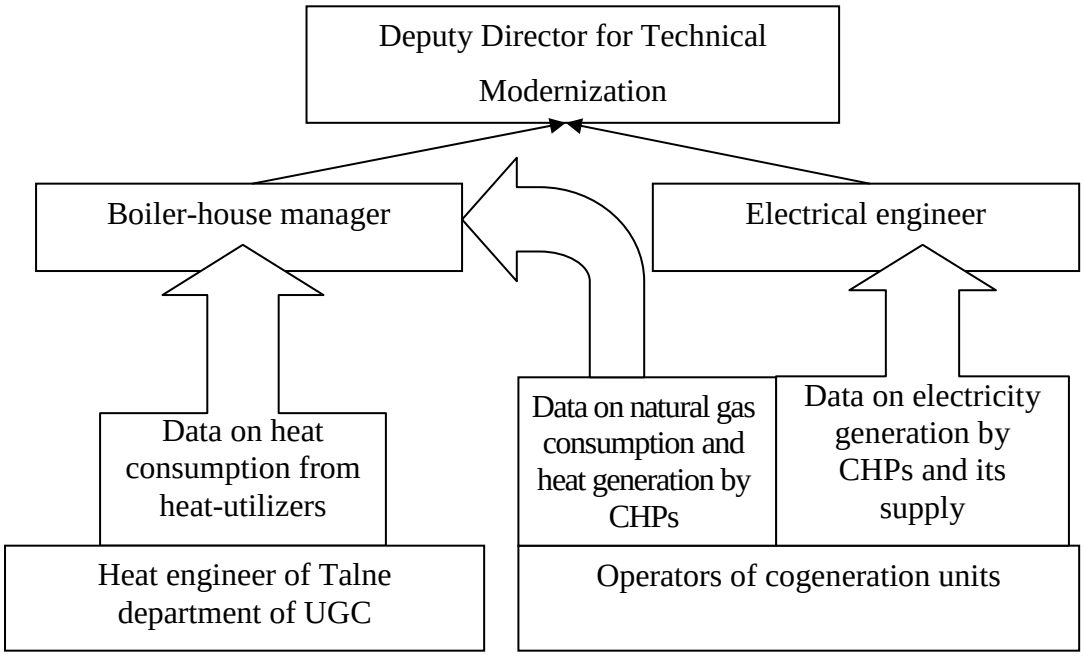

Fig. 1. Monitoring system management structure.

Monitoring data is 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 provide monthly reports to the Deputy Director for Technical Modernization, who is responsible for the performance of monitoring data to LLC 'KT-Energy'.

B.6 Monitoring of environmental impacts of the project

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.

SECTION C

C.1 Documented procedures

In order to ensure accurate recording of the monitoring data the special Monitoring Procedure was introduced at the Enterprise. The Procedure was approved by the Director of PRAE "Uman Greenhouse Combinate", Gordiy M.V. Under the Procedure the Deputy Director for Technical Modernization is responsible for the supervising and archiving of the monitoring data. According to the paragraph 6 of the Procedure, Deputy Director for Technical Modernization is responsible for keeping of the monitoring data for at least two years after the last transfer of ERUs for the current joint implementation project.

The Procedure clearly points out the distribution of powers and duties. Monitoring data are 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 are responsible for providing monthly reports to the Deputy Director for Technical Modernization. In the Monitoring Procedure monitoring parameter, its unit, recording frequency, way of archiving, calibration frequency is indicated so to ensure proper data metering, recording and archiving.

Within Monitoring Procedure cross-checking procedures are also foreseen. A particular cross-checking procedure for estimating and/or measuring of each monitoring parameter was developed in details to assure accuracy of emission reductions estimation.

Deputy Director for Technical Modernization is responsible for the performance to LLC "KT-Energy" all monitoring data that is necessary for GHGs emission reduction calculations. The specialists of LLC "KT-Energy" provide calculation of actual emission reductions according to the monitoring plan implemented.

The names of the personnel involved for this monitoring period are following:

1. Deputy Director for Technical Modernization, Zozulya Kostyantyn
2. Chief heat engineer, Kolomiets Mykola
3. Boiler-house manager, Petyk Vasyl
4. Electrical engineer, Koroban Volodymyr
5. Heat engineer of Talne department, Gorbachenko Yuriy

To ensure proper operating and maintenance of the cogeneration units in Uman and heat-utilizers in Talne initial trainings of the personnel were conducted. 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. As it was mentioned before, the special Monitoring Procedure was introduced at the Enterprise. According to the Act on Conducting the Trainings for Monitoring Parameters for Calculation of Emission Reduction from 20th of October, 2009, the stuff involved in the monitoring of parameters was also acquainted with the Procedure.

C.2 Control measures

Deputy Director for Technical Modernization is responsible for the accuracy of data provided according to the Monitoring Procedure. In order to control accurate recording of data monitored chief heat engineer every day checks values of such parameters as heat energy generation, natural gas consumption, total electricity generation in the registers and panels of metering equipment. Every month chief heat engineer rechecks total heat energy generation by heat utilizer TUV-16 according to the register and data of heat meter. Deputy Director for Technical Modernization every month rechecks data on electricity export.

To control proper operation of metering equipment its calibration will be provided regularly according to the national requirements.

C.3 Troubleshooting procedures

Under the Monitoring Procedure the boiler-house manager and the electrical engineer are responsible for the reporting to the Deputy Director for Technical Modernization about the cases of any malfunctioning within one day. In case of any disruption in functioning of metering equipment it would be replaced with a working one or cross-checking procedure would be used for the calculations of that period.

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SECTION D

D.1 Baseline emissions calculations

Table D.1-1. Baseline emission estimation

Data variable	Description	Method of calculation
BE_y	Total baseline GHGs emissions, tonnes CO_{2e}/year	$BE_y = BE_{th} + BE_{th\ equiv\ fug} + BE_{elec\ grid} + BE_{elec\ own}$
BE_{th}	Baseline CO_2 emissions from combustion of baseline fuel for heat supply, tonnes CO_2/year	$BE_{th} = ABEC_{BF} \times EF_{BF}$
$BE_{th\ equiv\ fug}$	Baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply, tonnes CO_{2e}/year	$BE_{th\ equiv\ fug} = ABEC_{BF} \times MLR \times GWP\ (CH_4) \times 10^{-3}$
$BE_{elec\ grid}$	Baseline emissions of CO_2 from electricity supply to electricity grid that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year	$BE_{elec\ grid} = CEO_{EG} \times EF_{prod\_elec\ grid} \times 10^{-3}$
$BE_{elec\ own}$	Baseline emissions of CO_2 from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system, tonnes CO_{2e}/year	$BE_{elec\ own} = CEO_{IP} \times EF_{red\_elec\ grid} \times 10^{-3}$
$ABEC_{BF}$	Annual energy consumption for heat supply at baseline plant, GJ/year	$ABEC_{BF} = (CHO / e_b + HEHO / e_b) \times 4.1868$
EF_{BF}	CO_2 emission factor of the fuel used to generate heat, tonnes CO_2/GJ	See table B.2.2-1.1
CHO	Cogeneration heat supplied to industrial plant, Gkal/year	See table B.2.3-1.1
$HEHO$	Heat-exchanger heat supplied to industrial plant, Gkal/year	See table B.2.3-1.1
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	See table B.2.2-1.
$GWP\ (CH_4)$	Global warming potential of methane	See table B.2.2-1.
CEO_{EG}	Cogeneration electricity supplied to electricity grid, MWh/year	See table B.2.3-1.1
$EF_{prod\_elec\ grid}$	Emission factor for electricity of Ukrainian grid for projects producing electricity to the grid, kg CO_2/MWh	See table B.2.3-1.2
CEO_{IP}	Cogeneration electricity supplied to	$CEO_{IP} = CEP - CEO_{EG}$

	industrial plant, MWh/year	
$EF_{red\_elec\ grid}$	Emission factor for electricity of Ukrainian grid for projects reducing electricity consumption from the grid, kg CO_2/MWh	See table B.2.3-1.2

Table D.1-2. Baseline emissions

Data variable	Period	Baseline emissions
BE_{2009}	1.12.2009-31.12.2009	4 263
BE_{2010}	1.01.2010-31.12.2010	45 963
BE_{2011}	1.01.2011-30.04.2011	25 774

D.2 Project emissions calculations

Table D.2-1. Project emission estimation

Data variable	Description	Method of calculation
PE_y	Total project GHGs emissions during year y, tonnes CO_{2e}/year	$PE_y = PE_{cs}$
PE_{cs}	Project carbon dioxide emissions from natural gas combustion in the cogeneration system, tonnes CO_2/year	$PE_{cs} = AEC_{NG} \times EF_{NG}$
AEC_{NG}	Annual energy consumption of natural gas in cogeneration system, GJ/year	$AEC_{NG} = V_{NG} \times NCV \times 1000$
V_{NG}	Volume of natural gas consumed by cogeneration units (under standard conditions), m^3/year	See table B.2.3-3.
NCV_{NG}	Natural gas net calorific value, GJ/ 1000 m^3	See table B.2.3-3.
EF_{NG}	CO_2 emission factor of natural gas (lower heating value basis), tonnes CO_2/GJ.	See table B.2.2-1.

Table D.2-2. Project emissions

Data variable	Period	Project emissions
PE_{2009}	1.12.2009-31.12.2009	1 219
PE_{2010}	1.01.2010-31.12.2010	11 914
PE_{2011}	1.01.2011-30.04.2011	6 528

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D.3 Leakage emissions calculations

Table D 3-1. Leakages emission estimation

Data variable	Description	Method of calculation
$LE_{equiv\ fug,y}$	Leakage methane emissions from natural gas production and leakage in transport and distribution, corresponding to consumption of natural gas in cogeneration system in the year y, tonnes CO_{2e}/year	$LE_{equiv\ fug,y} = AEC_{NG} \times MLR \times GWP\ (CH_4) \times 10^{-3}$,
AEC_{NG}	Annual energy consumption of natural gas in cogeneration system, GJ/year	$AEC_{NG} = V_{NG} \times NCV_{NG} \times 1000$
V_{NG}	Volume of natural gas consumed by cogeneration units (under standard conditions), m^3/year	See table B.2.3-2.
NCV_{NG}	Natural gas net calorific value, GJ/ 1000 m^3	See table B.2.3-2.
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	See table B.2.2-1.
$GWP\ (CH_4)$	Global warming potential of methane	See table B.2.2-1.

Table D.3-2. Leakage emissions

Data variable	Period	Leakage
$LE_{equiv\ fug,2009}$	1.12.2009-31.12.2009	255
$LE_{equiv\ fug,2010}$	1.01.2010-31.12.2010	2 491
$LE_{equiv\ fug,2011}$	1.01.2011-30.04.2011	1 365

D.4 Emission reductions calculations

Calculation of emission reductions is based on conservative assumptions.
Emission reductions were calculated according to the following formulae:

$$ER_{2009}=(BE_{2009}-PE_{2009})- LE_{equiv\ fug,2009}$$
$$ER_{2010}=(BE_{2010}-PE_{2010})- LE_{equiv\ fug,2010}$$
$$ER_{2011}=(BE_{2011}-PE_{2011})- LE_{equiv\ fug,2011}$$

Table D.4-1. Emission reductions

Period	Emission reductions
1.12.2009-31.12.2009	2 789
1.01.2010-31.12.2010	31 558
1.01.2011-30.04.2011	17 881

The amount of total emission reductions during the period from 1st of December, 2009 till the 30th of April, 2011 is 52 228 tonnes CO_{2e}.