**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 LLC “Lukoil Energy and Gas Ukraine”

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

JI PDD version number: 2.4

Data of Completion: 9th of June, 2011.

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

Purpose of the project
The purpose of the project is the increasing of the organic fuel use efficiency through combined heat and power generation based mainly on the visbroken atmospheric residue combustion, accompanied by greenhouse gases emission reductions. Project is realized by LLC “Lukoil Energy and Gas Ukraine” (LEGU) to improve the reliability of heat energy supply to the nearby JSC “Lukoil-Odesskyi Oil-Refining Plant” (LOORP).

Generated electricity is supplied to the national grid to substitute electricity generated by power plants, but could also be used for covering electricity supply of LOORP. Generated heat energy is used for covering the heat energy demand of the LOORP.

Before project implementation five boilers have generated heat energy to satisfy LOORP’s heat demand. Boilers were installed in 1971-1986 and used residual fuel oil, natural gas and refinery gas as fuels, with the growing emphasis on the residual fuel oil during last four years (see Table A-2.1). Electricity demand of the oil-refining plant has been covered by purchasing electricity from the national grid and there was no electricity generating capacities at the project site.

Baseline scenario was assumed as further boilers’ exploitation with their graduate replacement with the new ones utilizing residual fuel oil and partially refinery gas and natural gas as fuels and no electricity generation on site. As for the LOORP’s baseline electricity supply, the most favourable option has been identified as the continuation of the electricity consumption from the national grid (for more details see Section B).

Concept of the project
LEGU realizes the project of the cogeneration unit construction (diesel engine power plant with 2 exhaust-boilers) with total electricity capacity of 17.8 MW and total heat energy capacity of 176.6 GJ per hour.

Expected results of the project:
Project activity aims to achieve the following results:

- greenhouse gases emission reductions in the amount of 1 135 268 tonnes of CO_{2e} for the period of 2010-2024,
- efficient utilization of visbroken atmospheric residue,
- more efficient utilisation of energy resources due to introduction of cogeneration technology instead of separate generation of electricity and heat energy.

Implementation schedule and cost of the project

Project implementation start date (beginning of the investment stage) was 23rd of July 2007, when the contract on purchasing the cogeneration unit's diesel engine power plant equipment was concluded. The end date of the investment stage was 17th of February, 2010.

Cogeneration unit's diesel engine power plant equipment was installed in September, 2008 and exhaust-boilers were installed in April, 2010. The operation of cogeneration unit started on 1st of July, 2010.

Expected operational lifetime of the exhaust-boilers is 30 years, while operational lifetime of the Wartsila diesel engines is not set in the technical documentation, although it is indicated that every 48 000 hours the operation they need major repairs.

Total indicative budgeted cost of the project is about Euro 32 million.

Grounds for the project implementation

Project implementation was started on the grounds of the necessity to ensure the reliability of heat energy supply to the nearby LOORP.

Heat energy generated by LEGU is supplied to LOORP, which is one of six oil-refining plants in Ukraine with a capacity of 2.8 million tonnes of oil refined per year, constituting 6.5% of the total capacity of Ukrainian oil-refining plants. Main products of the plant are petrol, diesel fuel, residual fuel oil, jet fuel, bitumen and liquefied gas. In 2005-2008 some reconstruction was made at the Plant, which allowed producing Euro-3 petrol, Euro-4 diesel fuel, jet fuel and also introducing the process of visbreaking to ensure more efficient crude oil refining.

Information about organic fuel consumption for heat energy generation by boilers before the project realization and energy consumption by the Plant is presented in the table below.

Table A-2.1. Fuel and heat energy consumption by LOORP

Data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Heat energy consumption, Gkal	101 191	148 995	162 850	144 061	151 119	91 923	16 420	15 667	130 332	148 764
Natural gas consumption by boilers, 1000 m^3	5	164	794	1490	1770	4070	3 285	2 561	3 859	817
Residual fuel oil consumption by boilers, tonnes	7 219	5 092	4 910	2 045	2 861	1 900	78	1	4 695	8 086
Refinery gas consumption by boilers, tonnes	3 979	10 847	10 549	10 524	10 563	4 379	0.00	0.00	5 847	8 261

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party A: Ukraine (Host Party)	LLC "Lukoil Energy and Gas Ukraine" Project owner	No
Party B: Germany	RWE Power Aktiengesellschaft ERUs buyer	No

LLC "Lukoil Energy and Gas Ukraine" is the Project owner. The company aims at producing electricity and heat energy utilizing its cogeneration unit based on VAR. LLC "Lukoil Energy and Gas Ukraine" has more than 130 employees ensuring necessary operations and delivery outcomes.

RWE Power Aktiengesellschaft 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:

Project area location – Ukraine, Odessa region, Odessa city.

Fig. A 4-1. Project area location, Odessa, Ukraine

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.:

Odessa region

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

Odessa

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

Project is implemented at the project site of JSC "Lukoil-Odesskyi Oil-Refining Plant" in Odessa, 1\1, Shkodova Gora st. The geographical coordinates of the project site are the following: 46°30'49"N, 30°41'3"E.

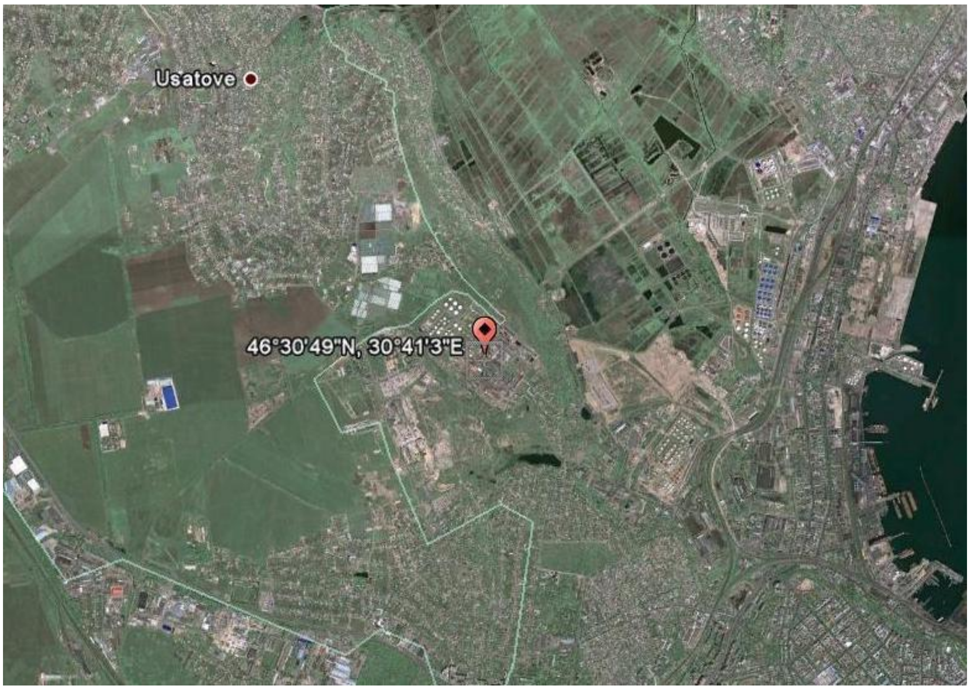

Fig. A 4-2. Information allowing the unique identification of the project

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:

Within the proposed project activity the cogeneration unit for combined heat and power generation with visbroken atmospheric residue, diesel fuel and natural gas combustion is installed instead of boilers, which combust organic fuel and generate heat power.

The project uses the state-of-the-art technologies, which 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).

Cogeneration is much more effective than separate heat and power production. According to different estimates, the efficiency of cogeneration is about 30% higher than that one of separate heat and power production. Additional advantage of cogeneration is that environmental pollution is lower than in separate production[1].

The cogeneration unit, which consists of the diesel engine power plant equipment, two exhaust-boilers and outgoing gases purification system, is installed within project boundaries.

The diesel engine power plant equipment includes generating set, electrical systems, heat recovery system, automation system and mechanical auxiliary systems. Generating set consists of two diesel engines Wartsila 20v32, two generators and other equipment. All the equipment was improved for combustion of non-common fuel – visbroken atmospheric residue, although other fuels such as residual fuel oil can be also used for combustion. Starting fuel for the engines is diesel. Technical characteristics of the diesel engines are presented in the table below.

Table A.4.3-1. Technical characteristics of engines of cogeneration unit's diesel engine power plant

Data	Engine №1	Engine №2
Producer of the engine	Wartsila (Finland)	Wartsila (Finland)
Engine type and model	20V32	20V32
Power capacity under 100% load, kW	8525-8924	8525-8924
Fuel that can be used	Visbroken atmospheric residue, residual fuel oil M-100	Visbroken atmospheric residue, residual fuel oil M-100
Fuel consumption, tonnes/hour	1844 (VAR), 1794 (residual fuel oil)	1844 (VAR), 1794 (residual fuel oil)
Efficiency, %	43.9	43.9

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

Fig. A 4-3. Cogeneration unit engine Wärtsilä 20V32

Table A.4.3-2. Technical characteristics of exhaust-boilers of the cogeneration unit

Data	Exhaust-boiler №1	Exhaust-boiler №2
Producer of exhaust-boiler	JSC HKP “Kotloenergoproekt”	JSC HKP “Kotloenergoproekt”
Exhaust-boiler type and model	E-35-1.4/250	E-35-1.4/250
Fuels that can be used	Natural gas, refinery gas, liquid fuels	Natural gas, refinery gas, liquid fuels
Fuel consumption	2972 m3/hour (natural gas), 1735 m3/hour (refinery gas), 2000.5 tonnes/hour (liquid fuels (RFO, VAR))	2972 m3/hour (natural gas), 1735 m3/hour (refinery gas), 2000.5 tonnes/hour (liquid fuels (RFO, VAR))
Capacity, GJ per hour	88.3	88.3
Productivity, tonnes of steam per hour	35	35
Steam pressure, MPa	1.4	1.4
Steam temperature, C°	250	250
Efficiency, %	89-93	89-93

Main type of fuel, which is used in the cogeneration unit, is visbroken atmospheric residue (VAR), which is a by-product in the process of goudrons’ visbreaking. Visbreaking is a non-catalytic thermal process that converts atmospheric or vacuum residues via thermal cracking to gas, naphtha, distillates and visbroken residue.

Physicochemical characteristics of VAR are presented in the table below.

Table A.4.3-3. Physicochemical characteristics of visbroken atmospheric residue[2]

Parameter	Value
Density at a temperature of 15˚ C, kg/m^3	960-1025
Kinematic Viscosity at a temperature of 100˚C, mm^2/s	78-165
Sulphur mass fraction, %	3.5
Flash Point at opened crucible, ˚C	110
Water mass fraction, %	0.1
Ash content, %	0.14
Vanadium mass fraction, mg/kg	182-324
Pour Point, ˚C	42
Net Calorific Value, kJ/kg	38970

The cogeneration unit is equipped with efficient system of outgoing gases purification from SO_2, NO_x, CO and dust content. Purification of exhaust gases is based on wet limestone method and non-catalytic low-temperature purification with adding of a catalyst.

Generated electricity is supplied to the national grid to substitute electricity generated by power plants and heat energy is used for covering heat energy demand of JSC "Lukoil-Odesskyi Oil Refining Plant" substituting heat energy produced by steam boilers with residual fuel oil, refinery and natural gas combustion.

All the technological parameters of the project equipment meet environment protection normative requirements.

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:

Anthropogenic emissions of greenhouse gases are to be reduced due to more efficient use of organic fuel in combined cycle of heat and power generation. It implies emission reductions due to substitution of electricity from the national grid, which has high carbon intensity factor, with electricity based on visbroken atmospheric residue use as a main fuel in the cogeneration process, and also due to more efficient heat energy generation with visbroken atmospheric residue combustion mainly.

Taking into account a number of significant technological barriers, connected with use of non typical fuel, financial barriers described in details in Section B and the fact that using cogeneration unit of the type to generate electricity and heat energy is not a common practice in Ukraine, it is concluded that emission reductions would not occur in the absence of the proposed project.

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

The total length of the crediting period is 15 years. Total reductions of greenhouse gases emission within the defined project boundaries over the first crediting period of 2010-2012 are 212 571 tonnes of CO_2 equivalent. Total reductions of greenhouse gases emission within the defined project boundaries over the expected second crediting period 2013-2024 are 922 697 tonnes of CO_2 equivalent. An extension of the

[2] According to the Technical conditions TY Y 23.2-00152282-004:2009 on visbreaking residue dated 9th of April, 2009

crediting period beyond 2012 is subject to Host country approval. Overall emission reductions due to the project realisation during the period of 2010-2024 are 1 135 268 tonnes of CO_2 equivalent.

Estimates of total as well as annual emission reductions for the crediting period 2010-2024 are provided in the table below.

	Years
Length of the crediting period	15
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2010	42 069
2011	85 251
2012	85 251
Subtotal 2010-2012 (tonnes of CO_2 equivalent)	212 571
Annual average of estimated emission reductions over the first commitment period (tonnes of CO_2 equivalent)	85 028
2013	84 559
2014	84 697
2015	84 697
2016	84 697
2017	82 483
2018	80 131
2019	79 578
2020	68 371
2021	68 371
2022	68 371
2023	68 371
2024	68 371
Subtotal 2013-2024 (tonnes of CO_2 equivalent)	922 697
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 135 268
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	78 294

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. LEGU is not a project participant to any joint implementation or small-scale joint implementation project with a publicly available determination in accordance with paragraph 34 of the JI guidelines.

A.5. Project approval by the Parties involved:

The Project Idea Note had been submitted for review of the National Agency of the Ecological Investments of Ukraine. The National Environmental Investment Agency issued a Letter of Endorsement # 2254/23/7 from 27th of December, 2010 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 Agency of Ecological Investments 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 Agency of Ecological Investments of Ukraine the final determination report of the proposed project along with project design documentation and the copy of Letter of Endorsement.

Therefore the final PDD will be sent along with the final determination report to the National Agency of Ecological Investments of Ukraine for the Letter of Approval, which usually is expected within 30 days after PDD submission.

SECTION B. Baseline

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

The baseline scenario has been established in accordance with Appendix B of the JI Guidelines and in accordance with "Guidance on Criteria for Baseline Setting and Monitoring" Version 02 by the JISC.

Thus, JI specific approach with the application of some elements of CDM Methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" Version 02.1 has been chosen for justification of baseline scenario.

JI specific approach foresees use of project specific baseline and monitoring methodology based partly on CDM approved methodology AM0014 "Natural gas-based packaged cogeneration" Version 04. Namely the approaches for estimation of energy (fuel) consumptions for heat energy generation under the baseline scenario and associated baseline emissions as well as the approach for estimation of baseline emissions from electricity generation that is offset by the electricity supplied from the cogeneration units have been used. The mentioned CDM methodology is not applicable to this JI project to be used as a whole, because natural gas is not a main fuel type for project cogeneration unit and the project does not meet in full the applicability criteria of the methodology, namely the criterion that no excess heat from the cogeneration system is provided to another user and no excess of electricity is supplied to the power grid. Electricity generated within the project is supplied to the national grid.

Baseline scenario has been established on a project specific basis and using multi-project emission factor for electricity generated by power plants of the national grid. The project specific approach was used to estimate baseline emissions from heat energy generation. Thus, baseline scenario foresees further exploitation of the existing boilers with their graduate replacement with the new boilers utilizing residual fuel oil, refinery and natural gas as the main fuels and no on site electricity generation.

While establishing the baseline, national policies and circumstances were taken into account. As Ukraine satisfies its demand in natural gas by importing more than 70 % of natural gas used, one of the main goals of its national energy policy is decrease in natural gas consumption[3]. According to the Decree of Cabinet of Ministers of Ukraine № 256-р[4] "On Immediate Actions for Decrease of Natural Gas Consumption for the Period up to 2010", total substitution of natural gas by alternative sources of energy, coal and RFO should be provided. The decree is in line with the above mentioned National Energy Strategy of Ukraine.

At the same time, fuel oil is produced at LOORP in big quantities allowing ensuring reliable supply of the fuel. Besides, VAR can be used for combustion in boilers as it can be processed into residual fuel oil by adding of gasoil. Thus, baseline scenario is in line with national and sectoral policies and circumstances.

Detailed information about the parameters used to estimate baseline scenario greenhouse gases emissions within the project boundaries as well as key factors and data sources are clearly described in the tables below.

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[3] The Energy Strategy of Ukraine for the period up to 2030.
http://www.ukrenergo.energy.gov.ua/ukrenergo/control/uk/archive/docview?typeId=44577

[4] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=256-2009-%F0

Data / Parameter	**CEO_{grid}**
Data unit	MWh
Description	Electricity supply by the cogeneration unit to the national grid
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Operation report with data from power meter (on site measurements)
Value of data applied (for ex ante calculations / determinations)	For ax ante calculations amount of electricity supplied by the cogeneration unit to the national grid was estimated based on electricity capacity of the unit and annual operation hours. See Section E for details.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Power meter will be calibrated annually
Any comment	

Data / Parameter	**$EF_{CO2, national\ grid, prod.}$**
Data unit	tonne CO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid for JI projects producing electricity to the grid
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Development of the electricity carbon emission factors for Ukraine: Baseline Study for Ukraine, Final Report/EBRD, 14.10.2010
Value of data applied (for ex ante calculations / determinations)	See Table E.4-2.
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	The value of the parameter could be changed in case of new emission factors for electricity of Ukrainian grid will properly approved.

Data / Parameter	**CAHO**
Data unit	GJ
Description	Heat energy supply by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Heat energy meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Heat energy metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	

Data / Parameter	$\mathbf{EF_{CO2,BFM}}$
Data unit	*kg CO_2/GJ*
Description	Weighted CO_2 emission factor for baseline fuel mix
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	$EF_{CO2,\ BFM}$ was calculated on the basis of average fuel mix consumption over the period of 2000-2009, when heat energy was generated by boilers installed before the proposed project implementation, and CO_2 emission factor for each type of fuel. For more details see file *Lukoil_JI_SSC_ERU_Version.xls*, sheet *Calcul. of WEF (2000-2009).*
Value of data applied (for ex ante calculations / determinations)	*68.45*
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	$\mathbf{e_b}$
Data unit	%
Description	Efficiency of boilers with residual fuel oil/gas combustion
Time of determination / monitoring	Parameter is determined during PDD development based on conservative assumptions (see Section B above).
Source of data (to be) used	Parameter charts of the boilers
Value of data applied (for ex ante calculations / determinations)	Average natural gas boilers efficiency determined based on the latest approved data of parameter charts of the boilers installed at boiler room JSC “Lukoil-Odesskyi oil-refining plant” - e_b=90%.
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	

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:

In order to demonstrate that the project provides reductions in emissions by sources that are additional to any that would otherwise occur the following approach was used.

Indication and description of the approach applied

JI specific approach is used for demonstration of additionality of the project in accordance with the paragraph 2(a) of the Annex I to the "Guidance on criteria for baseline setting and monitoring" (Version 02)". The latest version of the CDM Executive Board approved "Tool for the demonstration and assessment of additionality" Version 05.2 has been applied to show that the reductions of anthropogenic emissions of the greenhouse gases are reduced below those that would have otherwise occurred. "Tool to determine the remaining time of the equipment" Version 01 has been used to estimate technical lifetime of the equipment and "Combined tool to identify the baseline scenario and demonstrate additionality" Version 02.1 was used to determine conservative assessment period for the investment analysis. Alternatives for the proposed project activity have been defined on the project specific basis.

Application of the approach chosen

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

Sub-step 1a: Define alternatives to the project activity

Plausible alternatives for the heat and power generation (supply) within the proposed project activity were established based on the existing practice analysis, national and sectoral policies and project specific circumstances.

The following alternatives were defined for the proposed project activity:

Alternative 1. The proposed project activity without being registered as a JI project. It implies combined heat and electricity generation using VAR and natural gas as the main fuel types. The alternative foresees all the same measures and use of the same equipment as the project scenario, but does not lead to additional revenues from emission reduction units' sale and thus less financially attractive.

The proposed alternative faces significant common practice and technological barriers as the project scenario does and is not financially favourable (For more details see Section B.2); nevertheless, it is still considered as one of alternatives.

Alternative 2. Further exploitation of the existing boilers with their graduate replacement with the new boilers utilizing residual fuel oil, natural and refinery gas as fuels; no on site electricity generation.

Technical characteristics of existing boilers allow the use of natural and refinery gas, and residual fuel oil as fuels. Data on fuel consumption of existing boiler house for the last ten years showed the significant share of residual fuel oil and refinery gas consumption in heat energy generation (See Table A-1.2). Such situation reflects national and sectoral circumstances: high and continuously increasing costs of the natural gas and associated risks from one side and the availability of the residual fuel oil in large quantities and its reliable supply by the nearby LOORP from the other. The use of refinery gas is determined by its availability as main by-product of the processes of nearby Lukoil-Odessa Oil-Refinery.

However, its volumes are strongly dependant on the operating of the LOORP, thus only the surplus of refinery gas could be used as a fuel by boilers.

Historical data on natural gas consumption for heat energy generation for the last ten years also showed a considerable dependence of fuel mix on the operation of Lukoil Refinery. As it can be seen from the table A-1.2, the highest rates of natural gas consumption were during the period of 2005-2008. It should be noted that from July 2005 until April 2008 LOORP has being reconstructed, and only natural gas was available as a fuel for combustion in boilers.

It should be also mentioned that low natural gas consumption totally corresponds with national and sectoral circumstances. Since Ukraine satisfies its demand in natural gas by importing more than 70 % of natural gas used, one of the main goals of Ukrainian Energy Strategy was stated as decrease of natural gas consumption[5]. According to the Decree of Cabinet of Ministers of Ukraine № 256-р[6] "On Immediate Actions for Decrease of Natural Gas Consumption for the Period up to 2010", total substitution of natural gas by alternative sources of energy, coal and RFO should be provided. The decree is in line with the above mentioned National Energy Strategy of Ukraine.

Thus, RFO and refinery gas were main fuels for heat generation during the period of 2000-2009, and natural gas was a reserve fuel. However, the most plausible scenario has been assumed as fuel mix consumption (RFO, natural and refinery gases) in quantities that were average for the period of previous ten years (2000-2009).

However, the boilers are old (installed in 1971-1986 years) and exceeded their exploitation lifetime (20 years). The applicable and valid in Ukraine Rules On Safety Operations and Exploitations of Steam and Water Heating Boilers (DNAOP 0.00-1.08-94) require the run of boilers' repair at least once during the year and the more frequent receipt of the permits for the boilers exploitation. And still, high level of safety and security of their operations may not be achieved. Thus, graduate boilers' replacement with the new ones would have been executed during the reasonable time (several years) ensuring, in this way, the necessary reliability of the heat generation and supply.

Last but not least, such option, as well, faces no barriers or hurdles associated with the availability of the trained and experienced staff to operate such boilers.

Boilers, which were used for heat energy generation before project implementation, produce steam with a pressure of 13-14 $kg \cdot s/sm^2$ and the temperature of 225-250 degrees Celsius, which are further used for technological purposes. The steam with such energy characteristics is problematic to be used for electricity generation as it can be used for electricity generation only with the low revolution turbine installation and specific generators capable to work in conjunction with such turbine. Moreover, use of the steam for electricity generation would have lead to lowering of steam energy content, which is not reasonable in light of reliable satisfaction of heat demand for technology purposes. Therefore, the alternative envisages no generation of electricity.

Taking into account all of the above-mentioned, this alternative has been identified as the most likely baseline scenario.

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[5] The Energy Strategy of Ukraine for the period up to 2030.
http://www.ukrenergo.energy.gov.ua/ukrenergo/control/uk/archive/docview?typeId=44577

[6] http://zakon1.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=256-2009-%F0

Alternative 3. Further exploitation of the existing boilers with their graduate replacement with the new boilers utilizing natural gas as the main fuel; electricity generation is absent on site.

Despite being rather convenient fuel type (the calorific value of the natural gas is around 34 MJ/m^3 [7]; the content of sulphur is minimal; it is, as well, easy to burn with respect to the respective technology application and availability of trained and experienced staff) natural gas and its usage in Ukraine is associated with the risks of its non delivery and gradual price rises[8].

Although existing boilers have technical capacity to be operated on natural gas, the share of the natural gas used by the boilers as the fuel out of the aggregated fuel used by the boilers decreased significantly over the last years (from 97% in 2006 to 3% in 2009), being thus in line with national and sectoral circumstances, clearly stated in the previous paragraph. Therefore, the use of natural gas as the main fuel type in existing boilers is presumed to be less favourable alternative in comparing with RFO use.

The alternative envisages no generation of electricity prescribing the continuation of its supply (to LOORP) from the national grid.

Taking into account, that all boilers exceeded their exploitation lifetime (20 years), their graduate replacement should have been executed. Although this option faces no technological difficulties, it is associated with all the related economic and political barriers and risks with respect to the use of the natural gas as the main fuel type, already mentioned while considering previous alternative (See paragraph on Alternative # 2 above).

Thus, this alternative is not considered as the most favourable.

Alternative 4. Installation of steam plant equipment with turbines for heat and electricity generation with VAR and refinery gas combustion.

Boilers, which were used for heat energy generation before project implementation, produce steam with a pressure of 13-14 kg·s/sm^2 and the temperature of 225-250 degrees Celsius, which are further used for technological purposes. The steam with such energy characteristics is problematic to be used for electricity generation as it can be used for electricity generation only with the low revolution turbine installation and specific generators capable to work in conjunction with such turbine. Thus, for reliable power generation the boilers should be replaced by high-pressure boiler to produce the motive steam, which leads to additional technological and economic barriers. Besides, energy generation cycle using steam turbine typically produce a large amount of heat compared with the electrical output meaning that the system generates less electrical energy per unit of fuel than reciprocating engine-driven cogeneration system[9]. Moreover, the additional limitation of the alternative is high water demand for cooling purposes and lack of the relevant water source in the project area.

Thus, this alternative is not considered as the most favourable.

Alternative 5. Installation of gas turbine equipment for heat and electricity generation

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[7] DBN V.2.5-20-2001 “Gas supply”

[8] Ukraine. Energy Policy Overview. Report published by International Energy Agency in 2006.

[9] See “A guide to cogeneration”, page 15. http://www.cogeneurope.eu/wp-content/uploads//2009/02/educogen_cogen_guide.pdf

The alternative foresees use of natural gas for combined heat and energy generation using gas turbine equipment. The alternative could not be considered as the most plausible due to the following technical restrictions of natural gas supply to the project site: not sufficient carrying capacity of natural gas pipeline, low pressure of supplied natural gas and consequent high electricity consumption and operation expenditures for compressing of natural gas. Besides, this alternative faces economic risks of natural gas price increase and possible break downs in its supply.

The use of fuel gas in a gas turbine is also not reasonable because of its low pressure (about 0.1 MPa comparing to 2.5 MPa needed) and not stable supply.

There is also a possibility of burning visbreaking atmospheric residue in specially modified gas turbines with exhaust boiler for heat utilisation. However, this alternative also could not be considered as realistic and plausible due to changing efficiency of gas turbine depending on ambient temperature and load factor, excessive heat energy generation during summer period, that could not be utilised and thus will be wasted, decreasing the efficiency of energy generation, and additional sufficient capital expenditures for purification system introduction due to higher volumes of exhaust emissions comparing to a steam turbine.

Thus, this alternative is not considered as the most favourable.

Alternative 6. Installation VAR gasification equipment

The alternative foresees gasification of visbreaking atmospheric residue and production of synthetic gas and its further combustion with heat energy and electricity generation using combined cycle gas turbine technology. The alternative is not plausible due to high capital expenditures exceeding USD 300 million (almost 10 times higher than expenditures for the project activity) and consequent low profitability level.

Thus, this alternative is not considered as the most favourable.

Alternative 7. Installation of boilers circulating fluidized bed technology

The alternative foresees combustion of visbreaking atmospheric residue in boilers using circulating fluidized bed technology and further heat energy and electricity generation. The alternative is not plausible due to high capital expenditures resulting in long pay-back period as well as low efficiency of energy generation cycle. The capital expenditures for fluidised bed technology are reported to be in the range of 1208-1351 $/kWe (2003$)[10] but are significantly affected by the type of fuel, the plant size and other factors. The typical capacity of power units using circulating fluidized bed technology is about 150-250 MWe and the typical fuel for such installation is coal. Economies of scale have a significant influence on the investment price, and it is economically unreasonable to implement circulating fluidized bed technology within small-scale projects. Besides, this alternative needs large area for construction activities and large ash-disposal area, which are significant additional barriers for the implementation of the alternative.

Thus, this alternative is not considered as the most favourable.

[10] Joris Koornneef, Martin Junginger, Andre´ Faaij. Development of fluidized bed combustion—An overview of trends, performance and cost // Progress in Energy and Combustion Science 33 (2007)

Sub-step 1b: Consistency with mandatory laws and regulations

All alternatives are in compliance with all mandatory applicable legal and regulatory requirements.

Thus, based on the analysis presented above, Alternative 2 has been identified as the baseline. Baseline scenario foresees heat energy generation by the gradually replaced boilers utilizing residual fuel oil, refinery and natural gas as their major fuels and no electricity generation on the site.

Project scenario foresees introduction of combined heat and electricity generation unit using VAR and natural gas as the main fuel types.

In the absence of project activity VAR would be processed into residual fuel oil by adding gasoil to reduce its viscosity. Thus, VAR would meet all regulatory requirements and technical conditions for residual fuel oil and could be sold to the customers.

Step 2: Investment Analysis

Sub-step 2a: Determine appropriate analysis method

The proposed project generates economic benefits in the form of revenues from the sale of electricity and heat energy; therefore simple cost analysis is not applicable. In line with the "Tool for demonstration and assessment of additionality" Version 05.2 Option III – benchmark analysis – has been chosen to show that the project is unlikely to be financially attractive.

Sub-step 2b: Option III. Apply benchmark analysis

The Internal Rate of Return (IRR) is used as a most suitable financial indicator in order to evaluate the project's attractiveness. IRR was applied to measure the profitability of the investments in the proposed project activity without revenues from ERUs sale and its comparison with a benchmark in order to determine whether the proposed project activity is financially/economically feasible, without the revenue from the sale of carbon credits.

The average commercial lending rate in Ukraine for the period when the decision about project implementation was made has been taken as the benchmark for this project's IRR. This means that the project could not be considered as financially/economically attractive if it is generating cash flow with an IRR less than the benchmark.

According to the National Bank of Ukraine data the loan interest rate for non-financial corporations for the period greater than 5 years was 16.6% at the time of decision-making on project implementation[11]. Thus, the benchmark IRR was considered to be equal 16.6%.

Sub-step 2c: Calculation and comparison of financial indicators

Project IRR without revenue from ERUs sale	12.22%
Benchmark rate	16.6%

The project activity has less favourable indicator (lower IRR) than the benchmark and thus the project activity cannot be considered as financially attractive. The application of the flexible mechanisms of Kyoto Protocol and additional revenues from emission reduction units' sales significantly improves the

[11] http://www.bank.gov.ua/Statist/Electronic%20bulletin/data/4-Financial%20markets(4.1).xls Spreadsheet 1.3. Cell M31. Data for March 2007, rate for the loans in national currency for the period greater than 5 years.

economic feasibility of the project and triggers project implementation. Thus, the investment analysis supports the conclusion that the project activity is unlikely to be economically attractive without ERU's sale and therefore provides a valid argument in favour of additionality of the project.

The key assumptions for the investment analysis are the following:

1. The assessment period is 2007-2024. Although expected operational lifetime of the exhaust-boilers is 30 years, and operational life time of the Wartsila diesel engines is not set in the technical documentation, but it is indicated that every 48 000 hours of the operation they need major repairs. According to the Annex: Guidelines on the Assessment of Investment Analysis (Version 03.1) of *"Combined tool to identify the baseline scenario and demonstrate additionality" Version 3.0.0* a minimum period of 10 years and a maximum period of 20 years for the assessment is appropriate. Taking into account operational lifetime of the exhaust-boilers (30 years) and major repairs of diesel engines (every 6 years) and the mentioned Guidelines the forecast period in the financial analysis model of the project has been assumed as 15 years. Moreover, LLC "Lukoil Energy and Gas Ukraine" operates the boiler-house, where the cogeneration unit and other auxiliary equipment within project boundaries are installed, under rent agreement until 2024.

2. The cost of financing expenditures (i.e. loan interest payment) is not included in the calculation of the project IRR.

3. The IRR adjustment for inflation is based on 8.36 % growth rate as an average inflation rate for 2003-2006[12].

4. The fare liquidation value at future point of time has been estimated using projected free cash flow in the first year beyond the projection horizon and dividing it by the discount rate minus the assumed perpetuity growth rate (Perpetuity Growth Model approach for estimation of terminal value).

5. All input values are used with VAT excluded.

6. All costs for fuel and power as well as capital expenditures were taken as expected values at the time of the investment decision.

Key data used in the investment analysis presented below.

Data	Value	Source of data
VAR price, UAH/tonne	3 206	Data provided by the Enterprise.
Natural gas price, UAH/1000 m^3	2 275	Data provided by the Enterprise.
Diesel fuel price, UAH/tonne	5 917	Data provided by the Enterprise.
Electricity price, UAH/MWh	893	Data provided by the Enterprise.
Heat energy price, UAH/Gkal	489	Data provided by the Enterprise.

Sub-step 2d: Sensitivity analysis

The 10% fluctuation of key parameters (VAR price, natural gas price, electricity price, heat energy price and operating expenses) has been assumed in sensitivity analysis. The results are provided below.

[12] http://ukrstat.gov.ua/operativ/operativ2006/ct/cn_rik/isc/isc_u/isc_m_u.htm

	Fluctuation		
Parameter	-10%	0%	10%
VAR Price	15.50	12.22	8.34
Natural Gas Price	13.83	12.22	10.49
Electricity Price	7.37	12.22	16.16
Heat Price	8.14	12.22	15.64
Operating Expenses	13.50	12.22	10.87

10% fluctuations to the key prices (VAR and natural gas costs, electricity and heat costs, and operating expenses) were applied in the sensitivity analysis. Prices fluctuations showed the robustness of results and conclusion of financial analysis. Therefore, the proposed project activity is unlikely to be financially attractive.

Step 3: Barrier Analysis

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

The project faced technological, prevailing practice and other barriers. Significant risks are connected with fuel used in the cogeneration unit, where visbroken atmospheric residue (67.06% of total fuel), natural gas (32.57%) and diesel (0.37%) are combusted.

Visbroken atmospheric residue is a main by-product in goudrons' visbreaking. This technology was implemented in 2008 at Lukoil-Odessa Refinery and is first of its kind in Ukraine; consequently, the VAR based cogeneration unit is also first of its kind. Taking into account the absence of both goudrons' visbreaking and VAR based cogeneration technologies' use in Ukraine, high technological risks exist for the proposed project implementation. This situation could lead to high risks of equipment disrepair or other underperformance. As it was mentioned, the process of goudrons' visbreaking is first of its kind in Ukraine, thus there are additional risks that are connected with availability of VAR as a fuel in Ukraine. However, it is foreseen to use reserve fuels (e. g., residual fuel oil) in cases of the lack of VAR.

What is more, there is a lack of skilled and properly trained staff to operate and maintain the cogeneration unit. To ensure proper operating and maintenance of the cogeneration unit, extensive initial trainings of the personnel were conducted before the start of cogeneration unit's operation. The trainings have been provided by Wartsila Land and Sea Academy during the period of 2008- 2009. Power Plant Introduction course, Power Plant Operation and Maintenance course and Power Plant Electrification course have been attended by the specialists of LEGU. Besides, electrical engineers and cogeneration units' operators have 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.

The other significant barrier is connected with natural gas use. Natural gas accounts for 50-70% of heat costs in Ukraine, and the increase in gas prices affects greatly the heat costs, thus causing debts and non-payments[13]. The same statement can be applied to natural gas based electricity production. It should be noticed that the main activity of LEGU is heat and electricity generation, and debts and non-payments of the consumers of heat and electrical energy can affects greatly functioning of the Enterprise. Besides, 70% of natural gas demand is satisfied by import supplies, mainly from Russia, it causes heavy dependence of natural gas supply and leads to the increase of prices on this energy carrier. It should be also noted that the price of natural gas for industrial enterprises starting from January 2007 was supplemented by a target increment of 2%, which was aimed to compensate losses of Naftogaz originating from gas sale to households. In 2008 this increment was increased three times (in January, April and June) and as of end of June 2008 it has reached 12% for industry. Moreover, starting from May 2008 one more component was introduced in the formula of gas price calculation for industrial consumers – the component of 87.43 UAH (without VAT) is aimed to compensate costs for gas selling.

All together, different increments increase significantly the final price for industries[13]. Taking into account all mentioned above, financial barriers can be stated.

Sub-step 3b: Show that identified barriers would not prevent the implementation of at least one of the alternatives

The Alternative #2 (Heat energy generation by the gradually replaced boilers utilizing residual fuel oil and refinery gas as their major fuels and natural gas as an additional fuel and no electricity generation on the site) would not have been affected by high technological risks as before project implementation the boilers with similar technical characteristics had been in operation for long period of time. The fuel for the boilers (residual fuel oil and refinery gas) is ensured by the nearby LOORP. Besides, the staff is experienced with operating of such equipment.

Some risk can be connected with natural gas use, but due to its negligible share in total heat energy generation, the risk was considered insignificant and it was assumed that it wouldn't prevent the Alternative #2.

Conclusion: The project activity faced significant technological and financial barriers compared with the alternative #2 (baseline scenario). Thus, baseline scenario is far more attractive than the project one.

Step 4: Common Practice Analysis
Sub-step 4a: Analyze other activities similar to the proposed project activity

Overall, there are about 250 CHPs in Ukraine. More than 200 of them are small CHP plants incorporated in the property of industrial enterprises. Industrial enterprises produce heat for their own needs and sell the rest of heat to households. About 30 CHPs are separate legal entities. They are large heat producers that supply heat to households and industry. Half of them are state owned and incorporated in National JSC "Energy Company of Ukraine" structure. About 10 CHPs are owned by local communities and 5 of them are privately owned[14].

Even though in 2005 the Cogeneration Act[15] 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.[16] As a result the share of combined heat and power generation in district heating systems is insignificant.[17]

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[13] Herasimovich V. Ukrainian Gas Sector Review // Center for Social and Economic Research, Kyiv, 2008.

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

[15] http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=2509-15

[16] 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/

[17] Ukraine. Energy Policy Overview. Report published by International Energy Agency in 2006.

Moreover, most of the cogeneration units in Ukraine use natural gas as a fuel. As it is stated above there are no other activities foreseeing cogeneration of electricity and heat energy based on combustion of visbroken atmospheric residue as a main fuel.

Sub-step 4b: Discuss any similar Options that are occurring

As it was clearly stated before, the project activity is the first of its kind in Ukraine. Taking into account that visbroken atmospheric residue is a by-product of goudrons' visbreaking, the technology that has not been used in Ukraine before, no similar project activities can be observed in Ukraine.

Thus, based on financial analysis, barriers analysis and common practice analysis it could be concluded that the project is additional and greenhouse emission reductions would not have been occurred in the absence of joint implementation activity.

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

Project boundary includes emission sources attributable to the project which are under the control of project participants.

Project boundaries include existing boiler workshop of JSC "Lukoil-Odesskyi oil-refining plant" (being currently under the operation of Lukoil Energy and Gas Ukraine based on the rent agreement) and equipment installed within the project activity (cogeneration unit with engines, exhaust-boilers and purification systems). At the same time, the source of greenhouse gases emissions is indirect - Ukrainian electricity grid, as a result of electricity generation using fossil fuels.

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

	Source	Gas	Incl./Excl.	Justification/Explanation[18]
Baseline	Emissions due to fossil fuel combustion for heat energy generation	CO_2	Incl	**Main source of emissions**
		CH_4	Excl	Considered negligible. Conservative
		N_2O	Excl	Considered negligible. Conservative
	Emissions due to electricity generation by power plants of the national grid	CO_2	Incl	**Main source of emissions**
		CH_4	Excl	Considered negligible. Conservative
		N_2O	Excl	Considered negligible. Conservative
Project	Emissions due to fossil fuel combustion for heat energy and electricity generation by cogeneration units	CO_2	Incl	**Main source of emissions**
		CH_4	Excl	Considered negligible. Conservative
		N_2O	Excl	Considered negligible. Conservative

[18] 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 as due to the *"Guidance on criteria for baseline setting and monitoring" Version 02*.

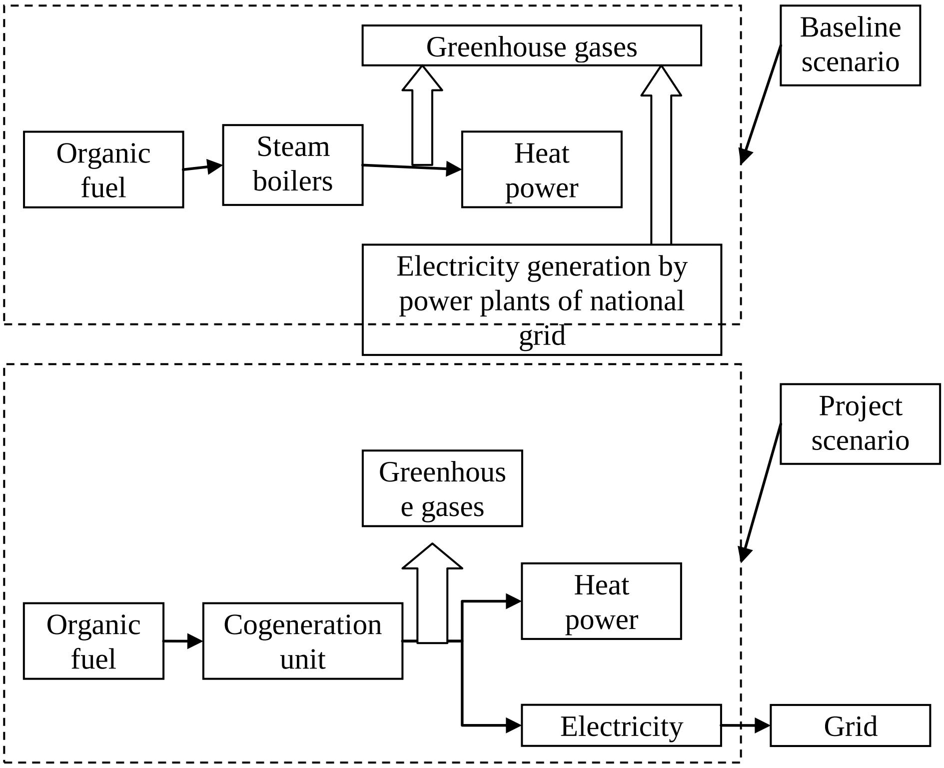

Fig. B-3.1 The scheme of project and baseline boundaries.

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: 9th of December, 2010
Kyryl Tomlyak, LLC 'KT-Energy'
15 B/22 Biloruska st., Kyiv, 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:

Project implementation starting date (beginning of the investment stage) was 23d of July 2007, when the contract on purchasing engines for cogeneration unit has been concluded.

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

Expected operational lifetime of the project is 15 years (or 180 months).

C.3. Length of the crediting period:

Start of the crediting period for proposed project activity is 1st of July, 2010.

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

Thus, the length of the first commitment period is 2 years and 6 months (30 months).

The start date of the second commitment period is expected to be January 1st, 2013 and the end date of the second commitment period is expected to be December 31st, 2024. The length of the second commitment period is expected to be 12 years or 144 months. The second commitment period does not extend beyond the operational lifetime of the project and is a subject to the Host Party approval. The length of the expected second commitment period could be changed based on adopted international or national regulations. The estimates of emission reductions are presented separately for the first and second commitment periods in section E below.

Thus, the length of the crediting period is 14 years and 6 months (174 months).

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

Detailed information on the collection and archiving of all relevant data necessary for estimating or measuring project emissions, determining baseline emissions, and assessing leakage effects is given below.

JI specific approach with elements of the approved baseline and monitoring methodology *AM0014 "Natural gas-based package cogeneration" (Version 04)* was chosen for monitoring of greenhouse emission reductions. 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)* and *Tool to calculate project or leakage CO_2 emissions from fossil fuels combustion" (Version 02).*

Emission reductions

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

$$ER_y = BE_y - PE_y$$

Project scenario emissions

The source of project greenhouse gases emissions is combustion of organic fuel (visbroken atmospheric residue (67.06%), diesel (0.37%) and natural gas (32.57%); RFO and refinery gas are also foreseen as reserve fuels) in cogeneration unit.

Greenhouse gases emissions sources in project scenario within the defined project boundaries include emissions due to organic fuel combustion by the cogeneration unit. Formulas according to the "*Tool to calculate project or leakage CO_2 emissions from fossil fuels combustion" Version 02* were used for project emissions calculations.

Greenhouse gases emissions are calculated using formula presented below:

$$PE_y = PE_{NG,y} + PE_{VAR,y} + PE_{DF,y} + PE_{RFO,y} + PE_{RG,y} \quad (1)$$

where
$PE_{NG,y}$ – project emissions due to natural gas consumption by the cogeneration unit, tonnes CO_{2e}/year.
$PE_{VAR,y}$ – project emissions due to VAR consumption by the cogeneration unit, tonnes CO_{2e}/year.
$PE_{DF,y}$ – project emissions due to diesel fuel consumption by the cogeneration unit, tonnes CO_{2e}/year.
$PE_{RFO,y}$ – project emissions due to residual fuel oil consumption by the cogeneration unit, tonnes CO_{2e}/year.
$PE_{RG,y}$ – project emissions due to refinery gas consumption by the cogeneration unit, tonnes CO_{2e}/year.

$$PE_{NG,y} = FC_{NG,y} \cdot NCV_{NG,y} \cdot EF_{CO2,\ NG} \cdot 10^{-6} \quad (1.1)$$

where

$PE_{NG,y}$ – project emissions due to natural gas consumption by the cogeneration unit, tonnes CO_{2e}/year.

$FC_{NG,y}$ is the quantity of natural gas used for combined heat and power generation by the cogeneration unit during the year *y*, m^3. Parameter is monitored throughout the crediting period.

$NCV_{NG,y}$ is the net calorific value of natural gas, GJ/thousand m^3. Parameter is monitored throughout the crediting period.

$EF_{CO2,\ NG}$ is the emission factor for natural gas, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\ NG}$ = *56.1 kg* CO_2*/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)). Parameter is not monitored throughout the crediting period.

$$PE_{VAR,\ y}= FC_{VAR,y} \cdot NCV_{VAR,y} \cdot EF_{CO2,\ VAR} \cdot 10^{-3} \quad (1.2)$$

where

$PE_{VAR,\ y}$ – project emissions due to VAR consumption by the cogeneration unit, tonnes CO_{2e}/year.

$FC_{VAR,y}$ is the quantity of visbroken atmospheric residue used for combined heat and power generation by the cogeneration unit during the year *y*, tonnes. Parameter is monitored throughout the crediting period.

$NCV_{VAR,y}$ is the net calorific value of visbroken atmospheric residue, GJ/tonne. Parameter is monitored throughout the crediting period.

$EF_{CO2,\ VAR}$ is the emission factor for other oil products, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,VAR}$ = *73.3 kg* CO_2*/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)). Parameter is not monitored throughout the crediting period.

$$PE_{DF,\ y}= FC_{DF,y} \cdot NCV_{DF,y} \cdot EF_{CO2,\ DF} \cdot 10^{-3} \quad (1.3)$$

where

$PE_{DF,y}$ – project emissions due to diesel fuel consumption by the cogeneration unit, tonnes CO_{2e}/year.

$FC_{DF,y}$ is the quantity of diesel fuel used for combined heat and power generation by the cogeneration unit during the year *y*, tonnes. Parameter is monitored throughout the crediting period.

$NCV_{DF,y}$ is the net calorific value of diesel fuel, GJ/tonne. Parameter is monitored throughout the crediting period.

$EF_{CO2,\ DF}$ is the emission factor for diesel fuel, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\ DF}$ = *74.1 kg* CO_2*/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)). Parameter is not monitored throughout the crediting period.

$$\mathbf{PE_{RFO,\,y} = FC_{RFO,y} \cdot NCV_{RFO,y} \cdot EF_{CO2,\,RFO} \cdot 10^{-3}} \quad \textbf{\textit{(1.4)}}$$

where

$\mathbf{PE_{RFO,y}}$ – project emissions due to residual fuel oil consumption by the cogeneration unit, tonnes CO_{2e}/year.

$\mathbf{FC_{RFO,y}}$ is the quantity of residual fuel oil used for combined heat and power generation by the cogeneration unit during the year y, tonnes. Parameter is monitored throughout the crediting period.

$\boldsymbol{NCV_{RFO,y}}$ is the net calorific value of residual fuel oil, GJ/tonne. Parameter is monitored throughout the crediting period.

$\boldsymbol{EF_{CO2,\,RFO}}$ is the emission factor for residual fuel oil, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\,RFO}$ = *77.4 kg CO_2/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)). Parameter is not monitored throughout the crediting period.

$$\mathbf{PE_{RG,\,y} = FC_{RG,y} \cdot NCV_{RG,y} \cdot EF_{CO2,\,RG} \cdot 10^{-3}} \quad \textbf{\textit{(1.5)}}$$

where

$\mathbf{PE_{RG,y}}$ – project emissions due to refinery gas consumption by the cogeneration unit, tonnes CO_{2e}/year.

$\mathbf{FC_{RG,y}}$ is the quantity of refinery gas used for combined heat and power generation by the cogeneration unit during the year y, tonnes. Parameter is monitored throughout the crediting period.

$\boldsymbol{NCV_{RG,y}}$ is the net calorific value of refinery gas, GJ/tonne. Parameter is monitored throughout the crediting period.

$\boldsymbol{EF_{CO2,\,RG}}$ is the emission factor for refinery gas, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\,RG}$ = *66.73 kg CO_2/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)). Parameter is not monitored throughout the crediting period.

Baseline scenario emissions

Baseline scenario of the proposed joint implementation project foresees the continuation of the steam boilers exploitation with their gradual replacement with the similar types of the boilers combusting residual fuel oil, natural and refinery gas. Greenhouse gases emissions would have been generated due to organic fuel combustion. They include emissions from generation heat power by boilers and electricity generated by power stations of the Ukrainian national grid.

Greenhouse gases' emissions sources in baseline scenario include the following:

- Heat power generation by boilers with residual fuel oil, natural and refinery gas combustion in the amount that will be supplied by the cogeneration unit within the project activity;

- Electricity generation by fossil fuels power plants of the national grid in the amount that will be supplied by the cogeneration unit within the project activity.

Formulas according to the approved baseline methodology AM0014 “Natural gas-based package cogeneration” Version 04 were applied for baseline emissions calculations.

Baseline emissions will be estimated by the following formulas:

$$\mathbf{BE_y = BE_{th} + BE_{elec.}} \quad \mathit{(2)}$$

where:
BE_{th}– baseline emissions due to heat energy supply by the boilers operated on the residual fuel oil, natural and refinery gas under the baseline scenario in the amount which will be substituted with heat energy supplied by the cogeneration unit under the project scenario.

BE_{elec} – baseline emissions due to electricity generation by power plants of the national grid under the baseline scenario in the amount which will be substituted with electricity supplied by the cogeneration unit under the project scenario.

$$\mathbf{BE_{th} = ((CAHO/e_b)\cdot \mathit{EF_{CO2,\ WEF}})\cdot 10^{-3}} \quad \mathit{(2.1)}$$

where
BE_{th}– baseline emissions due to heat supply by the boilers operated on the residual fuel oil, natural and refinery gas under the baseline scenario in the amount which will be substituted with heat energy supplied by the cogeneration unit under the project scenario during the year y, tonnes CO_2e.

$EF_{CO2,BFM}$ –weighted emission factor for baseline fuel mix, tonnes CO_2e. ***$EF_{CO2,\ BFM}$*** was calculated on the basis of average fuel mix consumption over the period of 2000-2009, when heat energy was generated by boilers installed before the proposed project implementation, and CO_2 emission factor for each type of fuel. Weighted emission factor for baseline fuel mix is equal to ***$EF_{CO2,\ WEF}$*** =68.45 tonnes of CO_2e/GJ. Parameter is not monitored throughout the crediting period.

CAHO – annual heat output from the cogeneration unit that is supplied to the consumer and is assumed to be equal to heat energy that would be supplied in the baseline scenario, GJ. Parameter is monitored throughout the crediting period.

e_b – average efficiency of residual fuel oil/gas fired boilers under the baseline scenario estimated according to operational tests of the boilers indicated in parameter charts of the boiler installed at JSC ‘Lukoil-Odessa oil refining plant’. Parameter is not monitored throughout the crediting period. According to parameter charts of the boilers the average efficiency of installed boilers *$\acute{\eta}_{boilers}$ = 90%.*

$$\mathbf{BE_{elec} = CEO_{,\ grid} \cdot EF_{CO2,\ national\ grid,\ prod.}} \quad \mathit{(2.4)}$$

where
BE_{elec} – baseline emissions due to electricity generation by power plants of the national grid under the baseline scenario in the amount which will be substituted with electricity supplied by the cogeneration unit under the project scenario.

$CEO_{,\ grid}$ – cogeneration electricity supplied to the national grid during the year y, MWh. Parameter is monitored throughout the crediting period.

$EF_{CO2,\ national\ grid,\ prod}$ – Emission factor for electricity of Ukrainian grid, tonne CO_{2e}/MWh; for each year throughout crediting period an appropriate carbon emission factor as due to the *Development of the electricity carbon emission factors for Ukraine: Baseline Study for Ukraine, Final Report/EBRD, 14.10.2010* will be used. See Table E.4-2. The results of the study were based on a power system simulation model that was specifically developed to incorporate the expected changes in efficiency and carbon emissions on a year to year basis for the period of 2009 – 2020. TÜV SÜD, an accredited independent entity under the Joint Implementation Supervisory Committee (JISC) assessed the study and confirmed that it was developed and implemented in accordance with relevant UNFCCC methodology (report from 15th of October, 2010).

D.2. Data to be monitored:

Data / Parameter	**$CEO_{,grid}$**
Data unit	MWh
Description	Electricity supply by the cogeneration unit to the national grid
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Operation report with data from power meter (on site measurements)
Value of data applied (for ex ante calculations / determinations)	For ax ante calculations amount of electricity supplied by the cogeneration unit to the national grid was estimated based on electricity capacity of the unit and annual operation hours. See Section E for details.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Power meter will be calibrated annually
Any comment	

Data / Parameter	**CAHO**
Data unit	GJ
Description	Heat energy supply by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Heat energy meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Heat energy metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	

Data / Parameter	**$FC_{NG,y}$**
Data unit	m^3
Description	Natural gas consumption by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Natural gas meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or	Conservative

description of measurement methods and procedures (to be) applied	
QA / QC procedures (to be) applied	Natural gas metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	

Data / Parameter	**$FC_{\mathbf{VAR},y}$**
Data unit	tonne
Description	Visbroken atmospheric residue consumption by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Visbroken atmospheric residue meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Visbroken atmospheric residue metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	

Data / Parameter	**$FC_{\mathbf{DF},y}$**
Data unit	tonne
Description	Diesel fuel consumption by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Diesel fuel meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Diesel fuel metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	

Data / Parameter	**$FC_{\mathbf{RFO},y}$**
Data unit	tonne
Description	Residual fuel oil consumption by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	RFO meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and	Conservative

procedures (to be) applied	
QA / QC procedures (to be) applied	Residual fuel oil metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	Reserve fuel

Data / Parameter	**$FC_{RG,y}$**
Data unit	tonne
Description	Refinery gas consumption by the cogeneration unit
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Refinery gas meter
Value of data applied (for ex ante calculations / determinations)	For ex ante calculations the value estimated based on technical documentation of the cogeneration unit was assumed.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Conservative
QA / QC procedures (to be) applied	Refinery gas metering equipment will be calibrated regularly in accordance with producer requirements and national regulations.
Any comment	Reserve fuel

Data / Parameter	**$NCV_{NG,y}$**
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)	Average natural gas net calorific value was applied for ex ante calculations; according to DBN V.2.5-20-2001 “Gas supply” NCV_{NG} = 34 GJ/1000 m^3
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	**$NCV_{VAR,y}$**
Data unit	GJ/tonne
Description	Net calorific value for visbroken atmospheric residue
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)	For ex ante calculations the value of NCV_{VAR}=38.97 GJ/tonne will be applied; according to the TY Y 23.2-00152282-004:2009 on visbreaking residue dated 9th of April, 2009.
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	**$NCV_{DF,y}$**
Data unit	GJ/tonne
Description	Net calorific value for diesel fuel
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)	For ex ante calculations the value of NCV_{DF} = 43.33 GJ/tonne will be applied; according to Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Table 1-3.
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	**$NCV_{RFO,y}$**
Data unit	GJ/tonne
Description	Net calorific value for residual fuel oil
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)	For ex ante calculations the value of NCV_{RFO} = 40.19 GJ/tonne will be applied; according to Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Table 1-3.
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	**$NCV_{RG,y}$**
Data unit	GJ/tonne
Description	Net calorific value for refinery 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)	For ex ante calculations the value of NCV_{RG} = 48.15 GJ/tonne will be applied; according to Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Table 1-3.
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	**$EF_{CO2, national grid, prod.}$**
Data unit	tonne CO_{2e}/MWh
Description	Emission factor for electricity of Ukrainian grid for JI projects producing electricity to the grid
Time of determination / monitoring	Parameter is monitored during the crediting period
Source of data (to be) used	Development of the electricity carbon emission factors for Ukraine: Baseline Study for Ukraine, Final Report/EBRD, 14.10.2010
Value of data applied (for ex ante calculations / determinations)	See Table E.4-2.
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	The value of the parameter could be changed in case of new emission factors for electricity of Ukrainian grid will be properly approved.

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.
$FC_{NG,y}$ Natural gas consumption by cogeneration unit	*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 0.45%;* *- once every two years gas flow meter is certified by state authorized laboratory.*
$FC_{VAR,y}$ Visbroken atmospheric residue consumption by cogeneration unit	*low*	*Devices used: Visbroken atmospheric residue consumption meter. Quality of measurement is ensured by Ukrainian standards applied for commercial metering of VAR consumption and payment for it:* *- accuracy of VAR meter is 0.15%;* *- once every two years visbroken atmospheric residue consumption meter is certified by state authorized laboratory.*
$FC_{DF,y}$ Diesel fuel consumption by cogeneration unit	*low*	*Devices used: Diesel fuel consumption meter. Quality of measurement is ensured by Ukrainian standards applied for commercial metering of DF consumption and payment for it:* *- accuracy of diesel fuel meter is 0.2%;* *- once every five years diesel fuel consumption meter is certified by state authorized laboratory.*
$FC_{RFO,y}$ Residual fuel oil consumption by cogeneration unit	*low*	*Devices used: Residual fuel oil consumption meter. Quality of measurement is ensured by Ukrainian standards applied for commercial metering of RFO consumption and payment for it:* *- accuracy of RFO meter is 0.15%;* *- once every two years residual fuel oil consumption meter is certified by state authorized laboratory.*

$FC_{RG,y}$ Refinery gas consumption by cogeneration unit	*low*	*Devices used: Refinery gas consumption meter. Quality of measurement is ensured by Ukrainian standards applied for commercial metering of refinery gas consumption and payment for it:* *- accuracy of gas flow meter is 0.5%;* *- once every three years refinery gas consumption meter is certified by state authorized laboratory.*
NCV_{NG} Natural gas net calorific value	*low*	*Supplier's data*
NCV_{VAR} Visbroken atmospheric residue net calorific value	*low*	*Supplier's data*
NCV_{DF} Diesel fuel net calorific value	*low*	*Supplier's data*
NCV_{RFO} Residual fuel oil net calorific value	*low*	*Supplier's data*
NCV_{RG} Refinery gas net calorific value	*low*	*Supplier's data*
CAHO Heat energy supply by cogeneration unit	*low*	*Devices used: Heat energy meter. Quality of measurement is ensured by Ukrainian standards applied for commercial metering of heat energy flow:* *- accuracy of heat energy flow meter is 0.02%;* *- once a year heat energy flow meter is certified by state authorized laboratory.*
$CEO_{, grid}$ Electricity supply by cogeneration unit to the national grid	*low*	*Devices used:* Electricity meter. *Quality of measurement is ensured by Ukrainian standards applied for commercial metering of electricity flow:* *- accuracy of electricity flow meter is 0.5%;* *- once every six years electricity flow meter is certified by state authorized laboratory.*

Monitoring data on fuel consumption and heat and electricity supply is daily recorded and saved by specially developed electronic programmes. Besides, monitoring data will be saved in the form of electronic reports as due to the Monitoring Procedure. Monitoring data on net calorific value of fuels used will be collected monthly according to the Certificates of quality of fuels, which are provided by fuel suppliers. Thus, double archiving of all monitoring data will be provided.

On the basis of daily reports Environmental Protection Engineer will perform monthly reports to the LLC "KT-Energy". Daily data as well as monthly reports will be kept for two years after the last transfer of ERUs for the project.

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. Initial data will be submitted by the Enterprise. Calculations of reduction of emissions will be prepared by LLC 'KT-Energy'.

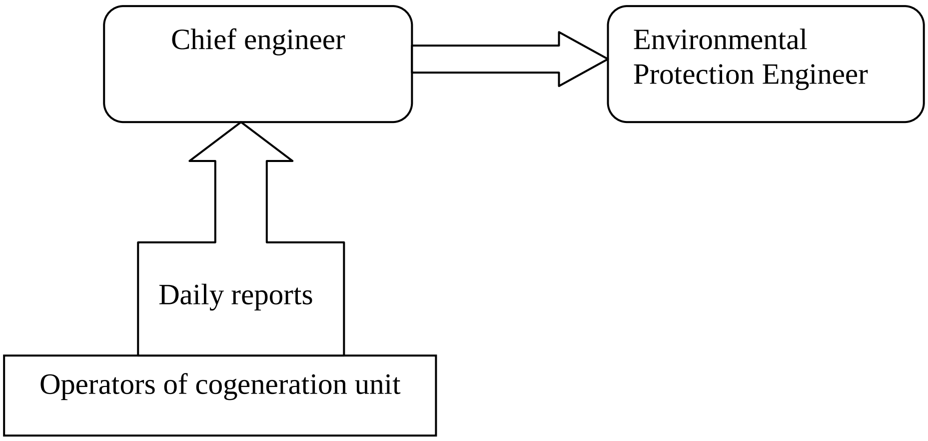

Fig. D-4.1 Monitoring system scheme

Before beginning of the project extensive initial trainings of the personnel were conducted to ensure proper operating and maintenance of the cogeneration unit. The trainings have been provided by Wartsila Land and Sea Academy during the period of 2008- 2009. Power Plant Introduction course, Power Plant Operation and Maintenance course and Power Plant Electrification course have been attended by the specialists of LEGU. Besides, electrical engineers and 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.

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

Date: 9^{th} of December, 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 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 estimation project emissions:

- fuel consumption for combined heat and power generation in 2010-2012 is estimated based on cogeneration unit fuel consumption rates and the assumptions of annual operation during 4290 hours in 2010 and 8580 hours in 2011-2024,

- residual fuel oil and gas refinery consumption were not taken into account while project emissions estimation as these types of fuel are reserve fuels and will be used only in the absence of VAR and natural gas respectively;

- emission factor for VAR is considered as 73.3 kg CO_{2e}/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, the value for other oil); emissions factors for other fuel types (natural gas, diesel) were also considered as default carbon emission factors according to Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories;

- fuel consumption was estimated on the basis of fuel consumption rates for the cogeneration unit, electricity generation was estimated on the basis on the electricity output rate for the cogeneration unit under 100% load;

- heat energy generation amount is assumed based on the data about forecasted heat energy demand obtained from the Enterprise. Heat energy generation is equal both in the project and baseline scenario. Natural gas consumption was calculated based on its consumption rates and forecasted heat energy demand.

Project GHGs include emissions due to organic fuel combustion by the cogeneration unit. Greenhouse gases emissions are calculated using formula presented below:

$$\mathbf{PE = PE_{NG} + PE_{VAR,} + PE_{DF},} \quad \mathit{(1)}$$

where
$PE_{NG,y}$ – project emissions due to natural gas consumption by the cogeneration unit,
$PE_{VAR,y}$ – project emissions due to VAR consumption by the cogeneration unit, tonnes CO_{2e}/year.
$PE_{DF,y}$ – project emissions due to diesel fuel consumption by the cogeneration unit, tonnes CO_{2e}/year.

$$\mathbf{PE_{NG,y} = FC_{NG} \cdot NCV_{NG} \cdot EF_{CO2,NG} \cdot 10^{-6}} \quad \mathit{(1.1)}$$

where
$PE_{NG,y}$ – project emissions due to natural gas consumption by the cogeneration unit,

$FC_{NG,y}$ is the quantity of natural gas used for combined heat and power generation by the cogeneration unit during the year y, m^3.

NCV_{NG} is the net calorific value of natural gas, GJ/thousand m^3. Average statistical data was used, NCV_{NG}= 34 GJ/1000 m^3 (DBN V.2.5-20-2001 “Gas supply”).

$EF_{CO2,\ NG}$ is the emission factor for natural gas, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\ NG}$ = *56.1 kg CO_2/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)).

$$\mathbf{PE_{VAR,\ CU} = FC_{VAR} \cdot NCV_{VAR} \cdot EF_{CO2,\ VAR} \cdot 10^{-3}} \quad (1.2)$$

where

$PE_{VAR,\ y}$ – project emissions due to VAR consumption by the cogeneration unit, tonnes CO_{2e}/year.
FC_{VAR} is the quantity of visbroken atmospheric residue used for combined heat and power generation by the cogeneration unit during the year y, tonne.

NCV_{VAR} is the net calorific value of visbroken atmospheric residue, GJ/tonne. *NCV_{VAR}*= 38.97 GJ/tonne was used according to the Technical conditions TY Y 23.2-00152282-004:2009 on visbreaking residue dated 9^{th} of April,2009.

$EF_{CO2,\ VAR}$ is the emission factor for other oil products, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\ VAR}$ = *73.3 kg CO_2/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)).

$$\mathbf{PE_{DF,\ CU} = FC_{DF} \cdot NCV_{DF} \cdot EF_{CO2,\ DF} \cdot 10^{-3}} \quad (1.3)$$

where

$PE_{DF,y}$ – project emissions due to diesel fuel consumption by the cogeneration unit, tonnes CO_{2e}/year.

FC_{DF} is the quantity of diesel fuel used for combined heat and power generation by the cogeneration unit during the year y, tonnes.

NCV_{DF} is the net calorific value of diesel fuel, GJ/tonne. IPCC default value ***NCV_{DF}***= 43.33 GJ/tonne was used (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Table 1-3).

$EF_{CO2,\ DF}$ is the emission factor for diesel fuel, kg CO_2/GJ. According to the data of IPCC, and with allowance for full oxidation of carbon fraction this factor is assumed constant and equal to $EF_{CO2,\ DF}$ = *74.1 kg CO_2/GJ* (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook, Module 1: Energy, Table 1-2 Carbon emission factors (CEF)).

Overall, the following data were used in calculation of project emissions for the proposed joint implementation project using formulae described above:

Table E.1-1. Fuel consumption by the cogeneration unit

Year	VAR consumption, tonnes	Natural gas consumption, 1000 m^3	Diesel fuel consumption, tonnes
2010	15822	10 487	72
2011	31643	20 974	141
2012	31643	20 974	141
2013	31643	20 974	141
2014	31643	20 974	141
2015	31643	20 974	141
2016	31643	20 974	141
2017	31643	20 974	141
2018	31643	20 974	141

2019	31643	20 974	141
2020	31643	20 974	141
2021	31643	20 974	141
2022	31643	20 974	141
2023	31643	20 974	141
2024	31643	20 974	141
Total	458 824	304120	2045

Table E.1-2. Heat energy and electricity generation

Year	Heat energy generation by the cogeneration unit, Gkal	Heat energy consumption for own needs of the cogeneration unit, Gkal	Heat energy supply, Gkal	Electricity generation by the cogeneration unit, MWh	Electricity consumption for own needs of the cogeneration unit, MWH	Electricity supply, MWh
2010	125393	17008	108385	76568	7389	69179
2011	250785	34017	216768	153136	14778	138358
2012	250785	34017	216768	153136	14778	138358
2013	250785	34017	216768	153136	14778	138358
2014	250785	34017	216768	153136	14778	138358
2015	250785	34017	216768	153136	14778	138358
2016	250785	34017	216768	153136	14778	138358
2017	250785	34017	216768	153136	14778	138358
2018	250785	34017	216768	153136	14778	138358
2019	250785	34017	216768	153136	14778	138358
2020	250785	34017	216768	153136	14778	138358
2021	250785	34017	216768	153136	14778	138358
2022	250785	34017	216768	153136	14778	138358
2023	250785	34017	216768	153136	14778	138358
2024	250785	34017	216768	153136	14778	138358
Total	3636383	493246	3143137	2220472	214281	2006191

30 573city supply, MWhhe nationaeeds of the cogeneration unit, MWHовании КГУ. ()

Estimated project emissions within the project boundary for the period 2010-2024 are presented in table below.

Table E. 1-3. Project emissions

Year	Project emissions due to VAR consumption, tonnes CO_2e	Project emissions due to natural gas consumption, tonnes CO_2e	Project emissions due to diesel fuel consumption, tonnes CO_2e	Total project emissions
2010	45196	20 003	228	65 427
2011	90388	40 006	453	130 847
2012	90388	40 006	453	130 847
2013	90388	40 006	453	130 847
2014	90388	40 006	453	130 847
2015	90388	40 006	453	130 847
2016	90388	40 006	453	130 847

2017	90388	40 006	453	130 847
2018	90388	40 006	453	130 847
2019	90388	40 006	453	130 847
2020	90388	40 006	453	130 847
2021	90388	40 006	453	130 847
2022	90388	40 006	453	130 847
2023	90388	40 006	453	130 847
2024	90388	40 006	453	130 847
Total	1 310 626	580 087	6 568	1 897 285

Thus, total amount of project emissions for the crediting period 2010-2024 within the project boundaries is 1 897 285 tonnes CO_{2e}.

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

No leakage is expected during the project activity.

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 assumptions were taken into account while estimation of the baseline emissions:

- the amount of electricity and heat energy generation in the baseline scenario is the same as in the project scenario (electricity in the baseline is produced by the power plants united in the Ukrainian electricity grid);
- heat energy would be generated by the boilers operated on residual fuel oil, natural and refinery gas in the absence of project activity;
- electricity would be generated by power plants of national grid in the absence of project activity.

Baseline Emissions were estimated by the following formulas:

$$\mathbf{BE = BE_{th} + BE_{elec}} \quad \mathit{(2)}$$

where:

BE_{th}– baseline emissions due to heat energy supply by boilers using residual fuel oil, natural and refinery gas under the baseline scenario in the amount which will be substituted with heat energy supplied by the cogeneration unit under the project scenario.

BE_{elec}– baseline emissions due to electricity consumption from the national grid under the baseline scenario in the amount which will be substituted with electricity supplied by the cogeneration unit under the project scenario.

$$\mathbf{BE_{th} = ((CAHO/e_b)\cdot \mathit{EF_{CO2,\ BFM}})\cdot 10^{-3}} \quad \mathit{(2.1)}$$

where

$\mathbf{BE_{th}}$– baseline emissions due to heat energy supply by the boilers operated on the residual fuel oil, natural and refinery gas under the baseline scenario in the amount which will be substituted with heat energy supplied by the cogeneration unit under the project scenario during the year y, tonnes CO_2e.

$EF_{CO2,\ BFM}$ – weighted average emission factor for baseline fuel mix, tonnes CO_2e. $EF_{CO2,\ BFM}$ was calculated on the basis of average fuel mix consumption over the period of 2000-2009, when heat energy was generated by boilers installed before the proposed project implementation, and CO_2 emission factor for each type of fuel. Weighted emission factor for baseline fuel mix is equal to $EF_{CO2,\ WEF}$ =68.45 tonnes of CO_2e/GJ.

CAHO – annual heat output from the cogeneration unit that is supplied to the consumer and is assumed to be equal to heat energy that would be generated in the baseline scenario, GJ.

e_b – average efficiency of residual fuel oil/gas fired boilers under the baseline scenario estimated according to operational tests of the boilers indicated in parameter charts of the boiler installed at JSC 'Lukoil-Odessa oil refining plant'. Parameter is not monitored throughout the crediting period. According to parameter charts of the boilers the average efficiency of installed boilers $\acute{\eta}_{boilers} = 90\%$.

$$\mathbf{BE_{elec} = CEO_{grid} \cdot EF_{CO2,\ national\ grid,\ prod.}} \quad (2.4)$$

where

$\mathbf{BE_{elec}}$ – baseline emissions due to electricity generation by power plants of the national grid under the baseline scenario in the amount which will be substituted with electricity supplied by the cogeneration unit under the project scenario.

$\mathbf{CEO_{,grid}}$ – cogeneration electricity supplied to the national grid during the year y, MWh.

$EF_{CO2,\ national\ grid,\ prod}$ – Emission factor for electricity of Ukrainian grid, tonnes CO_{2e}/MWh; for each year throughout crediting period an appropriate carbon emission factor as due to the *Development of the electricity carbon emission factors for Ukraine: Baseline Study for Ukraine, Final Report/EBRD, 14.10.2010* will be used. See Table E.4-2. For years 2020-2024 emission factor is assumed constant and equal to 0.941 tonnes CO_2e/MWh. Parameter is monitored throughout the crediting period.

Table E. 4-1. Energy consumption and electricity generation in the baseline scenario

Year	Energy consumption in the baseline scenario that is substituted by heat energy supply from the cogeneration unit, Gkal	Electricity generation by the national grid power stations that will be substituted by electricity generation of cogeneration unit, MWh
2010	108 385	69 179
2011	216 768	138 358
2012	216 768	138 358
2013	216 768	138 358
2014	216 768	138 358
2015	216 768	138 358
2016	216 768	138 358
2017	216 768	138 358
2018	216 768	138 358
2019	216 768	138 358
2020	216 768	138 358
2021	216 768	138 358
2022	216 768	138 358
2023	216 768	138 358

2024	216 768	138 358
Total	3 143 132	2 006 189

Emission factors for electricity of Ukrainian grid according to the *Development of the electricity carbon emission factors for Ukraine: Baseline Study for Ukraine, Final Report/EBRD, 14.10.2010,* are presented in the table below. For the years 2021-2024 the emission factor is assumed to be equal to the emission factor for the year 2020.

Table E.4-2. Carbon Emission Factors for Ukrainian electricity system for 2009-2020

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Emission Factor, tCO_2/MWh	1.055	1.063	1.063	1.058	1.059	1.059	1.059	1.043	1.026	1.022	0.941

Estimated baseline emissions within project boundaries for the period 2010-2024 are presented in table below.

Table E. 4-3. Baseline emissions

Year	Greenhouse gases emissions due to heat energy supply in the baseline scenario, tonnes CO_2e	Greenhouse gases emissions from electricity generation by power plants of the Ukrainian grid, tonnes CO_2e	Total baseline emissions, tonnes CO_2e
2010	34 512	72 984	107 496
2011	69 023	147 075	216 098
2012	69 023	147 075	216 098
2013	69 023	146 383	215 406
2014	69 023	146 521	215 544
2015	69 023	146 521	215 544
2016	69 023	146 521	215 544
2017	69 023	144 307	213 330
2018	69 023	141 955	210 978
2019	69 023	141 402	210 425
2020	69 023	130 195	199 218
2021	69 023	130 195	199 218
2022	69 023	130 195	199 218
2023	69 023	130 195	199 218
2024	69 023	130 195	199 218
Total	1 000 834	2 031 719	3 032 553

Thus, total amount of baseline emissions for the crediting period of 2010-2024 within the project boundaries is 3 032 553 tonnes CO_{2e}.

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

Reductions of anthropogenic emissions by sources of greenhouse gases (GHGs) generated by joint implementation (JI) projects are estimated/calculated by comparing the quantified anthropogenic emissions by sources within the project boundary in the baseline scenario with those in the project scenario and adjusting for leakage.

Year	Emission reductions, tonnes CO_2e
2010	42 069
2011	85 251
2012	85 251
2013	84 559
2014	84 697
2015	84 697
2016	84 697
2017	82 483
2018	80 131
2019	79 578
2020	68 371
2021	68 371
2022	68 371
2023	68 371
2024	68 371
Total	1 135 268

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

Table E.6-1. Emission reductions

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)
2010	65 427	0	107 496	42 069
2011	130 847	0	216 098	85 251
2012	130 847	0	216 098	85 251
Subtotal over the period of 2010-2012	327 121	0	539 692	212 571
2013	130 847	0	215 406	84 559
2014	130 847	0	215 544	84 697
2015	130 847	0	215 544	84 697
2016	130 847	0	215 544	84 697
2017	130 847	0	213 330	82 483
2018	130 847	0	210 978	80 131
2019	130 847	0	210 425	79 578
2020	130 847	0	199 218	68 371
2021	130 847	0	199 218	68 371
2022	130 847	0	199 218	68 371
2023	130 847	0	199 218	68 371
2024	130 847	0	199 218	68 371
Subtotal over the period of 2013-2024	1 570 164	0	2 492 861	922 697

Total over the period of 2010-2024	1 897 285	0	3 032 553	1 135 268

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:

Power generation has local impact on environment. In accordance to Ukrainian legislation, an Environmental Impact Assessment (EIA), as a part of the project design documents, has been completed for the proposed project and approved by local authority. The statement about emissions from the cogeneration unit operation has been published in the newspaper "Dobryj Vecher" #45 (257) on November 13th, 2008.

Implementation of the project has positive environmental effects in local and global scopes due to the more efficient fossil fuel consumption and greenhouse gases emission reductions. Modern cogeneration technology will be employed within the project and the produced power will substitute electricity from national grid (which have high carbon emission factor) and, in addition, produced heat will particular substitute heat energy currently being produced by boilers that combust residual fuel oil and refinery gas mainly.

Local air pollution could be slightly increased within project boundary due to the larger organic fuel consumption by cogeneration equipment in comparison with the amount of fuel needed for production of the same amount of heat energy by boilers. Although the fuel with high sulphur content will be combusted within project activities, efficient system of gas purification will be implemented. Using wet limestone method, SO_x emissions will significantly decrease, as they will be bound in calcium sulphates and sulphites prior to be released into the atmosphere. The by-product of sulphur purification will be utilized on Odesskyi Cement Plant. Besides, low-emission burning chambers will be used to decrease NO_x emissions.

Noise pollution and vibration will be decreased due to use of efficient silencers, installed on the engines and ventilation. Dampers will also eliminate vibration.

Expected concentrations of pollutants will be in compliance with the requirements of the plant's operational license and local environmental regulations. Additionally to greenhouse gases emissions, the substitution of electricity from national grid will lead to nitrous and sulphur oxide emission reductions.

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

The waste heat produced during electricity generation process will be utilised by exhaust boilers to produce heat power. All equipment has appropriate isolation in accordance to the technical requirements and state standards.

The social impact of the project is positive because its implementation will bring new working places at the Enterprise.

Assuming reasons described above, we can determine the influence of implementation of the project activity as positive and in accordance to current legislation.

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:

Environmental protection activities of the plant aim at the reduction of emissions into the atmospheric air, surface and underground water and land as well as improvements of environmental safety management system.

Proposed joint implementation project lead to more efficient use of organic fuel for heat and power generation and lowering atmospheric air pollution.

The project has been subject to a formal environmental impact assessment (EIA) undertaken in accordance with the applicable legislation and regulations of Ukraine. Permit #5110137600-148 on Polluting Substances' Emissions into the Atmospheric Air by Stationary Sources has been issued to Lukoil Energy and Gas Ukraine by State Department for Environmental Protection in Odesska Oblast. It is valid from June 1st, 2009, until June 1st, 2014. According to the Report on the influence of the project's activity on the atmospheric air of Ekotechnika dated 03.02.2009, all concentrations of polluting substances are below the maximum permissible concentrations. No considerable impact on the air is foreseen.

Project does not have significant impact on biotic and water mediums. In general, project realization has positive environmental impact.

SECTION G. Stakeholders' comments

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

Ukrainian legislation on conducting the environmental impact assessment stipulates that for every EIA, a public stakeholder consultation process, during which the affected public is informed of the proposed project activity and invited to provide comments.

The statement about emissions from the cogeneration unit operation has been published in the newspaper "Dobryj Vecher" #45 (257) on November 13th, 2008. No negative comments were received.

No stakeholder consultation process for the JI projects is required by the Host Party. Stakeholder comments will be collected during the time of PDD publication during the determination procedure.

Annex 1

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Annex 2

ABBREVIATIONS

IRR	–	Internal Rate of Return
The Enterprise, LEGU	–	Limited Liability Company Lukoil Energy and Gas of Ukraine
The Plant, Lukoil Refinery, LOORP	–	Joint Stock Company Lukoil-Odesskyi Oil-Refining Plant
RFO	–	residual fuel oil
VAR	–	visbroken atmospheric residue

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