PROJECT DESIGN DOCUMENT

JOINT IMPLEMENTATION PROJECT

“Greenhouse gases emissions reduction due to modernization of production facilities at LLC “Karpatnaftohim””

Position of the manager of the organization, which developed the document

LLC ‘KT-Energy’

____________	____________	________________
(position)	(signature)	(Name)

Date:

Position of the manager of economic entity, which is the owner of the project site at which realization of joint implementation project is planned

LLC ‘Karpatnaftohim’

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(Position)	(Signature)	(Name)

Date:

Kyiv, November, 2012

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

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Annexes

SECTION A. General description of the project

A.1. Title of the project:

Greenhouse gases emissions reduction due to modernization of production facilities at LLC "Karpatnaftohim"

Project pertains to the sectoral scope 3 Energy demand, Group I.

JI PDD version number: 2.2

Data of Completion: 29 of November, 2012

A.2. Description of the project:

Situation before project implementation

Before project implementation LLC "Karpatnaftohim" used diaphragm cell technology for caustic soda production and generated hydrogen has mostly been flared without useful utilization of energy.

Baseline scenario

Baseline scenario foresees continuation of previously existing practice of using diaphragm cell technology for caustic soda production and flaring of hydrogen without useful utilization of energy.

Purpose of the project

Project foresees greenhouse gases emissions reduction due to modernization of caustic soda production process and implementation of energy efficiency measures leading to decrease of specific energy resources consumption.

Project scenario

Project scenario foresees modernization of caustic soda production facilities by installing of new production unit using modern membrane technology.

Brief project history

The decision about project implementation has been made on 14th of November, 2005 taking into account the possibility of attracting additional investment using Kyoto Protocol's flexible mechanisms. Project implementation lasted during 2005-2010 and the new chlorine and caustic soda production facilities (membrane electrolysis unit or membrane electrolysis plant) have been put into operation at 11th of November, 2010.

Technical description of the project

Installed caustic soda production unit has the capacity of 200 000 tonnes per year. Main installed equipment includes 9 electrolysis units and 3 evaporation units. Besides, project allowed partial substitution of natural gas for heat energy generation by hydrogen, which is a by-product of caustic soda production process. Detailed technical description of the project is presented in Section A.4 below.

Non technical project summary

Reduction of greenhouse gases emissions within the potential joint implementation project is achieved due to introduction of modern energy-efficient technology of caustic soda production, which leads to decrease in specific heat energy and electricity consumption for production needs of the enterprise and allows partially substitution of natural gas by hydrogen.

Expected results of the project:

Project realization will help to achieve the following results:

- reduce energy resources (electricity and steam) consumption for caustic soda production;
- utilise energy potential of hydrogen that has been previously wasted;
- reduce anthropogenic greenhouse gases emissions due to fossil fuel combustion.

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 "Karpatnaftohim"	No
Party B: Switzerland	LITASCO S.A.	No

LLC "Karpatnaftohim" is a petrochemical enterprise located on the West of Ukraine and is a part of LUKOIL group. Product range of Karpatnaftohim includes polyethylene, polyvinyl chloride, ethylene, propylene, chlorine and caustic soda.

Entry number at Uniform State Register of Enterprises and Organizations of Ukraine – 33129683. Economic activity types according to Ukrainian Classification for Economic Activities (KVED): 20.11 production of industrial gases; 20.13 production of others basic non organic chemical products; 20.14 production of others basic organic chemical products; 20.16 production of plastic material in primary moulds; 49.20 freight railway transportation; 71.20 technical experiments and investigations.

LITASCO S.A. belongs and heads LITASCO Group – LUKOIL international trading and supply company. Main activity of the LITASCO SA consists in marketing production of crude oil and petroleum products in the markets outside of Russia, including sourcing and optimization the delivery of crude oil to LUKOIL refineries outside of Russia and of petroleum products to other LUKOIL Companies. LITASCO S.A. is also involved in carbon emissions reduction projects in Russian Federation and Ukraine as a project participant in joint implementation projects.

A.4. Technical description of the project:

A.4.1. Location of the project:

Project is being realized in Kalush, Ivano-Frankivsk region, 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 13th of April, 2012. Ukraine has also submitted its Fifth National Communication report on 29th of December 2009.

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

Project is located in Ivano – Frankivsk region (Western Ukraine).

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

Project is located in Kalush city, 4 Promyslova Str.

Pic.1 Project area location.

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

Geographical coordinates of the project site is the following: 49°08' N, 24°31' E.

Pic.2 Detailed location of project site

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

Project activity foresees the replacement of diaphragm cell technology with more energy efficient membrane cell technology for caustic soda production by construction membrane electrolysis unit with the capacity of 200 thousand tonnes per annum (new membrane electrolysis plant). The project is initiated in order to optimize energy resource consumption by the enterprise and to reduce greenhouse gases emissions.

Caustic soda (sodium hydroxide, NaOH) is a reagent used in the chemical industry, petrochemical industry, paper manufacturing, textile manufacturing and other industries as well as in the color metallurgical sector.

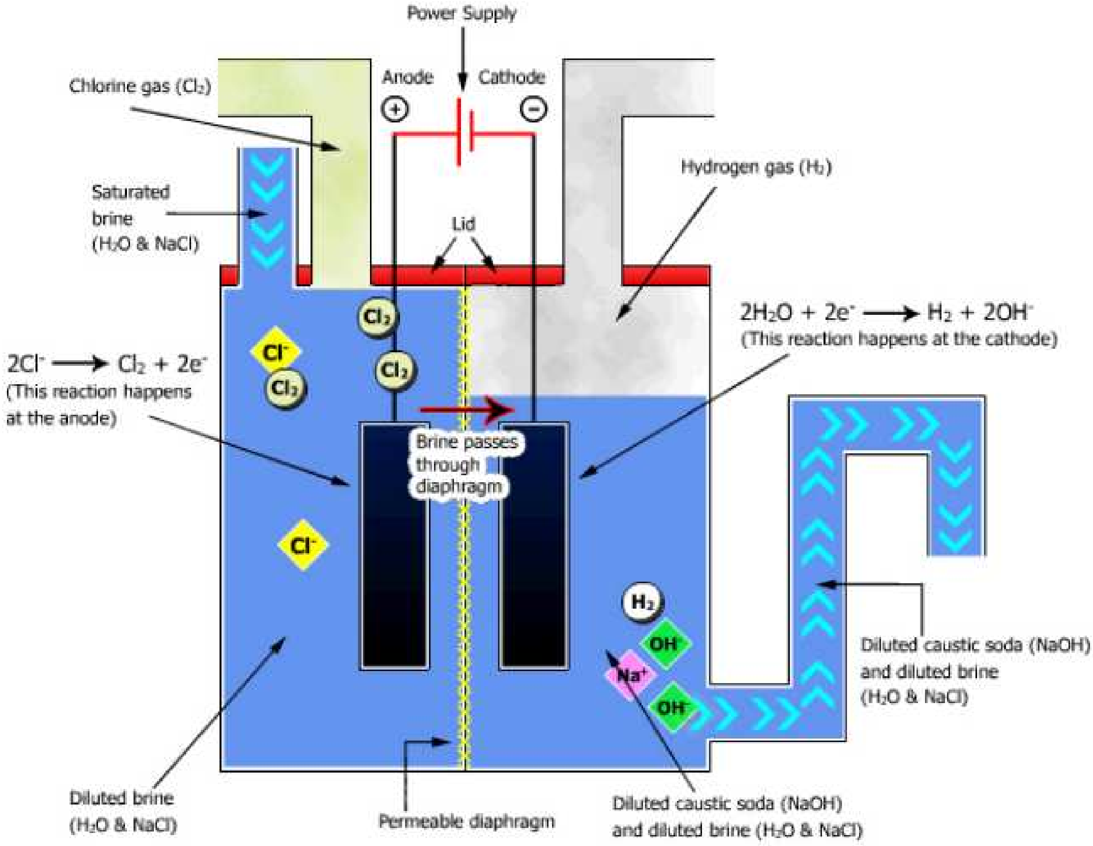
Before proposed project implementation caustic soda at LLC “Karpatnaftohim” was produced using diaphragm cell technology. Within this process saturated brine (sodium chloride solution) enters the anode compartment of the cell, where chlorine gas is liberated. The function of the diaphragm is to separate the brine from the caustic solution at the cathode side, which is also where hydrogen gas is released. Diaphragm cell technology supposes consumption of relatively high amounts of heat energy and electricity and thus causes relatively high emissions of greenhouse gases into the atmosphere.

The decision about project implementation has been made on 14th of November, 2005 taking into account the possibility of attracting additional investment using Kyoto Protocol’s flexible mechanisms. Project implementation lasted during 2005-2010 and the new chlorine and caustic soda production facilities (membrane electrolysis unit or membrane electrolysis plant) have been put into operation at 11th of November, 2010. Implementation schedule of the project is presented below.

Table A.4-1.Implementation schedule of the project

Year	Implemented measures
2005	The contract with the technology supplier (German company UHDE) on the construction of membrane cell caustic soda production unit has been signed on 16th of December 2005.
2006	Definition of the list of object for design works. Design works have been started in June, 2006.
2007	Design works. In May, 2007 agreement for construction and assembling works has been signed. Construction and assembling works have started in August, 2007.
2008	Construction and assembling works. Assembling of electrolysis units and other equipment.
2009	Construction and assembling works. Assembling of electrolysis units and other equipment.
2010	Commissioning of the constructed objects. Testing of the technological stages of caustic soda production by the specialists of UHDE company and confirmation of technological readiness. Cleaning of technological pipes and technological equipment. Testing and calibration of automatic control systems and measuring equipment. Supply of raw materials and chemicals for the start of operation. New caustic soda production unit has been commissioned on 11th of November, 2010.

Within the framework of proposed project implementation the existed chlorine and caustic soda production unit #2 with the capacity of 125 000 tonnes per annum has been taken out from operation at the 1st of August 2006 and the chlorine and caustic soda production unit #1 with the capacity of 66 000 tonnes per annum has been taken out from operation at 1st of June 2008 (both units were using diaphragm cell technology).



Pic. 3. Diaphragm cell technology of caustic soda production[1].

[1] Source: Euro Chlor. Available online at http://www.eurochlor.org/media/7818/diaphragm_cell_process.pdf

The historical data on the production volumes and energy consumption is provided in the table A.4-2 below.

Table A.4-2. Data on caustic soda production and energy consumption volumes.

Data	2004	2005	2006	2007	2008	Total
Production volumes, tonnes	117716	100571	98320	53362	23033	393002
Heat energy consumption, Gkal	395955	352304	328499	169123	80005	1325886
Electricity consumption, MWh	362924	311012	313572	176835	76881	1241224
Specific electricity consumption, MWh/tonne	3,083	3,092	3,189	3,314	3,338	3,158
Specific heat energy consumption, Gkal/tonne	3,364	3,503	3,341	3,169	3,473	3,374

Pic. 4. Caustic soda production unit based on membrane technology.

New production facilities employ membrane cell technology, which is significantly more energy efficient. Production facility consists of a single technological line. In the electrolysis department three groups of bipolar electrolysis units with three electrolysis units in each are installed.

The technology is provided by the German company UHDE. UHDE's scope of services included the basic and detail engineering, supply of equipment and supervision of the erection and commissioning work.

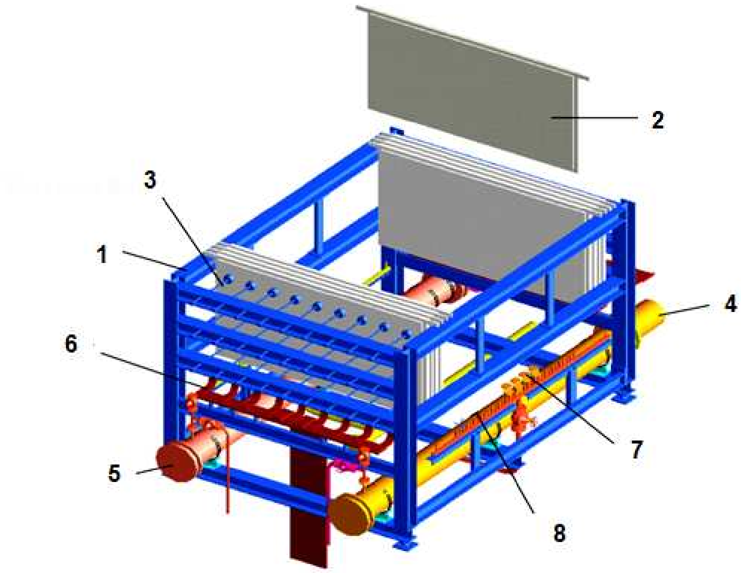
The technological process of caustic soda production consists of the following stages:

1. Unloading, preparation and storage of sodium chloride;
2. Saturation of the brine;
3. Sedimentation of the brine;
4. Brightening of the brine;
5. Filtration of the brine;
6. Fine purification of the brine;
7. Dechlorinating of anode solution;
8. Decomposing of chlorates;
9. Removal of sulphates;

10. Electrolysis;
11. Cooling and drying of chlorine and deconcentration of sulphuric acid;
12. Compression of chlorine;
13. Deconcentration of caustic soda;
14. Storage and loading of caustic soda;
15. Cooling of hydrogen;
16. Compression and drying of hydrogen.

Sodium chloride is delivered to the enterprise by rail and after unloading is transported by conveyer to the grinding machine and further either to the storage or to saturators. In the saturators the sodium chloride is diluted by weak sodium chloride solution and demineralized water. Sodium chloride solution with the concentration of about 300-310 g/dm^3 is further with the help of sodium carbonate and sodium alkali is being sedimented and significant part of the ions of Ca^{2+} та Mg^{2+} are converted into not soluble form.

After several stages of filtration and purification sodium chloride solution is heated up to 75ºC and transported to the electrolysis units. There are 9 electrolysis units UHDE BM 2.7.



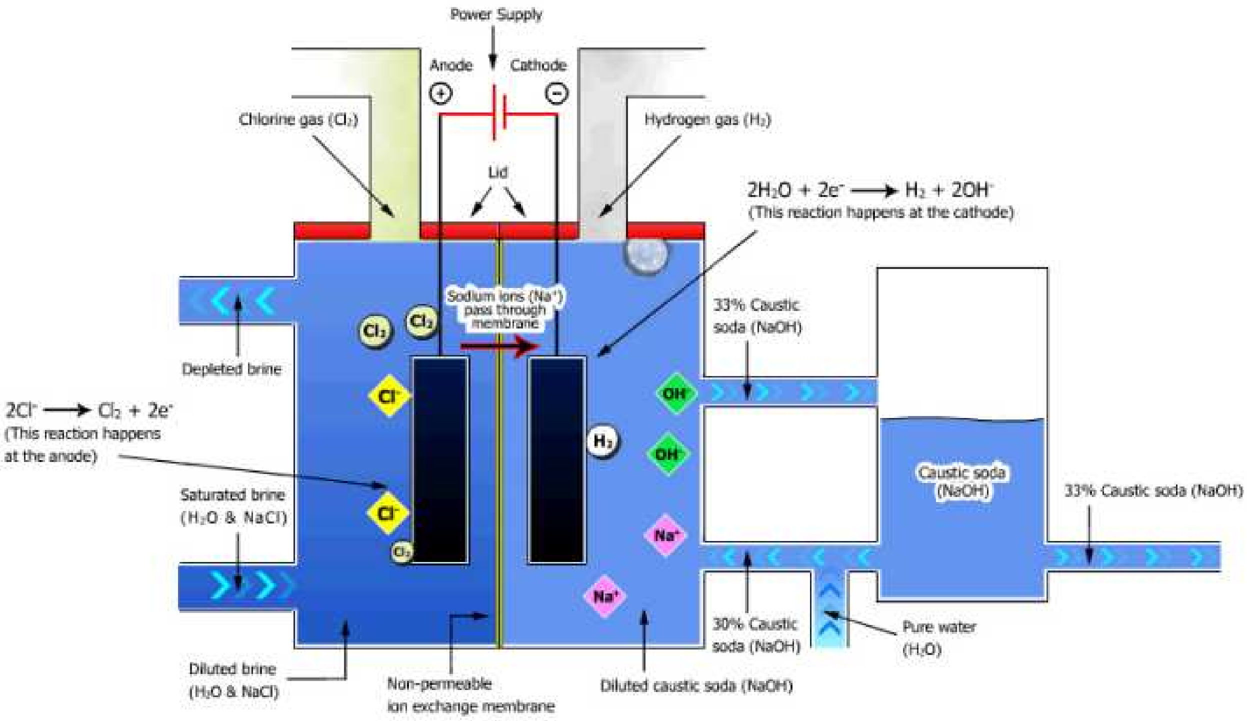
1 – frame of the electrolysis unit
2 – single element of the electrolysis unit
3 – holding-down bolt
4 – collector of anode solution
5 – collector of cathode solution
6 – collecting channels
7 – outcoming pipes
8 – incoming pipes

Pic. 5. Scheme of the electrolysis unit UHDE BM 2.7.

In the electrolysis process a sodium chloride solution is electrolytically decomposed to elemental chlorine (in the anode compartment), and sodium hydroxide solution and elemental hydrogen (in the cathode compartment). It differs from diaphragm cell technology in that the solutions surrounding each electrode are separated by a membrane rather than a diaphragm. The membrane is very selective and primarily allows the migration of sodium ions from the anode chamber to the cathode chamber.

Ion-selective membranes are produced from fluorine polymers with high molecular weight, which have ionogenic groups in their structure (channels) connected with ions, which are capable to exchange with the ions from the solutions that have the same charge. For caustic soda production cathion selective membranes with acid based ionogenic groups (i.e. — SO3Na, — COONa, — SO2Na) are used. Membranes are developed in order to produce cathodic solution with the concentration of caustic soda 32%-NaOH under optimal production conditions. Minimal lifetime of the membrane is 4 years.

Saturated brine (305 g/dm^3 NaC1) enters the anode compartment of the cell where chlorine gas is liberated. Since only sodium ions can pass through the membrane to the cathode (brine cannot pass through the membrane), the caustic soda (cell effluent) contains substantially less sodium chloride. No salt removal capabilities are required as in the diaphragm cell process. As a result of the process, from the anode compartment weak sodium chloride solution is removed and from the cathode compartment hydrogen and 32% solution of caustic soda is removed. Further, hydrogen is separated from the cathode solution in a special separator and is directed to a main collector of hydrogen. Cathode solution with a temperature of 84-90ºC is directed to a main collector of cathode solution and then pumped for cooling to the heat exchangers.



Pic. 6. Membrane cell technology of caustic soda production[2].

After the cooling solution of caustic soda is pumped to evaporation units, where the concentration of caustic soda reaches 50%.

The process is taking place in three sequential evaporator units manufactured by Bertrams company (Switzerland). Reverse-flow scheme of heating steam and 32% solution of caustic soda supply allows maximum utilization of heat energy of the solution. In order to decrease the boiling temperature of caustic soda solution two evaporator units are working under vacuum conditions.

Further, caustic soda (solution of NaOH with the concentration of 50%) is directed to storage facilities.

Under full utilization of power for each 1000 ampere-hours of electric charge, which passes through the electrolysis unit 1.323 kg of chlorine should be released at the anode and 0.0376 kg of hydrogen and 1.492 kg of caustic soda should be released in cathode compartment. However, due to the fact that some secondary reactions are taking place at the electrodes and in the solution the real output of products is at the level of 97-98% of theoretical output.

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[2] Source: Euro Chlor. Available online at http://www.eurochlor.org/media/7812/membrane_cell_process.pdf

Main technical parameters of applied technology (technical parameters of main technological equipment, namely, electrolysis units and evaporation units) are presented in table below.

Table A.4-3. Main technical parameters of applied technology

Name of the equipment: evaporation unit with falling film №1	
permissible jacket temperature	150 ºC
permissible heating chamber pipe temperature	120 ºC
permissible jacket pressure	-0,5-1 kgf/sm^2
permissible pipe pressure	-0,5-1 kgf/sm^2
heat exchange temperature	311 m^2
material	stainless steel/ nickel
evaporation unit height	11400 mm
heating chamber height	6878 mm
separator diameter	2600 mm
Name of the equipment: evaporation unit with falling film №2	
permissible heating chamber pipe temperature	210 ºC
permissible jacket pressure	150 ºC
permissible pipe pressure	-1-3 kgf/sm^2
heat exchange temperature	-0,5-1 kgf/sm^2
material	193,2 m^2
evaporation unit height	stainless steel/ nickel
heating chamber height	9908 mm
separator diameter	6723 mm
permissible heating chamber pipe temperature	1400 mm
Name of the equipment: evaporation unit with falling film №3	
permissible heating chamber pipe temperature	250 ºC
permissible jacket pressure	210 ºC
permissible pipe pressure	-1-13,8 kgf/sm^2
heat exchange temperature	-1-3 kgf/sm^2
material	192,1 m^2
evaporation unit height	stainless steel/ nickel
heating chamber height	9643 mm
separator diameter	6250 mm
permissible heating chamber pipe temperature	1000 mm
Name of the equipment: membrane electrolysis unit (electrolysis of sodium chloride water solution through ion exchanging membrane).	
quantity	9
length	12320 mm
height	2715 mm
width	2792 mm
active membrane surface area	2,72 m^2
number of single elements	136

Source of data: technical specification of the equipment provided in the Temporary operating procedure of the caustic soda production workshop using membrane technology

The consumption of electric energy during caustic soda production using membrane technology is lower than in diaphragm process of caustic soda production and the amount of steam needed for concentration of the caustic soda is relatively small. As a result of project implementation electricity consumption has decreased from 3.158 MWh per tonne of produced caustic soda (average value for the years 2004-2008) to 2.425 MWh per tonne of produced caustic soda (based on the results of operation in 2011), and heat energy consumption has decreased from 3.374 Gkal per tonne of produced caustic soda (average value for the years 2004-2008) to 0.699 Gkal per tonne of produced caustic soda (based on the results of operation in 2011).

Both in baseline and project scenario electricity for caustic soda production is supplied from the national grid of Ukraine, and heat energy for caustic soda production in form of steam – from the nearby natural gas fired Kalush TPP.

Besides, project implementation has allowed using hydrogen, being generated during caustic soda production process, for covering energy demand of the enterprise (ethylene and polyethylene production) by combusting it in fuel screen system of pyrogas pyrolysis, compression and separation workshop proportionally substituting natural gas. The fuel screen system of pyrogas pyrolysis, compression and separation workshop consists of the system of pipes and equipment, which combust fuel gas (natural gas or hydrogen), namely: pyrolysis ovens (F-0101, F-0201, F-0301, F-0401, F-0501, F-0601, F-0701, F-0801) and boiler house K-C 420/02. Before project realization, about 87% of generated hydrogen has been flared without any utilization of resulting energy, and energy demand of ethylene and polyethylene production has been covered by natural gas only. Within project realization the pipeline from the caustic soda production unit to the pyrogas pyrolysis, compression and separation workshop fuel screen system was constructed allowing substitution of natural gas with hydrogen.

The capacity of new caustic soda production facilities is 206 000 tonnes per annum. The plant can operate with the capacity in the range of 40% and 100% of the total production capacity.

The project uses the state-of-the-art technology, which is based on the latest scientific research and development efforts, and will result in a significantly better performance than commonly used technologies in the Host country. Besides, the technologyy is not likely to be substituted by other or more efficient technologies within the project period. All the technological parameters of the project equipment meet environment protection normative requirements. Due to the use of modern technology project requires initial training of the personal and introduction of special instructions at the enterprise, namely: instruction on occupational safety and fire safety during caustic soda and chlorine production by membrane technology, instruction on liquidation of emergency situations during caustic soda and chlorine production by membrane technology, etc.

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

Greenhouse gases emissions reduction will be achieved due to lowering of specific heat energy and electricity consumption for caustic soda production and consequent reduction of fossil fuel combustion for heat and electricity generation. Besides, greenhouse gases emissions reduction will be achieved due to partial substitution of natural gas by hydrogen. Emission reductions would not occur in the absence of the proposed project as the project scenario is not the most financially attractive option for the project owner as described in Section B within the financial analysis. Besides, it has been confirmed that using of more energy intensive diaphragm cell technology for caustic soda production is a common practice in the region of project implementation. Moreover, national and/or sectoral policies and circumstances do not oblige producers to switch the technology for caustic soda production or reduce energy consumption (see section B for details).

Taking into account prevailing practice and financial barriers described in details in Section B, it is concluded that emission reductions would not occur in the absence of the proposed project.

Only CO_2 emissions connected with fossil fuel combustion and electricity generation are included in the project boundary and addressed in PDD. CH_4 emissions and NO_x emissions were considered negligibly low and were not taken into consideration. Detailed description of project boundaries is presented in Section B.

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

	Years
Length of the crediting period	16
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2010	35 371
2011	172 183
2012	294 375
Subtotal estimated emission reductions over the period 2010-2012 (tonnes of CO_2 equivalent)	501 929
Annual average of estimated emission reductions over the first commitment period (tonnes of CO_2 equivalent)	231 660
2013	294 375
2014	294 375
2015	294 375
2016	294 375
2017	294 375
2018	294 375
2019	294 375
2020	294 375
2021	294 375
2022	294 375
2023	294 375
2024	294 375
2025	294 375
Subtotal estimated emission reductions over the period 2013-2025 (tonnes of CO_2 equivalent)	3 826 875
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4 328 804
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	285 416

A.5. Project approval by the Parties involved:

The substantiating materials of the project have been submitted for review of the State Environmental Investment Agency of Ukraine. The State Environmental Investment Agency of Ukraine has issued a Letter of Endorsement #3412/23/7 dated 13th of November, 2012 for the project providing its support for further development of proposed joint implementation project.

In accordance with the "Requirements for the Joint Implementation Projects Preparation" approved by National Environmental Investment Agency of Ukraine (Order #33 from 25th of June, 2008) to receive a Letter of Approval for the JI project the project proponent should provide to the National Environmental Investment Agency of Ukraine the final determination report of the proposed project along with project design documentation and the copy of Letter of Endorsement. Therefore, the final PDD will be sent along with the final determination report to the State Environmental Investment Agency of Ukraine for receiving of the Letter of Approval, which usually is expected within 30 days after PDD submission.

The project has received a Letter of Approval from designated focal point of Switzerland (Federal Office for the Environment (FOEN)) on 23rd of November, 2012.

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 the Guidance on Criteria for Baseline Setting and Monitoring (version 3)[3] by the JISC.

The Guidance on Criteria for Baseline Setting and Monitoring (version 3)[4] established by the JISC states: *'The baseline for a JI project is the scenario that reasonably represents the anthropogenic emissions by sources or anthropogenic removals by sinks of GHGs that would occur in the absence of the proposed project.'*

Taking into account guidelines mentioned above project participants established the baseline using JI specific approach by identifying and listing possible alternatives on the basis of conservative assumptions and identifying the most plausible one.

Analysis of alternatives for the project activity

Identifying and listing of the plausible future scenarios has been accomplished on the basis of conservative assumptions, taking into account relevant national and/or sectoral policies and circumstances, such as sectoral reform initiatives, local fuel availability and the economic situation in the project sector. Therefore, project participants indentified the following possible alternative scenarios to project implementation:

- Continuation of previously existed practice of caustic soda production using diaphragm cell technology;
- Implementation of the project activity without being registered as a JI project
- Introduction of mercury technology for caustic soda production.

Alternative 1. Continuation of previously existed practice of caustic soda production using diaphragm cell technology

Before proposed project implementation caustic soda at LLC "Karpatnaftohim" was produced using diaphragm cell technology. LLC "Karpatnaftohim" operated two caustic soda producing units – chlorine and caustic soda plants (further CCS-1 and CCS-2). Unit CCS-1 has been commissioned in 1973 and had a capacity of 66 000 tonnes of caustic soda per year and CCS-2 has been commissioned in 1983 and had a capacity of 125 000 tonnes of caustic soda per year. Thus, the total capacity of caustic soda production facilities was 191 000 tonnes per year. Both caustic soda producing units could continue operation with the repairing and maintenance works being undertaken.

Caustic soda producing units – chlorine and caustic soda plants consists of different elements and equipment and thus there is no specific exploitation lifetime for the units. Both caustic soda producing units could continue operation with the repairing and maintenance works being undertaken. Regular repairing and maintenance works include repairing of electrolysis units, evaporative units, centrifugal separators, compressors of chlorine and hydrogen as well as maintenance works at pumping, compressing equipment and at different technological units.

Moreover it is reported[5] that even taken into account the inherent ecological advantages of membrane

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[3] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

[4] Same as above.

[5] *Reference Document on Best Available Techniques in the Chlor-Alkali Manufacturing industry* *http://www.bvt.umweltbundesamt.de/archiv-e/bvt_**chloralkali**industrie_zf.pdf*

cell process the change of technology to membrane cells has been slow even in Western Europe because the majority of existing plants were installed in the 1970s with a plant life of 40-60 years and there has been no need for new production capacity. Nor has there been a legislative drive to change technology. The situation in Ukraine is similar and the continuation of exploitation of low energy efficiency technologies and equipment is even more likely due to poor investment climate and technological barriers.

Using diaphragm cell technology for caustic soda production is a common practice technology for Ukraine and for the former Soviet union countries in general and the continuation of existed practice faces no significant technological barriers (see also section on common practice analysis below). This alternative does not need intensive capital investments and thus it a plausible and realistic scenario for the project owner.

Alternative 2. Implementation of the project activity without being registered as a JI project

The realization of the project activity is a plausible and realistic scenario for the project owner but foresees intensive capital investments (total indicative budgeted cost of the project is about EUR 82.5) without any additional revenues from carbon units' sales and thus is less financially attractive and is not the most economically feasible for the project owner (see also section on financial analysis below).

Alternative 3. Introduction of mercury technology for caustic soda production

Introduction of mercury technology is a possible option for caustic soda production, however this alternative has not been considered by the project owner due to economic and environmental reasons. Modernization of caustic soda production facilities for the introduction of mercury technology requires stopping of the enterprise and significant investment in new equipment and construction works as in case of introduction of membrane technology. However, the reduction in specific energy consumption and associated greenhouse gases emissions reduction will be very low and will not cover the investment cost. Mercury technology does not require heat energy, however electricity demand is 20% higher than in diaphragm process and almost 30% higher than in membrane process. Overall energy consumption during mercury process is only less than 1% lower than in diaphragm process[6]. Besides, mercury technology brings concerns regarding the negative environmental impact of the project and demands measures to prevent contamination of air, water and land with mercury. Thus, this alternative has not been considered as a plausible and realistic scenario for the project owner and is not discussed further.

All alternatives are compliant with national laws and regulations.

The basic assumptions of the baseline methodology in the context of the project activity could be summarized as following:

- production volumes are assumed based on the historical and forecasted data from the enterprise as well as based on the technical characteristics of installed equipment; production volumes are conservatively assumed equal both in the baseline and project scenarios;
- specific electricity and natural gas consumption was assumed based on historical data on electricity and natural gas consumption and production volumes;
- emission factors for fossil fuel combustion (natural gas) were assumed based on the default n national values according to the latest available data from National Inventory Reports;
- specific carbon dioxide non direct emissions factors for consumption of electricity generated by power stations of united energy system of Ukraine were assumed based on standardised determined values for each year of the crediting period (See Annex 4 for more details).

[6] The European Chlor-Alkali industry: an electricity intensive sector exposed to carbon leakage http://www.eurochlor.org/media/9385/3-2-the_european_chlor-alkali_industry_-_an_electricity_intensive_sector_exposed_to_carbon_leakage.pdf

Formulae used for calculation of baseline emissions are presented below:

$$BE = BE_{electricity} + BE_{heat} + BE_{NG} \quad (B.1),$$

where:

BE – total baseline greenhouse gases emissions, tonnes of CO_2e;

$BE_{electricity}$ – non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine under the baseline scenario, tonnes of CO_2e;

BE_{heat} – non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario, tonnes CO_{2e};

BE_{NG} – greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario, tonnes CO_{2e}.

Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine will be calculated according to the following formula:

$$BE_{electricity} = SEC_{baseline} \cdot P_{caustic} \cdot EF_{grid} \quad (B.2),$$

where:

$SEC_{baseline}$ – specific electricity consumption for caustic soda production under the baseline, MWh/tonne; parameter is not monitored during the crediting period and is estimated based on historic data on electricity consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.158 MWh/tonne (See also section B);

$P_{caustic}$ – caustic soda production, tonnes; parameter is monitored during the crediting period (See M-6 from table D.1.1.3);

EF_{grid} – specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes CO_{2e}/ MWh; parameter is monitored during the crediting period (See M-2 from table D.1.1.1).

Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario are calculated according to the following formula:

$$BE_{heat} = SHC_{baseline} \cdot 4.1868 \cdot P_{caustic} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{NG} \quad (B.3),$$

where:

$SHC_{baseline}$ – specific heat energy consumption for caustic soda production under the baseline, GJ/tonne; estimated based on historic data on heat energy consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.374 Gkal/tonne (See also section B);

$P_{caustic}$ – caustic soda production, tonnes; assumed to be equal both in project and baseline scenario, and for the preliminary calculation of baseline greenhouse gases emissions is defined based on production plans of the enterprise (See M-6 from table D.1.1.3);

EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module “Energy” of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ (See M-4 from table D.1.1.1);

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in

1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995 (see M-5 from table D.1.1.1);

η_{NG} – efficiency factor for natural gas fired boilers used for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

Greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario are calculated according to the following formula:

$$BE_{NG} = HG_{hydrogen} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{hydrogen} \quad (B.4),$$

where:

EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module "Energy" of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ (See M-4 from table D.1.1.1);

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995 (see M-5 from table D.1.1.1);

$HG_{hydrogen}$ – amount of heat energy generation due to hydrogen combustion under the project scenario, GJ. Calculated according to the following formula:

$$HG_{hydrogen} = FC_{hydrogen} \cdot NCV_{hydrogen} \cdot \eta_{hydrogen} \quad (B.5),$$

where:

$FC_{hydrogen}$ – amount of hydrogen combusted for heat energy generation under the project scenario, 1000 m^3; parameter is monitored during the crediting period (See M-7 from table D.1.1.3);

$NCV_{hydrogen}$ – net calorific value of hydrogen, GJ/1000m^3; the value according to GOST 3022-80 "Hydrogen technical. Technical specifications" (28 670 kcal/kg), converted to GJ/1000m^3 is used – 10.8[7] GJ/1000m^3; parameter is not monitored during the crediting period (See also section B);

$\eta_{hydrogen}$ – efficiency of the equipment used for hydrogen combustion for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

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.

[7] Rounded value is presented here. In calculations not rounded value is used.

Data / Parameter	$P_{caustic}$
Data unit	tonne
Description	Caustic soda production
Time of determination / monitoring	Parameter is monitored during the crediting period on a monthly basis.
Source of data (to be) used	Statistical form 11-MTP "Report on the consumption of fuel, heat energy and electricity". Monthly technical reports of the caustic soda and chlorine production workshop using membrane method could also be used as an additional source of information.
Value of data applied (for ex ante calculations / determinations)	For the preliminary calculation of baseline greenhouse gases emissions is defined based on production plans of the enterprise. See Section E for details.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The source of information has been chosen according to the procedures established at the enterprise and existing accounting practices at the enterprise. Measurement methods and procedures are described in details in Section D.
QA / QC procedures (to be) applied	QA / QC is assured by regular calibration of measurement equipment in accordance with the recommendations of manufacturer and high accuracy level of measurement equipment. See Section D for details.
Any comment	

Data / Parameter	$SEC_{baseline}$
Data unit	MWh/tonne
Description	Specific electricity consumption for caustic soda production under the baseline
Time of determination / monitoring	Parameter is not monitored during the crediting period but estimated ex ante based on historical data.
Source of data (to be) used	Estimated based on historic data on electricity consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) based on the data of statistical form 11-MTP "Report on the consumption of fuel, heat energy and electricity"
Value of data applied (for ex ante calculations / determinations)	3.158
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For conservative purposes data for the last 5 years of using diaphragm technology at the enterprise have been used for the calculation of average specific electricity consumption for caustic soda production under the baseline, while the small scale methodology II.D. Energy efficiency and fuel switching measures for industrial facilities (Version 12) recommends using data for 3 years only.
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	EF_{grid}
Data unit	tonnes CO_{2e}/MWh
Description	Specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine
Time of determination / monitoring	Parameter is monitored during the crediting period on an annual basis
Source of data (to be) used	*See Annex 4*
Value of data applied (for ex ante calculations / determinations)	*See Annex 4*
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The choice of data is based on the orders of the National Environmental Investment Agency of Ukraine, which approves emission factors for electricity of Ukrainian grid recommended to be used for calculation of emission reductions due to joint implementation projects realization.
QA / QC procedures (to be) applied	For the period 2012-2025 the value for the year 2011 was used, however the value of the parameter would be changed in case of new emission factors for electricity of Ukrainian grid are properly approved.
Any comment	

Data / Parameter	$SHC_{baseline}$
Data unit	Gkal/tonne
Description	Specific heat energy consumption for caustic soda production under the baseline
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Estimated based on historic data on heat energy consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) based on the data of statistical form 11-MTP “Report on the consumption of fuel, heat energy and electricity”
Value of data applied (for ex ante calculations / determinations)	3.374
Justification of the choice of data or description of measurement methods and procedures (to be) applied	For conservative purposes data for the last 5 years of using diaphragm technology at the enterprise have been used for the calculation of average specific heat energy consumption for caustic soda production under the baseline, while the small scale methodology II.D. Energy efficiency and fuel switching measures for industrial facilities (Version 12) recommends using data for 3 years only.
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	EF_{NG}
Data unit	kg CO_2/GJ
Description	CO_2 emission factor for natural gas combustion
Time of determination / monitoring	Parameter is monitored during the crediting period on an annual basis
Source of data (to be) used	National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of GHG in Ukraine for 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module "Energy" of 1996 IPCC Guidelines for National Greenhouse Gas Inventories)
Value of data applied (for ex ante calculations / determinations)	55.62
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The choice of data is based on the standardised and approved value and thus assumed as conservative.
QA / QC procedures (to be) applied	For the period 2011-2025 the value for the year 2010 was used, however the value of the parameter would be changed in case of new emission factors for natural gas combustion is presented in National Inventory Reports.
Any comment	

Data / Parameter	$OXID_{NG}$
Data unit	
Description	Carbon oxidation factor for combustion of natural gas
Time of determination / monitoring	Parameter is monitored during the crediting period on an annual basis
Source of data (to be) used	National Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of GHG in Ukraine for 1990-2010 (Table П2.42 on page 471)
Value of data applied (for ex ante calculations / determinations)	0.995
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The choice of data is based on the standardised and approved value and thus assumed as conservative.
QA / QC procedures (to be) applied	For the period 2011-2025 the value for the year 2010 was used, however the value of the parameter would be changed in case of new carbon oxidation factor for combustion of natural gas is presented in National Inventory Reports.
Any comment	

Data / Parameter	**$NCV_{hydrogen}$**
Data unit	GJ/1000 m^3
Description	Net calorific value of hydrogen
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	National standard GOST 3022-80 "Hydrogen technical. Technical specifications"
Value of data applied (for ex ante calculations / determinations)	10.8 GJ/1000m^3
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The choice of data is based on the standardised and approved value and thus assumed as conservative.
QA / QC procedures (to be) applied	
Any comment	

Data / Parameter	**$FC_{hydrogen}$**
Data unit	1000 m^3
Description	Amount of hydrogen combusted for heat energy generation under the project scenario
Time of determination / monitoring	Parameter is monitored during the crediting period on a monthly basis
Source of data (to be) used	Monthly technical reports of the caustic soda and chlorine production workshop using membrane method
Value of data applied (for ex ante calculations / determinations)	For the preliminary calculation is defined based on production plans of the enterprise. See Section E for details.
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The source of information has been chosen according to the procedures established at the enterprise and existing accounting practices at the enterprise. Measurement methods and procedures are described in details in Section D.
QA / QC procedures (to be) applied	QA / QC is assured by regular calibration of measurement equipment in accordance with the recommendations of manufacturer and high accuracy level of measurement equipment. See Section D for details.
Any comment	

Data / Parameter	$\eta_{hydrogen}$
Data unit	%
Description	Efficiency of the equipment used for hydrogen combustion for heat energy generation
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Assumption. In line AM 0014: Natural gas-based package cogeneration -Version 4.0
Value of data applied (for ex ante calculations / determinations)	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	

Data / Parameter	η_{NG}
Data unit	%
Description	Efficiency factor for natural gas fired boilers used for heat energy generation
Time of determination / monitoring	Parameter is not monitored during the crediting period
Source of data (to be) used	Assumption. Assumption. In line AM 0014: Natural gas-based package cogeneration -Version 4.0
Value of data applied (for ex ante calculations / determinations)	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 JI project:

In accordance with Article 6 of the Kyoto Protocol a joint implementation project has to provide a reduction in emissions by sources, or an enhancement of net removals by sinks, which is additional to any that would otherwise occur. This supposes that the project scenario is not a part of the identified baseline scenario and that the project will lead to reductions of anthropogenic emissions by sources of GHGs.

JI specific approach has been used to demonstrate that anthropogenic emissions of greenhouse gases will be reduced below those that would have occurred in the absence of project activity. Financial analysis and common practice analysis were used to demonstrate project additionality.

Realistic and credible alternatives available to the project participants (see Section B.1), that provide outputs comparable with the proposed joint implementation project activity, are the following:
- continuation of previously existed practice of caustic soda production using diaphragm cell technology;
- implementation of the project activity without being registered as a JI project.

All alternatives are compliant with national laws and regulations.

Financial analysis

Financial analysis using NPV financial indicator has been used to demonstrate that the project scenario is not the most financially attractive for the project owner.

Total budgeted cost of the project is UAH 850 million (about EUR 82.5 million). Major capital costs structure (financial structure) is presented below:

project design works – UAH 57,5 million;
equipment – 446 UAH million;
construction and assembling works – UAH 322 million;
other costs – UAH 24 million.

The following main assumptions were used in the financial analysis:
- the forecasted period was assumed as 20 years (5 years of investment stage and 15 years of operation stage, which is guaranteed by the technology supplier lifetime of the new caustic soda production facilities);
- the price for electricity and heat energy was assumed based on actual price of electricity and heat for the project owner at the time of the decision-making about project implementation (December, 2005) and the escalation rate for the price of heat energy and electricity was assumed equal to the average inflation rate in 2001-2005;
- the cost of project implementation is UAH 849.8 million (without VAT). See also Annex 5 Financial Plan for details.

The results of the financial analysis are presented in the table below.

Project scenario, UAH	- 168 250 091
Project scenario with ERU sales, UAH	11 502 844

To demonstrate the robustness of the conclusion sensitivity analysis with 10% fluctuations for the values of main factors (heat energy and electricity price, production volume) was used. The results of the financial analysis for the project scenario under different assumptions are provided below.

Parameter	-10%	No change	10%
Production volume change	- 268 301 539	- 168 250 091	- 68 198 577
Heat energy price change	- 184 372 019		- 152 128 162
Electricity price change	- 192 436 028		- 144 064 153

Sensitivity analysis proves that under different scenarios project scenario remains not financially attractive for the project owner without additional revenues from emission reduction units' sale.

To sum up, financial analysis lead us to the conclusion that project scenario is not the most plausible scenario for the project owner without additional revenues from the emission reduction units' sale.

Common practice analysis

To provide conservative and more reliable conclusions common practice analysis of the technologies used for caustic soda production has not been limited to the enterprises operating in Ukraine, but also focused on the enterprises operating in former Soviet Union countries and Eastern European countries.

Ukrainian market of the caustic soda production is presented by two leading companies - LLC "Karpatnaftohim" and JSC "DniproAzot". The production of caustic soda in 2006 was 67 770 tonnes at JSC "DniproAzot" and 98 320 tonnes at LLC "Karpatnaftohim".

JSC "DniproAzot" uses diaphragm cell technology based caustic soda production facilities installed in 1960-tieth. The company developed the plan of technical modernization of caustic soda production facilities foreseeing transfer to membrane cell technology back in 2002[8]. However, the plan has not been realized and the enterprise continues to operate diaphragm based caustic soda production units.

There are also two smaller companies in caustic soda production industry of Ukraine, namely GP "Khimprom" (Pervomaysk, Kharkiv region) and PO "Slavyanskyi sodovyy zavod" (Slavyansk, Doneck region), which also employ diaphragm based caustic soda production technology[9]. However, they are not currently active[10].

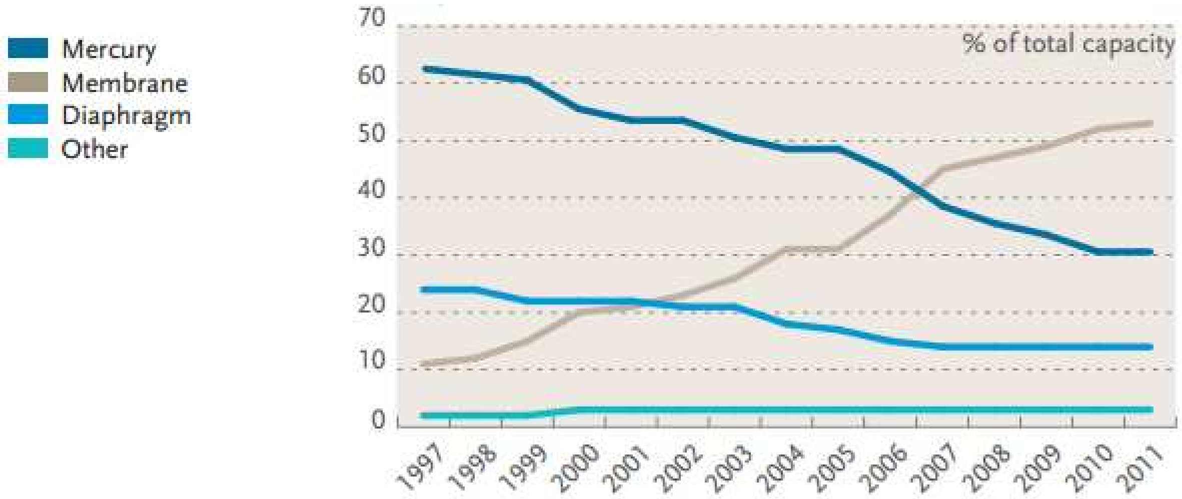
Thus, with respect to Ukraine we can conclude that it is a common practice to use diaphragm cell technology for caustic soda production.

It is also a common practice to use diaphragm cell technology for caustic soda production in the whole region of former Soviet Union countries. The 89% of caustic soda production market in the region belongs to Russia, 9% to Ukraine and the rest 2% for Uzbekistan and Azerbaijan. In the region there are only 2 caustic soda producers (out of about 20) using membrane cell technology: JSC 'Sayankhimplast' in Russia (membrane cell technology was introduced in September 2006 and the facility has a capacity of 169 000 tonnes of caustic soda per year) and JSC 'Navoyiazot'[11] (introduced in 2001 and has a capacity of 26 000 tonnes of caustic soda per year) company in Uzbekistan. 3 enterprises use mercury based technology, 2 enterprise use both mercury and diaphragm technology and 13 only diaphragm technology[12]. Thus, 15 enterprises producing caustic soda out of 20 in the region of former Soviet Union countries use diaphragm cell technology.

[8] http://www.investgazeta.net/politika-i-ekonomika/dneprazot-vystavlen-na-prodazhu-povtorno-138047/
[9] See Overview of the caustic soda market of CIS, p.15 http://megaresearch.ru/files/demo_file/4496.pdf
[10] http://bin.ua/companies/118507-v-iyune-proizvodstvo-kausticheskoj-sody.html
[11] http://www.navoiyazot.uz/rus/index.html
[12] See Overview of the caustic soda market of CIS http://megaresearch.ru/files/demo_file/4496.pdf

Thus, with respect to the region of former Soviet Union countries we can conclude that it is a common practice to use diaphragm cell technology for caustic soda production.

Even in Europe at the time of the decision-making about project implementation (2005) the share of membrane technology was 31% of total European capacity, while mercury accounted for 48%, diaphragm for 18% and other technologies for 3%[13]. The analysis of technology development in European countries during recent years shows the shift from mercury to membrane technology; however, this is partly caused by environmental concerns of potential mercury negative impact and respective regulations, and connected high investments costs leading to relatively long phase out period. The conversion process is restricted mainly to Europe, which has historically relied on mercury technology. Other regions, such as North America, China, India and Russia, tend to use diaphragm technology[14]. Thus, companies, which are using diaphragm technology do not face any potential or enforced restrictions on the use of mercury and are not forced to switch to other technologies. Here is why, against the switch from mercury to membrane technology the share of diaphragm technology in Europe remained almost stable during 2005-2011 (about 14% - see pic. 7 below).



Pic 7. The share of different technologies of caustic soda production in Europe[15].

In Eastern European Countries (Czech Republic, Hungary, Poland, Slovak Republic, Slovenia) at the time of the decision-making about project realization out of 10 plants with total production capacity of 888 thousand tonnes only 1 plant used membrane cell technology and has a capacity of only 15 thousand tonnes or 1.7% out of total capacity in the region[16]. Later, in April, 2006 another plant with the capacity of 214 thousand tonnes per year has been commissioned by Polish company Anwil SA. It is worth mentioning, that the modernization consisted in a switch from diaphragm to membrane technology was partly financed by the European Regional Development Fund as a part of Operational Program to Increase the Competitiveness of Companies[17].

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[13] Chlorine Industry Review 2005-2006
http%3A%2F%2Fwww.eurochlor.org%2Fupload%2Fdocuments%2Fdocument163.pdf

[14] European chlorine producers are pushing ahead to move in the direction of cleaner production technologies
http://www.icis.com/Articles/2010/09/06/9390781/chlorine-shifts-from-mercury-to-membrane.html

[15] http://www.eurochlor.org/media/10677/annualreview-2010-hd.pdf

[16] Chlorine Industry Review 2004-2005

[17] http://www.anwil.pl/EN/Press/AnnualReports/Documents/2006/raport_35.pdf

Thus, with respect to the region of Eastern Europe countries we can conclude that the use of membrane technology for caustic soda production is not a common practice and the modernization projects are rear and are being developed with financial support of European institutions.

To sum up, we conclude that it is a common practice to use the diaphragm cell technology for caustic soda production in the region and the proposed project foreseeing the transfer to membrane cell technology is the first of its kind in Ukraine.

Overall, due to long period of low energy prices and lack of financial resources (high cost of credit financing as well as high investment risks in the country) it is typical for Ukrainian industrial enterprises to continue operation using low energy efficient equipment and performing only basic maintenance of such equipment. Ukrainian industry has high energy intensive factors and even recent positive developments in decreasing of energy intensity of gross domestic products are caused mostly by the scale factor and has occurred against the small number of energy saving and modernization projects in the industry. Even the growth of energy sources prices has not led to the significant energy efficiency improvements due to not economically substantiated process of price formation (subsidies, transfer of the energy cost to the price of produced goods) and ineffective energy resources consumption accounting practices[18]. Factors that have contributed (and still contribute) to the high energy intensity include slow restructuring of energy-intensive industries, old capital stock in the public, private and household sectors, and inadequate reforms of the heat and power sectors[19].

Most of modernization projects in the Ukrainian industry are being implemented using additional financial incentives such as international financial help programs or revenues from carbon units’ sales.

Conclusion

Therefore, taking into account the results of financial analysis and common practice analysis we conclude that the most plausible and realistic scenario without realization of proposed joint implementation project (baseline scenario) is the continuation of previously existed practice using diaphragm cell technology for caustic soda production.

Thus, based on financial 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.

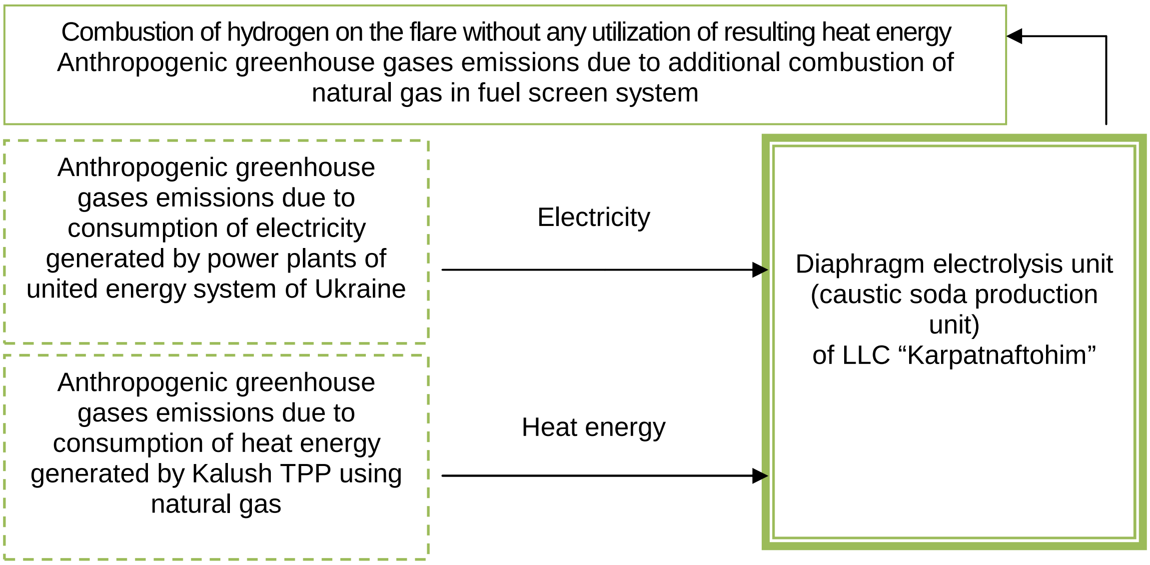
Therefore, the most plausible and realistic scenario without realization of proposed joint implementation project (baseline scenario) is the continuation of previously existed practice without implementation of energy efficiency improvements measures. Project scenario foresees implementation of the project on the introduction of membrane cell technology for caustic soda production.

[18] National report on the status and perspectives of the state energy efficiency policy in 2008. Prepared by the National Agency of Ukraine on Ensuring of Efficient Use of Energy Resources

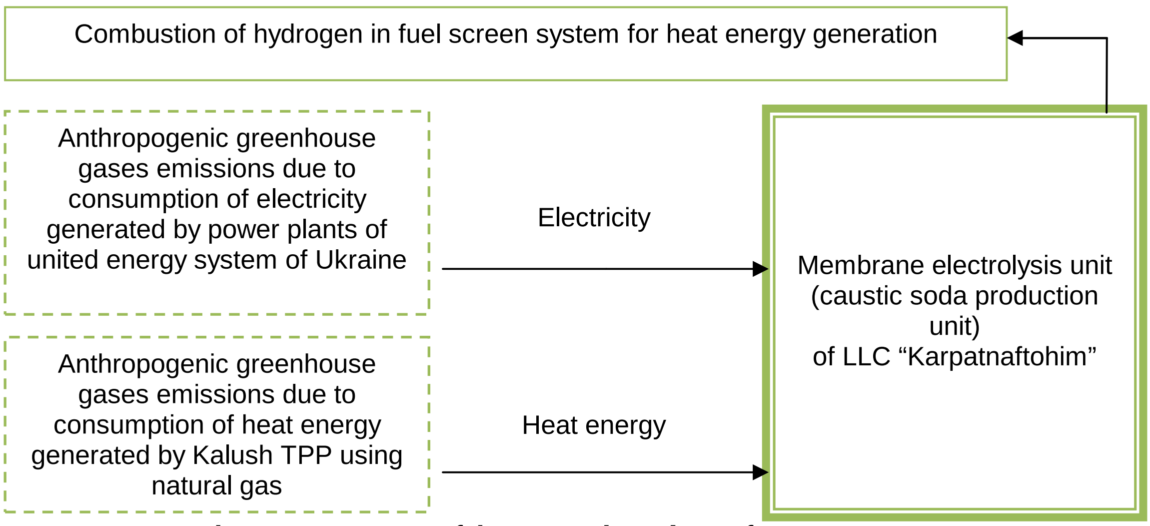
[19] Financing Energy Efficiency Investments for Climate Change Mitigation Project. Investor Interest and Capacity Building Needs. – United Nations, New York and Geneva, 2010.

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

Project boundaries include anthropogenic greenhouse gases emissions due to electricity and heat energy consumption by caustic soda production unit (membrane electrolysis unit or membrane electrolyser plant for the project scenario and diaphragm electrolysis unit – for the baseline scenario) of LLC "Karpatnaftohim", namely: non-direct anthropogenic greenhouse gases emissions due to consumption of electricity generated by power plants of united energy system of Ukraine and non-direct anthropogenic greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP using natural gas. Besides, project boundaries under the project scenario include the system for hydrogen combustion for covering energy demand of the enterprise (fuel screen system, which includes pyrolysis ovens and boiler house K-C 420/02), and under the baseline scenario – the system for hydrogen flaring without any utilization of resulting energy and consequently anthropogenic greenhouse gases emissions due to additional combustion of natural gas in fuel screen system. Project boundaries for the baseline scenario are graphically presented on pic. 8 and project boundaries for the project scenario are graphically presented on pic. 9: thin solid line indicates project boundaries and dotted line indicates broaden project boundaries.



Pic. 8. Graphic representation of the project boundaries for baseline scenario.



Pic. 9. Graphic representation of the project boundaries for project scenario.

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

Source		Gas	Incl./Excl.	Justification/Explanation
Baseline	Greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario	CO_2	Incl.	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas	CO_2	Incl.	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine	CO_2	Incl.	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
Project	Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas	CO_2	Incl.	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative
	Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine	CO_2	Incl.	**Main source of emissions**
		CH_4	Excl.	Considered negligible. Conservative
		N_2O	Excl.	Considered negligible. Conservative

Only CO_2 emissions concerned with fossil fuel combustions and electricity generation are included in the project boundary and addressed in PDD. CH_4 emissions and NO_x emissions were considered negligibly low and were not taken into consideration.

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: 29/11/2012

The information about the organization, which is responsible for setting the baseline and developed project design documentation, is presented below.

LLC 'KT-Energy' (registered in Ukraine)
15 B/22 Biloruska st., Kiev, 04119, Ukraine
Tel/Fax. + (38 044) 493 83 32, info@kt-energy.com.ua

Kyryl Tomlyak, Director
ktomlyak@kt-energy.com.ua
+38 (044) 493 83 32
LLC 'KT-Energy' is not a project participant listed in annex 1.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

Start date of the project is 16th of December, 2005, when the agreement on equipment supply for new caustic soda production unit was signed. Date of the completion of the investment phase – 11th of November, 2010.

Start date of the operational phase of the project is 11th of November, 2010, when the new caustic soda production unit was commissioned.

C.2. Expected operational lifetime of the project

Guaranteed exploitation period for the caustic soda production unit is equal to 15 years. The planned date of the completion of the operational phase of the project is 11th of November, 2025.

C.3. Length of the crediting period:

Start of the crediting period for proposed project activity is 11th of November, 2010.

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

Thus, the length of the first commitment period is 2 years and 2 months (26 months).

The second commitment period will 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 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, 2025. The length of the second commitment period is expected to be 13 years or 156 months.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

Step 1. Indication and description of the approach chosen regarding monitoring

JI specific approach was chosen for monitoring of greenhouse emission reductions in accordance with paragraph 9 (a) of the ‘Guidance on criteria for baseline setting and monitoring’ (version 3)[20]. Detailed theoretical description, assumptions, formulae, data sources and key factors used in the monitoring plan are described below.

Monitoring plan ensures the collection and archiving of all relevant data necessary for measuring anthropogenic emissions and calculation of GHGs emission reductions occurring within the project boundary during the crediting period. Monitoring plan provides also quality assurance and control procedures for the monitoring process and procedures for the periodic calculation of the reductions of anthropogenic emissions by sources by the proposed JI project.

Monitoring plan is established in accordance with Host Party regulations, namely in accordance with the 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).

The monitoring plan will serve to trace Project Emissions, Baseline Emissions and to calculate Emission Reductions in accordance with the gathered data fixed by direct measurement of specific related parameters through the application of technical devices and calculations.

Project owner has developed and enforced the system of monitoring of GHG emission reductions at the Enterprise, which defines the procedure of gathering and storing of necessary data and responsibility.

Monitoring data will be archived in paper and electronic form.

[20] http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

Based on the collected data the annual monitoring reports on actual GHG emission reductions due to implementation of JI project will be prepared. The monitoring reports must be delivered by the contractual party to an accrediting independent entity (AIE) at regular intervals. This entity examines the reports. Monitoring data will be kept for at least 2 years after the end of the crediting period or the last transfer of ERUs.

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

Step 2. Application of the approach chosen

Application of the approach chosen in the context of the project is described in sections below.

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

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
M-1 $EC_{project}$	Electricity consumption for caustic soda production under the project scenario	Power meter	MWh	m	Data are recorded on a daily basis in Electricity Accounting Journal and on a monthly basis in Technical Reports	100%	Paper	
M-2 EF_{grid}	Specific carbon dioxide non direct	The choice of data is based on the orders	tonnes of CO_2e/ MWh	c	Annually	N/A	Paper / Electronic	In case of lack of properly approved

	emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine	of the National environmental investments agency of Ukraine for 1st class electricity consumers						specific carbon dioxide non direct emissions factor of electricity generated by power stations of united energy system of Ukraine for the year 2012 and onwards the value for the year 2011 will be used
M-3 $HC_{project}$	Heat energy consumption for caustic soda production under the project scenario	Vortex Flow Meter	Gkal	m	Data are recorded once per each 2 hours in Steam Accounting Journal and on a monthly basis in Technical Reports	100%	Paper	
M-4 EF_{NG}	CO_2 emission factor for natural gas combustion	National inventory of anthropogenic emissions from sources and removals by sinks of GHG	kg of CO_2e/ GJ	c	Annually	N/A	Paper / Electronic	

		in Ukraine						
M-5 $OXID_{NG}$	Carbon oxidation factor for combustion of natural gas	National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine	%	c	Annually	N/A	Paper / Electronic	

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

Emissions of greenhouse gases under the project scenario include emissions due to electricity consumption and heat energy consumption.

Calculation of anthropogenic greenhouse gases emissions in metric tonnes of carbon dioxide equivalent will be made according to the following formula:

$$PE = PE_{electricity} + PE_{heat} \quad (D.1),$$

where:

PE – total project greenhouse gases emissions, tonnes of CO_2e;

$PE_{electricity}$ – non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine under the project scenario, tonnes of CO_2e;

PE_{heat} – non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP using natural gas under the project scenario, tonnes CO_{2e}.

Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine are calculated according to the following formula:

$$PE_{electricity} = EC_{project} \cdot EF_{grid} \quad (D.2),$$

where:

$EC_{project}$ – electricity consumption for caustic soda production under the project scenario, MWh; parameter is monitored during the crediting period (see M-1 from table D.1.1.1);

EF_{grid} – specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes of CO_2e/ MWh; parameter is monitored during the crediting period (see M-2 from table D.1.1.1);

Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP using natural gas under the project scenario are calculated according to the following formula:

$$PE_{heat} = HC_{project} \cdot 4.1868 \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{NG} \quad (D.3),$$

where:

$HC_{project}$ – heat energy consumption for caustic soda production under the project scenario, Gkal; parameter is monitored during the crediting period (see M-3 from table D.1.1.1);

EF_{NG} - CO_2 emission factor for natural gas combustion, kg of CO_2e/GJ; parameter is monitored during the crediting period (see M-4 from table D.1.1.1);

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; parameter is monitored during the crediting period (see M-5 from table D.1.1.1);

η_{NG} – efficiency factor for natural gas fired boilers used for heat energy generation – 90%; parameter is not monitored during the crediting period.

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

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
M-6 $P_{caustic}$	Caustic soda production	Mass flow meter	tonne	m	Daily	100%	Paper	Assumed to be equal both in project and baseline scenario

M-7 $FC_{hydrogen}$	Amount of hydrogen combusted for heat energy generation under the project scenario	Vortex flow meter	m^3	m	Daily	100%	Paper	

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

Baseline greenhouse gases emissions would have been generated due to electricity consumption, heat energy consumption and natural gas combustion for heat energy generation. Calculation of anthropogenic greenhouse gases emissions that would have taken place without joint implementation project realization (baseline emissions) will be made according to the following formula:

$$BE = BE_{electricity} + BE_{heat} + BE_{NG} \quad (D.4),$$

where:

BE – total baseline greenhouse gases emissions, tonnes of CO_2e;

$BE_{electricity}$ – non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine under the baseline scenario, tonnes of CO_2e;

BE_{heat} – non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario, tonnes CO_{2e};

BE_{NG} – greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario, tonnes CO_{2e}.

Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine will be calculated according to the following formula:

$$BE_{electricity} = SEC_{baseline} \cdot P_{caustic} \cdot EF_{grid} \quad (D.5),$$

where:

$SEC_{baseline}$ – specific electricity consumption for caustic soda production under the baseline, MWh/tonne; parameter is not monitored during the crediting period and is estimated based on historic data on electricity consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.157 MWh/tonne (See also section B);
$P_{caustic}$ – caustic soda production, tonnes; parameter is monitored during the crediting period (See M-6 from table D.1.1.3);
EF_{grid} – specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes CO_{2e}/ MWh; parameter is monitored during the crediting period (See M-2 from table D.1.1.1).

Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario are calculated according to the following formula:

$$BE_{heat} = SHC_{baseline} \cdot 4.1868 \cdot P_{caustic} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{NG} \quad (D.6),$$

where:
$SHC_{baseline}$ – specific heat energy consumption for caustic soda production under the baseline, GJ/tonne; parameter is not monitored during the crediting period and estimated based on historic data on heat energy consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.374 Gkal/tonne (See also section B);
$P_{caustic}$ – caustic soda production, tonnes; parameter is not monitored during the crediting period and assumed to be equal both in project and baseline scenario (See M-6 from table D.1.1.3);
EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module “Energy” of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ (See M-4 from table D.1.1.1);
$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995 (see M-5 from table D.1.1.1);
η_{NG} – efficiency factor for natural gas fired boilers used for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

Greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario are calculated according to the following formula:

$$BE_{NG} = HG_{hydrogen} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{hydrogen} \quad (D.7),$$

where:

EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module "Energy" of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ (See M-4 from table D.1.1.1);

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995 (see M-5 from table D.1.1.1);

$HG_{hydrogen}$ – amount of heat energy generation due to hydrogen combustion under the project scenario, GJ. Calculated according to the following formula:

$$HG_{hydrogen} = FC_{hydrogen} \cdot NCV_{hydrogen} \cdot \eta_{hydrogen} \quad (D.8),$$

where:

$FC_{hydrogen}$ – amount of hydrogen combusted for heat energy generation under the project scenario, 1000 m^3; parameter is monitored during the crediting period (See M-7 from table D.1.1.3);

$NCV_{hydrogen}$ – net calorific value of hydrogen, GJ/1000m^3; the value according to GOST 3022-80 "Hydrogen technical. Technical specifications" (28 670 kcal/kg), converted to GJ/1000m^3 is used – 10.8[21] GJ/1000m^3; parameter is not monitored during the crediting period (See also section B);

$\eta_{hydrogen}$ – efficiency of the equipment used for hydrogen combustion for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

[21] Rounded value is presented here. In calculations not rounded value is used.

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

This option is not used in monitoring of emission reductions from the project. The section D.1.2 is left blank for purpose.

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

This option is not used in monitoring of emission reductions from the project. The section D.1.2 .1 is left blank for purpose.

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

This option is not used in monitoring of emission reductions from the project. The section D.1.2 .2 is left blank for purpose.

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

No leakages are foreseen within the project activity. Section D.1.3 is left blank for purpose.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

No leakages are foreseen within the project activity. Section D.1.3.1 is left blank for purpose.

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

No leakages are foreseen within the project activity. Section D.1.3.2 is left blank for purpose.

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

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

$$ER = BE - PE \quad (D.8),$$

where:

ER – total greenhouse gases emissions reduction, tonnes CO_{2e};
BE – total baseline greenhouse gases emissions, tonnes CO_{2e};
PE – total project greenhouse gases emissions, tonnes CO_{2e}.

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

Collecting and archiving of the information on the environmental impacts of the project is undertaken in accordance with legislative and procedural requirements enforces in Ukraine.

Specifically, the enterprise files reports by the following official statistical forms:

- 2-tp (air) *Data on protection of atmospheric air*, which contains information on amounts of trapped and neutralized atmospheric pollutants, itemized emissions of specific pollutants, number of emission sources, measures on reduction of emissions into the atmosphere, emissions from particular groups of pollution sources;
- 2-tp (water resources) *Data on water use*, which presents information on consumption of water from natural sources, discharge of waste water, and content of pollutants in it, capacity of treatment facilities, etc.;
- 2-tp (waste) *Data on formation, use, neutralization, transportation and placement of industrial and household waste*, which presents the annual balance of waste flow, by waste types and hazard classes.

Data are monitored with compliance to Law of Ukraine "On metrology and metrological activities'.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
M-1 $EC_{project}$	*low*	*Electricity consumption is metered by Siemens ZFB 410 power meter with accuracy class 1. The power meter is calibrated once per 6 years. Last calibration has been made in 2009 and the next one is expected in 2015. The data on electricity consumption are also being controlled by automated electricity accounting system (AEAS).*
M-2 EF_{grid}	*low*	*The values of emissions factors are officially approved by designed focal point of Ukraine – State Environmental Investment Agency (former National Environmental Investment Agency).*
M-3 $HC_{project}$	*low*	*Heat energy consumption is meter by vortex flow meter OPTISWIRL 4070 manufactured by Krohne, which is able to measure both mass and energy flow of energy carrier. The accuracy of the flow meter is 1.5% of measured value. The flow meter is calibrated once per year. Last calibration has been made in 2012 and the next one is expected in 2013. The data on heat energy consumption are also being controlled by programme adder units of process management system CENTUM3000 based on the data of technical flow meters FT002 and FT003.*
M-4 EF_{NG}	*low*	*The values of emissions factors are set in the National Inventory Reports of Ukraine.*
M-5 $OXID_{NG}$	*low*	*The values of emissions factors are set in the National Inventory Reports of Ukraine.*

M-6 $P_{caustic}$	*low*	*Production of caustic soda is measured by mass flow meter OPTIMASS 7330S manufactured by Krohne and level meter APLISENS type APR 2000. The accuracy of the flow meter is 0.15% of measured value. The flow meter is calibrated once per year. Last calibration has been made in 2012 and the next one is expected in 2013. The data on caustic soda production are also controlled by programme adder units of process management system CENTUM3000.*
M-7 $FC_{hydrogen}$	*low*	*Consumption of hydrogen is measured by vortex flow meter OPTISWIRL 4070 manufactured by Krohne. The accuracy of the flow meter is 1.5% of measured value. The flow meter is calibrated once per year. Last calibration has been made in 2012 and the next one is expected in 2013.*

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

Project owner uses existing internal operational and management structure in order to implement the monitoring plan of joint implementation project.

Data on electricity consumption for caustic soda production are collected on a daily basis by leading specialist of the energy department and fixed in Electricity consumption accounting journals, which are stored during six months. Besides, data are stored in automatic electricity accounting system during 3 years. Monthly data on electricity consumption for caustic soda production are fixed in monthly Technical reports prepared by the Deputy Chief of the workshop on technical issues. Technical reports are stored in four paper copies during 5 years. Data on electricity consumption for caustic soda production are also reported in Statistical form 11-MTP “Report on the consumption of fuel, heat energy and electricity”, which is prepared two times per year (data for 6 months and data for the whole year).

Data on heat energy consumption for caustic soda production are collected each two hours by the Deputy Chief of the workshop on technical issues and fixed in Steam consumption from CHP accounting journals, which are stored during three years. Besides, data are stored in automatic process control system. Monthly data on heat energy consumption for caustic soda production are fixed in monthly Technical reports prepared by the Deputy Chief of the workshop on technical issues. Technical reports are stored in four paper copies during 5 years. Data on heat energy consumption for caustic soda production are also reported in Statistical form 11-MTP “Report on the consumption of fuel, heat energy and electricity”, which is prepared two times per year (data for 6 months and data for the whole year).
Data on hydrogen consumption for heat energy generation are collected on a daily basis by the Deputy Chief of the workshop on technical issues and fixed in reporting forms, which are stored during 1 month. Besides, data are stored in automatic process control system. Monthly data on hydrogen consumption for heat energy generation are fixed in monthly Technical reports prepared by the Deputy Chief of the workshop on technical issues. Technical reports are stored in four paper copies during 5 years.

Data on caustic soda production are collected on a daily basis by the Deputy Chief of the workshop on technical issues and fixed in reporting forms, which are stored during 1 month. Besides, data are stored in automatic process control system. Monthly data on caustic soda production are fixed in monthly Technical reports prepared by the Deputy Chief of the workshop on technical issues. Technical reports are stored in four paper copies during 5 years. Data on caustic soda production are also reported in Statistical form 11-MTP “Report on the consumption of fuel, heat energy and electricity”, which is prepared two times per year (data for 6 months and data for the whole year).

Data from Statistical forms 11-MTP “Report on the consumption of fuel, heat energy and electricity” as well as from the monthly technical reports are used for the preparation of special monthly monitoring reports on the data used for calculation of emission reduction due to realization of joint implementation project, which are further used for the development of annual monitoring reports on emission reductions achieved due to the realization of the project. Documentation with the monitoring data (monthly reports) will be kept during the period of project realization and two years after the last transfer of ERUs from the project.

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

Date: 11/05/2012

The information about the organisation, which has established the monitoring plan and developed project design documentation, is presented below.

LLC ‘KT-Energy’ (registered in Ukraine)
15 B/22 Biloruska st., Kiev, 04119, Ukraine
Tel/Fax. + (38 044) 493 83 32, info@kt-energy.com.ua

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LLC ‘KT-Energy’ is not a project participant listed in annex 1.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Project scenario foresees introduction of new caustic soda production unit employing modern membrane cell technology and hydrogen consumption for energy purposes.

Emissions of greenhouse gases under the project scenario include emissions due to electricity consumption and natural gas combustion for heat energy generation.

Preliminary calculation of anthropogenic greenhouse gases emissions in metric tonnes of carbon dioxide equivalent is made according to the following formula:

$$PE = PE_{electricity} + PE_{heat}, \text{(E.1)}$$

where:

PE – total project greenhouse gases emissions, tonnes of CO_2e;
$PE_{electricity}$ – non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine under the project scenario, tonnes of CO_2e;
PE_{heat} – non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural under the project scenario, tonnes of CO_2e.

Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine are calculated according to the following formula:

$$PE_{electricity} = EC_{project} \cdot EF_{grid}, \text{(E.2)}$$

where:

$EC_{project}$ – electricity consumption for caustic soda production under the project scenario, MWh; defined based on the monitoring data and for the preliminary calculation is defined based on production plans of the enterprise (see table E.1-1.);
EF_{grid} – specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes CO_{2e}/ MWh; the choice of data is based on the orders of the National environmental investments agency of Ukraine for 1st class electricity consumers (for the year 2012 and onwards the value for the year 2011 is used – see also table E.1-1.).

Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas are calculated according to the following formula:

$$PE_{heat} = HC_{project} \cdot 4.1868 \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{NG}, \text{(E.3)}$$

where:

$HC_{project}$ – heat energy consumption for caustic soda production under the project scenario, Gkal; defined based on the monitoring data and for the preliminary calculation is defined based on production plans of the enterprise (see table E.1-1.);
EF_{NG} - CO_2 emission factor for natural gas combustion, kg of CO_2e/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.39 on page 365) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module “Energy” of 1996 IPCC Guidelines for national greenhouse gas inventories) has been used for preliminary calculations – 55.62 kg of CO_2e/GJ;
$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.40 on page 366) has been used for preliminary calculations – 0,995;

η_{NG} – efficiency factor for natural gas fired boilers used for heat energy generation – 90%.

Results of the preliminary calculation of anthropogenic greenhouse gases emissions due to electricity consumption and heat energy consumption under the project scenario for each year of the crediting period (2010-2012) and in total in metric tonnes of carbon dioxide equivalent, as well as the data used for calculation are presented in table E.1-1 below.

Table E.1-1. Information on project greenhouse gases emissions.

Data	**2010**	**2011**	**2012**	**Total**
Caustic soda production, tonnes	23424	107015	178580	309019
Electricity consumption, MWh[22]	57993	259523	433076	750592
Specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes of CO_2e/ MWh	1.093	1.090	1.090	-
Heat energy consumption, Gkal	20095	74838	124885	219818
Project greenhouse gases emissions due to electricity consumption, tonnes of CO_2e	63386	282880	472053	818319
Project greenhouse gases emissions due to heat energy consumption, tonnes of CO_2e	5173	19267	32152	56592
Total project greenhouse gases emissions, tonnes of CO_2e	68559	302147	504205	874911

Data on caustic soda production, electricity and heat energy consumption are assumed according to the production plans of the enterprise.

Thus, total amount of project greenhouse gases emissions from electricity consumption and heat energy consumption during the years 2010-2012 (first crediting period) will constitute to 874 911 tonnes CO_2e.

Table E.1-2. Information on project greenhouse gases emissions for the years 2013-2025.

Years	**Project greenhouse gases emissions, tonnes CO_{2e}**
2013	504205
2014	504205
2015	504205
2016	504205
2017	504205
2018	504205
2019	504205
2020	504205
2021	504205
2022	504205
2023	504205
2024	504205
2025	504205
Total	6 554 665

Total greenhouse gases emissions from electricity consumption and heat energy consumption under the project scenario during the period 2013-2025 will constitute 6 554 665 tonnes of CO_2e.

[22] Data on electricity consumption are presented in round numbers in MWh. During calculation of greenhouse gases emissions due to electricity consumption data without rounding are used.

During the entire project lifetime (2010-2025) anthropogenic greenhouse gases emissions from electricity consumption and heat energy consumption under the project scenario amount to 7 429 576 tonnes of CO_2e.

E.2. Estimated leakage:

No leakages are foreseen within the project activity.

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

Taking into account that no leakages are foreseen within the project activity the sum of E.1 and E.2 is equal to E.1.

E.4. Estimated baseline emissions:

Baseline scenario of proposed joint implementation project foresees continuation of using diaphragm cell technology for caustic soda production and lack of hydrogen consumption for energy purposes.

Baseline greenhouse gases emissions would have been generated due to electricity consumption, heat energy consumption and natural gas combustion for heat energy generation. Calculation of anthropogenic greenhouse gases emissions that would have taken place without joint implementation project realization (baseline emissions) will be made according to the following formula:

$$BE = BE_{electricity} + BE_{heat} + BE_{NG}, \quad (E.4)$$

where:

- BE – total baseline greenhouse gases emissions, tonnes of CO_2e;
- $BE_{electricity}$ – non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine under the baseline scenario, tonnes of CO_2e;
- BE_{heat} – non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario, tonnes CO_{2e};
- BE_{NG} – greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario, tonnes CO_{2e}.

Non-direct greenhouse gases emissions due to consumption of electricity, generated by power stations of united energy system of Ukraine will be calculated according to the following formula:

$$BE_{electricity} = SEC_{baseline} \cdot P_{caustic} \cdot EF_{grid}, \quad (E.5)$$

where:

- $SEC_{baseline}$ – specific electricity consumption for caustic soda production under the baseline, MWh/tonne; parameter is not monitored during the crediting period and is estimated based on historic data on electricity consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.158 MWh/tonne (See also section B);
- $P_{caustic}$ – caustic soda production, tonnes; parameter is assumed equal both for project and baseline scenario and for preliminary calculation is defined according to the production plans of the enterprise (see table E-4.1. for details);
- EF_{grid} – specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes CO_{2e}/ MWh; values approved by the order of National environmental investment Agency of Ukraine for the 1^{st} class

consumers are used for preliminary calculations (for the years 2012 and onwards the value for the year 2011 is used – see also table E-4.1.).

Non-direct greenhouse gases emissions due to consumption of heat energy generated by Kalush TPP by combusting of natural gas under the baseline scenario are calculated according to the following formula:

$$BE_{heat} = SHC_{baseline} \cdot 4.1868 \cdot P_{caustic} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{NG}, \quad (E.6)$$

where:

$SHC_{baseline}$ – specific heat energy consumption for caustic soda production under the baseline, Gkal/tonne; estimated based on historic data on heat energy consumption for caustic soda production as an average value for last 5 years of using diaphragm technology at the enterprise (years 2004-2008) – 3.374 Gkal/tonne (See also section B);

$P_{caustic}$ – caustic soda production, tonnes; assumed to be equal both in project and baseline scenario, and for the preliminary calculation of baseline greenhouse gases emissions is defined based on production plans of the enterprise;

EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module "Energy" of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ;

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995;

η_{NG} – efficiency factor for natural gas fired boilers used for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

Greenhouse gases emissions due to combustion of natural gas for heat energy generation under the baseline scenario in the amount that would be equal to the amount of heat energy generated due to hydrogen combustion under the project scenario are calculated according to the following formula:

$$BE_{NG} = HG_{hydrogen} \cdot EF_{NG} \cdot OXID_{NG} \cdot 10^{-3} / \eta_{hydrogen}, \quad (E.7)$$

where:

EF_{NG} - CO_2 emission factor for natural gas combustion, kg CO_{2e}/GJ; value of the carbon content in natural gas according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.41 on page 470) converted to carbon dioxide emissions factor based on molar mass ratio (according to the step 6 on page 1.8 of the Workbook, Module "Energy" of 1996 IPCC Guidelines for national greenhouse gas inventories) and presented in kg CO_{2e}/GJ has been used for preliminary calculations – 55.62 kg CO_{2e}/GJ;

$OXID_{NG}$ – carbon oxidation factor for combustion of natural gas; value according to National inventory of anthropogenic emissions from sources and removals by sinks of GHG in Ukraine in 1990-2010 (Table П2.42 on page 471) has been used for preliminary calculations – 0,995;

$HG_{hydrogen}$ – amount of heat energy generation due to hydrogen combustion under the project scenario, GJ. Calculated according to the following formula:

$$HG_{hydrogen} = FC_{hydrogen} \cdot NCV_{hydrogen} \cdot \eta_{hydrogen}, \quad (E.8)$$

where

$FC_{hydrogen}$ – amount of hydrogen combusted for heat energy generation under the project scenario, 1000 m^3; for the preliminary calculations defined based on the production plans of the enterprise (see table E-4.1.);

$NCV_{hydrogen}$ – net calorific value of hydrogen, GJ/1000m^3; the value according to GOST 3022-80 "Hydrogen technical. Technical specifications" (28 670 kcal/kg), converted to GJ/1000m^3 is used – 10.8[23] GJ/1000m^3; parameter is not monitored during the crediting period (See also section B);

$\eta_{hydrogen}$ – efficiency of the equipment used for hydrogen combustion for heat energy generation – 90%; parameter is not monitored during the crediting period (See also section B).

Results of preliminary calculation of anthropogenic greenhouse gases emissions due to electricity consumption, heat energy consumption and natural gas combustion for heat energy generation under the baseline scenario for each year of the crediting period (2010-2012) and in total in metric tonnes of carbon dioxide equivalent, as well as the data used for calculation are presented in table E.4-1 below.

Table E.4-1. Information on baseline greenhouse gases emissions

Data	**2010**	**2011**	**2012**	**Total**
Caustic soda production, tonnes	23424	107015	178580	309019
Electricity consumption, MWh[24]	73980	337987	564012	975979
Heat energy consumption, Gkal	79026	361041	602482	1042549
Amount of hydrogen combusted for heat energy generation under the project scenario, 1000 m^3	4557	21701	48000	74258
Specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine, tonnes of CO_2e/ MWh	1.093	1.090	1.090	-
Baseline greenhouse gases emissions due to electricity consumption, tonnes CO_{2e}	80860	368406	614773	1064039
Baseline greenhouse gases emissions due to heat energy consumption, tonnes CO_{2e}	20345	92950	155109	268404
Baseline greenhouse gases emissions due to natural gas combustion for heat energy generation, tonnes CO_{2e}	2725	12974	28698	44397
Total baseline greenhouse gases emissions, tonnes CO_{2e}	103930	474330	798580	1376840

Data on caustic soda production and amount of hydrogen combusted for heat energy generation are assumed according to the production plans of the enterprise. Data on electricity and heat energy consumption are calculated based on caustic soda production and defined specific electricity consumption and heat energy consumption for caustic soda production under the baseline scenario (See section B for details).

Thus, total amount of baseline greenhouse gases emissions from electricity consumption, heat energy consumption and natural gas combustion for heat energy generation during the years 2010-2012 (first crediting period) will constitute to 1 376 840 tonnes of CO_2e.

[23] Rounded value is presented here. In calculations not rounded value is used.

[24] Data on electricity consumption are presented in round numbers in MWh. During calculation of greenhouse gases emissions due to electricity consumption data without rounding are used.

Table E.4-2. Information on baseline greenhouse gases emissions for the years 2013-2025

Years	**Baseline greenhouse gases emissions, tonnes CO_{2e}**
2013	798 580
2014	798 580
2015	798 580
2016	798 580
2017	798 580
2018	798 580
2019	798 580
2020	798 580
2021	798 580
2022	798 580
2023	798 580
2024	798 580
2025	798 580
Total	10 381 540

Total greenhouse gases emissions from electricity consumption, heat energy consumption and natural gas combustion for heat energy generation under the baseline scenario during the period 2013-2025 will constitute 10 381 540 tonnes of CO_2e.

During the entire project lifetime (2010-2025) anthropogenic baseline greenhouse gases emissions from electricity consumption, heat energy consumption and natural gas combustion for heat energy generation amount to 11 758 380 tonnes of CO_2e.

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

The amount of emission reduction units has been calculated as a difference between the amount of emissions in the baseline scenario and the amount of emissions in the project scenario.

$$ER = BE – PE, \quad (E.9)$$

where:

ER – total greenhouse gases emissions reduction, tonnes of CO_2e;
BE – total baseline greenhouse gases emissions, tonnes of CO_2e;
PE – total project greenhouse gases emissions, tonnes of CO_2e.

Results of preliminary calculation of the amount of emission reduction units in total within the defined boundaries of the project by years of crediting period are presented in table E.5-1 below.

Table E.5-1. Information on greenhouse gases emissions reduction

Data	**2010**	**2011**	**2012**	**Total**
Reduction of greenhouse gases emissions due to electricity savings, tonnes of CO_2e	17474	85526	142720	245720
Reduction of greenhouse gases emissions due to heat energy savings, tonnes of CO_2e	15172	73683	122957	211812
Reduction of greenhouse gases emissions due to substitution of natural gas by hydrogen for heat energy generation, tonnes of CO_2e	2725	12974	28698	44397
Total reduction of greenhouse gases emissions, tonnes of CO_2e	35371	172183	294375	501929

Thus, estimated amount of greenhouse gases emissions reduction for the period 2010- 2012 (first crediting period) will constitute to 501 929 tonnes of CO_2e.

Total greenhouse gases emissions reduction due to joint implementation project realization during the period 2013-2025 will be 3 826 875 tonnes of CO_2e.

During the entire project lifetime (2010-2025) greenhouse gases emissions reduction due to joint implementation project realization will be 4 328 804 tonnes of CO_2e.

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

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2010	68 559	0	103 930	35 371
2011	302 147	0	474 330	172 183
2012	504 205	0	798 580	294 375
Subtotal over the period of 2010-2012 (tonnes of CO_2 equivalent)	874 911	0	1 376 840	501 929
2013	504 205	0	798 580	294 375
2014	504 205	0	798 580	294 375
2015	504 205	0	798 580	294 375
2016	504 205	0	798 580	294 375
2017	504 205	0	798 580	294 375
2018	504 205	0	798 580	294 375
2019	504 205	0	798 580	294 375
2020	504 205	0	798 580	294 375
2021	504 205	0	798 580	294 375
2022	504 205	0	798 580	294 375
2023	504 205	0	798 580	294 375
2024	504 205	0	798 580	294 375
2025	504 205	0	798 580	294 375
Subtotal over the period of 2013-2025 (tonnes of CO_2 equivalent)	6 554 665	0	10 381 540	3 826 875
Total over the period of 2010-2025 (tonnes of CO_2 equivalent)	7 429 576	0	11 758 380	4 328 804

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:

Proposed joint implementation project will lead to reduction of specific electricity consumption and reduction of natural gas combustion for heat energy generation, and consequently to reduction of fossil fuel consumption for electricity and heat generation and thus will have positive impact on environment.

Overall, during caustic soda production using membrane technology there are three factors impacting natural environment, namely, atmospheric pollution, waste water and solid waste.

The enterprise has received from the State authority on environmental protection in Ivano-Frankivsk region (regional authority of the Ministry of environmental protection of Ukraine) additional permit #2622882400-1 dated 28.04.2011 amending the permit #260992 for the emissions of pollutants into the atmospheric air from stationary sources.

The advantage of membrane technology is absolute avoidance of chlorine emissions in the electrolysis department during normal technological operation. All gaseous emissions are collected into a closed system and directed for the dechlorination to the purification columns. The level of purification is – 99.99%.

Wastewater from the stages of electrolysis, water demineralization, evaporation, hydrogen drying, caustic storage facilities, etc. are directed for neutralization with further release in acid-alkali sewerage system. In order to protect water resources from contamination it is foreseen to reuse in technological processes water from cleaning of filtration materials of the equipment and neutralized wastewater.

Solid not hazardous waste in form of precipitated dehumidified sludge, which is created from not soluble minerals within the salt used for caustic soda production is collected into metal containers and sent third party organization for further use or utilization.

Reduction of greenhouse gases emissions during the period 2010-2012 will amount to 501 929 tonnes CO_2e, and for the entire project lifetime (2010-2025) – 4 328 804 tonnes CO_2e.

Besides, project implementation will lead to reduction of specific consumption of recirculated water from 202 m^3 to 97m^3 and technological air from 52 nm^3 to 20 nm^3, which would also have positive environmental impact.

Project does not have a sufficient impact on biotic medium.

In general, project realization will have positive environmental impact and will not cause deterioration of the environment on local level.

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

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

SECTION G. Stakeholders' comments

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

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

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Entry number at Uniform State Register of Enterprises and Organizations of Ukraine – 33129683. Economic activity types according to Ukrainian Classification for Economic Activities (KVED): 20.11 production of industrial gases; 20.13 production of others basic non organic chemical products; 20.14 production of others basic organic chemical products; 20.16 production of plastic material in primary moulds; 49.20 cargo rail transportation; 71.20 technical tests and examinations.

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Annex 2

BASELINE INFORMATION

See Section B.

Annex 3

MONITORING PLAN

See Section D.

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Annex 4

SPECIFIC CARBON DIOXIDE NON DIRECT EMISSION FACTORS FOR CONSUMPTION OF ELECTRICITY GENERATED BY POWER STATIONS OF UNITED ENERGY SYSTEM OF UKRAINE

DATA	VALUE	SOURCE
Specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine for 1st class consumers for 2010, tonne CO_{2e}/MWh	1,093	Order #43 from 28th of March, 2011, of National Environmental Investment Agency of Ukraine
Specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine for 1st class consumers for 2011, tonne CO_{2e}/MWh	1,090	Order #75 from 12th of May, 2011, of National Environmental Investment Agency of Ukraine

For the years 2012-2025 the value of specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine approved for the year 2011 was used in the calculations. At the stage of monitoring report preparation and in case of approval of specific carbon dioxide non direct emissions factor for consumption of electricity generated by power stations of united energy system of Ukraine for the year 2012 and forthcoming years calculations will be properly adjusted.

Annex 5

FINANCIAL PLAN

Total estimated project cost is about UAH 849.8 million (VAT excluded).

Due to the necessity of significant investments, realization of the project activity is not the most economically favorable without additional financial incentives, namely revenues from the sale of emission reduction units (ERUs), which are generated within the boundaries of the joint implementation project.

The contract with the technology supplier (German company UHDE) has been signed on 16th of December 2005. Construction and partly project design works have been done by local companies. Expenses on the realization of the project have been borne in 2006-2010.

Financial plan of the project is presented in the table below.

Table 1. Financial plan of the project

Year	2006	2007	2008	2009	2010
Design works	26 684 000	29 879 000	711 000	181 000	12 000
Equipment cost	7 383 000	348 835 000	65 926 000	22 375 000	1 640 000
Construction and assembling works	7 739 000	31 949 000	185 039 000	85 965 000	11 257 000
Other costs		2 654 000	13 488 000	10 720 000	+ 2 649 000*
Total investments	41 806 000	413 317 000	265 164 000	119 241 000	10 260 000

* return of previously paid costs

Financial indicators of the project

Financial analysis was used to demonstrate that proposed project activity is not the most financially attractive. Net present value (NPV) was used to perform the analysis (See also section B for more details).

Table 2. Results of financial analysis

Scenario	NPVC, UAH
Project scenario, UAH	- 168 250 091
Project scenario with ERU sales, UAH	11 502 844

The results of the financial analysis demonstrate that the project scenario is not the most financially attractive for the project owners. The application of the flexible mechanisms of Kyoto Protocol and additional revenues from emission reduction units' sales significantly improves the economic feasibility of the project and triggers project implementation.