JOINT IMPLEMENTATION PROJECT

"UkrHydroEnergo (UHE) Hydropower Rehabilitation Project in Ukraine"

Title of the head of company in charge of PDD development

Chairman of the Board
OJSC "UkrHydroEnergo"

(signature)

S. Potashnyk
(name)

Title of the head of company which owns the emission source where the JI project is planned to be implemented

Chairman of the Board
OJSC "UkrHydroEnergo"

(signature)

S. Potashnyk
(name)

Vyshhorod City

November, 2010

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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

UkrHydroEnergo (UHE) hydropower rehabilitation project in Ukraine
(hereafter referred to as the “Project” or “Project Activity”)

The project belongs to sectoral scope 1. Energy industries (renewable/non-renewable sources).

Version 8, February 4, 2010

Original PDD was developed in May 2005.[1]

A.2. Description of the project:

The Project involves the rehabilitation of 46 hydro units which are located at nine different sites on the Dnipro river and one site on the Dnister river. This will entail the replacement of hydrolic power, electro-technical and hydro-mechanical equipment such as gates, turbines, generators, excitation and governor systems, control, protection and automation systems, switchyard equipment and auxiliary equipment.

Some of the oldest hydro units (to be rehabilitated under the Project) were commissioned 70 years ago and although they will not be obsolete for many years to come, continue to run at increasingly lower efficiency levels. Hydropower generation in the Ukraine is limited by reservoir level. It is desirable to have turbines running at high efficiency to produce the maximum amount of power from the available water resources.

The Project will increase the electricity generation capacity and efficiency of the rehabilitated hydropower plants. Additional power generated by the hydro units during peak periods will displace that generated by thermal plants. It is estimated that emission reductions due to displaced thermal electricity generation will be 1.09 million tCO_2e during the years 2008 - 2012.

The Project will be implemented in stages and as more hydro units are rehabilitated, the Project’s hydropower plants will generate an increased amount of electricity. By the year 2012 it is expected that increased generation will be approximately 338GWh/a and peak by 2015 at 470 GWh/a.

At present in Ukraine, nuclear power plants supply the majority of base load power. Since hydropower plants, dispatched in peak times, are fully utilized, thermal plants must supply incremental demand. Most of the grid connected thermal plants were built before the 1980’s, with the oldest plants built in the 1950’s. These plants typically have very low efficiencies.

The Project will bring a number of benefits to the local community and Ukraine as a whole. It will help increase the reliability of power supply by enhancing the ability of the rehabilitated hydropower plants to provide critical electricity supply during peak times and frequency control. It also includes additional technical assistance to improve reservoir management and plant operation. Additionally, as part of the Project, a dam safety monitoring system will be installed along with other related components.

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[1] PDD was positively Determined by SGS in 2006. As no JI format was available at the time, PDD was based on the CDM format. PDD was therefore transformed into JISC PDD format in 16/01/2008 with no changes in the Project design but including minor updating and clarifications provided to the Determinator during the original determination process and reflecting changes since 2006 having an impact on assumptions.

In terms of environmental benefits, the Project will help reduce air pollution caused by the emission of SO_2, NO_X and CO_2 by outdated thermal plants. Water pollution will also be reduced at some of the reservoirs through the installation of environmentally safe runners to the hydro units, which eliminate oil leakage.

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)
Ukraine	UkrHydroEnergo (UHE)[2]	No
The Netherlands	International Bank for Reconstruction and Development (IRBD) as Trustee for the Netherlands European Carbon Facility	Yes

A.4. Technical description of the project:

A.4.1. Location of the project:

A.4.1.1. Host Party(ies):

Ukraine

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

Seven locations and nine plant sites on the Dnipro and Dnister rivers

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

Vyshgorod, Kaniv, Svetlovodsk, Dniprodzerzhynsk, Zaporizhzhya, Nova Kakhovka and Novodnistrovsk.

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

The Project will be located at nine sites on the Dnipro river and one site on the Dnister river (Novo-Dnistrovsk area). Dnipro river runs through central Ukraine where as Dnister river is located in western Ukraine. The sites and plant names are as follows:

[2] UHE is a fully state owned joint stock company which is involved in the generation of electricity using hydropower plants. The company owns and operates plants that generate approximately 99% of all hydropower generated electricity in the Ukraine. It sells electricity to the grid at a tariff rate predetermined by the National Energy Regulatory Commission (NERC).

Vyshgorod (Kyiv Pump Storage Power Plant and Kyiv Hydropower Plant), 07300, Kyiv region.
Coordinates: 50° 35′ 0″ N, 30° 30′ 0″ E.
Source: http://en.wikipedia.org/wiki/File:Map_of_Kyivska_Oblast.gif

Kaniv (Kaniv Hydropower Plant), 19000, Cherkassy region.
Coordinates: 49° 45′ N, 31° 28′ E
Source: http://upload.wikimedia.org/wikipedia/commons/e/eb/Cherkasy_oblast_detail_map.png

Svetlovodsk (Kremenchuk Hydropower Plant), 1-a Observotornaya str., 27500, Kirovograd region.
Coordinates: 49° 3′ 1″ N, 33° 14′ 31″ E
Source: http://upload.wikimedia.org/wikipedia/commons/5/5b/Kirovohrad_oblast_detail_map.png

Dniprodzerzhynsk (Dniprodzerzhynsk Hydropower Plant), 51918, Dnipropetrovsk region.
Coordinates: 48° 31′ 00″ N, 34° 37′ 00″ E.
Source: http://upload.wikimedia.org/wikipedia/commons/b/b9/Dnipropetrovsk_oblast_detai.png

Zaporizhzhya (DniproGES Hydropower Plant-1 and DniproGES Hydropower Plant-2), 1 Wintera str, 69096, Zaporizhzhya region.
Coordinates: 47° 50′ 0″ N, 35° 10′ 0″ E.
Source: http://upload.wikimedia.org/wikipedia/commons/c/c2/Zaporizhia_oblast_detail_map.png

Nova Kakhovka (Kakhovka Hydropower Plant), 74900, Kherson region.
Coordinates: 46° 46′ N, 33° 22′ E.
Source: http://upload.wikimedia.org/wikipedia/commons/c/c1/Kherson_oblast_detail_map.png

Novodnistrovsk (Dnistro Hydropower Plant), 60236, Chernivtsy region.
Coordinates: 48° 35′ 0″ N, 27° 26′ 0″ E
Source: http://upload.wikimedia.org/wikipedia/commons/c/cf/Chernivtsi_oblast_detail_ma.png

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

The project belongs to sectoral scope 1. Energy industries (renewable/non-renewable sources). The Project involves the rehabilitation of a total of 46 hydro units. This will entail the replacement of hydrolic power, electro-technical and hydro-mechanical equipment such as gates, turbines, generators, excitation and governor systems, control, protection and automation systems, switchyard equipment and auxiliary equipment.

Most of the mechanical equipment will be produced locally while control and regulation systems, circuit breakers and other electrical equipment will be imported from overseas.

The Project will also include civil works on hydraulic structures and installation of computer-aided dam safety monitoring systems.

Since technological equipment directly related to the project will no vary from the old equipment, no special training for the staff will be required. However, the staff will be required to study operation manuals, and regularly pass personnel certification.

New equipment maintenance will be performed according to the schedule provided in the operation manuals established by the company in accordance to the sectoral norms. Usually routine maintenance is performed every year, while overhauls of main generating equipment performed every 6-7 years.

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:

Since the Project will not result in an increase in the reservoir area, the rehabilitated hydropower plants will generate additional electricity without emitting GHG. It will reduce anthropogenic GHG emissions by displacing electricity produced by fossil fuel fired power plants during the crediting period of 2008-2012 total of 1,090,380 tCO_2e. In addition, the Project is estimated to generate 22,449 tCO_2e of Emission Reductions in 2007.

The Project is not Business As Usual, as demonstrated by the investment analysis (see section B.2). Additionally, the supporting arguments for additionality further demonstrate that the Project is additional due to the fact that it faces significant barriers.

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

	Years
Length of the crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	99,417
2009	145,384
2010	215,938
2011	268,319
2012	361,322
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1,090,380
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	218,076

In addition, the Project is projected to generate 22,449 tCO_2e of Emission Reductions in 2007.

A.5. Project approval by the Parties involved:

A Letter of Approval has been provided by Ukraine and the Netherlands.

SECTION B. Baseline

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

This PDD follows the elements of the approved CDM Methodology ACM0002 (*Consolidated methodology for grid-connected electricity generation from renewable sources*) version 7 with modifications to make this more applicable to the conditions found in Ukraine. The approach also takes into account the criteria for baseline setting included in Appendix B of *Guidelines for the implementation of article 6 of the Kyoto Protocol* and is in line with the recent guidance provided by the Joint Implementation Supervisory Committee.

The Project is a grid-connected zero-emission renewable power generation activity and has the following characteristics relevant to baseline emission determination:

- The Project supplies electricity capacity addition from the rehabilitation of a hydropower source, and the volume of the existing reservoirs is not increased;
- The Project is not an activity that involves switching from fossil fuels to renewable energy at the project site;
- The electricity grid is clearly identified (as Ukraine grid) and information is available on the characteristics of the grid.

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

Define alternatives to the project activity:

The project is producing additional electricity that will displace the electricity generated by the marginal thermal power plants during the peak time (please see the explanation below). Thus, the following alternatives are applicable:

Alternative #1: Additional electricity is supplied during peak time by new thermal plant(s) or by the expansion of existing thermal power plants.

Alternative #2: The Project participant decides that an electricity generation project is not warranted. Continuation of the current situation means that existing thermal plants continue to supply electricity to the Ukraine grid during peak times.

Alternative #3: The proposed Project activity is implemented without JI component and rehabilitated hydro units produce an increased amount of electricity for sale to the Ukraine grid during peak times.

Enforcement with applicable laws and regulations:

All the alternatives are in compliance with applicable laws and regulations.

Selection of the baseline scenario

Alternative #1 would not be a plausible alternative for the Project participant because, as stated earlier, there is already a large amount of excess thermal capacity. Furthermore, the high cost of building thermal plants, in a sector heavily burdened with debt, makes this alternative implausible.

Alternative #2. In fact, at the time of the investment decision there were no sectoral mandatory requirements to implement the rehabilitation of the hydro power plants in Ukraine. The only successful rehabilitation project was implemented in 2002, when UHE finished the rehabilitation of 16 hydro units funded by a World Bank loan under favorable conditions. Soon after this, UHE started a project to rehabilitate a further 10 units using their own equity. However, the project could not be completed due to lack of available funds. This demonstrates that the Alternative #2 is a plausible alternative for the Project activity.

Alternative #3 requires significant investment and is not financially attractive in the economic context in the power sector in Ukraine as it will be demonstrated in details by the investment analysis in the Section B.2. The Project requires financial assistance to help alleviate Project barriers (see Steps 2 and 3 below). This prompted UHE to look for alternative ways, including JI, to improve the IRR of the Project and to reduce risks associated with its implementation.

In conclusion, Alternative #2 is the only plausible and realistic alternative and represents a baseline scenario.

In the absence of the Project, CO_2 emissions would occur unabated from outdated thermal power plants. Hydropower, which is dispatched before thermal plants, is a renewable energy source. Emission free power generated by the Project will displace CO_2 emission intensive grid electricity generated by thermal plants.

Approach selected to estimate the baseline emissions

The Operating Margin (OM) is deemed to best represent what would occur in the absence of the Project. The Project will not affect the build margin due to the large excess installed thermal capacity of the Ukraine grid. The current excess capacity is over 43%; peak demand is about 28 GW compared to a total installed capacity of 55 GW (the State Committee of Statistic of Ukraine). The project's expected electricity generation (420 GWh per year) consist only approximately 0.25% of the entire Ukrainian power generation system (182,200 GWh in 2004 year). It is therefore inconceivable that the Project would have any impact on the Ukrainian power sector development trend. Capacity additions have been very few in the past and, given the large excess capacity in the system, little are planned for the future. In 2005, Ukraine completed and commissioned two nuclear reactors (each 1GW). Their construction started 20 years ago during the former Soviet Union. These two nuclear units are the only major capacity additions to the Ukraine grid since the 1980s. The use of 100% weighting of OM was accepted by SGS in original Determination report in 2006. Please see additional information in the Annex 2.

The baseline scenario is the amount and type of electricity that would have otherwise been generated by the operation of grid-connected thermal power plants.

The plants at the OM of the grid are analyzed to determine the OM CO_2 emission factor (EF_{grid}) of the Ukraine grid. Low cost/must-run resources excluded from the calculation of the EF for the OM are nuclear and hydropower installations. Nuclear units in Ukraine are operated as must run base load units and their generation profile is not impacted by the Project. Existing hydro installations are also generating at full capacity and in must run mode and the Project has no impact on the generation of power by existing hydro capacity.

Furthermore, demand for power in the Ukraine is forecast to increase in future years. This increased demand will be mainly met by thermal power plants[3], resulting in the portion of low-cost/must-run resources on the Ukraine grid is likely to decrease continuously. There is large excess generation capacity of coal plants in Ukraine and none of them can be considered as must run sources of power as they can be dispatched interchangeably, i.e. there is no need to dispatch any specific, individual coal plant for regulation or security of supply needs.

The share of nuclear and hydro has been slightly above 50% and therefore not meeting the typical requirements for simple operating margin (OM) calculation. The exclusion of these must run sources can, however, be substantiated based on two facts:

(i) As discussed above, the consumption of electricity is increasing and the share of must run sources are likely be below 50%.
(ii) Based on recent 2006 and 2007 data, it is demonstrated that must-run sources are never on the margin. This demonstration (described in details in the Annex 2) is using the principles of the calculation of the Simple Adjusted OM emission factor for the grid. In fact, the λ[4] based on the requirements of *Tool to calculate the emission factor for an electricity system* would be equal to zero.

These arguments allow concluding that the Project will not displace low-cost/must-run resources at any point in time now or in the foreseeable future. Hydro plants are also planned to generate electricity during the peak hours.

It should be noted that calculation of the (EF_{grid}) based on the OM only is conservative as the average EF of all the remaining plants is lower than the last plant in the dispatch merit order. The units with the lowest efficiency and highest cost per MWh are typically dispatched last in any power system.

Aggregated data for generation and fuel consumption obtained from the State Committee of Statistic of Ukraine is used in OM calculations. For net calorific values and carbon emission factors for fossil fuels, IPCC figures are used.

The OM for the Project will be determined *ex post*.[5] Generation by the Project is claimed for the proportion of increased electricity exported to the grid due to rehabilitation (increased efficiency) of the hydro units (identified in the Project boundary). Baseline emissions are determined by multiplying the OM emission factor by the amount of generation by the Project. Estimated emission reductions for each year of the Project up until 2012 are displayed in section E.6.

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[3] Ukrainian Government has set as an objective increased use of coal for power generation. Parts of existing excess thermal capacity may also be rehabilitated.

[4] Lambda (λ) refers to number of hours must-run sources are on the margin based on *Tool to calculate the emission factor for an electricity system*

[5] If data required for *ex post* determination of the OM cannot be acquired from the Ukraine power authorities, an *ex ante* default OM value will be used. This value is calculated as the 3-year average based on the most recent statistics available at the time of PDD production.

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:

Demonstration of Project Additionality:

The following steps are utilized to demonstrate Project additionality at the time of investment decision was made.

STEP 1 – Investment analysis
STEP 2 – Common practice analysis

STEP 1 – Investment analysis

Sub-step 1a – Determine appropriate analysis method

In order to determine whether the proposed Project is a financially attractive course of action, its IRR is compared to a relevant benchmark for similar projects in the Ukraine. The analysis has been completed below.

Sub-step 1b – Option III – Apply benchmark analysis

IRR is deemed the most suitable financial indicator for the Project. The benchmark value of the minimum IRR necessary for the positive investment decision was defined. The sector specific average interest rate for electricity production was 16.4% in 2004. For conservativeness reasons, the benchmark of 12.3% can be used. This corresponds to the average weighted annual rate of credits granted in foreign currency to electricity, gas and water production in Ukraine in 2004 at the time investment when decision was made[6]. As a risk premium for power projects would need to be added to the commercial lending rate to arrive at the suitable benchmark for the Project, 12.3 % can be seen as a conservative benchmark for the Project[7].

Sub-step 1c – Calculation and comparison of financial indicators

The table below represents the main data used in the IRR calculation for the Project.

[6] Bulletin of the National Bank of Ukraine, February, 2005, p. 58; National Bank of Ukraine. Available at http://www.bank.gov.ua/ENGL/Publication/Of_edit/Bulletin/2005/bull-02_05.pdf.

[7] Credit rating agencies also viewed Ukraine as a high risk country at the time of the investment decision. For example, Coface (France's export credit underwriter) had given Ukraine a C rating for country risk.

Table 1: Calculation and comparison of financial indicators

Item	Value
Financial Details	
Foreign exchange rate	5.28 UAH / 1 US$
Project initial cost (before tax and duties)	296,000,000 US$
Electricity tariff	0.0114 US$/kWh (in 2012)
Electricity sales (470 GWh)[8]	5,340,909 US$ (in 2012)
Project life	35 years
Expenses	
O&M costs (savings) /a	- 3,774,671 US$[9] (in 2012)
Project IRR	**4.1%**

<u>Data assumptions</u>

- The cost of the hydro unit equipment etc. was supplied by the project developer based on quotes, consultation with renewable energy experts and industrial standards.
- Predicted future tariff rates for hydropower generated electricity were supplied by UHE.
- Electricity sales will peak in 2015 after all of the Project's hydro units have been rehabilitated.
- O&M cost savings were estimated by the Project developer based on the cost of running the Project's hydro units before rehabilitation compared to the predicted cost of running the same units after rehabilitation.

The Project requires high initial capital investment of approximately $296 million. However, due to the low tariff rate in Ukraine[10], although the Project will receive favorable loan conditions for approximately 43% of the initial investment amount, the revenue base is too small to effectively absorb the initial investment costs. The high initial costs combined with the small revenue base result in a low IRR.

The Project's IRR is estimated to be 4.1% at the time of investment decision, which is well below the applicable Ukrainian benchmark. Therefore, the economic factors prevent the Project from being implemented on a BAU basis.

Sub-step 1d –Sensitivity Analysis

The following assumptions are analyzed to demonstrate that the conclusion regarding the financial attractiveness of the Project is robust under different favorable scenarios:

1) The tariff for electricity will be 10% per annum higher than expected. (Project IRR = 8.9%)
2) The initial costs for equipment, etc. will be 15% lower than expected. (Project IRR = 5.0%)
3) O&M cost savings will be 15% higher than expected. (Project IRR =4.6%)

Sensitivity analysis confirms that the project IRR would still be much lower than the benchmark. Therefore

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[8] Due to delay in project implementation, the revised estimation for incremental electricity sale by 2012 is 338 GWh making the IRR calculation conservative.

[9] This is negative because as a direct result of the Project, O&M cost savings are achieved.

[10] The power sector is in heavy debt due to a low rate of cash collection in the past and low tariff rates that are below the cost of power production. The tariff for electricity generated in 2005 by hydropower plants in the Ukraine was approximately 0.56 cents US.

the Project is unlikely to be financially attractive without JI component (e.g. which provides a means of paying the interest on the loan). Thus, the project is not BAU.

STEP 2 – Common practice analysis

Sub-step 2a – Analyse other activities similar to the proposed project

In 2002, UHE finished the rehabilitation of 16 hydro units funded by a World Bank loan under favorable conditions. Soon after this, UHE started a project to rehabilitate a further 10 units using their own equity but the project could not be completed due to lack of available funds. A subsequent detailed analysis of the underlying economic feasibility of rehabilitating hydro units in Ukraine found that project implementation is not possible without a loan with favorable conditions. Apart from these activities and two recently completed nuclear power plants, there has been no other new capacity addition to the Ukraine grid in the last 25 years.

Sub-step 2b –Discuss any similar option occurring

The 16 hydro units completed by UHE under stage 1 were partially funded with a favorable loan from the World Bank at a time when the issue of sectoral debt had not entered the national political spotlight. Since 2002, sector debt has continued to increase steadily and this has prompted the drafting of a new law which will force the energy sector to settle over US$7.7 billion in debt. In a move to stabilize the energy sector and reduce debt, power generation companies will be forced to increase profitability.

Lack of capital due to low tariffs was cited as the main reason why the UHE rehabilitation project started in 2002 was not been completed[11]. This supports the above argument and reflects the high investment risks in the Ukraine power sector.

Conclusion:

The Project's IRR is estimated to be 4.1%, which make the project not financially attractive for the company (in comparison to the applicable Ukrainian benchmark). Thus, the Project would not be implemented on a BAU basis, which is also confirmed by the sensitivity analysis. An additional revenue stream through the sale of ERUs could help increase profitability of the Project and alleviate other barriers. Expected revenue from JI was taken into account when planning project finance and will help to increase project profitability.

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

The spatial extent of the Project boundary includes the Project sites (as listed in section A.4.1.4.) and all power plants connected physically to the Ukraine grid.

[11] In 2005 the Project was only half finished and the funds necessary to complete this project were not available.

Table 2: Sources and gases included in the project boundary:

	Source	Gas	Included?	Justification / Explanation
	Fossil fuelled power plant in Ukrainian grid	CO_2	Yes	The main source of CO2 emissions.
		CH_4	No	This amount is likely to be minor and exclusion is conservative.
		N_2O	No	This amount is likely to be minor and exclusion is conservative.
	Source	**Gas**	**Included?**	**Justification / Explanation**
	Hydro power plants	CO_2	No	No emissions
		CH_4	No	No change from baseline to project
		N_2O	No	No emissions

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

The baseline study was completed in 31/05/2005 by Clean Energy Finance Committee.

Clean Energy Finance Committee
Mitsubishi Securities Company Ltd.
Tokyo, Japan
Tel: (81-3) 6213-6860
E-mail: hatano-junji@mitsubishi-sec.co.jp

Clean Energy Finance Committee, Mitsubishi Securities Company Ltd is not a project participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01/01/2006

C.2. Expected operational lifetime of the project:

35 years

C.3. Length of the crediting period:

The crediting period is 5 years, 01/01/2008-31/12/2012 for ERUs. Subject to relevant approvals, crediting can be extended beyond 2012. In addition, potential ERs generated 01/01/2007-31/12/2007 could be transferred as AAUs or sold as VERs subject to relevant agreements or approvals.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The following items will be monitored in order to determine baseline emissions in a conservative and transparent manner[12]:

- Names of plants and hydro unit number for those hydro units which have recommenced operation after undergoing rehabilitation as part of the Project[13].
- Amount of generation (MWh/a) supplied to the grid by each project hydropower plant.
- Total water flow (m^3/a) for each project hydropower plant
- The Simple OM emission factor of the Ukrainian power grid (tCO_2/MWh) calculated *ex post*
- Aggregated annual fuel consumption data (kt/a) for all thermal generation sources connected to the Ukraine grid
- Carbon emission factor of each fuel type.
- Aggregated electricity generation data (MWh/a) for all generation sources connected to the Ukraine grid.

The historical efficiency factors for the hydro power plants were determined *ex ante* based on actual data from 2002 to 2005, i.e. utilizing the correlation between the water flow and the electricity generation. The correlation is used to determine the amount of the baseline hydropower generation that would have occurred in the absence of the Project activity.

In order to retain a conservative approach, only CO_2 is included in the baseline emission calculations. It should be noted that all operational data is collected by UHE as part of routine operations.

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[12] The Project is located on existing reservoirs which are not increased in size as a result of project implementation. Therefore, methane emissions will not be monitored/determined.

[13] Project hydropower plants will be included in emission reduction calculations from the year that the first hydro unit is rehabilitated.

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

Not applicable

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

Not applicable. There are no project emissions.

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
1	Name of rehabilitated plant and hydro unit number	UHE	Text	m	At the moment of staring operation	100%	electronic	

2	Date rehabilitated hydro unit recommenced operation	UHE	Date	m	At the moment of staring operation	100%	electronic	
3	Power generation by each rehabilitated hydro unit $EG_{pr,HPP,i,y}$	UHE	MWh	m	daily	100%	electronic	Recorded by electricity meter and data is aggregated yearly for each hydro unit. The yearly total for each hydropower plant is double checked by receipt of sale
4	Water flow (m^3/yr) for each HPP, $WF_{HPP,y}$	UHE	m^3	m	tri-monthly	100%	electronic	The water flow is monitored continuously and aggregated tri-monthly. The total water flow for each HPP is also calculated at the end of each year.
5	Historical power generation data for 2002-2005 for each hydro power plant before rehabilitation $EG_{BL, HPP, hist}$	UHE	MWh	M (available ex ante)	Yearly	100%	electronic	This data was used for establishing the historical correlation between water flow and power generation, as well the efficiency of each HPP prior to the Project implementation.
6	Historical water flow for 2002-2005 (m^3/a) for each HPP, $WF_{HPP, hist}$	UHE	m^3	M (available ex ante)	Yearly	100%	electronic	This data was used for establishing the historical correlation between water flow and power generation, as well the efficiency of each HPP prior to the Project implementation.
7	CO_2 emission factor of the grid $EF_{grid,y}$	State Committee of Statistic of Ukraine.	tCO2/MWh	c	Yearly	100%	electronic	Calculated based on the State Committee of Statistic of Ukraine (latest local statistics).

8	Amount of each fossil fuel consumed by grid connected TPPs, $FC_{i,y}$	State Committee of Statistic of Ukraine	Various (mass and volume)	M	Yearly	100%	electronic	Obtained from SCSU (latest local statistics).
9	Carbon emission factor of each fuel type $EF_{C,i}$	IPCC	tCO_2/TJ	M	Yearly	100%	Electronic	IPCC default values used in the absence of official national values.
10	Electricity generation by grid connected TPPs, $EG_{BL,FF,y}$	State Committee of Statistic of Ukraine	MWh	M	Yearly	100%	Electronic	Obtained from SCSU (latest local statistics).

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 emission reductions are to be determined using the following three steps:

1) Determine the Simple OM emission factor of the Ukrainian grid (tCO_2/MWh)
2) Determine the incremental (net) amount of electricity generation (MWh/a) by the Project
3) Determine the amount of baseline emission (tCO_2e/a)

Step 1 - Calculate the Simple OM factor

The Simple OM is defined as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, not including low-operating cost/must-run power plants (Pls. see Section B.1. for further discussion). It is determined *ex post* at the start of each year after the Project is implemented.

Actual data is sourced from the State Committee of Statistic of Ukraine (national statistic form 11- MTP "Report of fuel, electricity and heat use") for aggregate fuel consumption / electricity generation for each generation type on the Ukraine grid. Default IPCC figures are to be used for calorific values and carbon emission factors, for the different fuel types if national values are not available.

In the case that sufficient data cannot be accessed from the State Committee of Statistic of Ukraine to calculate the simple OM *ex post*, the Project will revert to a simple OM factor which has been calculated *ex-ante* based on the most recent 3 years of Ukraine grid data available at the time of the original PDD production (see Annex 3 for data and calculations). [14]

The CO_2 emissions for each fossil fuel are calculated using the following formula:

$$FE_{CO2,i,y} = FC_{i,y} * NCV_i * EF_{C,i} * F_{oxyd} * 44/12, \qquad (1)$$

Where

$FE_{CO2,\ i,\ y}$	CO_2 emission for fuel *i* in year *y*, tCO_2
$FC_{i,y}$	Consumption of fuel *i* in year *y*, thousands tce[15]
NCV_i	Net calorific value of fuel I, TJ/thousands tce
$EF_{C,\ i}$	Carbon emission factor of fuel *I*, tC/TJ
F_{oxyd}	Fraction of Carbon oxidized
44/12	Mass conversion factor, tCO_2/tC

The emission values for all the above types of thermal power plants are tallied to get the total amount of CO_2 emissions for the Ukraine grid in 2007. The total amount of CO_2 emission is divided by the total electricity generated from fossil fuelled plants to calculate the Simple OM emission factor.

The simple OM for the year y is calculated according to the following formula:

$$EF_{gird,y} = \frac{\sum EF_{CO2,i,y}}{\sum EG_{BL,FF,y}}, \qquad (2)$$

Where

$EF_{grid,,y}$	Simple OM emission factor in year *y*, tCO_2
$EF_{CO2,\ i,\ y}$	CO_2 emission for fuel *i* in year *y*, tCO_2

[14] If the data is not available to recalculate the OM, it should be noted that this approach is conservative as the share of coal is expected to increase

[15] 29.308 (TJ/tce) is net calorific value for tonnes of coal equivalent.

$EG_{BL, FF, y}$ Total electricity generated from fossil fuel-based plants in year *y*, TWh

The simple OM is obtained as an average based on the most recent 3 years of Ukraine's grid data.

Step 2 - Determine incremental amount of electricity generation (MWh/a) by the Project

The amount of electricity generation per Project plant per year is determined as the sum of generation by each plant after project implementation in each 10-day/tri-monthly period. The formulae are designed to calculate the incremental generation in MWh by the rehabilitated plants that form the Project.

The baseline generation in year y is determined based on the ex ante developed correlation between the total water flow through each hydropower plant and its power generation at a historical efficiency rate. This correlation is based on historical data from 2002 - 2005. This means in practical terms that, for each tri-monthly (one third of a month) period[16], the total flow of water through each of the plant sites forming the Project and the total kWh generated are used as baseline data. The tri-monthly flow index was calculated using a polynomial trend equation (like that typically found using Excel TREND function). This correlation will be used to define the baseline electricity production for a given tri-monthly flow index. The relationship between the flow index and the correspondent aggregate generation was established, as seen graphically in Annex 2.

Each project year, the baseline generation and the actual generation will be calculated using the tri-monthly flow index in year y and using the measured electricity production for that flow index in the baseline period to determine what the generation of electricity would have been for that period if the hydro plant had not been rehabilitated.

The total baseline electricity generation will simply be a sum of all the tri-monthly and per plant calculations. The formulae used to calculate Baseline Electricity Generation in year y is as follows:

$$EG_{BL,HPP,y} = \sum_{\substack{TRI-MONTHLY,\\ Period\ X=1}}^{36} \left(\sum_{HPP=1}^{\Psi g} EG_{HPP}\ produced\ in\ year\ 0\ at\ Q(index)tri-monthly\ period_{y} \right), \quad (3)$$

[16] The time period of 10 days ("tri-monthly") was selected because unlike a day or hour it should capture all of the various usage peaks that typically fall within a 10 day period (weekend versus weekday). It also is preferable to longer periods such as a month, since an average flow over this longer period would mask the hydrologic variability. Furthermore, the project entity is routinely measuring such data in 10 day periods.

Where

$EG_{BL, HPP, y}$	Total baseline electricity generation by HPP in year *y*, MWh
Y	Given project year being compared to baseline
HPP	Hydro power plant
Ψg	Total number of hydro power plants included in the Project
Q(index)	Total of all generation flows during the tri-monthly period, calculated as demonstrated in Annex 2 and in the separate excel file
Tri-Monthly Period *y*	Tri-monthly period in year *y* (1-36)
Year 0	Baseline period

The total actual generation will be the sum of all the actual tri-monthly figures. These two values will then be compared, to determine the additional electricity generated through the Project.

The formulae used to calculate the total increased electricity generation due to the Project is as follows:

$$EG_{PR,NET,y} = EG_{PR,HPP,y} - EG_{BL,HPP,hist}, \quad (4)$$

Where

$EG_{PR, NET, y}$	Total incremental electricity generation due to the Project in year *y*, MWh
$EG_{PR, HPP, y}$	Total electricity generation by HPP after project implementation in year *y*, MWh
$EG_{BL, HPP, hist}$	Total baseline electricity generation by HPP, MWh

This Project generation data will be replaced with data measured *ex post* as directed in the monitoring plan.

Step 3 - Determine the amount of baseline emission due to increased electricity generation per year (tCO_2)

The baseline emission (the CO_2 displaced by the project) is calculated as follows:

$$CO_{2,BL,y} = EG_{PR,NET,y} * EF_{grid,y}, \quad (5)$$

Where

$CO_{2, BL, y}$	Baseline emissions displaced by the project Total incremental electricity generation due to the Project in year *y*, tCO_2
$EG_{PR, NET, y}$	Total incremental electricity generation due to the Project in year *y*, MWh
$EF_{grid, y}$	Emission factor of the Ukrainian grid, tCO_2/MWh in year *y*, (calculated *ex-ante*)

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

Not applicable

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

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):

$$ER_{PR,NET,y} = CO_{2,BL,y}, \quad (6)$$

Where

$ER_{PR, y}$	Emission reduction due to the Project activity in year *y*, tCO_2
$CO_{2, BL, y}$	Baseline emissions displaced by the project Total increased electricity generation due to the Project in year *y*, tCO_2

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

Not applicable

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

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

Not applicable

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):

The emission reduction of the Project is equal to baseline emissions because the Project itself does not produce any emissions.

$$ER_{PR,NET,y} = CO_{2,BL,y}, \quad (6)$$

Where

$ER_{PR,\ y}$ Emission reduction due to the Project activity in year *y*, tCO_2
$CO_{2,\ BL,\ y}$ Baseline emissions displaced by the project Total increased electricity generation due to the Project in year *y*, tCO_2

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:

Not applicable

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.
1-2	n/a	n/a
3-6	Low	Monitoring is based on relevant national requirements. Sales record to the grid and other records are used for cross-checking. Parameters 5 & 6 are historical data available *ex-ante*. Pls see Annex 3 for details
9	Low	Default factors from IPCCare used.
8,10	Low	Official statistical data from SCSU will be used

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

All monitoring equipment will be installed by experts and regularly calibrated to the highest standards by Project staff based on relevant national requirements. Staff will be trained in the operation of all monitoring equipment and all readings will be taken under the supervision of management. UHE will appoint an executive to be responsible for all data monitoring/acquisition and recording for JI purposes. Please see Annex 3 for details.

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

The baseline study was completed in 31/05/2005 by Clean Energy Finance Committee, Mitsubishi Securities Company Ltd.

Clean Energy Finance Committee
Mitsubishi Securities Company Ltd.
Tokyo, Japan
Tel: (81-3) 6213-6860, E-mail: hatano-junji@mitsubishi-sec.co.jp

Clean Energy Finance Committee, Mitsubishi Securities Company Ltd is not a project participant.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

The Project shall be responsible for zero GHG emissions. Hydropower plants which do not require the construction of a new dam or result in an increase in the area of an existing reservoir are classed as zero emission projects.

E.2. Estimated leakage:

The Project is not responsible for any leakage.

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

The Project is not responsible for any project activity emissions. Project activity emissions are zero due to the fact that there are no anthropogenic emissions or leakage.

E.4. Estimated baseline emissions:

Baseline emission reductions are to be determined using the following three steps:

1) Determine the Simple OM emission factor for the Ukrainian grid (tCO_2/MWh)
2) Determine the incremental amount of electricity generation per year (MWh) by the Project
3) Determine the amount of baseline emission per year (tCO_2)

Step 1 - Calculate the Simple OM factor

The Simple OM is defined as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, not including low-operating cost/must-run power plants (Pls. see Section B.1. for further discussion). It is determined *ex post* at the start of each year after the Project is implemented.

Actual data is sourced from the State Committee of Statistic of Ukraine (national statistic form 11- MTP "Report of fuel, electricity and heat use") for aggregate fuel consumption / electricity generation for each generation type on the Ukraine grid. Default IPCC figures are to be used for calorific values and carbon emission factors, for the different fuel types if national values are not available.

In the case that sufficient data cannot be accessed from the State Committee of Statistic of Ukraine to calculate the simple OM *ex post*, the Project will revert to a simple OM factor which has been calculated based on the most recent 3 years of Ukraine grid data available at the time of the original PDD production (see Annex 3 for data and calculations).

To demonstrate simple OM calculations, Ukraine grid data from 2007 is used:

Table 3: Demonstration of Simple OM calculation for 2007.

Type of Fuel	Fuel consumption (tce)	Electricity generated (TWh)	Fuel consumption (TJ)	Carbon emission factor (tC/TJ)	Oxidation factor	Grid emission (tCO_2)	CEF (tCO_2e/ MWh)
Coal	23,984,018	67.487	702,914	26.8	0.98	67,691,556	
Natural gas	2,532,617		74,225	15.3	0.995	4,143,198	
Fuel oil	82,019		2,404	20	0.99	174,514	
Total			779,543			72,009,269	**1.067**

The CO_2 emission each fossil fuel is calculated using the following formula:

$$EF_{CO2,i,y} = FC_{i,y} * NCV_i * EF_{C,i} * F_{oxyd} * 44/12, \qquad (1)$$

Where

$EF_{CO2,\ i,\ y}$ — CO_2 emission for fuel *i* in year *y*, tCO_2
$FC_{i,y}$ — Consumption of fuel *i* in year *y*, thousands tce
NCV_i — Net calorific value of fuel *i*, TJ/thousands tce
$EF_{C,\ i}$ — Carbon emission factor of fuel *i*, tC/TJ
F_{oxyd} — Fraction of Carbon oxidized
44/12 — Mass conversion factor, tCO_2/tC

The calculation for CO_2 emission for the natural gas consumption (tCO_2) appears below. The calculated value represents the grid CO_2 emission from natural gas for the 2007 Ukraine grid:

$FE_{CO2,\ NG,\ 2007}$ = 2,532,617 (tce/a) * 29.3076 (TJ/ktce) * 15.3 (tC/TJ) * 0.995 * 44/12 = 4,143,198 tCO_2

The above calculation is repeated to obtain the CO_2 emissions (tCO_2/a) for coal, other solid fuel, oil and other oil.

The emission values for all the above types of thermal power plants are tallied to get the total amount of CO_2 emissions for the Ukraine grid in 2007. The total annual amount of CO_2 emission is divided by the total annual electricity generated from fossil fuelled plants to calculate the Simple OM emission factor for the year y.

The simple OM emission factor for the year y is calculated according to the following formula:

$$EF_{gird,y} = \frac{\sum EF_{CO2,i,y}}{\sum EG_{BL,FF,y}}, \qquad (2)$$

Where

$EF_{grid,,y}$ — Simple OM emission factor in year *y*, tCO_2

$EF_{CO2, i, y}$ CO_2 emission for fuel *i* in year *y*, tCO_2
$EG_{BL, FF, y}$ Total electricity generated from fossil fuel-based plants in year *y*, TWh

The Simple OM emission factor for 2007 is calculated as:

$$EF_{grid, 2007} = 72{,}009{,}269 tCO_2/a \,/\, 67.487 TWh = 1.067\ tCO_2/MWh$$

The Simple OM emission factor is 1.069 tCO_2/MWh. It was calculated based on the most recent 3 years of Ukraine's grid data.

Table 4: Simple OM emission factor for the period 2005-2007.

	2005	2006	2007	Average
Simple OM emission factor, tCO_2/MWh	1.057	1.084	1.067	**1.069**

Step 2 - Determine the total amount of electricity generation (MWh/a) by the Project

The amount of electricity generation per Project plant per year is determined as the sum of generation by each plant after project implementation in each 10-day/tri-monthly period. The formulae are designed to calculate the incremental generation in MWh by the rehabilitated plants that form the Project.

The baseline generation is determined based on data from period 2005 - 2007 and calculation as explained in section D.1.1.4.

The total baseline electricity generation will simply be a sum of all the tri-monthly and per plant calculations. The formulae used to calculate Baseline Electricity Generation in year y is as follows:

$$EG_{BL,HPP,y} = \sum_{\substack{TRI-MONTHLY,\\ Period\ X=1}}^{36} \left(\sum_{HPP=1}^{\Psi g} EG_{HPP}\ produced\ in\ year\ 0\ at\ Q(index) tri-monthly\ period_y \right), (3)$$

Where

$EG_{BL, HPP, y}$	Total baseline electricity generation by HPP in year *y*, MWh
Y	Given project year being compared to baseline
HPP	Hydro power plant
Ψg	Total number of hydro power plants included in the Project
Q(index)	Total of all generation flows during the tri-monthly period, calculated as demonstrated in Annex 3 and in the separate excel file
Tri-Monthly Period *y*	Tri-monthly period in year *y* (1-36)
Year 0	Baseline period

The total actual generation will be the sum of all the actual tri-monthly figures. These two values will then be compared, to determine the additional electricity generated through the Project.

The formulae used to calculate the Project electricity generation is as follows:

$$EG_{PR,NET,y} = EG_{PR,HPP,y} - EG_{BL,HPP,hist}, \qquad (4)$$

Where

$EG_{PR,\ NET,\ y}$	Total increased electricity generation due to the Project in year *y*, MWh
$EG_{PR,\ HPP,\ y}$	Total electricity generation by HPP after project implementation in year *y*, MWh
$EG_{BL,\ HPP,\ hist}$	Total baseline electricity generation by HPP, MWh

For the purpose of ER estimation in the PDD increased power generation due to the Project is assumed as follows:

Table 5: Incremental electricity generation due to the Project activity

Year	Generation, $EG_{PR,\ NET,\ y}$(MWh)
2008	93,000
2009	136,000
2010	202,000
2011	251,000
2012	338,000

In addition, the Project is expected to generate 21,000 MWh of electricity in 2007.

This Project generation data will be replaced with data measured *ex post* as directed in the monitoring plan.

<u>Step 3 - Determine the amount of baseline emission due to incremental electricity generation (tCO_2)</u>

Lastly, the baseline emission (the CO_2 displaced by the project) is calculated.

$$CO_{2,BL,y} = EG_{PR,NET,y} * EF_{grid,y}, \qquad (5)$$

Where

$CO_{2,\ BL,\ y}$	Baseline emissions displaced by the project Total incremental electricity generation due to the Project in year *y*, tCO_2
$EG_{PR,\ NET,\ y}$	Total incremental electricity generation due to the Project in year *y*, MWh
$EF_{grid,\ y}$	Emission factor of the Ukrainian grid, tCO_2/MWh in year *y*, (calculated *ex-ante*)

The total amount of predicted baseline emissions from the Project for 2008 – 2012 are shown in the table below:

Table 6: Estimates for the baseline emissions.

Year	Increased generation due to Project, $EG_{PR, NET, Y}$ (MWh)	Baseline emissions $CO2_{, BL,}$(tCO_2e)
2008	93,000	99,417
2009	136,000	145,384
2010	202,000	215,938
2011	251,000	268,319
2012	338,000	361,322
Total	1,020,000	1,090,380

In addition, the Project is expected to generate 22,449 t of Emission Reductions in 2007.

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

The emission reduction of the Project is equal to baseline emissions because the Project itself does not produce any emissions.

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

Table 7: Estimates of the emission reduction for 2007, 2008 - 2012

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)
2007	0	0	22,449	22,449
Total (tonnes of CO_2 equivalent)	0	0	22,449	22,449

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)
2008	0	0	99,417	99,417
2009	0	0	145,384	145,384
2010	0	0	215,938	215,938
2011	0	0	268,319	268,319
2012	0	0	361,322	361,322
Total (tonnes of CO_2 equivalent)	0	0	1,090,380	1,090,380

SECTION F. Environmental impacts

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

The Hydropower Rehabilitation Project is in full compliance with all environmental requirements of the Government of the Ukraine and the World Bank. In accordance with the World Bank Environmental Assessment safeguard policy and procedures (OP/BP/GP 4.01) the project has been assigned Category B and an Environmental Management Plan (EMP) has been prepared.

The Project will not adversely affect the quality or quantity of water flows to the other riparians; and the Project will not be adversely affected by other riparians' water use.

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:

UHE's capacity for implementing the requirements of the EMP was reviewed by the Bank and found to be highly adequate, having benefited from the experience gained in the first hydropower project. All environmental issues for both the project implementation and operation phases are minor, of limited duration and extent and readily managed. As part of the Project, UHE will implement dam safety measures agreed with the World Bank.

SECTION G. Stakeholders' comments

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

UHE (the project implementation agency) provided an English language version of the EMP acceptable to the World Bank on March 9, 2005 and disclosed Ukrainian language versions of the EMP at each of the nine subproject sites from March 4 to 9, 2005. The World Bank provided the English language version to the World Bank Infoshop on March 9, 2005. Prior to disclosure, public consultations were held at each of the nine subproject sites. Project approval by the Ukrainian environmental authorities (State Ecological Expertise) is also presented in the EMP.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Open Joint Stock Company "Ukrhydroenergo"
Street/P.O.Box:	
Building:	
City:	Vyshgorod
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Phone:	+38 (04496) 2-20-06, 2-22-93
Fax:	
E-mail:	postmaster@ukrhydroenergo.org
URL:	www.ukrhydroenergo.org
Represented by:	
Title:	Chief of the Board
Salutation:	Mr.
Last name:	Potashnyk
Middle name:	
First name:	Semen
Department:	
Phone (direct):	+38 (044) 226-28-38; (04496) 2-20-06
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Mobile:	
Personal e-mail:	kanc@ges.kv.energy.gov.ua

Organisation:	International Bank for Reconstruction and Development (IRBD) as Trustee for the Netherlands European Carbon Facility
Street/P.O.Box:	1818 H street, NW
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Fax:	+1-202-522-7432
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URL:	www.carbonfinance.org
Represented by:	
Title:	Manager, Carbon Finance Unit
Salutation:	Mrs
Last name:	Chassard
Middle name:	
First name:	Joelle
Department:	Environment
Phone (direct):	
Fax (direct):	
Mobile:	
Personal e-mail:	

Annex 2

BASELINE INFORMATION

A. Supporting arguments for the selected approach for baseline emission calculation (Operating Margin only)

The Operating Margin (OM) is deemed to best represent what would occur in the absence of the Project as far as calculation of ER is concerned. The Project will not affect the build margin due to the large excess installed thermal capacity of the Ukraine grid. The excess capacity is over 43%; peak demand is about 28 GW compared to a total installed capacity of 55 GW (the State Committee of Statistic of Ukraine). The project's expected electricity generation (420 GWh per year) consist only 0.25% of the entire Ukrainian power generation system (182,200 GWh in 2004 year). It is therefore inconceivable that the Project would have any impact on the Ukrainian power sector development trend. Capacity additions have been very few in the past and, given the large excess capacity in the system, little are planned for the future. The use of 100% weighting of OM was accepted by SGS in original Determination report in 2006 based e.g. on the fact the Ukrainian system is drastically overbuilt.[17]

B. Supporting arguments for the exclusion of must-run low-cost

Electricity demand is increasing in Ukraine, and it is likely that the share of must-run sources will decrease below 50% in the future as there is no significant new hydro or nuclear capacity available. It is unlikely that the Project would replace must-run generation.

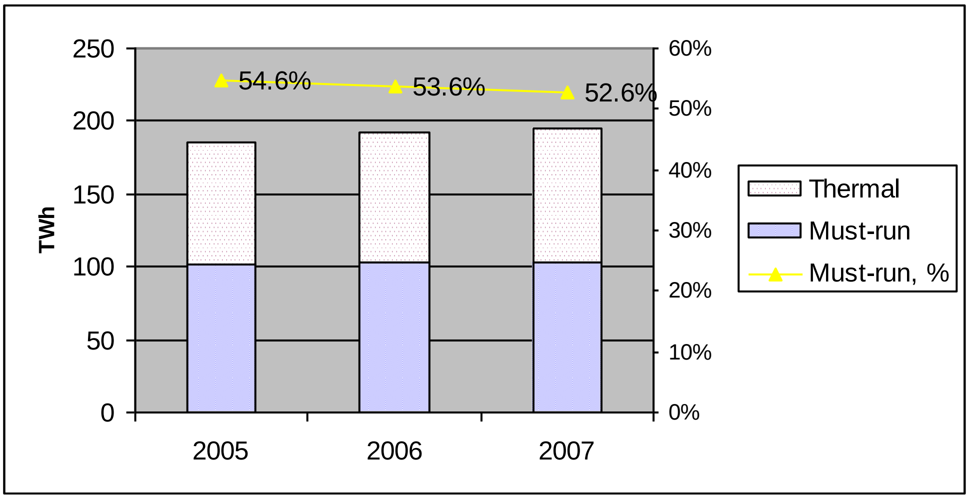


Figure 1: Electricity generation in Ukraine and share of must-run sources (source: NPC "Ukrenergo", www.urkenergo.energy.gov.ua)

Furthermore, based on recent 2006 and 2007 data, it is demonstrated that must-run sources are never on the margin. Table 7 based demonstrates the following based on 2007 data:

[17] SGS, 2006, Determination Report, UkrHydroEnergo Hydropower Rehabiliation Project in Ukraine

(i) Combined **maximum** nuclear and hydro production capacity (15694 MW in January) would not meet the minimum demand (16022 in July)
(ii) Thermal Plants are always present, even during the minimum demand

Therefore it can be concluded that a new hydro plant would never replace must-run sources. According to the principles of the calculation of the Simple Adjusted OM emission factor for the grid, the λ calculated based on the requirements of *Tool to calculate the emission factor for an electricity system* would be equal to zero. Given this fact, the value of Simple Adjusted OM emission factor would be identical to the Simple OM emission factors calculated below in Tables 9 to 13.

Table 8: Minimum (July) and maximum (January) demand and the role of different sources in Ukrainian Grid in 2007 (Source: NPC "Ukrenergo")

2007	**JANUARY**		**JULY**			
	Actual balance per day of MAX capacity consumption during evening peak load		Actual balance per day of MAX capacity consumption during evening peak load		Actual balance per day of MIN capacity consumption during evening dip load	
	30-Jan-07		24-Jul-07		01-Jul-07	
	min	max	min	max	min	max
Hours:	03:00	18:00	03:00	22:00	05:00	22:00
Consumption, MWh	20596	27679	17618	22253	16022	19682
Pumping by Hydro-accumulative PPs, MWh	134	0	311	0	265	0
Generation, MWh	21959	29559	18728	23580	16922	20598
Nuclear, MWh	12144	12119	10135	10068	10411	10394
TPP, MWh	9712	13865	8543	12232	6462	8095
Hydro PP, MWh	103	3350	50	983	49	1850
Hydro-accumulative PPs, MWh	0	225	0	297	0	259
External power flow, MWh	-1229	-1880	-799	-1327	-635	-916

C. Simple OM calculations

To demonstrate Simple OM calculations, Ukraine grid data from 2005-2007 is used.

Table 9: Electricity production by Ukrainian TPPs and fuel consumption, 2005-2007 years

Type of Fuel	*2005*	*2006*	*2007*
For general use TPPs electricity production (Ministry of Fuel and Energy annual report data), MWh	55,756	63,581	67,487
Fuel oil, tce*	80,557	146,352	82,019
Natural gas, tce	3,424,145	1,953,662	2,532,617
Coal, tce	18,815,180	23,181,898	23,984,018
Others Solid Fuel, tce	21,027	0	0

*Tonne of coal equivalent

Table 10: Fuel consumption, TJ (tce to GJ conversion factor is 29.3076 = 7Mcal/tce * 4.1868 J/cal)

Type of Fuel	*2005*	*2006*	*2007*
Fuel oil	2,361	4,289	2,404
Natural gas	100,353	57,257	74,225
Coal	551,428	679,406	702,914
Others Solid Fuel	616	0	0
Total	***654,758***	***740,952***	***779,543***

Table 11: IPCC (2006) carbon emission factors for fossil fuels are used for CO_2 emissions calculation

Type of Fuel	Carbon emission factor, (tC/TJ)	Oxidation factor
Fuel oil	20	0.99
Natural gas	15.3	0.995
Coal	26.8	0.98
Others Solid Fuel	25.8	0.98

Table 12: CO_2 emissions for the Ukraine grid, tCO_2

Type of Fuel	*2005*	*2006*	*2007*
Fuel oil	171,404	311,398	174,514
Natural gas	5,601,681	3,196,065	4,143,198
Coal	53,103,229	65,427,684	67,691,556
Others Solid Fuel	57,131	0	0
Total CO_2 emission	58,933,445	68,935,147	72,009,269

Table 13: Total amount of CO_2 emission is divided by the total electricity generated from fossil fuelled plants to calculate the Simple OM emission factor for Ukrainian grid.

	2005	*2006*	*2007*	**Average**
Total CO_2 emission	58,933,445	68,935,147	72,009,269	
For general use TPPs electricity production, MWh	55,756	63,581	67,487	
Simple OM emission factor tCO_2/MWh	1.057	1.084	1.067	**1.069**

The final OM emission factor is calculated as the average OM emission factor based on 2005, 2006 and 2007 data is **1.069 tCO_2/MWh.**

D. Calculation of incremental electricity production and ERs

The following section demonstrates the calculation of ER based on historic electricity generation

Table 14: Commissioning year and rehabilitation schedule for hydro units (number of hydro units to be rehabilitated per plant)

Years	Comm. date	2007	2008	2009	2010	2011	2012
Plant names							
Kyiv HPP	1971-1972	0	2	2	2	2	0
Kyiv PSPP	1964-1968	0	0	0	1	1	1
Kaniv HPP	1972-1975	0	2	2	2	2	2
Kremenchuk HPP	1959-1960	0	0	1	1	1	1
Dniprodzerzhynsk HPP	1963-1964	1	0	1	2	1	1
Dnipro HHP	1932-1950	0	0	1	2	2	2
Kakhovka HHP	1955-1956	1	0	1	1	0	0
Dnistro HHP	1981-1983	0	0	0	0	0	1
Total		2	4	8	11	9	8

Table 15: Predicted increased generation by the Project (GWh) in 2007 to 2012.

Years	2007	2008	2009	2010	2011	2012
Plant names						
Kyiv HPP	0	32	38	46	58	58
Kyiv PSPP	0	0	0	12	17	22
Kaniv HPP	0	40	46	56	62	78
Kremenchuk HPP	0	0	10	18	24	34
Dniprodzerzhynsk HPP	10	10	18	26	32	42
Dnipro HHP	0	0	10	26	40	60
Kakhovka HHP	11	11	14	18	18	18
Dnistro HHP	0	0	0	0	0	26
Total	21	93	136	202	251	338

See the following samples of data sets, ER calculations and trend lines for 3 project sites (note: for presentation purposes some lines of the excel sheets have been hidden):

Table 16: Data on water flow in 2002-2005.-

Data on water flow in 2002-2005 simple OM = 0.915

Month	day	Year	Kyiv HPP: Q (thousand m^3)	Kyiv HPP: Electricity production (thousand kWh)	Kaniv HPP: Q (thousand m3)	Kaniv HPP: Electricity production (thousand kWh)	Krem HPP: Q (thousand m3)	Krem HPP: Electricity production (thousand kWh)
January	1-10	2002	534,816	13,404	711,936	18,349	858,816	28,344
		2003	394,848	9,921	565,056	15,397	723,168	23,867
		2004	508,540	12,221	591,186	15,618	735,298	24,816
		2005	896,718	21,894	1,069,239	27,258	1,189,930	40,398
	11-20	2002	562,464	14,062	648,000	17,234	876,096	28,537
		2003	451,008	11,136	572,832	15,399	908,928	29,899
		2004	400,927	9,660	589,930	15,881	850,222	28,407
		2005	1,426,877	33,864	1,690,796	39,502	1,734,457	57,340
	21-31	2002	608,256	14,908	848,707	22,572	1,211,760	39,089
		2003	429,408	10,682	623,462	17,223	869,616	28,700
		2004	607,729	14,728	824,946	21,487	1,149,131	37,712
		2005	922,439	24,093	1,389,860	33,604	1,373,540	46,310
February	1-10	2002	857,088	21,007	1,118,880	28,912	1,099,872	35,480
		2003	405,216	10,130	543,456	14,930	755,136	24,517
		2004	622,031	15,898	853,463	22,107	1,185,988	38,611
		2005	457,588	11,226	609,616	15,560	916,785	31,072
	11-20	2002	1,409,184	33,157	1,772,928	40,945	1,405,728	45,939
		2003	482,976	12,014	592,704	16,194	707,616	22,826
		2004	942,355	21,025	1,142,039	28,151	1,379,057	44,119
		2005	695,737	16,486	878,600	21,512	1,126,349	37,670
	21-28	2002	1,614,816	36,868	1,455,667	33,464	1,179,187	33,123
		2003	472,608	11,698	472,090	12,969	709,171	22,730
		2004	849,911	19,760	1,140,815	27,147	1,245,969	39,803
		2005	732,092	14,579	819,113	20,295	1,398,002	45,227
November	1-10	2002	602,208	15,441	785,376	19,684	1,093,824	37,718
		2003	776,736	19,179	964,224	23,460	1,369,440	47,883
		2004	534,065	13,569	674,950	17,318	1,155,262	40,993
		2005	470,944	12,051	617,367	16,166	961,670	34,147
	11-20	2002	730,944	18,412	896,832	22,762	965,088	33,051
		2003	786,240	19,366	989,280	24,247	1,426,464	49,530
		2004	522,975	13,260	648,385	16,900	1,265,725	44,357
		2005	477,138	12,018	646,450	16,825	858,294	30,212
	21-30	2002	654,912	16,373	903,744	22,880	1,311,552	44,309
		2003	729,216	17,529	950,400	23,180	1,393,632	47,727
		2004	598,357	15,076	767,140	19,773	1,006,371	34,729
		2005	363,604	10,946	607,676	15,892	1,000,018	34,905
December	1-10	2002	552,096	13,700	711,072	18,140	1,068,768	35,626
		2003	682,560	16,689	906,336	22,658	1,444,608	48,804
		2004	470,877	11,817	587,251	15,372	910,234	31,870
		2005	510,307	12,815	766,626	19,828	1,007,619	34,702
	11-20	2002	316,224	7,985	385,344	10,443	727,488	24,331
		2003	687,744	16,693	882,144	22,220	1,325,376	44,327
		2004	709,566	17,969	860,938	21,973	1,185,877	40,670
		2005	608,020	15,354	923,048	23,446	1,131,754	38,801
	21-31	2002	376,704	9,347	564,538	15,176	975,110	32,288
		2003	620,352	15,057	856,310	21,957	1,198,454	39,684
		2004	816,413	21,971	941,851	24,400	1,131,092	38,754
		2005	538,455	14,883	783,834	20,207	1,129,456	38,817
Total	I	2002	8,482,752	209,842	11,296,800	267,269	11,913,696	427,685
		2003	7,998,912	197,204	10,717,056	258,323	11,030,688	392,615
		2004	10,370,532	244,629	13,687,367	309,147	15,098,846	538,538
		2005	11,702,625	277,779	14,659,523	338,257	14,531,459	518,450
	II	2002	8,817,984	215,436	11,258,784	265,019	11,890,368	425,817
		2003	7,632,576	190,159	10,440,576	253,288	11,759,904	415,252
		2004	10,818,243	251,159	14,441,812	315,683	14,970,335	533,440
		2005	12,508,423	294,342	15,852,685	361,909	16,401,940	579,848
	III	2002	8,278,848	203,541	10,889,338	260,688	12,288,154	431,829
		2003	8,025,696	196,825	11,209,190	270,633	11,805,350	416,274
		2004	11,296,594	275,759	15,018,610	341,041	16,116,974	575,213
		2005	11,312,890	282,465	15,346,346	353,073	17,144,165	604,542
Total		2002	25,579,584	628,819	33,444,922	792,976	36,092,218	1,285,331
		2003	23,657,184	584,187	32,366,822	782,244	34,595,942	1,224,141
		2004	32,485,370	771,547	43,147,790	965,872	46,186,155	1,647,191
		2005	35,523,938	854,585	45,858,554	1,053,239	48,077,564	1,702,839

Table 17: Calculation example of estimated ERs in 2008

Determination of emission reductions in 2008 year

!!! Yellow mark for example value

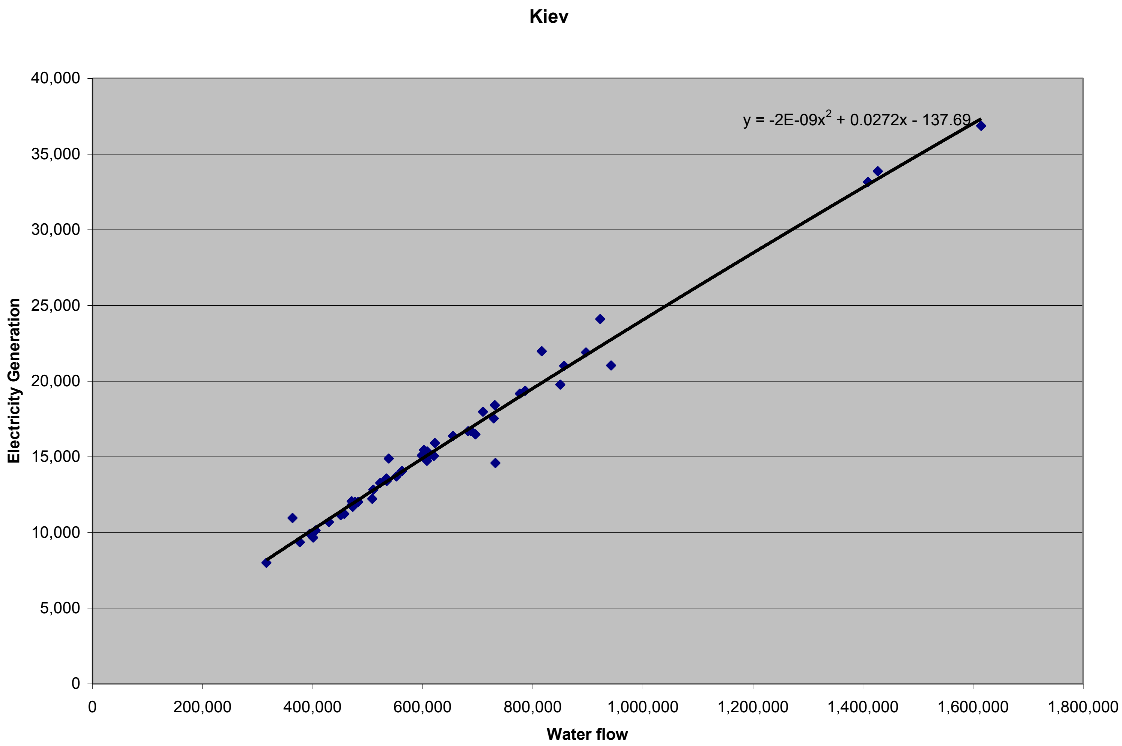
HPP	Water flow (m^3/yr)	Baseline electricty (MWh/yr)	After rehab gen. (MWh/yr)	Final project gen. (MWh/yr)	Emission reductions (tCO2/yr)
Kyiv HPP	35,523,938	841,254	966,000	124,746	114,183
Kaniv HPP	45,858,554	1,038,369	1,119,000	80,631	73,803
Krem HPP	48,077,564	1,701,995	1,776,000	74,005	67,738
DndzHPP	0	0	0	0	0
DniproHPP	50,045,301	4,310,265	4,449,500	139,235	127,445
Kakh HPP	45,759,600	1,645,561	1,715,000	69,439	63,559
Dnist HPP			0	0	0
				Total	*446,729*

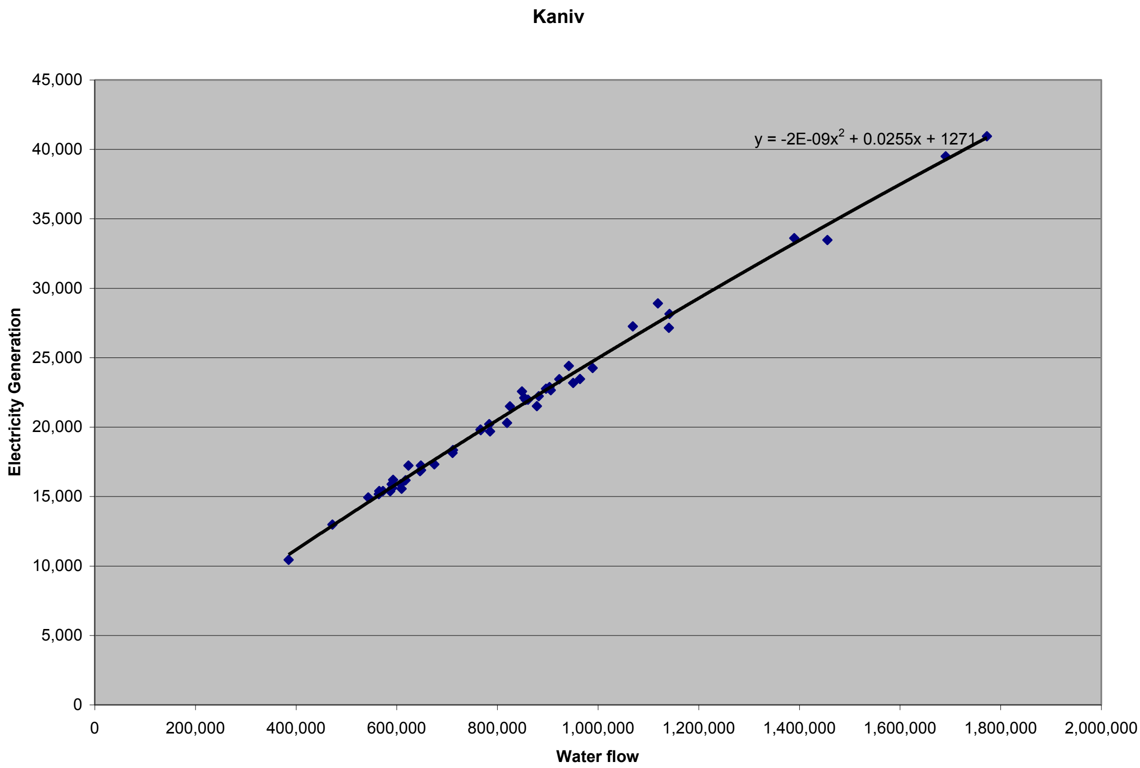
		Kyiv HPP				
Month	Day	measured outflow, m^3	Baseline electricity (thousand kWh/Tri-Monthly) *calculated by determining the actual Tri-Monthly flow index*	After rehab generation (thousand kWh/Tri-Monthly)	Final project gen. (thousand kWh/Tri-Monthly)	Emission reductions (tCO2/Tri-Monthly)
January	1-10	896,718	21,462	25,000	3,538	3,238
	11-20	1,426,877	32,682	35,000	2,318	2,122
	21-31	922,439	22,007	25,000	2,993	2,740
February	1-10	457,588	12,169	20,000	7,831	7,168
	11-20	695,737	17,209	20,000	2,791	2,555
	21-29	732,092	17,978	20,000	2,022	1,850
March	1-10	917,774	21,908	23,000	1,092	1,000
	11-20	1,155,232	26,933	28,000	1,067	977
	21-31	1,278,356	29,539	30,000	461	422
April	1-10	2,024,602	45,331	45,000	-331	-303
	11-20	2,120,937	47,370	45,000	-2,370	-2,169
	21-30	1,821,158	41,026	45,000	3,974	3,638
May	1-10	1,909,492	42,895	45,000	2,105	1,927
	11-20	2,121,029	47,372	50,000	2,628	2,406
	21-31	2,344,316	52,097	55,000	2,903	2,657
June	1-10	1,777,821	40,109	45,000	4,891	4,477
	11-20	1,517,349	34,596	40,000	5,404	4,946
	21-30	1,250,612	28,952	38,000	9,048	8,282
July	1-10	1,135,753	26,521	30,000	3,479	3,185
	11-20	898,914	21,509	25,000	3,491	3,196
	21-31	570,237	14,553	20,000	5,447	4,986
August	1-10	625,412	15,721	18,000	2,279	2,086
	11-20	653,718	16,320	18,000	1,680	1,538
	21-31	641,469	16,061	18,000	1,939	1,775
September	1-10	572,342	14,598	17,000	2,402	2,199
	11-20	473,757	12,511	15,000	2,489	2,278
	21-30	381,097	10,551	12,000	1,449	1,327
October	1-10	403,871	11,032	17,000	5,968	5,462
	11-20	359,715	10,098	17,000	6,902	6,318
	21-31	469,056	12,412	17,000	4,588	4,200
November	1-10	470,944	12,452	20,000	7,548	6,909
	11-20	477,138	12,583	20,000	7,417	6,789
	21-30	363,604	10,180	20,000	9,820	8,988
December	1-10	510,307	13,285	15,000	1,715	1,570
	11-20	608,020	15,353	18,000	2,647	2,423
	21-31	538,455	13,881	15,000	1,119	1,025
Total		**35,523,938**	**841,254**	**966,000**	**124,746**	**114,183**

		Kaniv HPP				
Month	Day	measured outflow, m3	Baseline electricity (thousand kWh/Tri-Monthly) calculated by determining the actual Tri-Monthly flow index	After rehab generation (thousand kWh/Tri-Monthly)	Final project gen. (thousand kWh/Tri-Monthly)	Emission reductions (tCO2/Tri-Monthly)
January	1-10	1,069,239	24,846	30,000	5,154	4,718
	11-20	1,690,796	36,991	40,000	3,009	2,755
	21-31	1,389,860	31,110	35,000	3,890	3,560
February	1-10	609,616	15,865	20,000	4,135	3,785
	11-20	878,600	21,121	25,000	3,879	3,551
	21-29	819,113	19,958	22,000	2,042	1,869
March	1-10	1,099,039	25,428	28,000	2,572	2,354
	11-20	1,522,404	33,700	38,000	4,300	3,936
	21-31	1,715,820	37,479	40,000	2,521	2,307
April	1-10	2,402,078	50,889	52,000	1,111	1,017
	11-20	2,710,771	56,920	57,000	80	73
	21-30	2,595,386	54,666	55,000	334	306
May	1-10	2,381,811	50,493	52,000	1,507	1,380
	11-20	2,625,738	55,259	57,000	1,741	1,594
	21-31	2,768,450	58,047	60,000	1,953	1,787
June	1-10	2,270,983	48,327	50,000	1,673	1,531
	11-20	1,860,014	40,297	42,000	1,703	1,559
	21-30	1,620,738	35,622	38,000	2,378	2,177
July	1-10	1,390,048	31,114	32,000	886	811
	11-20	1,182,028	27,049	30,000	2,951	2,701
	21-31	1,043,024	24,333	25,000	667	610
August	1-10	883,126	21,209	22,000	791	724
	11-20	802,871	19,641	20,000	359	329
	21-31	928,517	22,096	25,000	2,904	2,658
September	1-10	682,857	17,296	17,000	-296	-271
	11-20	540,487	14,514	15,000	486	445
	21-30	471,651	13,169	14,000	831	761
October	1-10	486,734	13,464	17,000	3,536	3,237
	11-20	469,478	13,127	17,000	3,873	3,545
	21-31	602,277	15,721	17,000	1,279	1,170
November	1-10	617,367	16,016	20,000	3,984	3,646
	11-20	646,450	16,585	20,000	3,415	3,126
	21-30	607,676	15,827	20,000	4,173	3,820
December	1-10	766,626	18,933	20,000	1,067	977
	11-20	923,048	21,989	25,000	3,011	2,756
	21-31	783,834	19,269	22,000	2,731	2,500
Total		**45,858,554**	**1,038,369**	**1,119,000**	**80,631**	**73,803**

		Krem HPP				
Month	Day	measured outflow, m3	Baseline electricity (thousand kWh/Tri-Monthly) calculated by determining the actual Tri-Monthly flow index	After rehab generation (thousand kWh/Tri-Monthly)	Final project gen. (thousand kWh/Tri-Monthly)	Emission reductions (tCO2/Tri-Monthly)
January	1-10	1,189,930	42,231	43,000	769	704
	11-20	1,734,457	61,109	64,000	2,891	2,646
	21-31	1,373,540	48,597	50,000	1,403	1,284
February	1-10	916,785	32,762	35,000	2,238	2,049
	11-20	1,126,349	40,027	45,000	4,973	4,552
	21-29	1,398,002	49,445	52,000	2,555	2,339
March	1-10	1,194,830	42,401	48,000	5,599	5,125
	11-20	1,829,670	64,410	68,000	3,590	3,286
	21-31	2,286,865	80,261	84,000	3,739	3,423
April	1-10	1,630,333	57,500	59,000	1,500	1,373
	11-20	1,539,399	54,347	55,000	653	598
	21-30	1,190,627	42,256	44,000	1,744	1,597
May	1-10	1,636,288	57,706	59,000	1,294	1,184
	11-20	2,372,775	83,239	85,000	1,761	1,612
	21-31	2,675,231	93,725	96,000	2,275	2,083
June	1-10	1,940,230	68,243	70,000	1,757	1,608
	11-20	2,040,098	71,706	75,000	3,294	3,016
	21-30	2,184,472	76,711	78,000	1,289	1,180
July	1-10	1,494,243	52,781	55,000	2,219	2,031
	11-20	1,312,022	46,464	50,000	3,536	3,236
	21-31	1,293,722	45,830	47,000	1,170	1,071
August	1-10	1,065,657	37,923	40,000	2,077	1,901
	11-20	889,395	31,812	32,000	188	172
	21-31	993,989	35,438	37,000	1,562	1,429
September	1-10	814,995	29,233	32,000	2,767	2,533
	11-20	772,269	27,752	30,000	2,248	2,058
	21-30	590,457	21,448	22,000	552	505
October	1-10	678,879	24,514	25,000	486	445
	11-20	795,459	28,556	30,000	1,444	1,322
	21-31	1,027,788	36,610	40,000	3,390	3,103
November	1-10	961,670	34,318	36,000	1,682	1,540
	11-20	858,294	30,734	32,000	1,266	1,159
	21-30	1,000,018	35,647	37,000	1,353	1,238
December	1-10	1,007,619	35,911	37,000	1,089	997
	11-20	1,131,754	40,214	42,000	1,786	1,634
	21-31	1,129,456	40,135	42,000	1,865	1,707
Total		**48,077,564**	**1,701,995**	**1,776,000**	**74,005**	**67,738**

Figures below demonstrate the historical correlation between the water flow and electricity generation for different plants as examples.





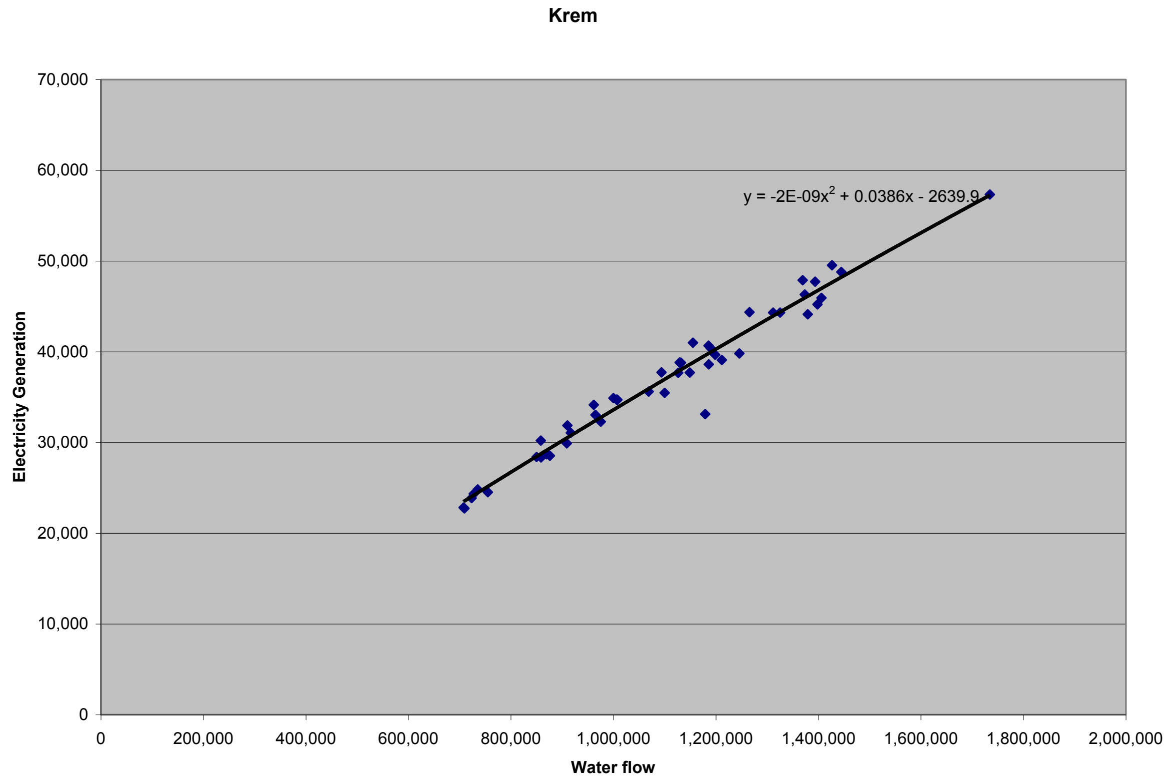

Krem
y = -2E-09x2 + 0.0386x - 2639.9
Electricity Generation
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
1,600,000
1,800,000
2,000,000
Water flow

Table 18: Data on the technical details of the rehabilitation of each power plant covered by the project

Power Plant	**Details of the Rehabilitation of Each Plant**
Kyiv HPP	- Installation of nonpolluting runners and guide vanes - rehabilitation of the stators and rotors of generators and speed governors - switch of generator voltage to 6,3 kV - reconstruction of excitation systems and control systems - installation generator switches
Kaniv HPP	- Installation guide vanes, nonpolluting runners, generators and speed governors - reconstruction of servomotors' guide vanes and runners - reconstruction of the cooling compressor
Kremenchuk HPP	Installation of: - nonpolluting runners - guide vanes - runner chamber - oil receiver - stator - stator and rotor winding of generators - speed governors - excitation system
Dniprodzerzhynsk HPP	Installation of: - runner chamber - nonpolluting runners - stator and rotor winding of generators Rehabilitation of: - turbine spindle - turbine bearing - oil receiver
Dnipro HPP	Installation of: - nonpolluting runners - guide vanes - kinematics

	- turbine bearing - turbine feedback system - speed governors - excitation system - slowdown systems - control system and relay protection - electric current transformers 13.8 kW - voltage transformers 13.8 kW
Kakhovka HPP	Installation of: - nonpolluting runners - speed governors - control system and relay protection - excitation system - reconstruction of guide vanes - turbine spindle - turbine coverage - reconstruction of technical water system supply

Table 19: UHE hydro units composition/types

Name of HPP	# HU	Capacity, MW	Technical type of HU	Run-of-river or reservoirs type
Kyiv HPP	HU1	16.3	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU2	16.3	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU3	16.3	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU4	16.3	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU5	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU6	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU7	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU8	18.5	ПЛ-15-984Г-600, СГК-538-160/70	Run-of-river
	HU9	18.5	ПЛ-15-984Г-600, СГК-538-160/70	Run-of-river
	HU10	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU11	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU12	18.5	ПЛ-15-984Г-600, СГК-538-160/70	Run-of-river
	HU13	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU14	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU15	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU16	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU17	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU18	18.5	ПЛ-15-984Г-600, СГК-538-160/70	Run-of-river
	HU19	18.5	ПЛ-15-/3251-ГК-600, СГК-538-160/70М	Run-of-river
	HU20	18.5	ПЛ-15-984Г-600, СГК-538-160/70	Run-of-river
	Total	**361.2**	**Planned rehabilitation – 8 units**	

Kaniv HPP	HU1	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU2	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU3	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU4	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	HU5	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	HU6	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU7	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	HU8	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU9	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU10	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU11	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU12	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU13	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU14	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU15	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU16	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU17	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	HU18	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU19	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU20	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU21	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU22	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	HU23	18.5	ПЛ-15-984-Г-600, СГК-2-538-160/70	Run-of-river
	HU24	18.5	ПЛ-15-3521-ГК-600, СГК-2-538-160/70М	Run-of-river
	Total	**444.0**	**Planned rehabilitation – 13 units**	
Kremenchuk HPP	HU1	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU2	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU3	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU4	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU5	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU6	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU7	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU8	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU9	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU10	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU11	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	HU12	52.08	ПЛ-661-ВБ-800, СВКр-1340/150-96	Run-of-river
	Total	**625.0**	**Planned rehabilitation – 7 units**	

Dniprodzerzhynsk HPP	HU1	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU2	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU3	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU4	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU5	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU6	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU7	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	HU8	44	ПЛ-661-ВБ-930, СВ-1500/110-116	Run-of-river
	Total	**352**	**Planned rehabilitation – 5 units**	
Dnipro HPP	HU1	65	F-193, AT-1-72	Run-of-river
	HU2	65	F-193, AT-1-72	Run-of-river
	HU3	65	F-193, AT-1-72	Run-of-river
	HU4	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU5	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU6	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU7	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU8	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU9	65	PO-45-B-545, CB-1160/180-72M	Run-of-river
	HU10	2	PO-123, ATI-V	Run-of-river
	HU11	100.8	ПЛ40-В-680, СВ1230/140-56	Run-of-river
	HU12	100.8	ПЛ40-В-680, СВ1238/145-56	Run-of-river
	HU13	112.5	ПР40-В-680, СВ1230/140-56	Run-of-river
	HU14	112.5	ПР40-В-680, СВ1230/140-56	Run-of-river
	HU15	112.5	ПР40-В-680, СВ1238/145-56	Run-of-river
	HU16	112.5	ПР40-В-680, СВ1230/140-56	Run-of-river
	HU17	112.5	ПР40-В-680, СВ1230/140-56	Run-of-river
	HU18	112.5	ПР40-В-680, СВ1230/140-56	Run-of-river
	Total	**1463.6**	**Planned rehabilitation – 10 units**	
Kakhovka HPP	HU1	50	ПЛ20-В-800, СВК1340/150-96	Run-of-river
	HU2	50	ПЛ20-В-800, СВК1340/150-96	Run-of-river
	HU3	50	ПЛ20-В-800, СВК1340/150-96	Run-of-river
	HU4	50	ПЛ20-В-800, СВК1340/150-96	Run-of-river
	HU5	50	ПЛ20-В-800, СВК1340/150-96	Run-of-river
	HU6	50	ПЛ548-ВБ-800, СВК1340/150-96	Run-of-river
	Total	**300.0**	**Planned rehabilitation – 2 units**	
Dnistro HPP	HU1	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	HU2	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	HU3	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	HU4	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	HU5	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	HU6	117	ПЛ60-В-600, ГСВ1230/140-48	Run-of-river
	Total	**702.0**	**Planned rehabilitation – 1 unit**	
Total UHE	**100**	**4247.8**	**Total planned rehabilitation – 46 units**	

Annex 3

MONITORING PLAN

1.0 Introduction

Monitoring of a JI project activity can be defined as the collection and archiving of all relevant data necessary for determining the baseline, measuring anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary of a JI project activity and leakage, as applicable. Verification is defined as the periodic independent review and *ex post* determination by an accredited independent entity (AIE) of monitored reductions in anthropogenic emissions by sources of greenhouse GHG that have occurred as a result of a JI project activity during the crediting period.

The purpose of this MP is to provide a standard by which UHE is to conduct monitoring and verification. The MP shall be in accordance with all relevant JI guidelines as they are established. After the project is determined, this MP will become an integral part of the contractual agreement between the World Bank and UHE.

The MP is consistent with the project design document (PDD) prepared for the UHE hydropower rehabilitation project in Ukraine (hereafter referred to as the Project). Both the MP and PDD can be utilized by UHE to facilitate accurate and consistent monitoring of the Project’s emission reductions.

It should also be noted that JI monitoring is part of routine UHE monitoring, and every plant has measurement and calculation guidelines that are adopted by the cabinet of Ministers at the national level. The project will also install new measuring equipment further ensuring accuracy of all measurements. More detailed information was provided to the determinator in 2006.

UHE is required to use the MP for the duration of the Project activity. It is necessary to strictly follow the MP in order to measure and track the project impacts and prepare for the periodic verification process required to confirm the amount of ERs achieved and to be transferred as ERUs.

Specifically, the MP facilitates the following;

- Establishing and maintaining a suitable monitoring system
- Easy calculation of ERs using the attached spreadsheets
- Guide for the implementation of necessary measurement and management operations
- Guide for meeting requirements in regards to verification and auditing by the AIE (based on requirements similar to those applicable to CDM projects)

At some stage in the project’s life the MP may need to be modified to meet changes in operational requirements. Furthermore, modification to the MP may be necessary as the rules and regulations for JI projects may be further developed.

2.0. Concepts, Principle Assumptions and Calculations

The MP is an extension of the baseline and summary of the monitoring requirements contained in the PDD. It provides an outline of the project boundary and provides the tools for determining ERs in an accurate and transparent manner. Baseline emissions are determined following the elements of the approved CDM Methodology ACM0002 (Consolidated methodology for grid-connected electricity generation from renewable sources) and the Tool to calculates the emission factor for an electricity system with modifications to make these more applicable to the conditions found in Ukraine. The approach also takes into account the criteria for baseline setting included in Appendix B of Guidelines for the implementation of article 6 of the Kyoto Protocol and is in line with the recent guidance provided by the Joint Implementation Supervisory Committee.

2.1. Baseline emissions for the UHE Project

The Project involves the rehabilitation of 46 hydro units which are located at nine different sites on the Dnipro River and one site on the Dnister River. It will increase the electricity generation capacity and efficiency of the rehabilitated hydropower plants. Additional power generated by the hydro units during peak periods will displace power that generated by thermal plants. It is estimated that total emission reductions due to displaced thermal electricity generation will be 1.09 million tCO_2e between 2008 and 2012.

The operating margin (OM) is deemed to best represent what would occur in the absence of the Project calculated using Simple OM principle. The baseline scenario is the amount (and type) of electricity that would have otherwise been generated by the operation of Ukraine grid-connected thermal power plants during peak times. Emission reductions will be claimed based on total CO_2 emission mitigated by the Project.

The OM for the Project is the generation-weighted average of all generating sources, excluding hydropower and nuclear power plants, essentially a Simple OM assuming the share of must run to be zero and updated yearly. *Ex post* data is used to update the OM upon being released by the State Committee of Statistic of Ukraine (SCSU).

Baseline emissions due to displaced thermal electricity are determined by multiplying the simple OM factor by the increased amount of electricity generated by the Project's rehabilitated hydro units.

The Project will not be responsible for any project emissions or leakages.

2.2 Geographic and system boundaries for the MP

The spatial extent of the project boundary includes the Project sites (listed below) and all power plants connected physically to the Ukraine grid. The Project will be located at nine sites on the Dnipro River and one site on the Dnister River (Novo-Dnistrovsk region). Dnipro River runs through central Ukraine where as Dnister river is located in western Ukraine. The sites (and plant names) are as follows:

- Vyshgorod (Kyiv Hydropower Plant and Kyiv Pump Storage Power Plant)
- Kaniv (Kaniv Hydropower Plant)

- Svetlovodsk (Kremenchuk Hydropower Plant)
- Dniprodzerzhynsk (Dniprodzerzhynsk Hydropower Plant)
- Zaporizhzhya (DniproGES Hydropower Plant-1 and DniproGES Hydropower Plant-2)
- Nova Kakhovka (Kakhovka Hydropower Plant)
- Novodnistrovsk (Dnistro Hydropower Plant)

The only gas included in the emission reduction calculation is CO_2.

2.3 Time boundary and baseline review protocol

The Project will be eligible to generate ERs to be transferred as ERUs for the period beginning 2008 year and continuing to at least the end of 2012. In addition, some ERs are expected to be generated in 2007.

2.4 Workbook - calculating emission reductions

The following steps must be completed each year in order to calculate ERs (tCO_2e/a) for the Project using *ex post* grid data provided by SCSU and monitored data for electricity generated by the Project:

1. Calculation of the simple OM emission factor for the Ukraine grid;
2. Determination of the incremental amount of electricity generation due to the Project; and
3. Calculation of the ERs for the Project due to increased electricity generation

2.4.1 Calculation of the simple OM emission factor for the Ukraine grid
The project participant will be required to enter new fuel consumption data (million tce) and new electricity generation data (MWh) to the table provided in the model (file "Ukraine Hydro Rehab Monitoring Workbook.xls", sheet "simple OM emission factor"). With these data inputs the OM emission factor is recalculated automatically. The cells for input data are marked in yellow color.

From 2008 the initial data should be inserted annually using the statistic form 11-MTP of SCSU, namely "Report of fuel, electricity and heat use". The statistic form 11-MTP for previous year usually become available in SCSU at autumn of current year. At autumn of 2008 the data for three years (2005- 2007) should be inserted to the model. From 2009 until 2013 it is necessary to insert data from the previous year accordingly.

Total electricity production by TPPs should be taken from the form 11-MTP, chapter "40.10.1 Electricity Production by Thermal Power Plants for general use" (see table 1 below).

Table 20: "40.10.1 Electricity Production by Thermal Power Plants for general use, Table 1, Form 11-MTP"

Type of products	Year						
	2005	2006	2007	2008	2009	2010	2011
Electricity production by TPPs, MWh	69 954 967*	73 253 627*	75 581 591*	NA	NA	NA	NA

* For the purpose of demonstration - some values are included for 2005-2007 years.

Fuel consumption by 20 types of fuel for electricity production by TPPs should be inserted from chapter "appendix Table 1, Form 11 MTP "The actual fuel consumption for producing some types of products". An example of the table is shown below.

Table 21: 40.10.1 Thermal Power Plants, The actual fuel consumption, appendix Table 1, Form 11 MTP

Year	Name	Total consumption, tce	Including by type of fuel										
			Coal										
			Total	Coking Coal	Lignite	:	Coke	Others Solid Fuel	:	Fuel oil	Natural Gas (Dry)	:	other oil
	A	1	2	3	4	:	8	9	:	12	16	:	21
2005*	Electricity generation by TPPs	26 052 871	14 760 700	0	0	:	14 267	196 928	:	239 165	10 822 126	:	2
	Apparent consumption (TJ)	763 547	432 601	0	0	:	418	5 771	:	7 009	317 171	:	0.06
	Carbon emission factor (t C/TJ)		26.80		27.60	:	25.8	25.80	:	20.00	15.30	:	20.00
	Fraction of carbon oxidized		0.98		0.98	:	0.98	0.98	:	0.99	0.995	:	0.990
	Grid emission, t CO_2	60 450 570	41 660 023		0	:		535 063	:	508 879	17 704 301	:	4
2006	Electricity generation by TPPs					:			:			:	
	Apparent consumption (TJ)					:			:			:	
	Carbon emission factor (t C/TJ)					:			:			:	
	Fraction of carbon oxidized					:			:			:	
	Grid emission, t CO_2					:			:			:	
:	:	:	:	:	:	:	:	:	:	:	:	:	:
2011	Electricity generation by TPPs					:			:			:	
	Apparent consumption (TJ)					:			:			:	
	Carbon emission factor (t C/TJ)					:			:			:	
	Fraction of carbon oxidized					:			:			:	
	Grid emission, t CO_2					:			:			:	

* For the purpose of demonstration only

Apparent consumption is calculated in TJ for each of the fuel types according to the following equation:

Apparent consumption (TJ) = $FC_{i,y}$ (tce) * 29.308 (TJ/tce)

where 29.308 (TJ/tce) is net calorific value for tonnes of coal equivalent.

CO_2 emissions for each of the fuel types are calculated using the following equation:

$$FE_{CO2,i,y} = FC_{i,y} * NCV_i * EF_{C,i} * F_{oxyd} * 44/12, \qquad (1)$$

IPCC default carbon emission factor is provided in the model. It is recommended to check the values for Carbon emission factor for each of the fuel types in comparison with the values used for the last available Ukrainian national GHG inventory report, as it is possible to use the national carbon emission factors for the national GHG inventory in the future.

The sum of all emission values for each of the fuel types are tallied to get the total amount of CO_2 emissions for the Ukraine grid.

To calculate the simple OM emission factor for the year y the total amount of CO_2 emissions is divided by the total electricity generated from fossil fuelled plants.

$$EF_{gird,y} = \frac{\sum EF_{CO2,i,y}}{\sum EG_{BL,FF,y}}, \qquad (2)$$

The simple OM emission factor are recalculated automatically and stored in Table below.

Table 22: Simple OM emission factors.

Initial Data Period for year	2005-2007 2008	2006-2008 2009	2007-2009 2010	2008-2010 2011	2009-2011 2012
simple OM emission factor	0.886*	0.915*	0.912*		

* For the purpose of demonstration only.

2.4.2 Determination of the total amount of incremental electricity generation due to the Project

The baseline generation in year y is determined based on *ex ante* developed correlation between the total water flow through each hydropower plant and its power generation at a historical efficiency rate... This means in practical terms that, for each tri-monthly (one third of a month) period, the total flow of water through each of the plant sites forming the total kWh generated are used as baseline data. The tri-monthly flow index was calculated using a polynomial trend equation (like that typically found using Excel .TREND. function). This correlation will be used to define the baseline electricity production for a given tri-monthly flow index. The tri-monthly flow index is determined based on data from period 2002 – 2005. This data for each HPPs is collected in the sheet “Data” of Excel file “Ukraine Hydro Rehab Monitoring Workbook.xls”. Example of initial data table for Kyiv HPP is shown below.

Table 23: Initial data table for Kyiv HPP.

Month	day	Year	Q water flow (thousand m^3)	Electricity production (MWh)
January	1-10	2002	534 816	13 404
		2003	394 848	9 921
		2004	508 540	12 221
		2005	896 718	21 894
	11-20	2002	562 464	14 062
		2003	451 008	11 136
		2004	400 927	9 660
		2005	1 426 877	33 864
	21-31	2002	608 256	14 908
		2003	429 408	10 682
		2004	607 729	14 728
		2005	922 439	24 093
February	1-10	2002	857 088	21 007
		2003	405 216	10 130
		2004	622 031	15 898
		2005	457 588	11 226
	11-20	2002	1 409 184	33 157
		2003	482 976	12 014
		2004	942 355	21 025
		2005	695 737	16 486
	21-28	2002	1 614 816	36 868
		2003	472 608	11 698
		2004	849 911	19 760
		2005	732 092	14 579
March	1-10	2002	1 669 248	38 024
		2003	491 616	12 139
		2004	1 031 622	24 121
		2005	917 774	21 340
	11-20	2002	1 785 888	39 775
		2003	625 536	15 037
		2004	920 053	21 398
		2005	1 155 232	25 922
	21-31	2002	1 492 992	35 295
		2003	819 072	19 272
		2004	1 873 384	41 925
		2005	1 278 356	30 927

:	:	:	:	:
December	1-10	2002	552 096	13 700
		2003	682 560	16 689
		2004	470 877	11 817
		2005	510 307	12 815
	11-20	2002	316 224	7 985
		2003	687 744	16 693
		2004	709 566	17 969
		2005	608 020	15 354
	21-31	2002	376 704	9 347
		2003	620 352	15 057
		2004	816 413	21 971
		2005	538 455	14 883

The relationship between the flow index and the aggregated generation is established, as seen graphically below (example for Kyiv HPP).

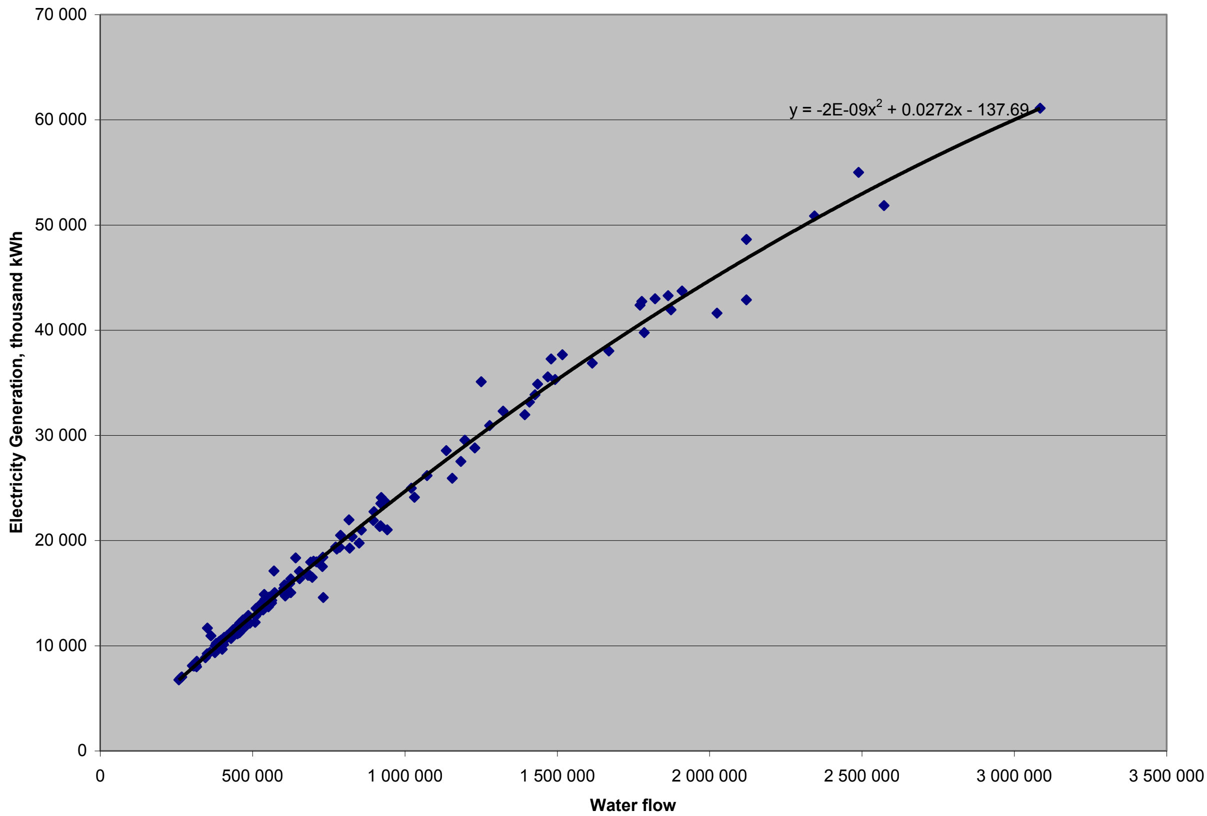


Figure 5. The relationship between the flow index and the actual aggregate generation for Kyiv HPP.

Each project year, the baseline generation will be calculated using the established correlation to determine what the generation of electricity would have been for that period if the hydro plant had not been rehabilitated.

The total baseline electricity generation will simply be a sum of all the tri-monthly and per plant calculations. The formulae used to calculate Baseline Electricity Generation in year y is as follows:

$$EG_{BL,HPP,y} = \sum_{\substack{TRI-MONTHLY,\\ Period\ X=1}}^{36} \left(\sum_{HPP=1}^{\Psi g} EG_{HPP}\ produced\ in\ year\ 0\ at\ Q(index)tri-monthly\ period_{y} \right) \quad (3)$$

The amount of electricity generation per (Project) plant per year is determined as the sum of generation by each plant after project implementation in each 10-day/tri-monthly period.

The following table is provided in electronic form and simply requires the Project participant to enter in the amount of actual generation by each hydropower plant (MWh/a) and the water flow (m^3/a). An example of table for generation by the Project is shown below; please see the electronic worksheets 'ER calculations *20XX*' for the tables for each year from 2008 to 2012 (excel file "Ukraine Hydro Rehab Monitoring Workbook.xls").

Table 24: Determination of increased generation due to the Project.

Kyiv HPP							
Month	Day	Measured outflow, m^3	Baseline electricity (MWh/Tri-Monthly) *calculated by determining the actual Tri-Monthly flow index*	After rehab generation (MWh/ Tri-Monthly)	Final project gen. (MWh/ Tri-Monthly)	Emission reductions (tCO_2/ Tri-Monthly)
Jan	1-10*	896 718*	21 462*	25 000*	3 538*	3 135*
	11-20		0		0	0
	21-31		0		0	0
Feb	1-10		0		0	0
	11-20		0		0	0
	21-29		0		0	0
Mar	1-10		0		0	0
	11-20		0		0	0
	21-31		0		0	0
Dec	1-10		0		0	0
	11-20		0		0	0
	21-31		0		0	0
Total		896 718*	21 462*	25 000*	3 538*	3 135*

* For the purpose of demonstration only.

Important Note: In case the electricity generation after rehabilitation will be less than the baseline electricity generation, the final project generation will be set at zero. This situation is a theoretical possibility in case the upper water reservoir has a water level lower than the level during the historical 2002-2005 data. In such a case a polynomial trend equation provides an incorrect result. Under low water level circumstances, the result of the equation in baseline scenario will be lower than project generation; however, the correct result cannot be calculated using the equation. Therefore, the assumption is that the rehabilitated hydro units can not produce less electricity than in the situation without the project.

The amount of electricity generation per (Project) plant is determined using the following formula:

$$EG_{PR,NET,y} = EG_{PR,HPP,y} - EG_{BL,HPP,hist}, \quad (4)$$

Net (i.e. incremental) electricity generation (MWh/a) is equal to the sum of generation by all the rehabilitated plants – baseline electricity generation identified in the Project boundary (after being rehabilitated) as calculated above.

2.4.3 Calculation of the ERs for the Project due to increased electricity generation

The emission reductions (tCO_2e) for each year will be calculated automatically once all the monitored data has been inserted for a particular year.

Table 25: Determination of Project ERs.

Year	Increased generation due to Project (MWh)	ERs due to increased generation (tCO_2e)
2008	$EG_{PR,net\ (2008)}$	$EG_{PR,net\ (2008)}$ x OM = $ER_{gen(2005-2007)}$
2009	$EG_{PR,net\ (2009)}$	$EG_{PR,net\ (2009)}$ x OM = $ER_{gen(2006-2008)}$
2010	$EG_{PR,net\ (2010)}$	$EG_{PR,net\ (2010)}$ x OM = $ER_{gen(2007-2009)}$
2011	$EG_{PR,net\ (2011)}$	$EG_{PR,net\ (2011)}$ x OM = $ER_{gen(2008-2010)}$
2012	$EG_{PR,net\ (2012)}$	$EG_{PR,net\ (2012)}$ x OM = $ER_{gen(2009-2011)}$
Total	$EG_{PR,net\ (2006-2012)}$	$ER_{gen(2008-2012)}$

2.5 Conservative and transparent approach to ER calculations

The formulas proposed for this PDD are transparent and reproducible. Data sources and factor used are clearly referenced and official national data has been used where possible. Only CO_2 is taken into account in baseline emission calculations.

It should also be noted that calculation of the EF_{grid} is conservative as the average EF of all the remaining plants is lower than the last plant in the dispatch merit order. The units with the lowest efficiency and highest cost per MWh are typically dispatched last in any power system.

3.0 Operational and Monitoring Obligations

In order to facilitate successful ER verification, the project participant must fulfill a number of operational and data collection obligations. This will ensure that ERs to be transferred as ERUs are calculated in a transparent manner and monitoring is carried out as stipulated in the Monitoring Plan.

3.1 Operational obligations

The amount of electricity generated by each hydro unit shall be constantly monitored via a meter and the amount double checked by receipt of sales.

3.2 Data requirements and project database

The following data shall be collected:

- Names of plants and hydro unit number for those hydro units which have recommenced operation after undergoing rehabilitation as part of the Project[18].
- Amount of generation (MWh/a) supplied to the grid by each project hydropower plant.
- Total water flow (m^3/a) for each project hydropower plant

In order to calculate the simple OM emission factor *ex post*, the following data shall be acquired from SCSU after each year and the calculations in the spreadsheet completed;

- Aggregated fuel consumption data (kt/a) for all thermal generation sources connected to the Ukraine grid based.
- Carbon emission factor of each fuel type and NVC (IPCC factors to be used if national data not available).
- Aggregated electricity generation data (MWh/a) for all thermal generation sources connected to the Ukraine grid.

The complete list of data that needs to be monitored by UHE is included in Table D.1.1.3. of the PDD ..

4.0 Management and Operational Systems MP

In order to ensure a successful operation of the Project and the credibility and verifiability of the ERs achieved, the project must have a well defined management and operational system. It is the obligation of the operator to put such a system in place for the Project. It must include the operation and management of the monitoring and record keeping system that is described in this MP.. Therefore, the project management responsibilities that concern this MP are outlined in this section.

[18] Project hydropower plants will be included in emission reduction calculations from the year that the first hydro unit is rehabilitated.

4.1 Allocation of Project management responsibilities

The management and operation of the project is the responsibility of UHE, the project operator. Ensuring the environmental credibility of the project through accurate and systematic monitoring of the project's implementation and operation for the purpose of generating ERs is the key responsibility and accountability of the operator as far as this MP is concerned. For calculating the ERs, the operator, UHE, shall rely on data published yearly by the SCSU.

The World Bank will arrange for periodic verification of the ERs in line with the Kyoto Protocol requirements and modalities as well as other relevant rules, to receive the verified ERs as ERUs and to pay the operator as agreed.

4.2 Management and operational systems

It is the responsibility of the operator to develop and implement a management and operational system that meets the requirements of the Project and of this MP. The MP can only offer general guidance in this regard. This includes:

4.2.1 Data handling

- The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems. The operator must develop and implement a protocol that provides for these critical functions and processes, which must be fit for independent auditing.
- For electronic and paper based data entry and record keeping system, there must be clarity in terms of the procedures and protocols for collection and entry of data, use of workbooks and spreadsheets and any assumptions made, so that compliance with requirements can be assessed by a third party. Stand-by processes and systems, e.g. paper based systems, must outlined and used in the event of and to provide for the possibility of system failures. The record keeping system must provide the paper train that can be audited.

4.2.2 Quality assurance

- The operator, UHE, must designate a competent manager who will be in charge of and accountable for the generation of ERs including monitoring, record keeping, computation of ERs, audits and verification. The person will officially sign-off on all GHG Emission worksheets.
- Well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting procedures will ease time and costs, while making it considerably easier for the auditor and verifier to do their work - the more organized and transparent the organization, the easier to track, monitor, verify and audit.
- Proper management processes and systems records must be kept by the operator, UHE, as the auditors will request copies of such records to judge compliance with the required management systems. Auditors will accept only one set of official information, and any discrepancies between the official, signed records and on-site records will be questioned.

4.2.3 Reporting

- The operator will report regularly to the World Bank as well as to Ukraine authorities as required.
- The operator must transmit copies of completed worksheets to the World Bank on a regular basis (at least quarterly) while maintaining originals on file.
- The operator, UHE, will prepare reports as needed for audit and verification purposes.
- The project should prepare an brief annual or biannual report which should include: information on overall project performance, emission reductions generated and verified and comparison with targets, observations regarding MP baseline scenario indicators, compliance with sustainable development targets, information on adjustment of key MP assumptions concepts, calculation methods and other amendments of the MP and the monitoring system. The report can be combined with the periodic verification report.

4.2.4 Training

It is the responsibility of the operator to ensure that the required capacity and internal training is made available to its operational staff to enable them to undertake the tasks required by this MP. Initial staff training must be provided before the project starts operating and generating ERs.

4.2.5 Verification and commissioning

- The management and operational system and the capacity to implement this MP must be put in place before the project can start generating ERs.

This will be verified before the project is commissioned by the World Bank to generate ERs

The following Table summarizes the roles and responsibilities of the various project partners with regard to the monitoring system.

Table 26: MP Management and Operation System: Roles of Project Partners

	UHE	World Bank
Monitoring system	• Review MP and suggest adjustments if necessary • Develop and establish management and operations system • Establish and maintain monitoring system and implement MP • Establish or confirm sustainable development indicators and performance targets • Prepare for initial verification and project commissioning	• Review monitoring and management system • Ensure project meets the World Bank requirements and safeguards • Arrange for initial verification
Data Collection	• Establish and maintain data measurement and collection systems for all MP indicators • Check data quality and collection procedures regularly	• Review data collection systems
Data computation	• Enter date in MP workbooks • Use MP workbooks to calculate emission reductions	• Review completed worksheets
Data storage systems	• Implement record maintenance system • Store and maintain records (paper trail) • Implement sign off system for completed worksheets • Forward monthly and annual worksheet outputs	• Receive copies of key records and reports • Maintain the World Bank records
Performance monitoring and	• Analyze data and compare project performance with project targets	• Review reports • Evaluate performance and assist with

	UHE	World Bank
reporting	• Analyze system problems and recommend improvements (performance management) • Prepare and forward periodic (monthly) reports	performance management
MP Training and Capacity Building	• Develop and establish MP training, and skills review and feedback system • Ensure that operational staff is trained and enabled to meet the needs of this MP	• Assist with MP training and capacity building
Quality assurance, audit and verification	• Establish and maintain quality assurance system with a view to ensuring transparency and allowing for audits and verification • Prepare for, facilitate and co-ordinate audits and verification process	• Supervise projects • Arrange for periodic verification

5.0 Verification

The verification process for the project shall follow the relevant JI procedures and requirements..