CDM – Executive Board

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

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SECTION A. General description of small-scale project activity

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

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(1) Title of the project activity:
- New Energy and Hongik Energy & Research small-scale hydroelectric power plants project

(2) Version number of the document:
-Version 06

(3) Date of the document:
-01/06/2009

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

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Project activity	Type	Category	Technology/Measure
Small-scale hydroelectric power	AMS I	D	Renewable energy technologies that supply electricity to a grid

- About this project:
Small-scale hydroelectric power plants in this project produce electric power by using the existing reservoir for irrigation instead of construction work for the reservoir. Therefore, the impact to the environment was kept to a minimum.

- The purpose of this project:
The renewable energy project (Gomun and Dongjin-river SSC hydroelectric power plants) generates electricity as well as socio-economic benefits in local and national level. This project contributes to effective development of hydroelectric power through utilizing environmental friendly energy sources. In addition, it will cope with the increasing demand to electricity and reduce fossil fuels imports in Korea.

- Summary of the project:
• Gomun small− scale hydroelectric power plant which is located in Gomun-ri, Yeoncheon-eup, Yeoncheon-gun, Gyeonggi-do, Republic of Korea consists in 1,500kW of generation capacity, and expected power generation of 5,251MWh per year.

• Dongjin- river small –scale hydroelectric power plant which is located in Geosan-ri,Taein-myeon ,Jeongeup-si, Jeollabuk-do, Republic of Korea consists in 850kW of generation capacity, and expected power generation of 4,983MWh per year.

∴ This proposed project generates electricity utilizing hydroelectric power and provides the electricity to the grid-connected electricity system in South Korea.

- Contribution to sustainable development:
By using renewable local source of energy, the project will contribute to sustainable development in South Korea as follows:

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- Power generation from small-scale hydroelectric power plants reduces consumption of fossil fuels, decreases imports of fossil fuel, and hence brings in national profits.
- As an alternative energy source, small-scale hydroelectric power does not emit air pollutants or wastes.
- As the renewable energy source, hydroelectric power, does not deplete natural resources and therefore it will be used as alternative energy sustainable by future generations.
- There are no Green House Gas (GHG) emissions.
- Demonstrate replicable clean energy technology.

A.3. Project participants:

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<Table A-1> Project Participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of KOREA (host)	•**Private entity:** -New Energy Co., Ltd -Hongik Energy Co., Ltd -Ecoeye Co., Ltd (consulting company)	No

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

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

A.4.1.1. Host Party(ies):

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Republic of Korea

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

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- Gomun small-scale hydroelectric power plant: Gyeonggi-do
- Dongjin-river small-scale hydroelectric power plant: Jeollabuk-do

A.4.1.3. City/Town/Community etc:

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- Gomun small-scale hydroelectric power plant: Gomun –ri, Yeoncheon- eup, Yeoncheon-gun
- Dongjin-river small-scale hydroelectric power plant: Geosan-ri, Taein-myeon, Jeongeup-si

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

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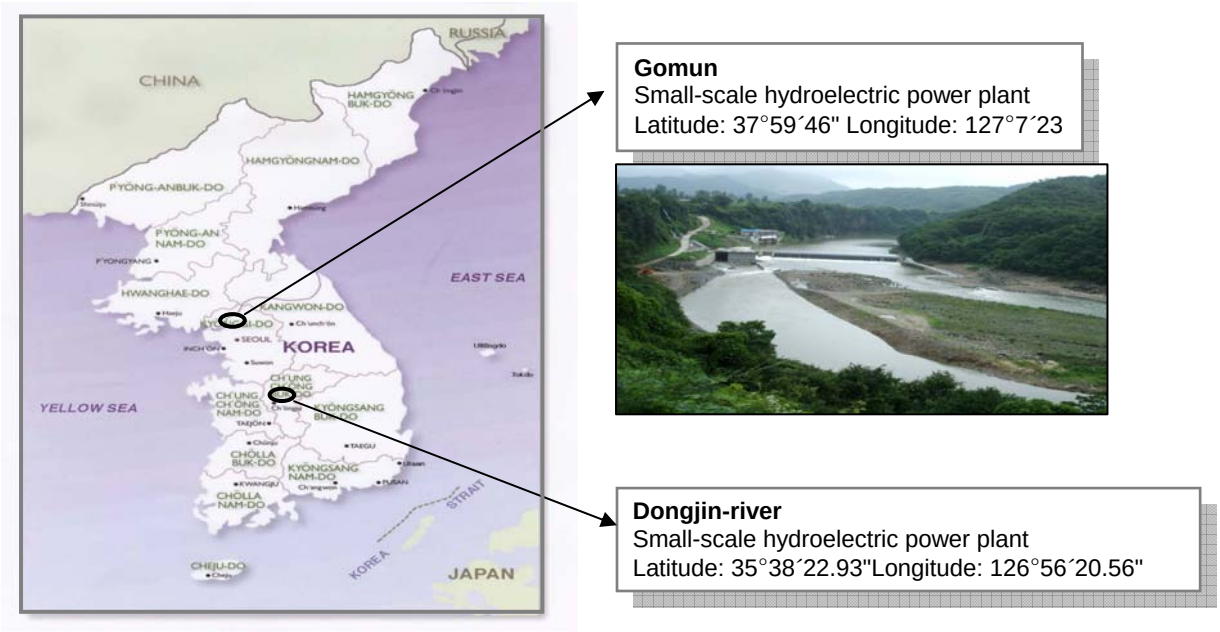

<Figure A-1> Map depicting the location of the project activity

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

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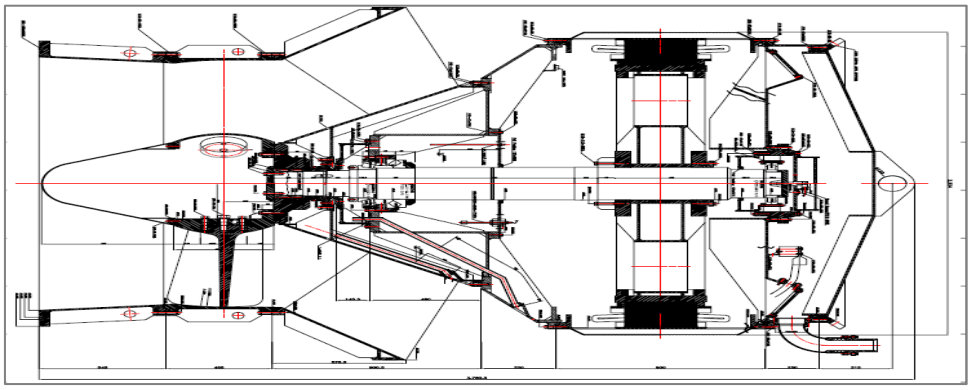
The project is a small-scale CDM project activity. The project type, as defined in UNFCCC's Appendix B of the simplified modalities and procedures for small-scale CDM project activities, is **type I.D**: Renewable energy projects; **Grid connected renewable electricity generation**.

The project generates electricity utilizing renewable energy, hydroelectric power, and supplies the electricity to the grid. Furthermore, the capacity of the power plant is 2.35MW (each capacity 1.5MW, 0.85MW) which is less than 15 MW. Therefore, the project is eligible for type I.D. project activity.



<Figure A- 2> Assembly diagram of the power generator

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<Table A-2> Description of technology about small-scale hydroelectric power plants

Classification		**The Gomun small-scale hydroelectric power plant**	**The Donjin-river small-scale hydroelectric power plant**
Wheel	Type	Tubular type propeller	Kaplan
	Output power	550 kW	350kW, 150kW
	Rotation	300 RPM	240 RPM
	Unit	3	350kW:2, 150kW:1
Generator	Type	Three-phase induction	Three-phase induction
	Output power	500 kW	850kW
	Unit	3	350kW:2, 150kW:1
Transformer	Type	Oil type	Mold type
	capacity	2,000 kVA	1,000kVA
	Voltage	19.9 kV / 600V	22.9KV/380-220V
	Connect-ion type	Y-△	Y-△
	Unit	1	1

As the project activity generates electricity with using unaccounted outflows from the existing dams, there are no severe environmental impacts. Accordingly, technology adopted to this project is environmentally safe and sound.

Water turbine generator is the main equipment, is designed and made by Daeyang Co., Ltd.,. Also the technology can be applied optimally.

Technology details of Gomun hydroelectric power are followed:

• Firstly, water turbine generator technology for this project optimally designed considering the properties of water resources (e.g. water head, water quantity); therefore, efficiency of water turbine generator is stable.

• Secondly, this is not the gear/belt connection type but unified shaft which is directly related to water turbine generator. Therefore, components are simple and operation & maintenance is easy.

• Third, operation and maintenance performed efficiently; therefore, generation loss can be minimized.

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Technology details of Dongjin-river hydroelectric power are followed:

• The sort of the water turbine is Kaplan Tube Turbine and it is primarily used in the low head range with large volume of water, but the adjustability of the guide wheel and runner blades allows optimal use of varying water flow.

There is no technology transfer from other countries involved in the project activity.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

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Years	Annual estimation of emission reductions in tonnes of CO_2 e
Aug 2009~Jul 2010	**5,501** (=2,822+ 2,678)
Aug 2010~Jul 2011	**5,501**
Aug 2011~Jul 2012	**5,501**
Aug 2012~Jul 2013	**5,501**
Aug 2013~Jul 2014	**5,501**
Aug 2014~Jul 2015	**5,501**
Aug 2015~Jul 2016	**5,501**
Aug 2016~Jul 2017	**5,501**
Aug 2017~Jul 2018	**5,501**
Aug 2018~Jul 2019	**5,501**
Total estimated reductions (tonnes of CO_2 e)	**55,008**
Total number of crediting years	**10**
Annual average of the estimated reductions over the crediting period (tCO_2 e)	**5,501**

A.4.4. Public funding of the small-scale project activity:

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Public funding is not involved in this project activity.

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

This project is not a part of any large scale project activity.
According to Appendix C of the simplified modalities and procedures for small-scale CDM project

activities, debundling is defined as the fragmentation of a large project activity into smaller parts.

A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or another small-scale CDM project activity requested for registration which has the conditions as follow:

- With the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

Bundled two small-scale hydroelectric power plants have 2.35MW capacity. None of these two plants are part of a large project. Therefore this project is not a debundled project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

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AMS-I.D. version 13 (14 Dec 2007)

"Grid connected renewable electricity generation." as outlined in Annex B of the simplified modalities and procedures for small-scale CDM project activities. ("SSC M&P")

B.2 Justification of the choice of the project category:

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This category I.D is absolutely applicable to the Project activity because electricity generated by renewable energy source is provided to grid-connected system. Additionally, renewable energy is to be generated by 2.35MW (1.5MW+0.85MW) hydropower plants, which are under the 15MW limit.

B.3. Description of the project boundary:

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As referred to in Appendix B for small-scale project activities, the project boundary for a small scale hydropower project that provides electricity to a grid encompasses the physical, geographical site of the renewable generation source.

For the baseline determination, project boundary is related to CO_2 emissions from power generation in a fossil fuel power plant replaced by this project activity. The spatial extent of the project boundary includes the project sites and all the power plants connected physically to the electricity system of Korea Electric Power Corporation (KEPCO).

For calculation of baseline GHG emissions from the project boundary are not included emissions during plant construction, leakage from electricity transfer, and emission from transportation, mining, and pumping.

B.4. Description of baseline and its development:

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According to clause 9 of AMS I.D version 13, the baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_2equ/kWh) calculated in a transparent and conservative manner as:

(a) A combined margin(CM), consisting of the combination of operating margin(OM) and build

margin(BM) according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system".

OR

(b) The weighted average emissions (in kg CO_2equ/kWh) of the current generation mix. The data of the year in which project generation occurs must be used.

Therefore the baseline for this project was calculated according to "Tool to calculate the emission factor for an electricity system(version 01.1)", on the authority of (a) as mentioned above. The baseline emission factor (EF_y) was calculated as a combined margin (CM), consisting of the combination of operating margin(OM) and build margin(BM) factors according to the following six steps. Intend to calculating this combined margin(CM), it were applied that the data originated from existing power plants that provide electricity to the current grid-connected electricity generation. Here, these data were collected form the "Statistics of Electric Power in KOREA published at the most recent 3-years (2005, 2006, 2007) (KEPCO)", and should be proper because the host country of this project, Republic of Korea, does not import/export electricity from/to other countries.

STEP 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, a **project electricity system** is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

Similarly, a **connected electricity system**, e.g. national or international, is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD. In doing, so the following criteria can be used to determine the existence of significant transmission constraints:

- In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year.
- The transmission line is operated at 90% or more of its rated capacity during 90% percent or more of the hours of the year.

In this sense, it is clear that the project electricity system to be applied is the whole Korean national grid system since all power plants, including Gomun and Dongjin-river small-scale hydroelectric power plant, are physically connected to each other through transmission and distribution lines constituting the grid.

Therefore the Korean national grid has been chosen as relevant electricity power system for purpose of determining the electricity emission factors.

<Figure B-1> Electric Power Grid Nationwide in Republic of Korea
Source: 2008 Annual Report, Korea Electric Power Corporation

STEP 2. Select an operating margin (OM) method

The calculation of the Operating Margin emission factor ($EF_{grid,OM,y}$) shall be calculated basis on one of the four following methods:

Option (a) Simple OM
Option (b) Simple adjusted OM
Option (c) Dispatch Data Analysis OM
Option (d) Average OM

If low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most recent years, simple OM can be chosen.

Referring to the gross electricity generation rate by energy sources of the host country (Republic of Korea), the rate of low cost/must run power generation does not exceed 50% of the total grid. Actually, the most recent 5-year (2003~2007) average data shows that the rate of low cost/must run is 41.49%. (Source: KEPCO)

Therefore, for this project case, "Option (a) Simple OM" is available. <Table B-1> is shown the yearly proportion of the generation of electricity based on the source of energy (Korea Electric Power Corporation, 2008).

<Table B-1> Gross generation by energy sources

(Unit: million kWh)

Item \ Year		2003	2004	2005	2006	2007
Hydro*		6,887	5,861	5,189	5,219	5,042
Thermal	Domestic Coal*	5,398	4,603	4,484	4,312	4,470
	Bituminous Coal	114,878	122,556	129,174	134,894	150,204
	Heavy Oil	23,656	21,591	20,079	18,596	20,769
	Diesel Oil	2,870	474	412	599	446
	Gas	39,091	55,999	58,118	68,302	78,427
Nuclear*		129,672	130,715	146,779	148,749	142,937
Alternative*		-	350	404	511	829
Total		322,452	342,148	364,683	381,181	403,124
The rate of low cost/must run power generation (%)		41.49				

Source: Electricity statistics on Electricity quantity from Korea Electric Power Corporation, 2008
(* low-operating cost and must-run power plants)

And the Simple OM emission factor can be calculated using either of the two following data vintages for years(s) *y*:

• Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period, or

• Ex post option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

On this PDD, *ex-ante* data were applied. The Simple OM emission factor is calculated as followed step 3.

STEP 3. Calculate the Operating Margin emission factor ($EF_{grid,OM,y}$)

The simple OM emission factor is calculated as the generation-weighed emissions per electricity unit of all generating units serving the system, excluding low-operating cost and must-run power plants. Low-

operating cost and must run power plants include hydro, nuclear, low cost biomass, geothermal and domestic coal. And it is calculated based on data on fuel consumption and net electricity generation of each power plant /unit (Option A) as follows:

$$EF_{grid,OMSimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,j}}{\sum_{m} EG_{m,y}} \quad (1)$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,m,y}$	=	Amount of fossil fuel type i consumed by power plant / unit m in year y (mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$	=	Net electricity generated and delivered to the grid by power plant / unit m in year y (MWh)
m	=	All power plants / units serving the grid in year y except low-cost / must-run power plants / units
i	=	All fossil fuel types combusted in power plant / unit m in year y
y	=	Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2

In case of this project, the applied parameters are presented for estimation of Operating Margin emission factor ($EF_{grid,OM,y}$) at <Table Annex-1, 2, 3> in Annex 3. As a result, the OM emission factor ($EF_{grid,OM,y}$) is 0.6817 (tCO_2/MWh).

STEP 4. Identify the cohort of power units to be included in the Build Margin emission factor ($EF_{grid,BM,y}$)

The sample group of power unit m used to calculate the build margin consists of either:

(a) The set of five power units that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use the set of power units that comprises the larger annual generation.

As a general guidance, a power unit is considered to have been built at the date when it started to supply electricity to the grid.

Power plant registered as CDM project activities should be excluded from the sample group m. However, If group of power units, not registered as CDM project activity, identified for estimating the build margin emission factor includes power unit(s) that is(are) built more than 10 years ago then:

(i) exclude power unit(s) that is (are) built more than 10 years ago from the group; and
(ii) include grid connected power projects registered as CDM project activities, which are dispatched by dispatching authority to the electricity system.

Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor.

In terms of vintage of data, project participants can choose between one of the following two options:

Option 1. For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

For this project case, *Option* 1 is taken to calculate the Build Margin emission factor, $EF_{grid,BM,y}$ *ex-ante*, and it is estimated as <Table B-2> according with each regulation to compose proper sample group(*m*) that the electricity quantity of candidate sample groups and it ratio to total generation in Korea.

<Table B-2> Sample Plant group(*m*) for determining Build margin Emission factor

Sample group(m) Classification	**Regulation 1**	**Regulation 2**	**Comments**
	"The five power plants that have been built most recently"	**"The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently."**	
Electricity quantity	33 MWh	84,736,759 MWh	Total generation is 385,990,619MWh in Korea (based on KEPCO's data of the year 2007) CDM registered Power plants generation is 376,177MWh.
Proportion (ratio to total generation in Korea)	0.00001%	21.953%	
Selected Group		**O**	

The annual generation of "the five power plants that have been built most recently" was 33MWh (0.00001% of total generation of the grid system), and the annual generation of "the power plants capacity additions in the electricity system that comprise 21.953% of the system generation and that have

been built most recently" was 84,736,759MWh. Therefore, the latter was chosen for this project as a lager figure than the other one. It is presented at <Table Annex-4> in Annex 3 that the sample group of plants used in the Build Margin emission factor ($EF_{grid,BM,y}$).

STEP 5. Calculate the build margin emission factor ($EF_{grid,BM,y}$)

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(2)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation data is available

According to the BM calculation formula and variables of above tables, $EF_{BM,y}$ is 0.3933(tCO_2/MWh).

STEP 6. Calculate the combined margin emissions factor ($EF_{grid,CM,y}$)

The combined margin emissions factor is calculated using the following formula:

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y} \quad \textbf{(3)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emissions factor (%)
w_{BM}	=	Weighting of build margin emissions factor (%)

• Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.

• All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

Alternative weights can be proposed, as long as $w_{OM} + w_{BM} = 1$, for consideration by the Executive Board, taking into account the guidance as described below. The values for $w_{OM} + w_{BM}$ applied by project participants should be fixed for a crediting period and may be revised at the renewal of the crediting

period.

Therefore baseline emission factor ($EF_{grid,CM,y}$) for this project is = 0.5375(tCO_2/MWh) as follows :

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM\,y} + w_{BM} \cdot EF_{grid,BM,y}$$
$$= 0.5 \cdot 0.6817(tCO_2/MWh) + 0.5 \cdot 0.3933(tCO_2/MWh)$$
$$= 0.5375(tCO_2/MWh)$$

Depending on AMS I.D (Version13), baseline emissions should be obtained by the below equation

$$BE_y = (EG_y - EG_{baseline}) \cdot EF_y \quad (4)$$

where:
BE_y is the baseline emissions (in tCO_2)
EG_y is the electricity supplied by the project activity to the grid (in MWh)
$EG_{baseline}$ is the baseline electricity supplied to the grid in the case of modified or retrofit facilities (in MWh)
EF_y is the baseline emissions factor (in tCO_2/MWh)

However $EG_{baseline}$ is zero because there are no modified or retrofit facilities in this project. Therefore the baseline emissions (BE_y) can be calculated as follows;

$$BE_y = EG_y \cdot EF_y \quad (5)$$

The electricity supplied by the project activity to the grid (EG_y) is expected to be 10,234MWh/yr as described at section A.

As a result, the baseline emission (BE_y) is 5,501(tCO_2 /yr).

The key information and data used for calculation of baseline emission by this project activity have been taken from following sources.

<Table B-1> Key information and data used to determine the baseline scenario

Parameter	Value	Source
$EG_{m,y}$ **(MWh)** is the electricity delivered to the grid by source *j*.	Refer to <Table Annex-3>	Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO)
$FC_{i,m,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y*, *m* refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid	Refer to <Table Annex-1>	Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO)

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Parameter	Value	Source
Net Calorific Values by Power Plant	Refer to <Table Annex-2>	Caloric value sourced from Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO) (net caloric value = Caloric value* net caloric value conversion factor)
Net Caloric Values Conversion Factor	Solid/Liquid fuel : 0.95 Gaseous fuel : 0.90	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Fuels CO_2 Emission Factor ($EF_{CO2,i,i}$)	Refer to <Table Annex-5>	2006 IPCC Guidelines for National Greenhouse Gas Inventories 1.23
$EF_{grid,OM\,y}$ Operating Margin Emissions Factor (in ton CO_2/MWh) 2005~2007	0.6817	Calculated
$EF_{grid,BM,\,y}$ Build Margin Emissions Factor (in ton CO_2/MWh)	0.3933	Calculated
$EF_{grid,CM,y}$ Baseline Emissions Factor (in ton CO_2/MWh)	0.5375	Calculated

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

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Considering CDM seriously prior to the project activity start date

These project participants, New Energy Co., Ltd. and Hongik Energy Co., Ltd., seriously have considered CDM project activity prior to the start dates. The translated evidences for prior consideration of CDM are attached Annex 3 <Table Annex-10, 11>.

The CEO of 'New Energy Co., Ltd.' and 'Hongik Energy Co., Ltd.' was performed executives design individually prior to the start dates.

According to Executive design report by New Energy Co., Ltd. on Jan. 2005, it is contained how much effect on GHG reduction and CERs revenues with variation range of 5.5(euro/tCO_2e) and 100(euro/tCO_2e) of CERs price are obtained by the project activity. Executive design report on Jun. 2006, by Hongik Energy Co., Ltd. also is contained how much CO_2 gas reduction are expected and how much CERs revenues are obtained with variation of CERs price 2($/$tCO_2e$) to 10($/tCO_2e).

Project participants have considered CERs revenues as prime element seriously in the decision to implement this project.

These project participants are the small business that is organized the CEO and the power plant operator. And these companies have no executive board. Therefore, the final decision maker of the company is the CEO.

A similar manner, the CEOs have decided to implement the CDM project on them responsibility.

When New Energy Co., Ltd. Considering CDM, it thought that Gomun small-scale hydroelectric power project capacity is too small to proceeding CDM, independently. So it was searched CDM business partner for a long time. Finally it contacted with Hognik Energy Co., Ltd. And they decided to proceed CDM bundling. They contracted with Ecoeye, CDM consulting company (12/02/2007), and have been progressing bundle CDM project.

For the details refer to the follow "timeline".

Date	Description	
	Gomun small-scale hydroelectric power project	**Dongjin-river small-scale hydroelectric power project**
2005-01 ~ 2006	- CEO of New Energy Co., Ltd. made final decision to proceed into the Gomun small-scale hydroelectric power project activity as a CDM project activity. - CEO of New Energy Co., Ltd. thought that Gomun small-scale hydroelectric power project capacity is too small to proceeds CDM, independently. So she has searched CDM business partner for a long time. And finally she contacted with CEO of Hongik Energy Co., Ltd. and proposed CDM project together.	
2005-03	- Make a CDM business consultation for Ecoeye by telephone.	
2005-06	- Submit a written application of the electric enterprise permit to Gyonggi-do	
2005-07	- New Energy Co., Ltd. has proposed small-scale hydroelectric power project and CDM project to Hongik Energy Co., Ltd.	
2005-09	- Contract for hydroelectric power plant construction work was finalized with Daeyang Co., Ltd.	
2005-10	- Make a MOU (Memorandum Of Understanding) (New Energy Co., Ltd., Hongik Energy Co., Ltd. and Ecoeye Co., Ltd.)	
2005-11	- 22nd, Issuing of the "permit of the electricity enterprise" of Gomun small-scale hydroelectric power project	
2006-01	- 5th, Issuing of the "permit of the occupation of river site"	

Date	Description	
	Gomun small-scale hydroelectric power project	**Dongjin-river small-scale hydroelectric power project**
2006-06		- CEO of Hongik Energy Co., Ltd. made final decision to proceed into the Dongjin-river small-scale hydroelectric power project activity as a CDM project activity.
2006-07	- Meeting on the progress of small-scale hydroelectric power projects.	
2006-08	- Contract for hydroelectric power plant construction work was finalized with BOAZ engineering & construction Co., Ltd.	
2006-09	- Start of the Gomun small-scale hydroelectric power plant construction work	
2006-12		- Contract for hydroelectric power plant construction work was finalized with DAEWOO engineering Co., Ltd. - Submit a written application of the electric enterprise permit to Jeollabuk-do - 5th, Issuing of the "permit of the occupation of river site"
2007-02		- 9th, Issuing of the "permit of the electricity enterprise" of Dongjin-river small-scale hydroelectric power project
	- 12th, CDM consulting agreement was finalized with ECOEYE Co., Ltd.	
2007-05	- Drawing up of the PDD (ver. 01)	
2007-07	- 3rd, Validation contract was finalized with KEMCO	
	- 20th, Completion of the Gomun small-scale hydroelectric power plant construction work	
2007-08	- On-site Assessment	
2007-09		- 7th, Start of the Dongjin-river small-scale hydroelectric power plant construction work
	- Issuing of the non conformity report (draft)	
2007-11	- CDM EB instructed the DOE (KEMCO) to suspend the validation procedure of project activity due to the possible conflict of interest of the DOE with the project activity. - Cancel of contract with KEMCO - Validation contract was finalized with KFQ	

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Date	Description	
	Gomun small-scale hydroelectric power project	**Dongjin-river small-scale hydroelectric power project**
2007-12	- On-site Assessment	
2008-03	- Issuing of the validation report (draft)	
2008-04	- Request for issuing of LoA at DNA	
2008-06		- Completion of the Dongjin-river small-scale hydroelectric power plant construction work
2008-07	- 30th, Issuing of the LoA	
2008-11	- Request for registered at UNFCCC	

The additionality on investment barrier

To prove additionality of the project, attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities was referred. According to attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities, project participants shall provide and explanation to show that the project activity would not have occurred anyway due to at least one of barriers such as investment barrier, technological barrier, barrier due to prevailing practice or other barriers.

The biggest barrier of the project is investment barrier because small-scale hydroelectric power project requires high investment cost, but expectation of capital return is very low. Due to these reasons, these hydroelectric power plants are not attractive alternative as power generation. It can be explained by calculating IRR (Internal Rate of Return). IRR is the discount rate which makes that present value of income flow and present value of cost flow same.

Benchmark rate of this project has applied 6.5%, social discount rate of the public enterprise at the water resources, based on guidelines for feasibility study published by Korea Development Institute (KDI). Although it can be applied at public enterprise, this project has applied it as conservative manner. Because the discount rate of the public enterprise is generally lower than the discount rate of the private enterprise.

Gomun and Dongjin-river small-scale hydroelectric power plant's calculated IRRs are 1.55% and 5.38% respectively. The detail financial parameter is shown in <Table B-4> and <Table B-5>.

As mentioned the EB 22nd conference, we can exclude the national policy (subsidy) for the additionality (investment analysis), from after 11.Nov. 2001.

In case of Republic of Korea, government gives subsidy as "Promotion Act for New and Renewable energy development, Utilization & Dissemination" from after 26.Sep. 2002.

So, we does not include subsidy for electricity price in the investment analysis refers to the EB 22nd conference.

<Table B-4> Investment analysis of Gomun small scale hydroelectric power plant

Used values for economic analysis		
Content	Value	Remarks
Analysis period (years)	2005~2037	Feasibility study of the project was performed in 2005.
Construction period	2005.09~2007.03	
Discount rate (%)	6.5	"Korea Development Institute" report ('04. 07)
Unit cost of electricity sale (won/kWh)	60.42	Price in 2005 source from Electric Power Statistics Information System
Total Expenses (unit: million won)	4,180	Equipment cost (1,235) +generating plant cost (2,662) +design cost (88) +extra-expenses (195)

Details of economic analysis implementation			
Total Investment Cost (million won)	Operation & Maintenance Cost (million won/year)	Expected electricity produced by this plant (MWh/year)	IRR (%)
4,180	130	5,251	**1.55**

<Table B-5> Investment analysis of Dongjin-river small scale hydroelectric power plant

Used values for economic analysis		
Content	Value	Remarks
Analysis period (years)	2006~2037	Feasibility study was performed in 2004. Therefore, the point in time for converting net present value is 2005. Construction period and expected project activity period(30years)
Construction period	2007.06~2008.05	
Discount rate (%)	6.5	"Korea Development Institute" report ('04. 07)
Unit cost of electricity sale (won/kWh)	77.55	Price in 2006 source from Electric Power Statistics Information System
Total Investment Cost (unit: million won)	3,522	Equipment cost (1,474) +generating plant cost (1,892) +design cost (156)

Details of economic analysis implementation			
Total Expenses (million won)	Operation & Maintenance Cost (million won/year)	Expected electricity produced by this plant (MWh/year)	IRR (%)
3,522	106	4,983	**5.38**

*Detailed calculation contents of economic analysis were submitted to DOE as an excel file.

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Based on result of analysis, IRR of Gomun small-scale hydroelectric power is 1.55% which is lower than Discount rate, 6.5%. Therefore, this project cannot be considered financially attractive. In addition, IRR of Dongjin-river small-scale hydroelectric power is 5.38% which is lower than Discount rate, 6.5%. Therefore, this project cannot be considered financially attractive as well.

Variation in the SMP of the Small-scale hydroelectric power project has represented range of +11.3% and -4.5% by year (2001-2005). And average variation value of the SMP was 5.9% at the same period. Therefore, sensitivity analysis of the unit price of electricity sale is performed with variation up to +12%. Also, variation in the producer price index related with electric equipment (Electromotor, Power generator and Electricity converter) has represented range of +1.59% and -0.30% by month (2004-2005). And average variation value of which was 0.28% at the same period. Therefore, sensitivity analysis of the total investment cost and the O&M cost rate are performed with variation up to -10%. Electricity generation of the small-scale hydroelectric power is affected by rainfall. Rainfall is very capricious. Therefore sensitivity analysis of the electricity generation is performed with variation up to +10% based on paragraph 17 of "Guidance on the Assessment of Investment analysis".

Variation of the sensitivity analysis is performed as following range.

- +5%, +12%: Increasing unit price of electricity sale
- -5%,-10%: Decreasing Total Investment Cost
- +5%, +10%: Increasing Electricity generation
- -5%,-10%: Decreasing O&M cost rate

<Table B-6> Sensitivity analysis of Gomun small scale hydroelectric power plant

Increasing rate of unit price of electricity sale (%)	SMP (won/KWh)	IRR (%)
.	60.42	1.55
5	63.44	2.01
12	67.67	2.62

Decreasing rate of total Investment Cost (%)	Total Investment Cost (million won)	IRR (%)
.	4,180	1.55
5	3,971	2.03
10	3,762	2.55

Increasing Electricity generation (%)	Electricity generation (MWh)	IRR (%)
.	5,251	1.55
5	5,514	2.01
10	5,776	2.45

Decreasing O&M cost rate (%)	O&M cost rate (%)	IRR (%)
.	3.12%	1.55
5	2.96%	1.74
10	2.81%	1.93

<Table B-7> Sensitivity analysis of Dongjin-river small scale hydroelectric power plant

Increasing rate of unit cost of electricity sale (%)	SMP (won/KWh)	IRR (%)
.	77.55	5.38
5	81.43	5.85
12	86.86	6.48

Decreasing rate of total Investment Cost (%)	Total Investment Cost (million won)	IRR (%)
.	3,522	5.38
5	3,346	5.89
10	3,170	6.45

Increasing Electricity generation (%)	Electricity generation (MWh)	IRR (%)
.	4,983.04	5.38
5	5,232.19	5.85
10	5,481.34	6.30

Decreasing O&M cost rate (%)	O&M cost rate (%)	IRR (%)
.	3.00%	5.38
5	2.85%	5.51
10	2.70%	5.64

<Table B-6>, <Table B-7> shows the result of sensitivity analysis. As it can be seen, the project IRR is still lower than discount rate although the price of electricity increases, total investment cost decreases, electricity generation increases, and O&M cost decreases, respectively.

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B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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1. Project Emissions

The project is a hydroelectric power project: it does not give rise to direct GHG emissions. Therefore, no formulae for calculation of direct emissions are provided here.

2. Baseline Emissions

Depending on "Tool to calculate the emission factor for an electricity system(Version 01.1)", baseline emissions should be obtained by the below equation (4)

$$BE_y = (EG_y - EG_{baseline}) \cdot EF_y \quad (4)$$

Where,

BE_y : Baseline emissions (in tCO_2)
EG_y : Electricity supplied by the project activity to the grid (in MWh)
$EG_{baseline}$: Baseline electricity supplied to the grid in the case of modified or retrofit facilities (in MWh)
EF_y : Baseline emissions factor (in tCO_2/MWh)
y : Refers to a given year

However $EG_{baseline}$ is zero because there are no modified or retrofit facilities in this project. Therefore the baseline emissions (BE_y) can be calculated as follows;

$$BE_y = EG_y \cdot EF_y \quad (5)$$

The baseline emission factor (EF_y) calculations will be based on the "Tool to calculate the emission factor for an electricity system(Version01.1)".

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM\,y} + w_{BM} \cdot EF_{grid,BM,\,y} \quad (3)$$

Where,

$EF_{grid,CM,y}$: Baseline emission factor (tCO_2/MWh)
w_{OM} : Operation Margin weight, which is 0.5 by default
w_{BM} : Build Margin weight, which is 0.5 by default
$EF_{grid,OM,y}$: Operational Margin emission factor (tCO_2/MWh)
$EF_{grid,BM\,,y}$: Build Margin emission factor (tCO_2/MWh)
Y : Refers to a given year

Operational Margin emission factor ($EF_{grid,OM,y}$) is obtained based on 'Simple OM method'. Build Margin emission factor ($EF_{grid,BM\,,y}$) is estimated as *Option* 1 ($EF_{BM,y}$ *ex-ante*).

The OM emission factors is calculated as follows,

$$EF_{grid\,,OMSimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,j}}{\sum_{m} EG_{m,y}} \quad (1)$$

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Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,m,y}$	=	Amount of fossil fuel type i consumed by power plant/unit m in year y (mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{m,y}$	=	Net electricity generated and delivered to the grid by power plant/unit m in year y (MWh)
m	=	All power plants/units serving the grid in year y except low-cost/must-run power plants/units
i	=	All fossil fuel types combusted in power plant/unit m in year y
y	=	Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in step 2

The emission factor of Build margin is calculated using the following equation:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}} \quad \textbf{(2)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation data is available

<Table B-8>Annual electricity generation and baseline emission of wind power plant

Category	Annual electricity generation
Operational Margin emission factor ($EF_{OM,y}$)	0.6817(tCO_2/MWh)
Build Margin emission factor ($EF_{BM,y}$)	0.3933(tCO_2/MWh)
Baseline emission factor(EF_y)	0.5375(tCO_2/MWh)
Project electricity generation(EG_y)	10,234(MWh/yr)
Baseline emission(BE_y)	5,501(tCO_2 /yr)

3. Emission reduction

Project emission reduction = BE (Baseline emissions) − PE (Project emissions)

4. Leakage

Leakage due to the project activity is not occurred.

The calculation result of the OM/BM refers to the section B.4 and Annex 3.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	EFy
Data unit:	tCO_2/MWh
Description:	CO_2 emissions intensity of the electricity displaced
Source of data used:	Calculated
Value applied:	0.5375 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value was calculated according to "Tool to calculate the emission factor for an electricity system (version 01.1)." Applied value was calculated by referring Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO) and Status of Generation facility (2008) (Korea Power Exchange).
Any comment:	-The same value will be applied during the first crediting period without updating. -For detail calculation method, refer to Annex 3.

Data / Parameter:	$EF_{OM, y}$
Data unit:	tCO_2/MWh
Description:	Operating Margin emission factor
Source of data used:	Calculated
Value applied:	0.6817 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value was calculated according to "Tool to calculate the emission factor for an electricity system (version 01.1)." Applied value was calculated by referring Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO) and Status of Generation facility (2008) (Korea Power Exchange).
Any comment:	-This data will be calculated at the time of PDD submission and will not be changed during the first crediting period. - This value is ex-ante value which is calculated at the time of PDD submission and will be applied during the crediting period without update.

Data / Parameter:	$EF_{BM, y}$
Data unit:	tCO_2/MWh
Description:	Build Margin emission factor
Source of data used:	Calculated
Value of data	0.3933 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value was calculated according to "Tool to calculate the emission factor for an electricity system (version 01.1)." Applied value was calculated by referring Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO) and Status of Generation facility (2008) (Korea Power Exchange).
Any comment:	-This data will be calculated at the time of PDD submission and will not be changed during the first crediting period. - This value is ex-ante value which is calculated at the time of PDD submission and will be applied during the crediting period without update.

Data / Parameter:	$FC_{i,m,y}$
Data unit:	mass or volume unit
Description:	Amount of fossil fuel type i consumed by power plant / unit m in year y
Source of data used:	Statistics of electric power in KOREA (KEMCO)
Value of data	See the <Table Annex-1>
Justification of the choice of data or description of measurement methods and procedures actually applied :	Applied value was referred Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO).
Any comment:	- The same value will be applied during the first crediting period without updating.

Data / Parameter:	$NCV_{i,v}$
Data unit:	mass or volume unit
Description:	Amount of fossil fuel type i consumed by power plant / unit m in year y
Source of data used:	Statistics of electric power in KOREA (KEMCO)
Value of data	See the <Table Annex-2>
Justification of the choice of data or description of measurement methods and procedures actually applied :	Applied value was referred Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO).
Any comment:	- $NCV_{i,v}$ is the $GCV_{i,v}$ multiplied the Net caloric values conversion factor. - $GCV_{i,v}$ value was referred Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO) and Net caloric values conversion factor was referred 2006 IPCC Guidelines for National Greenhouse Gas Inventories. - The same value will be applied during the first crediting period without updating.

Data / Parameter:	$EF_{CO2,i,y}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of fossil fuel type i in year y
Source of data used:	2006 IPCC Guidelines on National GHG Inventories
Value of data	See the <Table Annex-5>
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values at the lower limit of the uncertainty at 95% confidence interval as provided in table 1.4 of Chpter1 of Vol.2(Energy)
Any comment:	- The same value will be applied during the first crediting period without updating.

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The calculation of the OM and BM emission factors were submitted to DOE as an excel file. It's including following information:

- Information to clearly identify the plant
- The date of commissioning
- The fuel type(s) used
- The quantity of net electricity generation in the relevant year(s)
- The fuel consumption of each fuel type in the relevant year(s)
- Information of a low-cost/must-run plant

B.6.3 Ex-ante calculation of emission reductions:

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Baseline emission

−Gomun

The capacity of the project is 1.5MW and expected electricity produced by the project is 5,251 MWh per year.

EFy is 0.5375tCO_2/MWh and for detail calculation method, **refer to Annex 3.**

Baseline emission = electricity produced by the project * emission coefficient
= 5,251MWh/yr * 0.5375tCO_2/MWh
= **2,822 tonCO_2/yr**

−Dongjin-river

The capacity of the project is 0.85MW and expected electricity produced by the project is 4,983 MWh per year.

EFy is 0.5375tCO_2/MWh and for detail calculation method, **refer to Annex 3.**

Baseline emission = electricity produced by the project * emission coefficient
= 4,983MWh/yr * 0.5375tCO_2/MWh
= **2,678 tonCO_2/yr**

Project emission

Project emission is zero

Ex-ante emission reduction

-Emission reduction = Baseline emission – Project emission
= (2,822 + 2,678) tonCO_2/yr – 0 tonCO_2/yr
= **5,501 tonCO_2/yr**

* The generation capacity refers to the Annex 3.

B.6.4 Summary of the ex-ante estimation of emission reductions:

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<Gomun small scale hydroelectric power plant >

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Aug2009~Jul 2010	0	2,822	0	2,822
Aug 2010~Jul 2011	0	2,822	0	2,822
Aug 2011~Jul 2012	0	2,822	0	2,822
Aug 2012~Jul 2013	0	2,822	0	2,822
Aug 2013~Jul 2014	0	2,822	0	2,822
Aug 2014~Jul 2015	0	2,822	0	2,822
Aug 2015~Jul 2016	0	2,822	0	2,822
Aug 2016~Jul 2017	0	2,822	0	2,822
Aug 2017~Jul 2018	0	2,822	0	2,822
Aug 2018~Jul 2019	0	2,822	0	2,822
Total (tonnes of CO_2e)	**0**	**28,220**	**0**	**28,220**

<Dongjin-river small scale hydroelectric power plant >

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Aug2009~Jul 2010	0	2,678	0	2,678
Aug 2010~Jul 2011	0	2,678	0	2,678
Aug 2011~Jul 2012	0	2,678	0	2,678
Aug 2012~Jul 2013	0	2,678	0	2,678
Aug 2013~Jul 2014	0	2,678	0	2,678
Aug 2014~Jul 2015	0	2,678	0	2,678
Aug 2015~Jul 2016	0	2,678	0	2,678
Aug 2016~Jul 2017	0	2,678	0	2,678
Aug 2017~Jul 2018	0	2,678	0	2,678
Aug 2018~Jul 2019	0	2,678	0	2,678
Total (tonnes of CO_2e)	**0**	**26,780**	**0**	**26,780**

* Detailed calculation contents were submitted to DOE as an excel file.

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	EGy_{Gomun}/ $EGy_{Dongjin\text{-}river}$
Data unit:	MWh
Description:	Electricity supplied to the grid by the project
Source of data to be used:	Measured
Value of data	5,251MWh/yr / 4,983MWh/yr
Description of measurement methods and procedures to be applied:	Read from watt-hour meter.
QA/QC procedures :	- Uncertainty of data is low - QA/QC procedure for this is planned. - The allowable error of data must be within ± 0.5%.
Any comment:	- Data will be measured hourly and recorded monthly. - Data will be kept for two years after the last issuance of CERs for this project activity. - Data will be aggregated weekly, monthly and yearly - Measured data will be double checked against receipt of sales - This data is electricity generated except electricity consumed in the plant and electricity imported for the project activity.

Data / Parameter:	Auxiliary
Data unit:	MWh/yr
Description:	Auxiliary consumption of electricity
Source of data to be used:	measured
Value of data	N/A in the PDD.
Description of measurement methods and procedures to be applied:	Read from watt-hour meter.
QA/QC procedures to be applied:	- If necessary, QA/QC procedure is same as QA/QC procedure for EGy. - If electricity for the project activity is imported from the grid, watt-hour meter is not maintained by the project participant. In this case, watt-hour meter is maintained by KPX (Korea Power Exchange) and QA/QC will be performed by KPX.
Any comment:	- Data will be measured hourly and recorded monthly. - Data will be kept for two years after the last issuance of CERs for this project activity. - Data will be aggregated weekly, monthly and yearly - If the electricity for the project activity is imported from the grid, measured data will be double checked against receipt of purchase. - This data is electricity consumed in the plant and it can be part of gross generation or electricity imported from the grid.

	- This data will be excepted from gross generation by the plant when EGy is monitored.

Quality control (QC) and quality assurance (QA) procedures

1. Monitoring equipment

1-1. Electricity measuring meters shall be set up transparently in accordance with "Law regarding measurement" and "Act on operation of electricity market" and shall be sealed after affirmation of Korea Power Exchange.
1-2. The meters shall be approved through the certified official process (the valid period for the authorized certification: 7 years.)
1-3. The meters shall be calibrated when they are installed, and re-calibrated every three years after installation regularly.

2. Measure & Archive

2-1. The amount of electricity transmitted to the grid shall be measured automatically by established meters. The measured data are simultaneously transferred to Hydroelectric Power Plant and Korea Power Exchange.
2-2. The measured amount of electricity shall be collected daily, weekly, and monthly and shall be archived in electronic way.
2-3. The collected data in article 2-2. shall be compared with those of Korea power Exchange.
2-4. If the two data compared in article 2-3. are different, the operation condition of electricity meters and other equipments shall be examined. In case meters are improperly operated, internal audits and correction procedure shall be implemented and be certified by the final decision-maker and Korea Power exchange.

3. Management of monitoring and electricity safety

3-1. The person in charge of monitoring and electricity safety shall attend the following courses three times per year.
- Course on 'Law regarding measurement'
- Course on 'Act on operation of electricity market
- Course on Electricity safety

3-2. In case of absence of the responsible person, the second responsible person shall be selected.
3-3. If the responsibility for monitoring and electricity safety is transferred to another person, it is needed to be approved by the final decision-maker.

B.7.2 Description of the monitoring plan:

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Applied monitoring methodology for the project is AMS I.D. and electricity produced will be monitored. Also, related facility including watt-meter will be managed properly. Operational and management structure is as follow:

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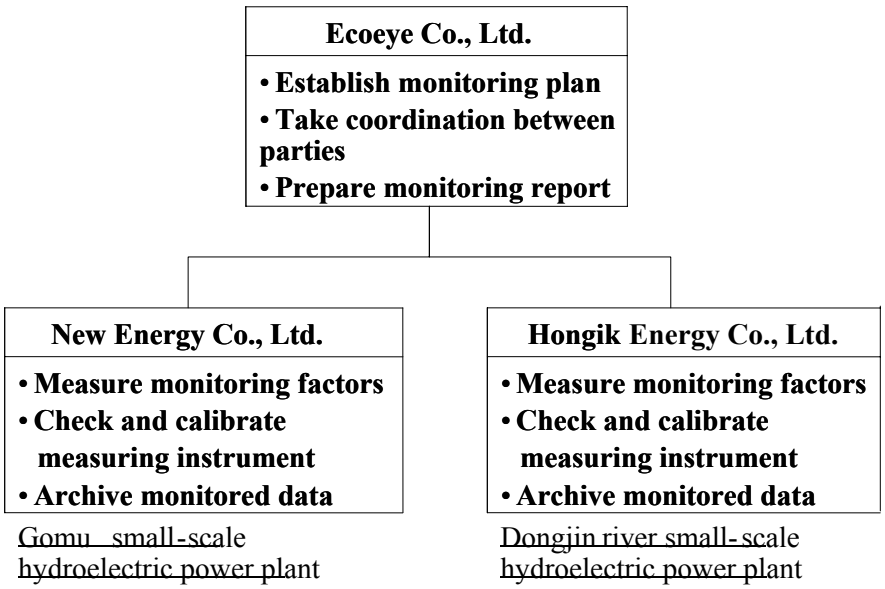
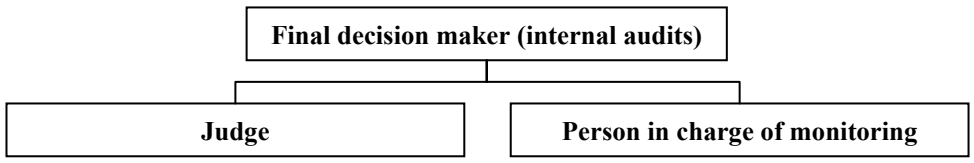


<Figure B-1> Operational and management structure

<Table B-9> Monitoring plan

1. Monitoring structure & duties



position	duties
Final decision maker	- General management of the small hydroelectric power plant
Judge	- Separate from final decision maker, supervision of proper implementation of the monitoring.
Person in charge of monitoring	- recording of electricity imported and exported - inspection & correction of the meters - kept for documents

2. Internal audits

2.1 Internal audits
Internal audits mean as inspected internally whether planned decision and requirement of monitoring are properly operated or not.

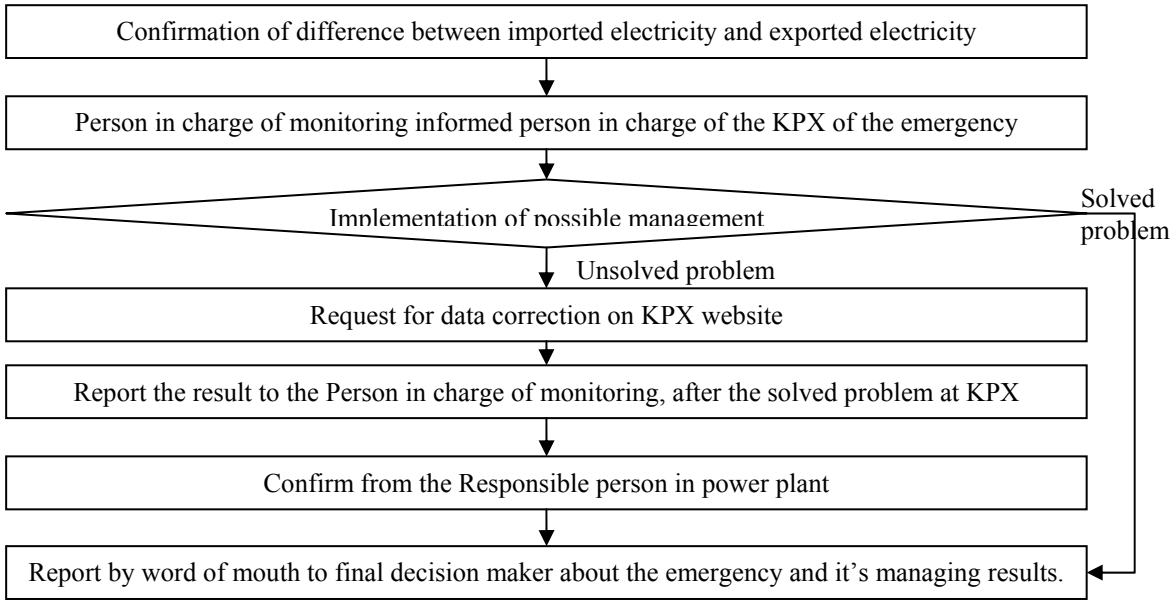
	frequency
Regular Inspector	Regular inspector implement once in every two years.
Occasional Inspector	Occasional inspector implement in case of the Final decision maker's decision.

2.2 Data of internal audits
- Comparison with internal electricity exported records and receipts
- Comparison with internal electricity imported records and receipts
- Conformation observance of preserved condition and record periods
- Observance of periods of measuring equipment Inspection & correction.
- Conformation of Management register of measuring equipment

3. Emergency

-Electricity comparison with meter and receipt

In case the error occurred in meters follow next process.



4. Inspection & correction of the measuring equipments

4.1 Inspection of the measuring equipments
Inspects once in 3years in conformity with the reliable law.

4.2 Allowable error
Allowable error between the meters and record meters is ±0.5%.

4.3 Management register of measuring equipment
Record the management diary about result of Inspection & correction and it's managing, considering measuring equipment respectively.
And it is kept for two years after the end of crediting period.

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B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

- Date of completion of the application of the methodology
: 12/03/2007
- Responsible person/entity
: Dr. Jung, Jae soo / Ecoeye Co., Ltd

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>

The dates of contract for hydroelectric power plant construction work are followed:

The Gomun small-scale hydroelectric power plant: 27/09/2005
The Dongjin-river small-scale hydroelectric power plant: 18/12/2006

C.1.2. Expected operational lifetime of the project activity:

>>

- The Gomun small-scale hydroelectric power plant: 30 years
- The Dongjin-river small-scale hydroelectric power plant: 30 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>>

N/A

C.2.1.2. Length of the first crediting period:

>>

N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

01/08/2009 or Registration date whatever is later.

C.2.2.2. Length:

>>

10 years

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SECTION D. Environmental impacts

>>

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

According to the Korean Environmental Law, the Act on Assessment of Impacts, and the projects whose facility is less than 10MW does not have to be require EIA (Environmental Impact Assessment).

The reason why, 1.5MW Gomun and 0.85MW Dongjin-river hydroelectric power plants project (total capacity of facility: 2.35MW) is not the object of EIA.

Although this project didn't have duty to be conducted in general procedure of EIA, project participants, New Energy Co., Ltd and Hongik Energy Co., Ltd, have tried to anticipate the expected environmental impacts by studying the effects on the natural environment, life environment, and social economy environment of similar projects thoroughly.

After the analysis of similar projects, project participants figure out there are no serious environmental impacts. That is, this project is able to support sustainable development.

* The detailed contents of EIA about similar projects were submitted to DOE as a CD file.

They observe the related law under construction. And they tried to mitigate the environmental effects.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

− Gomun and Dongjin-river small-scale hydroelectric power project stakeholders & the process getting comments

• Stakeholders

Stakeholders	Gomun	Dongjin-river
Authorities related to these projects	-Gyeonggi-do -Yeoncheon-gun	-Jeollabuk-do -Jeongeup-si
Other stakeholders	-Local Residents(fishermen)	-Local Residents

• The process getting comments

1) The local press reports the proposed project.

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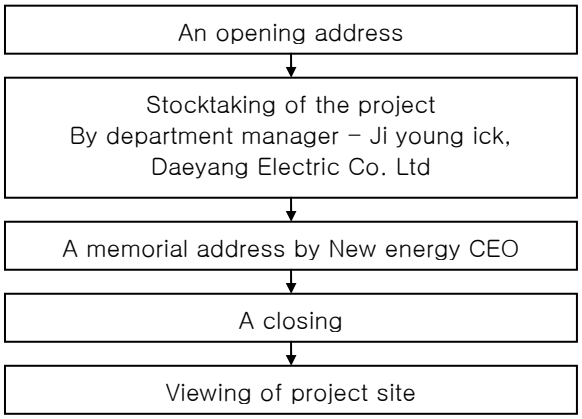
<Table E-1> Activities for inviting and comments from local residents near the hydroelectric power plant

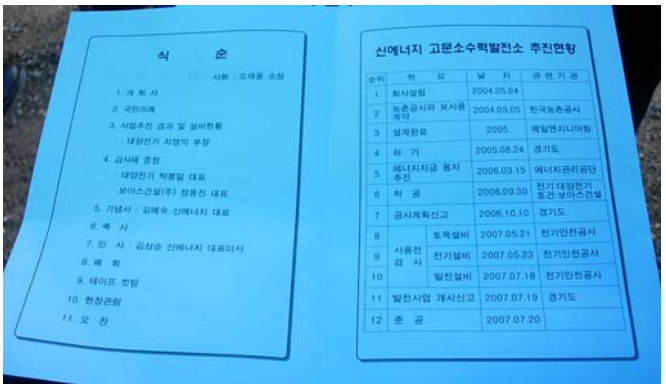
method	content	date
News release	 "The completion of the unattended system small hydroelectric power plant in Gomun-ri, Yeoncheon-gun" Source: E2NEWS, www.e2news.com/	20 Jul 2007
News release	 "First domestic nongovernmental small hydroelectric power plant, Gomun hydroelectric power plant, promotes CDM certification" Source: Electimes, www.electimes.com/	25 Jul 2007
News release	 "First domestic nongovernmental small hydroelectric power plant promotes CDM" This mentioned Gomun and Dongjin-river small-scale hydroelectric power plants. Source: The energy Economic News, www.eenews.co.kr	21 Jul 2007

method	content	date
News release	 "The birth of hydroelectric power plant using the reservoir for irrigation" This mentioned Gomun small-scale hydroelectric power plants. Source: The gas Industry News, www.enn.co.kr	20 Jul 2007

2) Presentation at the ceremony for the completion (Gomun small-scale hydroelectric power plant)

New energy co., ltd has announced "the overview of Gomun small-scale hydroelectric power plant" to the residents at the front of the office of Gomun small-scale hydroelectric power plant in 20 July 2007.





<Figure E-1> the program of ceremony

3) Explanation at the Ground-breaking ceremony (Dongjin-river small-scale hydroelectric power plant)

Hongik Energy Co., ltd has announced "the overview of Dongjin-river small-scale hydroelectric power plant" to the residents near the project site in 7 Sept 2007.

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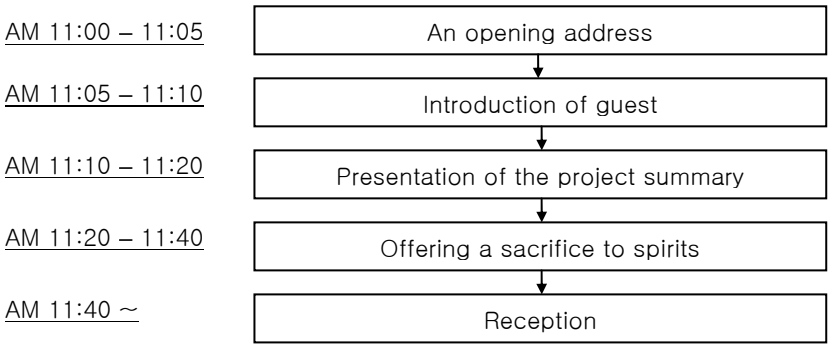

<Figure E-2> the program of ceremony

E.2. Summary of the comments received:

>>

<Table E-2> Summary of stakeholders' comments (Gomun small-scale hydroelectric power plant)

Stakeholder	Comment	Date
Gyeonggi-do	For issue "the permit of the Electricity Enterprise" • Request for issue "the permit of the Occupation of River site" • The project participant has a prior consultation with local fisherman. • To avoid civil appeal, the presentation should be held after the issue "the permit of the Electricity Enterprise"	22 Nov 2005
Yeoncheon-gun	For issue "the permit of the Occupation of River site" • If there is any damage caused by administrative problem, the project participant pays for damage.	5 Jan 2006
Local residents	• There is no special comment.	20 Jul 2007
fisherman	• No change in the regular course for fish after the operation of the plant • Do not damage to the fishing net. (If there is any damage, the project participant has to compensate for the loss of the fisherman.) • Guarantee right of way to fisherman always after the completion of the power plant.	25 Sep 2006
Regional NGO	• Project participant (New energy Co., Ltd) left the earth and sand which come from power plant construction. And it damaged natural view.	Jun 2007

<Table E-3> Summary of stakeholders' comments (Dongjin-river small-scale hydroelectric power plant)

Stakeholder	Comment	Date
Jeollabuk-do	For issue "the permit of the Electricity Enterprise" • Request for issue "the permit of the Occupation of River site" • To avoid civil appeal, the presentation should be held after the issue "the permit of the Electricity Enterprise"	9 Feb 2007
Jeongup-si	For issue "the permit of the Occupation of River site" • If there is any damage caused by administrative problem, the project participant pays for damage.	5 Dec 2006
Local residents	•There is no special comment.	7 Sep 2007

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E.3. Report on how due account was taken of any comments received:

>>

Common Fact

These project participants listened to stakeholders needs carefully and observed strictly the related laws & regulations. Also, they obtained essential warranties, for example "The permit of the Electricity Enterprise", " The permit of the Occupation of River site" etc.
Essential warranties present in following <Table E-4>, <Table E-5>.
And, they have planned to hold the meeting with local residents at stated periods.

Gomun small-scale hydroelectric power plant

The fisherman has objected to default on articles; No change in the regular course for fish after the operation of the plant. The project participant have claimed that problem could be solved through the introduction of unmanned system which was planned to operate at early 2008. Also, the Hantan-river Dam will construct in 3-4years at upstream. Then, water level will be stable.
Therefore, the fisherman has requested for them to keep the above plans.

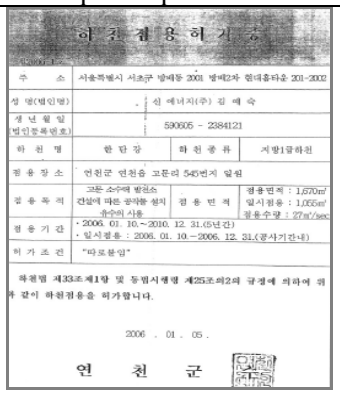
And, New energy Co., Ltd tried to solve the problem which proposed from regional NGO and brings back to river's former condition.

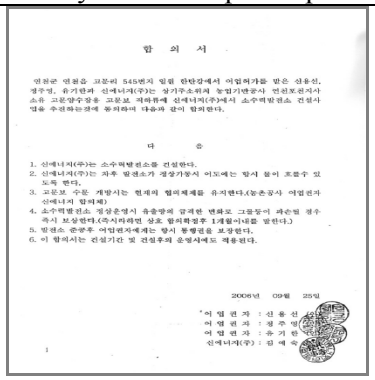
Dongjin-river small-scale hydroelectric power plant

Local residents are favorable to the power plant construction. So there is no special comment.

<Table E-4> documents in relation to Gomun small-scale hydroelectric power plant

<table>
<tr>
<td> 

"The permit of the Electricity Enterprise" of the Gomun small-hydroelectric power plant is issued.</td>
<td> 

"The permit of the Occupation of River site" of the Gomun small-hydroelectric power plant is issued.</td>
</tr>
<tr>
<td> 

Draw up a written agreement between "New energy" and three local fishermen.</td>
<td> 

The presentation of the Gomun small-hydroelectric power plant was held and there is no comment.</td>
</tr>
</table>

<Table E-5> documents in relation to Dongjin-river small-scale hydroelectric power plant

전북 제2007-10호

발전사업허가증

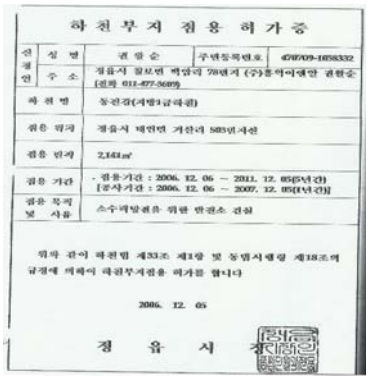
① 상 호(명칭)	주식회사 종익이엔알			
② 주소(소재지)	전북 정읍시 칠보면 백암리 78번지			
③ 대표자 성명	권 할 순	④ 전화	063)534-3358	
⑤ 사업의 내용	소수력 발전소			
⑥ 전기사업용 전기설비에 관한 사항	설치장소	전북 정읍시 대인면 거산리 503의 3필지		
	원동력의 종 류	소수력 발전	설비용량	850Kw
	공급전압	22.9kv	주파수	60Hz
⑦ 특정한 공급구역				
⑧ 사업의 준비기간	허가일로부터 2년			
⑨ 허가의 조건	붙임 "전기사업 허가조건" (도시계획 의 9분야)			
⑩ 기 타				

전기사업법 제7조 및 동법 시행규칙 제6조의 규정에 의하여 위와 같이 발전사업을 허가합니다.

2007년 2월 9일

전 라 북 도 지

"The permit of the Electricity Enterprise" of the Dognjin-river small-hydroelectric power plant is issued.



하 천 부 지 점 용 허 가 증

신청인	성 명	권 할 순	주민등록번호 470709-1058332
	주 소	정읍시 칠보면 백암리 78번지 (주)종익이엔알 권할순 (전화 011-477-3609)	
하 천 명		동진강(제명1급하천)	
점용 위치		정읍시 대인면 거산리 503번지선	
점용 면적		2,141㎡	
점용 기간		· 점용기간 : 2006. 12. 06 ~ 2011. 12. 05(5년간) [공사기간 : 2006. 12. 06 ~ 2007. 12. 05(1년간)]	
점용 목적 및 사용		소수력발전을 위한 한권소 건설	

위와 같이 하천법 제33조 제1항 및 동법시행령 제18조의 규정에 의하여 하천부지점용 허가를 합니다

2006. 12. 05

정 읍 시

"The permit of the Occupation of River site" of the Dognjin-river small-hydroelectric power plant is issued.

The presentation of the Dongjin-river small-hydroelectric power plant was held and there is no comment.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	**Ecoeye Co., Ltd**
Street/P.O.Box:	153
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FAX:	+82-31-716-1848
E-Mail:	
URL:	http://www.ecoeye.com
Represented by:	
Title:	President &CEO
Salutation:	Dr.
Last Name:	Jung
Middle Name:	
First Name:	Jae soo
Department:	
Mobile:	+82-19-331-1675
Direct FAX:	+82-31-716-1848
Direct tel:	+82-31-716-1648
Personal E-Mail:	civilenvi@ecoeye.com

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Street/P.O.Box:	
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Postfix/ZIP:	
Country:	Republic of Korea
Telephone:	+82-31-834-6550
FAX:	+82-31-834-6551
E-Mail:	ybsy1959@ hanmail.net
URL:	
Represented by:	
Title:	President &CEO
Salutation:	Mrs.
Last Name:	Kim
Middle Name:	
First Name:	Ye Suk
Department:	
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Direct FAX:	+82-31-834-6551

Direct tel:	+82-31-834-6550
Personal E-Mail:	ybsy1959@hanmail.net

Organization:	**Hongik Energy Co., Ltd**
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State/Region:	Geosan-ri, Taein-myeon, Jeongeup-si
Postfix/ZIP:	
Country:	Republic of Korea
Telephone:	+82-43-733-5331
FAX:	+82-43-733-5320
E-Mail:	ksangseung@korea.com
URL:	
Represented by:	
Title:	President &CEO
Salutation:	Mr.
Last Name:	Kwon
Middle Name:	
First Name:	Wal Soon
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Personal E-Mail:	Gweon38@naver.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding invested for this project.

Annex 3

BASELINE INFORMATION

<Table Annex-1> Data on fuel consumption for plants in the Operating Margin

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
2005	Honam	#1	870,214	961	278	-
		#2	912,497	338	185	-
	Samchonpo	#1	1,534,223	-	1,220	-
		#2	1,731,265	-	626	-
		#3	1,723,152	-	377	-
		#4	1,632,334	-	1,029	-
		#5	1,516,654	-	1,415	-
		#6	1,546,663	-	1,001	-
	Yonghung	#1	2,081,972	-	4,541	-
		#2	1,761,395	-	2,903	-
	Boryeong	#1	1,440,343	-	761	-
		#2	1,388,532	-	551	-
		#3	1,589,150	-	90	-
		#4	1,421,343	-	603	-
		#5	1,587,999	-	156	-
		#6	1,260,305	-	627	-
	Taean	#1	1,508,570	-	621	-
		#2	1,323,078	-	395	-
		#3	1,494,175	-	650	-
		#4	1,383,297	-	365	-
		#5	1,411,398	-	742	-
		#5	1,504,962	-	417	-
	Hadong	#1	1,513,930	-	284	-
		#2	1,410,099	-	792	-
		#3	1,422,196	-	472	-
		#4	1,511,054	-	567	-
		#5	1,345,648	-	614	-
		#6	1,520,774	-	331	-
	Dangjin	#1	1,438,702	-	637	-
		#2	1,437,473	-	632	-
		#3	1,549,041	-	141	-
		#4	1,544,010	-	134	-

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
		#5	499,714	-	5,701	-
		#6	38,671	-	1,779	-
	Ulsan	#1	-	70,183	750	-
		#2	-	67,296	585	-
		#3	-	53,085	662	-
		#4	-	375,417	1,971	-
		#5	-	363,992	1,676	-
		#6	-	352,776	1,708	-
	Youngnam	#1	-	359,910	844	-
		#2	-	190,085	584	-
	Yosu	#1	-	106,919	434	-
		#2	-	218,356	346	-
	Pyongtaek	#1	-	293,214	118	3,553
		#2	-	321,188	140	2,641
		#3	-	308,042	132	1,784
		#4	-	311,245	138	2,047
	Namjeju	#1	-	14,628	15	-
		#2	-	15,031	12	-
	Jeju	#1	-	12,564	12	-
		#2	-	129,516	-	-
		#3	-	122,866	48	-
	Seoul	#4	-	-	-	49,143
		#5	-	-	1	108,761
	Incheon	#1	-	-	-	4,365
		#2	-	-	-	8,505
		#3	-	-	372	746
		#4	-	-	400	6,620
	Pyongtaek C/C	C/C	-	-	1	110,953
	Ilsan	C/C	-	-	-	533,188
	Bundang	C/C	-	-	-	671,944
	Ulsan	C/C	-	-	-	470,131
	Seoincheon	C/C	-	-	335	989,645
	Shinincheon	C/C	-	-	-	1,458,763
	Boryeong	C/C	-	-	-	1,161,510
	Incheon	C/C	-	-	-	281,813
	Busan	C/C	-	-	-	1,211,144
	Hallim	C/C	-	-	29,686	-

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
	Anyang	C/C	-	-	-	261,202
	Bucheon	C/C	-	-	-	261,705
	POSCO POWER	C/C	-	-	-	445,253
	G S Bugog	C/C	-	-	-	297,976
	Yulchon	C/C	-	-	159	194,534
	Namjeju	D/P	-	56,727	37	-
	Jeju	G/T	-	-	2,869	-
	Jeju	D/P	-	31,808	72	-
2006	Honam	#1	781,139	1,113	279	
		#2	859,736	1,251	359	
	Samchonpo	#1	1,696,271		860	
		#2	1,508,082		1,362	
		#3	1,519,385		457	
		#4	1,521,263		1,818	
		#5	1,665,339		977	
		#6	1,770,348		428	
	Yonghung	#1	2,004,193		2,548	
		#2	2,129,118		2,545	
	Boryeong	#1	1,638,140		306	
		#2	1,389,425		1,137	
		#3	1,323,779		514	
		#4	1,610,928		82	
		#5	1,296,455		541	
		#6	1,553,273		518	
	Taean	#1	1,354,832		514	
		#2	1,532,209		162	
		#3	1,338,967		575	
		#4	1,548,909		133	
		#5	1,542,775		544	
		#6	1,294,577		1,113	
		#7	61,910		4,799	
	Hadong	#1	1,373,049		515	
		#2	1,543,074		293	
		#3	1,549,094		153	
		#4	1,376,612		796	
		#5	1,554,524		242	
		#6	1,371,801		690	

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
	Dangjin	#1	1,380,527		966	
		#2	1,570,077		161	
		#3	1,402,916		433	
		#4	1,386,317		1,549	
		#5	1,456,458		745	
		#6	1,216,582		3,051	
		#7	1,008		505	
	Ulsan	#1		72,243	605	
		#2		80,187	469	
		#3		96,459	518	
		#4		360,919	3,729	
		#5		375,985	3,678	
		#6		378,331	3,694	
	Youngnam	#1		107,090	1,016	
		#2		95,127	1,494	
	Yosu	#1		99,129	281	
		#2		215,957	291	
	Pyongtaek	#1		261,458	141	3,997
		#2		277,025	166	5,687
		#3		303,858	134	3,891
		#4		245,602	103	3,473
	Namjeju	#1		11,406	17	
		#2		9,772	14	
		#3		46,504	2,509	
	Jeju	#1		8,603	23	
		#2		113,679	64	
		#3		117,464	67	
	Seoul	#4			1	69,383
		#5			1	152,891
	Incheon	#1				6,945
		#2				5,223
		#3			311	15,426
		#4			311	12,454
	Pyongtaek C/C	C/C			45	84,054
	Ilsan	C/C			1,384	556,504
	Bundang	C/C				720,381
	Ulsan	C/C				536,196

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
	Seoincheon	C/C			1,066	1,199,196
	Shinincheon	C/C				1,641,038
	Boryeong	C/C				998,683
	Incheon	C/C				484,606
	Busan	C/C				1,396,417
	Hallim	C/C			48,475	
	Anyang	C/C				230,969
	Bucheon	C/C			215	225,713
	POSCO POWER	C/C				408,018
	G S Bugog	C/C				389,811
	Yulchon	C/C				315,132
	Namjeju	D/P		51,347	111	
	Jeju	G/T			8,264	
	Jeju	D/P		52,907		
2007	Honam	#1	866,853	889	281	
		#2	846,931	811	262	
	Samchonpo	#1	1,631,706		296	
		#2	1,804,695		384	
		#3	1,755,374		434	
		#4	1,543,140		677	
		#5	1,850,764		315	
		#6	1,714,320		619	
	Yonghung	#1	1,902,557		3,320	
		#2	2,296,289		1,779	
		#3	119,883		3,964	
		#4				
	Boryeong	#1	1,466,761		811	
		#2	1,655,488		169	
		#3	1,648,008		187	
		#4	1,347,303		646	
		#5	1,629,904		195	
		#6	1,490,809		387	
	Taean	#1	1,524,391		410	
		#2	1,434,221		374	
		#3	1,521,349		350	
		#4	1,320,380		422	
		#5	1,342,358		676	

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
		#6	1,535,931		491	
		#7	1,430,171		2,321	
		#8	919,055		3,636	
	Hadong	#1	1,582,726		178	
		#2	1,396,830		637	
		#3	1,424,033		375	
		#4	1,572,409		292	
		#5	1,486,776		452	
		#6	1,585,307		109	
	Dangjin	#1	1,512,904		269	
		#2	1,358,316		543	
		#3	1,516,065		119	
		#4	1,519,231		342	
		#5	1,279,796		1,038	
		#6	1,281,318		878	
		#7	1,059,612		6,681	
		#8	467,807		4,873	
	Ulsan	#1		107,844	406	
		#2		108,381	483	
		#3		120,571	576	
		#4		341,170	3,525	
		#5		370,712	4,711	
		#6		216,409	3,021	
	Youngnam	#1		174,082	1,232	
		#2		122,249	796	
	Yosu	#1		121,572	332	
		#2		257,420	367	
	Pyongtaek	#1		269,284	114	3,316
		#2		359,870	140	6,339
		#3		349,481	157	4,874
		#4		255,443	117	4,047
	Namjeju	#1				
		#2				
		#3		124,559	225	
		#4		127,900	341	
	Jeju	#1		1,049	4	
		#2		70,122	112	

Year	Plant		Amount of fossil fuel($FC_{i,m,y}$)			
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)
		#3		98,846	34	
	Seoul	#4			1	75,080
		#5			1	206,908
	Incheon	#1				30,402
		#2				31,528
		#3			354	41,270
		#4			201	18,892
	Pyongtaek C/C	C/C			67	151,414
	Ilsan	C/C				635,260
	Bundang	C/C			3	660,899
	Ulsan	C/C				649,494
	Seoincheon	C/C				1,495,687
	Shinincheon	C/C				1,761,001
	Boryeong	C/C				1,121,251
	Incheon	C/C				494,690
	Busan	C/C				1,552,997
	Hallim	C/C			17,753	
	Anyang	C/C				289,384
	Bucheon	C/C				269,651
	POSCO POWER	C/C				660,445
	G S Bugog	C/C				371,586
	Yulchon	C/C				292,336
	Namjeju	D/P		35,297	238	
	Jeju	G/T			850	
	Jeju	D/P		49,613		

Source: Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO)

<Table Annex-2> Net Caloric Value

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	**Heavy oil (kcal/l)**	**Diesel oil (kcal/l)**	**L. N. G (kcal/kg)**
2005	Honam	#1	5,122	9,343	8,368	
		#2	5,107	9,362	8,364	
	Samchonpo	#1	5,618		8,399	
		#2	5,628		8,439	
		#3	5,602		8,550	
		#4	5,603		8,496	
		#5	5,079		8,183	
		#6	5,107		8,550	
	Yonghung	#1	5,824		8,488	
		#2	5,750		8,500	
	Boryeong	#1	5,539		8,496	
		#2	5,525		8,496	
		#3	5,588		8,303	
		#4	5,596		8,311	
		#5	5,588		8,312	
		#6	5,606		8,312	
	Taean	#1	5,700		8,257	
		#2	5,708		8,249	
		#3	5,707		8,242	
		#4	5,699		8,270	
		#5	5,730		8,242	
		#5	5,716		8,256	
	Hadong	#1	5,703		8,493	
		#2	5,697		8,481	
		#3	5,698		8,533	
		#4	5,699		8,491	
		#5	5,695		8,526	
		#6	5,695		8,481	
	Dangjin	#1	5,664		8,392	
		#2	5,664		8,469	
		#3	5,638		8,402	
		#4	5,644		8,387	
		#5	5,809		8,458	
		#6	5,910		10,540	
	Ulsan	#1		9,405	8,660	
		#2		9,408	8,657	
		#3		9,413	8,663	
		#4		9,501	8,666	
		#5		9,494	8,666	
		#6		9,480	8,662	
	Youngnam	#1		7,108	8,495	
		#2		7,342	8,496	
	Yosu	#1		9,462	8,442	
		#2		9,447	8,441	

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	**Heavy oil (kcal/l)**	**Diesel oil (kcal/l)**	**L. N. G (kcal/kg)**
	Pyongtaek	#1		9,407	8,496	11,608
		#2		9,409	8,513	11,585
		#3		9,412	8,502	11,647
		#4		9,413	8,502	11,604
	Namjeju	#1		9,384	8,853	
		#2		9,385	8,842	
	Jeju	#1		9,435	8,441	
		#2		9,433		
		#3		9,429	8,491	
	Seoul	#4				11,702
		#5			8,617	11,707
	Incheon	#1				11,729
		#2				11,723
		#3			8,516	11,727
		#4			8,506	11,723
	Pyongtaek C/C	C/C			8,503	11,727
	Ilsan	C/C				11,710
	Bundang	C/C				11,723
	Ulsan	C/C				11,475
	Seoincheon	C/C			8,740	11,709
	Shinincheon	C/C				11,712
	Boryeong	C/C				11,727
	Incheon	C/C				11,711
	Busan	C/C				11,700
	Hallim	C/C			8,524	
	Anyang	C/C				11,723
	Bucheon	C/C				11,702
	POSCO POWER	C/C				11,721
	G S Bugog	C/C				12,381
	Yulchon	C/C			10,384	11,721
	Namjeju	D/P		9,383	8,526	
	Jeju	G/T			8,473	
	Jeju	D/P		9,435	8,506	
2006	Honam	#1	5,164	9,318	8,472	
		#2	5,137	9,332	8,426	
	Samchonpo	#1	5,640		8,373	
		#2	5,645		8,373	
		#3	5,565		8,373	
		#4	5,568		8,363	
		#5	4,974		8,550	
		#6	4,993		8,550	
	Yonghung	#1	5,768		8,447	
		#2	5,782		8,454	

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	**Heavy oil (kcal/l)**	**Diesel oil (kcal/l)**	**L. N. G (kcal/kg)**
	Boryeong	#1	5,479		8,412	
		#2	5,478		8,496	
		#3	5,552		8,496	
		#4	5,533		8,496	
		#5	5,552		8,312	
		#6	5,542		8,312	
	Taean	#1	5,683		8,312	
		#2	5,679		7,952	
		#3	5,684		8,216	
		#4	5,680		8,232	
		#5	5,638		8,232	
		#6	5,662		8,232	
		#7	5,667		8,130	
	Hadong	#1	5,670		8,396	
		#2	5,662		8,482	
		#3	5,660		8,481	
		#4	5,671		8,384	
		#5	5,665		8,466	
		#6	5,669		8,456	
	Dangjin	#1	5,588		8,526	
		#2	5,611		8,529	
		#3	5,592		8,556	
		#4	5,581		8,564	
		#5	5,743		8,507	
		#6	5,814		8,450	
		#7	5,527		8,535	
	Ulsan	#1		9,419	8,664	
		#2		9,427	8,664	
		#3		9,423	8,664	
		#4		9,529	8,664	
		#5		9,531	8,664	
		#6		9,533	8,664	
	Youngnam	#1		9,631	8,403	
		#2		9,605	8,419	
	Yosu	#1		9,465	8,358	
		#2		9,456	8,356	
	Pyongtaek	#1		9,222	8,496	11,647
		#2		9,233	8,496	11,647
		#3		9,260	8,501	11,573
		#4		9,208	8,501	11,667
	Namjeju	#1		9,413	8,525	
		#2		9,412	8,504	
		#3		9,403	8,491	

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	**Heavy oil (kcal/l)**	**Diesel oil (kcal/l)**	**L. N. G (kcal/kg)**
	Jeju	#1		9,377	8,429	
		#2		9,454	8,524	
		#3		9,455	8,524	
	Seoul	#4			8,617	11,716
		#5			8,617	11,594
	Incheon	#1				11,733
		#2				11,725
		#3			8,533	11,716
		#4			8,532	11,722
	Pyongtaek C/C	C/C			8,503	11,727
	Ilsan	C/C			8,540	11,715
	Bundang	C/C				11,723
	Ulsan	C/C				11,381
	Seoincheon	C/C			8,740	11,723
	Shinincheon	C/C				11,723
	Boryeong	C/C				11,730
	Incheon	C/C				11,698
	Busan	C/C				11,716
	Hallim	C/C			8,506	
	Anyang	C/C				11,726
	Bucheon	C/C			10,381	11,711
	POSCO POWER	C/C				11,728
	G S Bugog	C/C				11,727
	Yulchon	C/C				12,039
	Namjeju	D/P		9,734	8,462	
	Jeju	G/T			8,352	
	Jeju	D/P		9,136		
2007	Honam	#1	5,186	9,311	8,497	
		#2	5,190	9,311	8,493	
	Samchonpo	#1	5,545		8,373	
		#2	5,537		8,373	
		#3	5,525		8,349	
		#4	5,540		8,349	
		#5	4,865		8,550	
		#6	4,864		8,550	
	Yonghung	#1	5,745		8,391	
		#2	5,739		8,457	
		#3	5,822		7,878	
		#4				
	Boryeong	#1	5,519		8,496	
		#2	5,515		8,496	
		#3	5,518		8,655	

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	Heavy oil (kcal/l)	Diesel oil (kcal/l)	L. N. G (kcal/kg)
		#4	5,513		8,944	
		#5	5,520		8,655	
		#6	5,518		8,655	
	Taean	#1	5,733		8,174	
		#2	5,733		8,387	
		#3	5,734		8,388	
		#4	5,727		7,963	
		#5	5,686		8,361	
		#6	5,695		8,347	
		#7	5,717		8,044	
		#8	5,722		7,256	
	Hadong	#1	5,647		8,492	
		#2	5,645		8,456	
		#3	5,627		8,469	
		#4	5,639		8,519	
		#5	5,652		8,492	
		#6	5,640		8,495	
	Dangjin	#1	5,660		8,610	
		#2	5,663		8,606	
		#3	5,657		8,617	
		#4	5,659		8,635	
		#5	5,713		8,620	
		#6	5,737		8,613	
		#7	5,725		8,621	
		#8	5,742		8,596	
	Ulsan	#1		9,413	8,664	
		#2		9,420	8,664	
		#3		9,360	8,664	
		#4		9,508	8,664	
		#5		9,511	8,664	
		#6		9,502	8,664	
	Youngnam	#1		9,643	8,402	
		#2		9,643	8,403	
	Yosu	#1		9,464	8,368	
		#2		9,462	8,370	
	Pyongtaek	#1		9,445	8,534	11,650
		#2		9,448	8,530	11,653
		#3		9,447	8,518	11,650
		#4		9,460	8,517	11,651
	Namjeju	#1				
		#2				
		#3		9,411	8,201	
		#4		9,410	8,515	

year	Plant		Net Caloric value($NCV_{i,y}$)			
			Coal (kcal/kg)	**Heavy oil (kcal/l)**	**Diesel oil (kcal/l)**	**L. N. G (kcal/kg)**
	Jeju	#1		9,412	8,458	
		#2		9,420	7,906	
		#3		9,419	8,490	
	Seoul	#4			7,411	11,727
		#5			8,617	11,727
	Incheon	#1				11,727
		#2				11,730
		#3			8,514	11,730
		#4			8,483	11,730
	Bundang fuel cell					11,673
	Pyongtaek C/C	C/C			8,503	11,739
	Ilsan	C/C				11,725
	Bundang	C/C			8,716	11,728
	Ulsan	C/C				11,610
	Seoincheon	C/C				11,739
	Shinincheon	C/C				11,735
	Boryeong	C/C				11,735
	Incheon	C/C				11,726
	Busan	C/C				11,727
	Hallim	C/C			8,533	
	Anyang	C/C				11,741
	Bucheon	C/C				11,898
	POSCO POWER	C/C				11,756
	G S Bugog	C/C				11,734
	Yulchon	C/C				11,732
	Kwangyang	C/C				-
	Namjeju	D/P		9,419	8,323	
	Jeju	G/T			8,447	
	Jeju	D/P		9,396		

Source: Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO)

<Table Annex-3> Electricity delivered to the grid by power plants ($EG_{m,y}$) and *EF* for each plant

Year	Plant		Net electricity generated $EG_{m,y}$ (MWh)	EF for each plant ($tonCO_2/MWh$)
2005	Honam	#1	1,787,715	0.9363
		#2	1,875,790	0.9318
	Samchonpo	#1	3,810,079	0.8484
		#2	4,323,618	0.8448
		#3	4,343,666	0.8330
		#4	4,112,297	0.8341
		#5	3,542,728	0.8158
		#6	3,643,969	0.8130
	Yonghung	#1	5,623,299	0.8101
		#2	4,658,862	0.8163
	Boryeong	#1	3,547,140	0.8433
		#2	3,433,608	0.8377
		#3	4,124,745	0.8068
		#4	3,698,705	0.8061
		#5	4,121,314	0.8069
		#6	3,283,477	0.8068
	Taean	#1	3,992,112	0.8075
		#2	3,484,251	0.8126
		#3	3,957,054	0.8079
		#4	3,653,534	0.8088
		#5	3,744,413	0.8099
		#5	3,999,847	0.8062
	Hadong	#1	3,997,914	0.8094
		#2	3,732,583	0.8070
		#3	3,769,077	0.8060
		#4	3,989,315	0.8092
		#5	3,553,901	0.8085
		#6	4,037,763	0.8040
	Dangjin	#1	3,797,307	0.8045
		#2	3,798,078	0.8037
		#3	4,081,017	0.8020
		#4	4,079,557	0.8005
		#5	1,318,670	0.8360
		#6	96,365	0.9478
	Ulsan	#1	262,393	0.8027
		#2	255,812	0.7883
		#3	200,518	0.7964

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
		#4	1,549,091	0.7312
		#5	1,500,935	0.7307
		#6	1,454,644	0.7299
	Youngnam	#1	1,022,470	0.7931
		#2	531,006	0.8337
	Yosu	#1	430,310	0.7458
		#2	904,597	0.7218
	Pyongtaek	#1	1,258,662	0.7004
		#2	1,376,342	0.6994
		#3	1,321,167	0.6975
		#4	1,338,204	0.6964
	Namjeju	#1	44,602	0.9738
		#2	44,654	0.9994
	Jeju	#1	36,266	1.0341
		#2	532,700	0.7249
		#3	502,189	0.7294
	Seoul	#4	207,498	0.6301
		#5	444,324	0.6515
	Incheon	#1	16,450	0.7075
		#2	37,727	0.6008
		#3	-	-
		#4	29,202	0.6396
	Pyongtaek C/C	C/C	659,932	0.4482
	Ilsan	C/C	2,873,958	0.4939
	Bundang	C/C	3,742,073	0.4785
	Ulsan	C/C	3,131,075	0.3917
	Seoincheon	C/C	7,001,031	0.3764
	Shinincheon	C/C	10,543,280	0.3684
	Boryeong	C/C	8,221,926	0.3766
	Incheon	C/C	2,055,016	0.3651
	Busan	C/C	9,076,327	0.3549
	Hallim	C/C	100,346	0.7665
	Anyang	C/C	1,433,978	0.4854
	Bucheon	C/C	1,404,160	0.4959
	POSCO POWER	C/C	2,571,095	0.4615
	G S Bugog	C/C	2,189,808	0.3830
	Yulchon	C/C	1,300,627	0.3989
	Namjeju	D/P	268,073	0.6280

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
	Jeju	G/T	5,069	1.4577
	Jeju	D/P	151,759	-
2006	Honam	#1	1,622,639	0.9340
		#2	1,782,016	0.9313
	Samchonpo	#1	4,161,219	0.8620
		#2	3,703,880	0.8622
		#3	3,779,585	0.8387
		#4	3,816,997	0.8328
		#5	3,761,205	0.8259
		#6	4,065,091	0.8150
	Yonghung	#1	5,337,432	0.8129
		#2	5,727,937	0.8065
	Boryeong	#1	3,988,848	0.8434
		#2	3,423,101	0.8341
		#3	3,409,486	0.8082
		#4	4,133,946	0.8080
		#5	3,364,148	0.8022
		#6	3,987,488	0.8093
	Taean	#1	3,556,797	0.8116
		#2	4,035,753	0.8081
		#3	3,528,613	0.8086
		#4	4,069,820	0.8101
		#5	4,013,235	0.8125
		#6	3,381,867	0.8131
		#7	159,677	0.8976
	Hadong	#1	3,607,063	0.8092
		#2	4,068,036	0.8049
		#3	4,079,158	0.8056
		#4	3,631,374	0.8061
		#5	4,092,625	0.8065
		#6	3,610,222	0.8077
	Dangjin	#1	3,598,820	0.8040
		#2	4,115,891	0.8021
		#3	3,666,490	0.8020
		#4	3,610,984	0.8041
		#5	3,946,931	0.7947
		#6	3,392,395	0.7836
		#7	1,474	2.3058

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
	Ulsan	#1	275,016	0.7879
		#2	306,668	0.7832
		#3	376,132	0.7675
		#4	1,511,557	0.7257
		#5	1,583,846	0.7213
		#6	1,589,838	0.7232
	Youngnam	#1	359,205	0.9149
		#2	323,595	0.9043
	Yosu	#1	403,547	0.7367
		#2	906,849	0.7126
	Pyongtaek	#1	1,123,948	0.6879
		#2	1,198,620	0.6875
		#3	1,304,568	0.6899
		#4	1,052,228	0.6884
	Namjeju	#1	34,448	0.9864
		#2	28,686	1.0148
		#3	179,033	0.8082
	Jeju	#1	24,748	1.0328
		#2	462,023	0.7357
		#3	479,676	0.7323
	Seoul	#4	306,558	0.6028
		#5	685,011	0.5883
	Incheon	#1	32,932	0.5625
		#2	24,366	0.5714
		#3	78,669	0.5325
		#4	62,414	0.5446
	Pyongtaek C/C	C/C	497,441	0.4507
	Ilsan	C/C	3,038,165	0.4890
	Bundang	C/C	4,059,300	0.4730
	Ulsan	C/C	3,608,435	0.3845
	Seoincheon	C/C	8,726,521	0.3666
	Shinincheon	C/C	11,797,500	0.3707
	Boryeong	C/C	7,089,662	0.3757
	Incheon	C/C	3,648,288	0.3533
	Busan	C/C	10,455,401	0.3557
	Hallim	C/C	175,356	0.7147
	Anyang	C/C	1,286,480	0.4786
	Bucheon	C/C	1,241,795	0.4845

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
	POSCO POWER	C/C	2,338,128	0.4653
	G S Bugog	C/C	2,911,683	0.3569
	Yulchon	C/C	2,276,276	-
	Namjeju	D/P	239,690	0.6603
	Jeju	G/T	15,986	1.3123
	Jeju	D/P	252,764	0.6045
2007	Honam	#1	1,806,765	0.9343
		#2	1,773,852	0.9303
	Samchonpo	#1	3,903,591	0.8687
		#2	4,398,382	0.8515
		#3	4,311,704	0.8431
		#4	3,840,729	0.8345
		#5	4,074,103	0.8284
		#6	3,823,174	0.8177
	Yonghung	#1	5,020,901	0.8174
		#2	6,081,490	0.8128
		#3	320,502	0.8457
		#4		
	Boryeong	#1	3,604,642	0.8421
		#2	4,120,511	0.8303
		#3	4,214,892	0.8086
		#4	3,438,773	0.8099
		#5	4,162,530	0.8101
		#6	3,817,024	0.8078
	Taean	#1	4,055,394	0.8078
		#2	3,796,670	0.8118
		#3	4,039,811	0.8094
		#4	3,504,214	0.8089
		#5	3,523,988	0.8121
		#6	4,036,733	0.8123
		#7	3,868,817	0.7934
		#8	2,528,587	0.7824
	Hadong	#1	4,140,667	0.8089
		#2	3,681,670	0.8030
		#3	3,727,907	0.8056
		#4	4,115,014	0.8075
		#5	3,905,190	0.8067
		#6	4,158,792	0.8057

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
	Dangjin	#1	3,968,103	0.8088
		#2	3,595,927	0.8019
		#3	4,010,715	0.8014
		#4	4,009,178	0.8037
		#5	3,443,482	0.7965
		#6	3,497,359	0.7882
		#7	2,904,680	0.7886
		#8	1,297,925	0.7853
	Ulsan	#1	406,685	0.7916
		#2	407,321	0.7955
		#3	458,584	0.7812
		#4	1,418,034	0.7296
		#5	1,540,400	0.7316
		#6	899,604	0.7314
	Youngnam	#1	688,935	0.7748
		#2	474,475	0.7896
	Yosu	#1	497,053	0.7334
		#2	1,071,405	0.7195
	Pyongtaek	#1	1,147,515	0.7085
		#2	1,553,162	0.7031
		#3	1,502,099	0.7037
		#4	1,095,986	0.7070
	Namjeju	#1	-	
		#2	-	
		#3	484,459	0.7661
		#4	500,222	0.7623
	Jeju	#1	3,019	1.0379
		#2	280,454	0.7455
		#3	396,186	0.7430
	Seoul	#4	357,572	0.5598
		#5	962,861	0.5729
	Incheon	#1	148,821	0.5446
		#2	157,042	0.5354
		#3	205,530	0.5399
		#4	95,143	0.5350
	Pyongtaek C/C	C/C	909,449	0.4445
	Ilsan	C/C	3,506,350	0.4830
	Bundang	C/C	3,741,296	0.4710

Year	Plant		Net electricity generated	EF for each plant
			$EG_{m,y}$ (MWh)	($tonCO_2$/MWh)
	Ulsan	C/C	4,383,453	0.3911
	Seoincheon	C/C	10,895,505	0.3664
	Shinincheon	C/C	12,533,994	0.3748
	Boryeong	C/C	7,839,371	0.3816
	Incheon	C/C	3,696,784	0.3567
	Busan	C/C	11,616,221	0.3564
	Hallim	C/C	61,752	0.7457
	Anyang	C/C	1,615,090	0.4783
	Bucheon	C/C	1,523,068	0.4789
	POSCO POWER	C/C	3,788,598	0.4659
	G S Bugog	C/C	2,767,811	0.3581
	Yulchon	C/C	2,083,451	0.3743
	Namjeju	D/P	164,390	0.6430
	Jeju	G/T	1,294	1.6864
	Jeju	D/P	235,626	0.6254

Source: Statistics of Electric Power in KOREA (2006, 2007, 2008) (KEPCO)

<Table Annex-4> Sample group plants used in the Build Margin calculation and CO_2 Emission Factor of the Build Margin

Year	No.	Plant name		Technology	Type of Fossile Fue	year operation	Net electricity generated (EGm,y)	CO_2 emission factor ($EF_{EL,m,y}$)	Results
							MWh in 2007	tCO2/MWh	EF for each plant (tonCO2eq./MWh)
	1	Hanbit Sungsan the second solar		solar		2007.12	-		
	2	Taein gangjin solar		solar		2007.12	6		
	3	Suni gangjin solar		solar		2007.12	11		
	4	Korea yeongcheon solar		solar		2007.12	17		
	5	Solar yungam solar		solar		2007.12	-		
	6	Changwhan yeongduk solar		solar		2007.12	5		
	7	Samsung jindo		solar		2007.12	9		
	9	Hwaseong heat & power		combined		2007.12			
	10	Dangjin	#8	steam power	Bituminous coal	2007.12	1,297,925	0.7853	0.0120
	11	SP solar yonggwang		solar		2007.11	38		
	12	Dongyang energy sinan		solar		2007.11	268		
	13	Ef yungam solar		solar		2007.11	40		
	14	Dongwon gangjin solar		solar		2007.11	214		
	15	Solec yonggwang solar		solar		2007.11	120		
	16	Solar jungeub solar		solar		2007.11	92		
	17	Sinbuk yungam solar		solar		2007.11	178		
	18	Hyein haenam solar		solar		2007.11	364		
	19	Samlangjin solar		solar		2007.11	646		
2	20	Hyosung daegi-wind power		wind		2007.11	42		
	19	Nonhyun heat & power		combined		2007.10			
	20	Wuriyungam solar		solar		2007.08	267		
0	21	Hwasung solar		solar		2007.08	309		
	22	Yeongju the first solar		solar		2007.08	230		
	23	Muan solar		solar		2007.08	622		
0	24	Jangheung solar		solar		2007.08	125		
	25	Gomun		small hydro power		2007.08	2,996		
	26	Taean	#8	steam power	Bituminous coal	2007.08	2,528,587	0.7824	0.0233
7	27	Dangjin	#7	steam power	Bituminous coal	2007.06	2,904,680	0.7886	0.0270
	28	Munkyung solar		solar		2007.06	2,563		
	29	Younggwang solar park		solar		2007.06	853		
	30	Yungam Solar		solar		2007.06	770		
	31	Wonjungsu		small hydro power		2007.05			
	32	baegok		small hydro power		2007.05	1,001		
	33	damyangho		small hydro power		2007.05	1,771		
	34	Juam		small hydro power		2007.05			
	35	Namjeju	#4	thermal	heavy oil	2007.03	500,222	0.7623	0.0045
	36	Eco energy		solar		2007.03	231,029		
	37	hapcheon		small hydro power		2007.02	6,777		
	38	Jeonju-resource recovery facility				2007.02	13,059		
	39	Seoul Marin(suncheon)		solar		2007.02	1,223		
	40	Mirae energy		solar		2007.02	165		
	41	Seomjingang		small hydro power		2007.02			
	42	samcheonpo		small hydro power		2007.02			
	43	dalbang		small hydro power		2007.02			
	44	Taean	#7	steam power	Bituminous coal	2007.02	3,868,817	0.7934	0.0362
	45	Yeongju the second solar		solar		2007.01	646		
	46	Hyundaedaesan		combined		2007.01			

	1	Cheongsong pumping	#2	pumping		2006.12	145,042		
	2	S&P Solar		solar		2006.10	995		
	3	Bundang fuel cell		fuel cell	LNG	2006.10	1,959	0.4243	0
	4	Yonnggwang Solar park		solar		2006.10	853		
	5	Namhae Solar		solar		2006.10	1,462		
	6	HanlaJeunggong Solar		solar		2006.10	1,292		
2	7	Yungam Solar		solar		2006.09	770		
	8	Enepark		solar		2006.09	416		
	9	Yongheng solar		solar		2006.09	1,214		
0	10	Cheongsong pumping	#1	pumping		2006.09	164,069		
	11	Namjeju	#3	thermal	heavy oil	2006.09	484,459	0.7661	0.0044
	12	yangyang(pumping)	#4	pumping		2006.08	91,270		
0	13	Donghae solar		solar		2006.08	1,118		
	14	Kangwon-wind power		wind		2006.07			
	15	yangyang pump windpower		wind		2006.06			
	16	Hadongho		small hydro power		2006.06	1,832		
6	17	yangyang (pumping)	#3	pumping		2006.06	56,495		
	18	Goheung Solar		solar		2006.06	1,233		
	19	Jangseong		small hydro power		2006.05	648		
	20	yangyang (pumping)	#2	pumping		2006.04	103,698		
	21	Dangjin	#6	thermal	Bituminous coal	2006.04	3,497,359	0.7882	0.0325
	22	Sinchang-wind power		wind		2006.03	3,572		
	23	yangyang (pumping)	#1	pumping		2006.02	106,973		

	1	Janghengdam		small hydro power		2005.12			
	2	Suncheon Solar		solar		2005.12	1,259		
	3	Samcheonpo solar energy		solar		2005.12	131		
	4	Dangjin	#5	steam power	Bituminous coal	2005.10	3,443,482	0.7965	0.0324
	5	yangyang pump small hydro		small hydro power		2005.10			
	6	Taean solar energy		solar		2005.10	118		
	7	Jeju DP		internal combustion	heavy oil	2005.07	235,626	0.6254	0.0017
	8	WunjeongLFG		internal combustion	LFG	2005.07	11,415		
	9	Yulchon		combined	LNG	2005.07	2,083,451	0.3743	0.0092
	10	Incheon		combined	LNG	2005.07	3,696,784	0.3567	0.0156
	11	Daegok		small hydro power		2005.07	1,278		
	12	Donghwa		small hydro power		2005.07	2,481		
2	13	Ulchin	#6	nuclear		2005.04	7,911,305		
	14	Hanrye		LFG	LFG	2005.04	5,102		
	15	Busan Bio-gas		internal combustion	LFG	2005.03	1,551		
	16	Sungnam		small hydro power		2004.12			
0	17	Yungduk-wind power		wind		2004.12			
	18	Yongdam		small hydro power		2004.12	24,928		
	19	Maebongsan-wind power		wind		2004.12	11,058		
0	20	Daegwanryung-wind power		wind		2004.12	4,288		
	21	Yongheng	#2	steam power	Bituminous coal	2004.11	6,081,490	0.8128	0.0583
	22	new solar energy		solar		2004.11	224		
	23	Yongheng	#1	steam power	Bituminous coal	2004.07	5,020,901	0.8174	0.0484
5	24	Ulchin	#5	nuclear		2004.07	8,025,928		
	25	Busan		combined combustion	LNG	2003.05/2004.03	11,616,221	0.3564	0.0489
	26	Chunsang		small hydro power		2004.02	240		
	27	Cheongju LFG		internal combustion		2004.02	5,808		
	28	Daejon Geumgodong		internal combustion		2003.06	9,160		
	29	Hoicheon ENC		internal combustion		2003.05	2,826		
	30	Andong		small hydro power		2003.09			
	31	Gunsan-wind power		wind		2002.11/2003.09	7,958		
	32	Sangwon ENC		internal combustion		2001.12/2003.03/2003.06			
	33	Muju		small hydro power		2003.04	637		
	34	Yonggwang	#6	nuclear		2002.12	7,859,224		
	35	Taean	#6	steam power	Bituminous coal	2002.05	4,036,733	0.8123	0.0387
	36	Yonggwang	#5	nuclear		2002.05	8,601,736		
Total							**84,736,759**		**0.3933**

Source: Statistics of Electric Power in KOREA (2007) (KEPCO), Current status of power generating facility (2007, Korea power exchange)

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<Table Annex-5> Fuels CO_2 Emission factor

Fuel Type	$EF_{CO2,I,y}$ (tCO2/TJ)
Gasoline	**67.5**
Diesel oil	**72.6**
residual fuel oil	**75.5**
LNG	**54.3**
bituminous coal	**89.5**
Anthracite	**94.6**

Source: 2006 IPCC Guidelines

Calculation of the Electricity transferred to a grid

Gomun small-scale hydroelectric power plant

To decide Power generation capacity and Quantity of water are based on minimum flow (source: project design document of the Gomun pumping station flood damage restoration, Nov. 1991) and month average outflow at Gomun small-scale hydroelectric power plant.

The formula of the Power generation capacity as follows;

$$\mathbf{P = 9.8 \times Q \times H \times \eta_t \times \eta_g = 9.8 \times Q \times H \times \eta}$$

Where, **P**: Power generation capacity (kW)
Q: Quantity of water (m^3/sec)
H: Effective head (m)
$\boldsymbol{\eta_t}$: Water wheel efficiency
$\boldsymbol{\eta_g}$: Generator efficiency
$\boldsymbol{\eta}$: Combined efficiency

Quantity of water (Q) is decided considerably by irrigation and maintenance water flow.
Quantity of water Refers to the <Table Annex-6>.

Effective head (H) is 7.0m.

Reservoir Head
Flood water level (F.W.L): EL.54.10m
High water level (H.W.L): EL. 49.00m
Restricted water level (R.W.L): EL. 49.00m
Low water level (L.W.L): EL. 43.00m
Tail water level (T.W.L): EL. 41.80m
Head loss (HL): 0.2m

Head drop
Total static head (H.W.L–T.W.L) : 7.2m
Maximum effective head (H.W.L–T.W.L–HL): 7.0m
Effective head (R.W.L–T.W.L–HL) : 7.0m

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Minimum head (L.W.L–T.W.L–HL) : 1.0m

Combined efficiency (η) has range from 0.80 to 0.90 in Tubular water wheel. Therefore, is 0.82 considering safety at this project.

Units of the water wheel are 3 as following formula.

$$\mathbf{N=0.6\times(Q_{max}/Q_{min})}$$

Where, **N:** Water wheel unit
$\mathbf{Q_{max}}$**:** Maximum Quantity of water
$\mathbf{Q_{min}}$**:** Minimum Quantity of water

Therefore, $\mathbf{P=9.8\times Q\times H\times\eta=9.8\times 9.0\times 7.0\times 0.82\times 3\fallingdotseq 1{,}500kW}$

As above formulas, generator capacity is 500kW × 3 units. And expected annual electricity produced by project is 5,251MWh which is outcome of HEC-5 Program. Therefore coefficient of utilization is 39.96%. Details refer to the <Table Annex-7>.

Coefficient of utilization of hydro power generator is calculated using generator capacity and expected power generation.

HEC-5 Program

1. General description
HEC-5 which was developed in 1973 by Bill Eichert who belongs to the CORPS of Engineers is representative multi-purpose reservoir management program.
It could be analyzed 40 reservoirs, 80 flow control points, 40 intake points and 35 power plants simultaneously.

2. Input data

- initial storage, storage at the target head and monthly target head
- discharge flow, storage area and low water level
- channel conveyance, minimum flow, Stage-Discharge Rating Curve, etc.

3. Output

- flow dara
- system management result
- inflow and outflow each periods
- investment analysis
- frequency curve
- hydrological analysis
- output error verification
- hydro power generation, etc.

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Dongjin-river small-scale hydroelectric power plant

Dongjin-river small-scale hydroelectric power plant estimates its power generation capacity based on power generation and effective head of Sumjin-river power generation. The 1st reservoir for irrigation is located in downstream of Sumjin-river Dam power generation.

Quantity of water (Q) decides to base on Sumjin-river Dam power generator's actual data from 1975 to 2005. Details refer to the <Table Annex-8>.

Effective head (H)
R.W.L – T.W.L – HL
= 13.15 – 7.90 – 0.35 = 4.90m

Water wheel efficiency (η_t) and **Generator efficiency(η_g)** are respectively 0.88 and 0.95.

Generator capacity is 820-1,847kW which resulted from implementing HEC-5 Program. Hence 850kW is selected as generator capacity.
As above formulas, generator capacity is 850kW and expected annual electricity produced by project is 4,983MWh. Therefore coefficient of utilization is 66.92%. Details refer to the <Table Annex-9>.

<Table Annex-6> Gomun small-scale hydroelectric power plant – Measurement of the Quantity of water

(Unit: m^3/sec)

Month / Quantity	1	2	3	4	5	6	7	8	9	10	11	12	average
Average outflow	5.8	5.0	7.5	16.9	20.8	22.3	135.4	150.8	30.7	11.5	8.1	5.4	35.0
Maintenance water flow	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Quantity of water	2.5	1.7	4.2	13.6	17.5	19.0	132.1	147.5	27.4	8.2	4.8	2.1	31.7

Source: a written application of the Electric enterprise permission (Gomun)

<Table Annex-7> Gomun small-scale hydroelectric power plant –power generation capacity

(Unit: MWh)

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12	Power Generation
1995	64	77	317	94	191	291	1,116	1,116	823	85	185	64	4,421
1996	89	72	276	216	297	1,080	1,116	435	70	260	279	64	4,253
1997	121	135	89	165	1,116	571	1,116	1,116	1,080	170	354	125	6,159
1998	73	154	187	1,012	1,116	1,080	1,116	1,116	827	130	319	60	7,188
1999	73	66	207	200	459	342	1,116	1,116	1,080	545	118	68	5,389
2000	227	75	68	137	504	827	814	1,116	1,080	77	86	105	5,117
2001	105	84	68	74	73	1,080	1,116	1,116	74	573	94	77	4,534
2002	227	69	150	1,080	203	338	1,116	1,116	165	284	74	121	4,944
Maximum Power Generation in month	227	154	317	1,080	1,116	1,080	1,116	1,116	1,080	573	354	125	7,188
Average Power Generation in month	122	91	170	372	495	701	1,078	1,116	650	265	188	86	**5,251**

Source: a written application of the Electric enterprise permission (Gomun)

<Table Annex-8> Dongjin-river small-scale hydroelectric power plant – Measurement of the Quantity of water

(Unit: m^3/sec)

Quantity \ Month		1	2	3	4	5	6	7	8	9	10	11	12	Average
The 1st reservoir for irrigation	**Sumjin-river Dam specific discharge**	0.84	1.41	2.00	2.50	1.88	4.31	10.67	9.08	5.66	0.80	0.81	0.92	3.40
	outflow	5.17	5.72	5.55	18.47	27.8	27.0	26.74	36.92	28.28	11.37	5.74	5.83	17.05
	Quantity of water	20.45	20.45	20.45	20.97	29.68	31.31	37.41	46.00	33.94	20.45	20.45	20.45	26.83

Source: a written application of the Electric enterprise permission (Dongjin-river)

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<Table Annex-9> Dongjin-river small-scale hydroelectric power plant –power generation capacity

(Unit: MWh)

Year	The 1st reservoir for irrigation
1975	5,129
1976	5,036
1977	3,230
1978	4,470
1979	5,354
1980	6,561
1981	6,189
1982	4,169
1983	4,350
1984	4,338
1985	7,264
1986	6,329
1987	6,440
1988	3,921
1989	5,448
1990	6,034
1991	4,989
1992	4,608
1993	5,696
1994	3,744
1995	2,199
1996	3,736
1997	4,285
1998	5,277
1999	4,978
2000	4,904
2001	4,797
2002	4,707
2003	6,127
2004	5,002
2005	5,164
Maximum Power Generation in month	7,264
Minimum Power Generation in month	2,199
Average Power Generation in month	**4,983**

Source: a written application of the Electric enterprise permission (Dongjin-river)

Evidences for prior consideration of CDM

This is translation of each chapter of evidences for prior consideration of CDM, Executive design report.

<Table Annex-10> Gomun small-scale hydroelectric power plant:

Chapter 8. Clean Development Mechanism project

8.1 Purpose

Using the greenhouse gas (GHG) reduction effect, Gomun small hydro electric power project can has Clean Development Mechanism (CDM) performance.

For this, it has planning that this project registered as CDM project and get earned additional benefit which comes from sales of greenhouse gas emission credit.

8.2 Estimation of CO_2 emission reduction

Major decreased GHG by this project is CO_2. GHG emission reduction of this project is calculated 'GHG emission per generated electricity connected with Korea grid' multiply 'electricity supplied to the grid by this project'. Emission reduction is calculated as following formula. This project uses the electricity from KEPCO (Korea Electric Power Corporation) for the initial energy of generator operation. But it was excepted from calculation because it is minor.

Carbon Dioxide Emission Reduction(ton**CO_2/yr)**
= Estimated annual electricity produced by this project(MWh/yr)
× **national electric emission factor**(ton**CO_2/MWh)**

Emission reduction of this project comes as <Table 8.2-1>.

< Table 8.2-1> Emission reduction

emission gas	national electric emission factor (tonCO_2/MWh)	Estimated annual electricity produced by this project (MWh/year)	Carbon Dioxide Emission Reduction (tonCO_2/year)
CO_2	0.424	5,251	2,226

Carbon Dioxide Emission Reduction is 2,226tonCO_2/year. It is a result of national electric emission factor multiplies Estimated annual electricity produced by this project. Value of Estimated annual electricity produced by this project is comes from "Chapter 3. Performance specifications of the small hydro electric power plant". Therefore this small hydro electric power plant has effect on green house gas reduction.

8.3 CERs sales benefit analysis

After verification of the GHG emission reduction, CERs (Certificated Emission Reduction) is issued. And it can earned additional benefit through CERs trading. Fluctuations in Expected benefit are follows.

<Table 8.3-1> Expected benefit of Emission credit sales

(Exchange rate: 1,000won/$)

Emission reduction (tonCO2/year)	Emission credit price ($/tonCO2)	Expected additional benefit ($/year)	Expected additional benefit (won/year)
2,226	2.0	4,452	4,452,000
2,226	3.0	6,678	6,678,000
2,226	4.0	8,904	8,904,000
2,226	5.0	11,130	11,130,000
2,226	6.0	13,356	13,356,000
2,226	7.0	15,582	15,582,000
2,226	8.0	17,808	17,808,000
2,226	9.0	20,034	20,034,000
2,226	10.0	22,260	22,260,000

8.4 Review result

According to the “Legal Issues Guidebook to the Clean Development Mechanism” published by UNEP(2004. Jan), market price of emission credit is 2-10$ per tonCO_2. In addition to benefit of electricity sales, additional credit benefit will help overcoming the financial/technical risk of this project. Therefore this project will pursue as CDM after getting the permit of electric enterprise.

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<Table Annex-11> Dongjin-river small-scale hydroelectric power plant:

Chapter 4. Review of project as Clean Development Mechanism

4.1 Summary

This project contributes to the international effort to prevent global warming by using renewable energy which reduces greenhouse gas (GHG).

To promoting CDM project, one of the Kyoto mechanism, it analyzed GHG reduction effect and additional CERs benefit

4.2 Analysis of GHG emission reduction

For calculating GHG emission reduction by this small hydro electric power project, it is using approved methodology ACM0002. First, it calculates baseline emission and then subtract project emission for calculation of emission reduction. Emission reduction is calculated as following formula.

Emission reduction = baseline emission - project emission

Baseline emission is calculated electricity produced by this project multiplied by emission factor. This project emission is zero by generating electricity utilizing renewable clean energy. Therefore emission reduction is same as baseline emission.

Eventually carbon dioxide emission reduction is calculated as following formula.

Carbon dioxide mission reduction($tonCO_2$/yr) = Estimated annual electricity produced by this project(MWh/yr) × national electric emission factor($tonCO_2$/MWh)

Calculated of GHG Emission reduction of this project is represented as <Table4-1>.

emission gas	national electric emission factor ($tonCO_2$/MWh)	Estimated annual electricity produced by this project (MWh/year)	Carbon Dioxide Emission Reduction ($tonCO_2$/year)
CO_2	0.424	4,983	2,113

Carbon Dioxide Emission Reduction is 2,113$tonCO_2$/year which is calculated estimated annual electricity produced by this project (4,983(MWh/yr)) multiply national electric emission factor (0.424 $tonCO_2$/MWh). (source: Korea Energy Economics Institute). Therefore this small hydro electric power

plant has effect on green house gas reduction.

4.3 Analysis of CERs benefit

After verification of the GHG emission reduction, CERs (Certificated Emission Reduction) is issued. And it can earned additional benefit through CERs trading.

Formula of expected additional benefit and fluctuations in expected benefit are follows.

Expected additional benefit(€/year)
= Reduction of Carbon Dioxide($tonCO_2$/year) × Price of Carbon Dioxide(€/$tonCO_2$)

Emission reduction ($tonCO_2$/year)	Emission credit price (€/$tonCO_2$)	Expected additional benefit (€/year)	Expected additional benefit (won/year)
2,113	5.5	11,622	13,945,800
2,113	10	21,130	25,356,000
2,113	20	42,260	50,712,000
2,113	30	63,390	76,068,000
2,113	40	84,520	101,424,000
2,113	50	105,650	126,780,000
2,113	60	126,780	152,136,000
2,113	70	147,910	177,492,000
2,113	100	211,300	253,560,000

4.4 Project review result as Clean Development Mechanism

It is showing that Dongjin-river small hydro electric power project has effect of GHG reduction and will get additional earnings growth from CERs benefit. Therefore this project will pursue as CDM after getting the permit of electric enterprise.

* Duplicates of these evidences were submitted to DOE.

Annex 4

MONITORING INFORMATION

Refer to Section B.7