Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Hasang Hydro Electric Power Plant
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	4
Completion date of the PDD	07/07/2021
Project participants	PT Binsar Natorang Energi (Host)
Host Party	Republic of Indonesia
Applied methodologies and standardized baselines	ACM0002 Version 20.0
Sectoral scopes	Sectoral Scope 1: Energy Industries (renewable/non-renewable sources)
Estimated amount of annual average GHG emission reductions	216,320

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The Hasang Hydro Electric Power Project (the "Project") involves the construction and operation of a large-scale run-of-river hydropower plant on the Aek Kualu River, in the Toba Samosir Regency, North Sumatera Province, Republic of Indonesia. The Project is being developed by PT Binsar Natorang Energi which is an Independent Power Producer (IPP). The project will consist of three turbines rated 13MW coupled with three generating units (with a Guaranteed rated capacity of 16.15MVA) with a net plant output of 39 MW to meet the Power Purchase Agreement (PPA) signed with PT PLN (Indonesian public electricity company).

The project boundary includes the regional electricity grid in Sumatera and all power stations connected to the grid. Emission sources included in the boundary include emissions from fossil-fuel fired power stations connected to the grid, primarily carbon dioxide (CO_2).

The purpose of the Project is to generate clean and renewable electric power from the existing water flow of the Aek Kualu River. Hasang Hydro Electric Power Project will sustainably produce electricity while replacing fossil fuel plants that are already in operation in the grid or will be added to the grid in the future.

The scenario existing prior to the development of the Project is as defined by ACM0002 v.20.0: *"Electricity delivered to the grid by the project activity would have* otherwise *been generated by the operation of grid-connected power plants and by the addition of new generation sources.*

The Project entails the installation of efficient turbines that will generate hydroelectric power from the Aek Kualu River. 3 Horizontal Francis type turbines of rated output of 13 MW) will be installed. Unit 1 and 2 commissioned on the 31st December 2019 followed by Unit 3 on the 10th January 2020[1]. Hydrological studies and grid consideration have been made and the load factor is determined to be 73.10% to meet the PPA. Civil works include the construction of a weir, intake, tunnel, penstock, powerhouse and other auxiliary systems. A transmission line will be built and tapped to the existing 150kV transmission line "Jalur Lintas Timur Sumatra" between Aek Kanopan and Rantau Prapat.

The baseline scenario of the project activity is the same as the scenario existing prior to the start of implementation of the project activity. The project displaces electricity that would otherwise have been supplied by the Sumatera grid which currently has an emission factor of 0.893 tCO2e/MWh [2] . This project will generate annual average GHG emission reductions of approximately 216,320 tCO_2e.

Contribution to Sustainable Development

The project activity will satisfy the sustainable development criteria for CDM projects set by the Designated National Authority (DNA) of Indonesia.

Social – the Project will create employment opportunities to the people during the construction and the operation period. The project will generate much-needed electricity to the Sumatera grid. Hence the project would contribute to the social well-being of Sumatera.

[1] The turbines are commissioned by public utility PT PLN. PLN declared the commercial operation date as January 14th 2020.

[2] (2018 Value) https://gatrik.esdm.go.id/frontend/download_index/?kode_category=emisi_pl

Economic – Apart from the employment opportunities, the Project will support the development of local infrastructure by building roads, street lighting, and transmission line. The project will also provide benefits for government's financial revenue (taxation). Hence the project activity would contribute to the economic well-being.

Environment – the Project utilises available hydropower potential and thus does not generate GHG emissions and other emission of other harmful gases such as sulphur and nitrogen oxides which would otherwise be emitted due to the combustion of fossil fuels by power stations in the baseline.
Furthermore, to satisfy the environmental flow requirements, a natural river flow of $3m^3/s$ will be maintained between the weir and powerhouse in order to minimise the impact on aquatic habitats.

Technology – the Project diversifies the electricity generation mix within Sumatera. The Project installs modern hydropower technology. All locally involved personnel (both professional and semi-skilled workers) gain knowledge and experience in hydroelectric power contributing towards the capacity building of the country. Finally, the Project utilises safe, modern technology and practices.

A.2. Location of project activity

>>
Lumban Rau Utara village, Lumban Rau Tenggara village and Siantarasa village

Nassau District
Toba Samosir Regency
North Sumatera Province
Indonesia

The geographical coordinates of the Project site are 2 °17'17.543" N, 99 °25'53.883" E. The Project site is shown in Figure 1 below:

Figure1: Location Map of Hasang HEPP

A.3. Technologies/measures

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The Project is a greenfield hydro power plant. The baseline scenario corresponds to the supply of an equivalent amount of electricity by the Sumatera grid.

The Project is a grid-connected (Sumatera grid), run-of-river type hydro power plant of installed output 39 MW which is expected to run at 73.10% load factor[3]. No dam will be constructed but an overflow weir will divert water to a series of headrace tunnel and headrace channel structures to the powerhouse where it will push turbines and generate electricity. After that the water will re-join the main river at the tailrace .

The Hasang HEPP will be connected via a 150kV transmission line (TL) tapping to the 150kV transmission line "Jalur Lintas Timur Sumatra" between Aek Kanopan and Rantau Prapat.

As the Hasang HEPP is planned as a pure run-of-river scheme, and no water storage facilities (e.g. a reservoir) are planned, the water balance in the river will not change significantly due to the construction and operation of the scheme.

The following are the salient features of the Project.

Table 1: Salient Features of the Project

Parameter	**Value**
Intake weir	
Type	Concrete gravity weir

[3] Plant Load Factor is calculated to meet PPA (Power Purchase Agreement) Exclusive Committed Energy

Parameter	Value
Normal High-Water Level	EL. 559m
Overflow weir net width	53m
Height of the weir	9.5m
Design Flood	25 m^3/s
Desander	
Dimension	(B) 8.0m ×(H) 7.5~8.8m ×2Basin
Length	101.75m
Headrace Tunnel	
Dimension	(B) 4.8m ×(H) 5.0m
Length	2,667.83m
Headrace Channel	
Type	Open channel / Box converts
Dimension	(B) 4.0m ×(H) 3.5m / (B) 4.0m ×(H) 3.5~5.5m
Length	1,361.77m
Head Tank	
Type	Concrete
Dimension	(B) 18m × (H) 9.0~16.2m x (L) 43.2m(L)
Flushing gate type	Sliding gate
Penstock	
Type	Circle steel
Diameter	2.7m
Length	1,271m
Powerhouse	
Type	Semi-underground
Turbine type	Francis, horizontal axis 3 units
Net head	189.27
Tailrace	
Type	Concrete channel

The technical specifications of the turbines are as follows

Parameter	Value
Type	Horizontal francis manufactured by Andritz Hydro
Turbine speed	750rpm
Gross head	207.10m
Rated Discharge	8.33m^3/sec per turbine
Head loss	17.83
Net Head	189.27
Overhead Crane	110t (Main hoist) 20t (Aux hoist)

The technical specification of the generators manufactured by ANDRITZ Hydro are as follows:

Parameter	Value
Number of units	3
Type	Horizontal axis
Voltage	11kV

Installed capacity	13.73 MW
Synchronous speed	750 rpm
Frequency	50Hz
Power factor	0.85

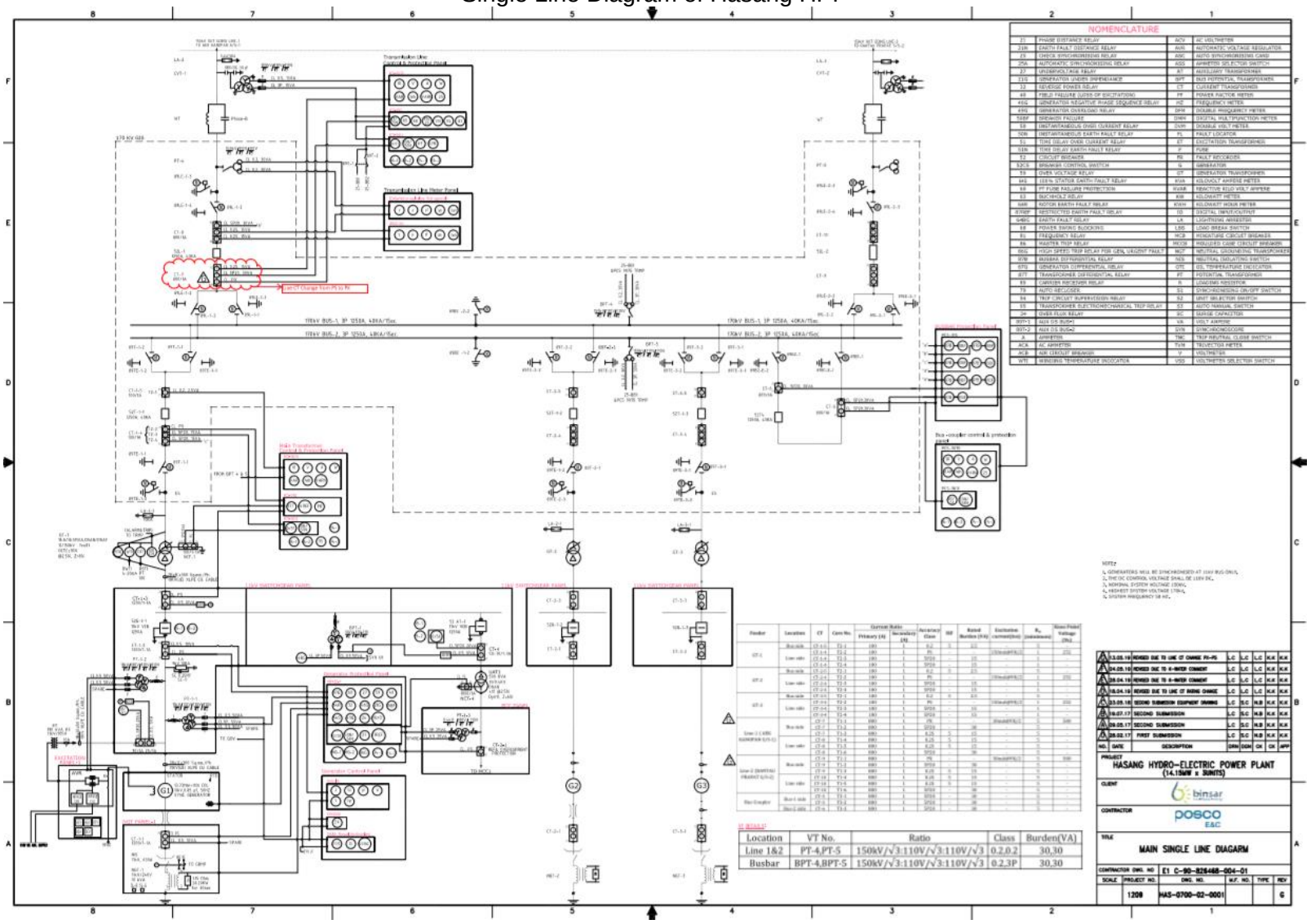
The specifications of the transformer are as follows:

Parameter	**Value**
Type	Hermetically sealed oil
Number	3
Frequency	50Hz
MVA rating (ONAN/ONAF)	16.8/18.5 MVA
Rated voltage	
High	150kV
Low	11kV

Location of Salient Features:

Feature	**GPS (UTM)**
Turbine + Generator	47 N 0552694 0253989
Penstock	47 N 0552252 0254386
Power House	47 N 0552694 0253989
Switchyard + Main Transformer	47 N 0552827 0254113
Main Meter / Check meter	47 N 0552843 0254138
Weir / Intake	47 N 0548121 0252872
Transition Channel + Desander	47 N 0548260 0252987
Headpond	47 N 0551775 0254808
Headrace Channel + Tunnel	47 N 0551121 0254717

Single Line Diagram of Hasang HPP



For HD Image please see link: [Single Line Diagram]

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Indonesia (Host Party)	PT Binsar Natorang Energi (Private Entity)	No

A.5. Public funding of project activity

>>
There is no public funding of the project activity

A.6. History of project activity

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The Project Proponents confirm that:

(a) The proposed CDM project activity is neither registered as a CDM project nor included as a component project activity (CPA) in a registered CDM Programme of activities (PoA)
(b) The proposed CDM project activity is not a project activity that has been deregistered.

The Project Proponents declare that:

(c) The proposed CDM project activity is not a CPA that has been excluded from a registered CDM PoA.
(d) No registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

>>
Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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Version 20.0 of ACM0002: “Large-scale Consolidated Methodology: Grid-connected electricity generation from renewable sources”

Related Tools:
“TOOL01: Tool for the demonstration and assessment of additionality” V 7.0
“TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality”V7.0
“TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”V3.0
“TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” V 3.0
“TOOL07: Tool to calculate the emission factor for an electricity system” V 7.0
“TOOL10: Tool to determine the remaining lifetime of equipment”V 1.0
“TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” V 3.0.1.
“TOOL32: Positive lists of technologies” V2.0

B.2. Applicability of methodologies and standardized baselines

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The Methodology is Applicable to:	Justification

This methodology is applicable to grid-connected renewable energy power generation project activities that: (a) Install a Greenfield power plant; (b) Involve a capacity addition to (an) existing plant(s); (c) Involve a retrofit of (an) existing operating plants/units; (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s)/unit(s).	The Project is a greenfield renewable hydro power plant with grid connectivity installed at a site where no renewable power plant was operated prior to the implementation of the Project.
The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;	The Project does not result in any reservoirs. It is a run-of-river hydro power plant utilizing an overflow weir.
In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects) the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.	The Project does not involve capacity additions, retrofits or replacements.
In case of hydro power plants, one of the following conditions shall apply (a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or (b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density, calculated using equation (3), is greater than 4 W/m^2; or (c) The project activity results in new single or multiple reservoirs and the power density, calculated using equation (3), is greater than 4 W/m^2; or (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs, calculated using equation (3), is lower than or equal to 4 W/m^2	The Project does not result in a new reservoir, does not utilize an existing reservoir and no dam is constructed. As it is a run-of-river project, only a small overflow weir is constructed.
In the case of integrated hydro power projects, project proponent shall: (a) Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively	This condition is not applicable since the project activity is not an integrated hydro project.

constitute to the generation capacity of the integrated hydro power project; or (b) Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore, this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum five years prior to implementation of CDM project activity.	

The methodology is not applicable to:	**Justification**
Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site	The project activity is a hydro power plant and therefore applicable under the methodology.
Biomass fired power plants/units.	The project activity is a hydro power plant and therefore applicable under the methodology.
In the case of retrofits, rehabilitations, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, that is to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	The project activity on a greenfield site and not a retrofit, rehabilitation or capacity addition.

B.3. Project boundary, sources and greenhouse gases (GHGs)

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	Source	GHG	Included?	Justification/Explanation
Baseline	CO^2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	Emissions of CH_4 from the reservoir.	CO_2	No	Minor emission source
		CH_4	No	No reservoir created. No existing reservoir used
		N_2O	No	Minor emission source
	CO2 emissions from the EDG used as a backup generator.	CO_2	No	The start up energy will be supplied by PLN, so no fossil fuel energy is involved. The EDG is used as a backup generator when the energy for start-up is not available from PLN, and can therefore be neglected as per para 34 of the methodology
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

Project Boundary:

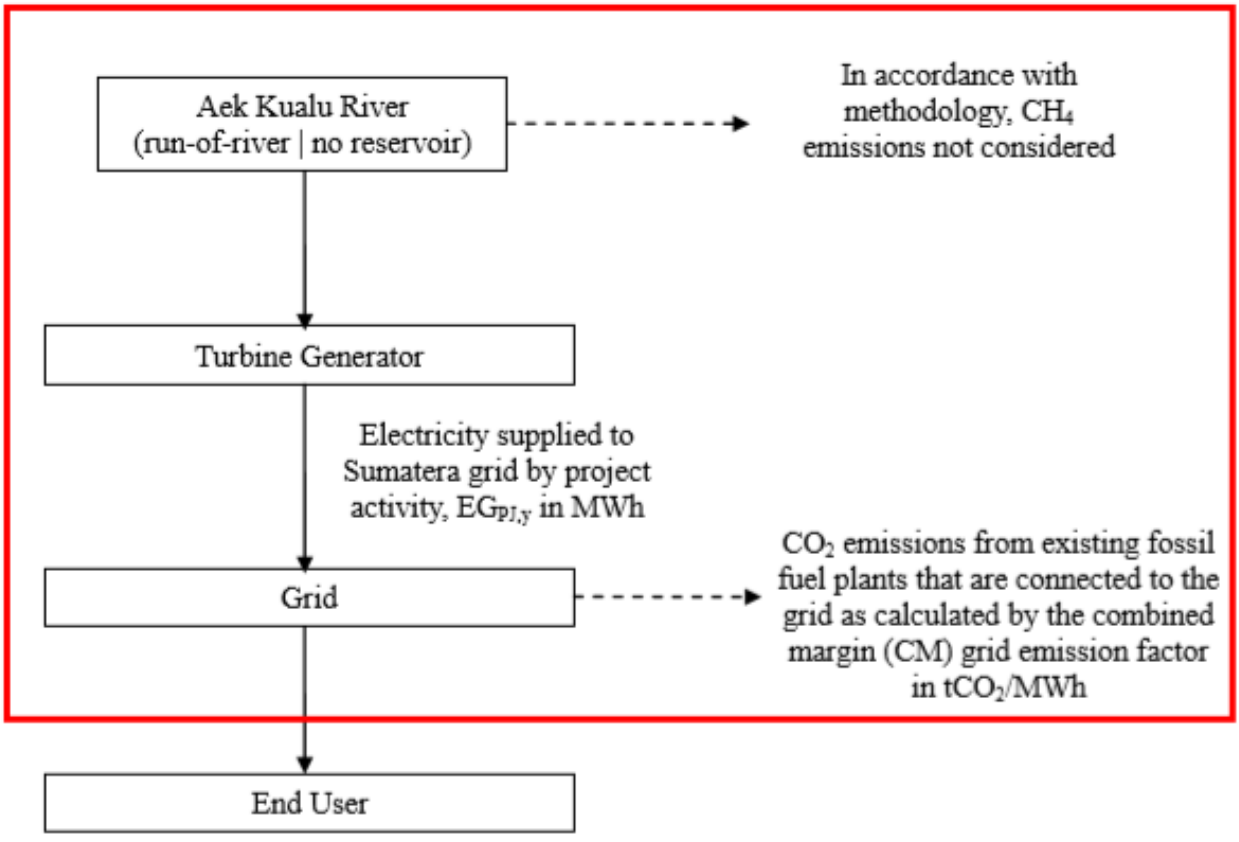

Figure 2: Project Boundary and Source Gases

B.4. Establishment and description of baseline scenario

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As per the applied methodology, the baseline for the Greenfield power plant is as below –

If the project activity is the installation of a Greenfield power plant, the baseline scenario is electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in "TOOL07: Tool to calculate the emission factor for an electricity system" V.7.0.

Hence, the baseline scenario is established as the electricity delivered to the grid by the project activity would otherwise have been generated by the operation of grid-connected power plants and by the addition of new generation sources to the grid.

B.5. Demonstration of additionality

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Prior CDM Consideration
As per the Guidance on Demonstration and Assessment of Prior Consideration of CDM, the CDM Prior Consideration form was sent to the UNFCCC secretariat as well as the host party DNA on **17 May 2016**, this was followed by a progress update on 14 May 2018

The project was previously webhosted by Project Participant E.ON Carbon Sourcing Gmbh, with Bureau veritas as the DOE with contractual obligation. However, E.ON Carbon Sourcing withdrew from the project and the contract with the DOE was terminated by letter on 15 January 2017. In line with Para 23 of the CDM project cycle procedure for project activities V 2.0 PT BNE, along with EPIC, acting as DOE, submitted a revised PDD for global stakeholder consultation.

Key Events – Withdrawal of E.ON

Date	Event	Source
31 January 2012	E.ON. BVQ Webhosting	CDM Database
15 January 2017	BVQ Letter of Termination	Letter of Termination

Key Events – BNE Project

Date	Event	Source
17 May 2016	Prior Consideration	Email to UNFCCC
18 October 2016	Draft Equity Support Agreement (Investment Decision Date)	Draft Equity Support Agreement
14 May 2018	Prior Consideration Update	Form submission to UNFCCC
December 2019	BNE & EPIC Agreement	Signed Agreement

Demonstration of Additionality
The "Tool for the demonstration and assessment of additionality v07" is applied in ACM0002 v.20.0 In order to demonstrate additionality of the Project, a **benchmark analysis** is performed.

Step 0: Demonstration whether the proposed project activity is the first-of-its-kind
This step is not applied – The proposed project activity is not the first-of-its-kind.

Step 1. Identification of Alternatives to the Project Activity Consistent with Current Laws and Regulations

Sub-Step 1a: Define alternatives to the project activity:
The demonstration of the baseline scenario (in section B4) incorporated the steps contained within this section and the plausible baseline scenarios correspond to the alternatives that are related to technology and circumstances as well as to the investor.

(a) *The proposed project activity undertaken without being registered as a CDM project activity i.e. the construction of a new hydro-electric power plant with an installed capacity of 39MW connected to the grid, implemented without CDM status.*

Under this scenario the project will generate zero emission power and cause emission reduction by displacing equivalent power generation from fossil fuels. However, the project cannot be implemented without CDM revenues due to the investment barrier, which is analysed in detail under Step 2. At Step 1 this is still considered a plausible alternative.

(b) *Other realistic and credible alternative scenario(s) to the proposed CDM project activity scenario that deliver outputs services (e.g. cement) or services (e.g. electricity, heat) with comparable quality, properties and application areas, taking into account, where relevant, examples of scenarios identified in the underlying methodology;*

Other alternatives like coal, wind, hydro power plants etc have not been considered plausible alternatives in the case of the project activity since as per the additionality tool these are not alternatives for an IPP. In the case the project activity was being set up by a public utility, these would have been plausible alternatives.

(c) *If applicable, continuation of the current situation (no project activity or other alternatives undertaken).*

Under this scenario electricity will continue to be generated by the existing generation mix operating in the North Sumatera grid. The increasing demand of electricity would be met by increasing the installed capacity through the possible expansion of existing power plants as well as construction of new power plants according to the current policies and regulations. This is a realistic and credible scenario.

Outcome of Sub-step 1a: As evident above, the only feasible scenarios are Alternative (a) and (c).

Sub-step 1b: Consistency with mandatory laws and regulations
There are no legal and regulatory requirements in the host country scenario that prevent alternatives from occurring.

To ensure that PLN meets the additional capacity required for national development plans, the government has introduced various fast-track programs[4] to accelerate power generation, with the fast track II program having a specific focus on renewable energy. The fast track program is voluntary and as such, there are no legal or regulatory requirements that prevent the project activity being undertaken without being a registered CDM project (a), similarly there are no legal or

[4] Indonesia President Decree No. 4/2010
Indonesia President Decree No. 48/2011
Indonesia President Decree No. 194/2014

regulatory requirements that would mandate the development of the project activity (c). Furthermore, the tariff applied is not an E- / E+ feed in tariff ; the only tariff or financial incentive considered in the financial analysis is that of the agreed PPA with PT PLN. Option a and c remain available.

Outcome of Sub-step 1b: Realistic and credible alternative scenario(s) to the Project activity have been identified that are in compliance with mandatory legislation and regulations taking into account the enforcement in Indonesia and EB decisions on national and/or sectoral policies and regulations.

Step 2. Investment Analysis:
The following section continues in accordance with the Methodological Tool – Investment Analysis – Version 10.0

Sub-step 2a: Determine appropriate analysis method

Option I: Simple cost analysis. This analysis method can be used if the Project activity produces no economic benefits other than CDM related income. However, this option is not applicable to the Project because the Project will generate electricity sales revenue.

Option II: **Investment comparison analysis.** According to the "Guidance on the assessment of investment analysis v.10.0, "If the alternative to the project activity is the supply of electricity from a grid this is not to be considered an investment and a benchmark approach (Option III) is considered appropriate." Thus, Option II is not applicable.

Option III: Benchmark analysis. Given that the alternative is the continuation of supply of electricity from the Sumatera Grid, benchmark analysis (Option III) is then used for assessing the financial attractiveness of the project activity.

Sub-step 2b: Option III. Apply benchmark analysis
70% of the financing of the project is through debt and the owners have a liability to service debt, which also needs to be considered while calculating the returns associated with the project. Thus, a project IRR was considered more appropriate for the project activity.

As per para 17 of the Investment tool v.10.0. in the cases of projects which could be developed by an entity other than the project participant the benchmark should be based on parameters that are standard in the market. Moreover, Paragraph 15 of Tool 27 v10 states 'Local commercial lending rates or WACC are appropriate benchmarks for a project IRR'.

The WACC is therefore calculated using the default value from Tool 27 for the cost of equity and the cost of debt uses parameters that are standard in the market, in this case, the WACC calculation applies the investment lending rate from the Central Bank of Indonesia. This is quoted at 11.64%[5] as the year to date average to the time of investment decision of the project activity i.e. October 18th 2016.

[5] https://www.bi.go.id/id/statistik/sdds/Pages/Default.aspx#FinancialSector (Copy + Paste to Browser) Investment Lending Rate - The investment lending rate is obtained from the investment lending rates of the reporting banks' branches located in Indonesia, as reported in the monthly commercial bank reports.

$$WACC = r_e \times W_e + r_d \times W_d \times (1 - T_c)$$ Equation (1)

Where:

r_e = Cost of equity (-)

W_e = Percentage of financing that is equity (-)

r_d = Cost of debt (-)

W_d = Percentage of financing that is debt (-)

T_c = Corporate tax rate (-)

Input	Value	Source
r_e	10.24	Default value for Indonesia Group 1 projects from TOOL27: Investment analysis Version 10.0
W_e	50%	In line with Para 26 of Tool 27 V.10
r_d	11.64	Investment lending rate from Central bank of Indonesia (Year to investment decision date average)*
W_d	50%	In line with Para 26 of Tool 27 V.10
T_c	25%	Law No. 36/2008 on Income Tax

WACC	9.485

Following the calculation of the WACC, the appropriate benchmark for the project is 9.485.

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

The financial analysis includes all relevant costs (including, for example, the investment cost, the operations and maintenance costs), and revenues (excluding CER revenues) In line with the guidance the post-tax project IRR analysis has been done for the lifetime of the project activity i.e. 30 years. Input values used in the analysis were valid and applicable at the time of the investment decision taken by the project participants.

The cost of financing expenditures (i.e. loan repayments and interest) have not been included in the calculation of project IRR.

Table 3: Project IRR parameters

Item	Value	Source Document
Initial capital investment cost (USD)	200,777,959	Input File_Hasang_150923_LGI (SMBC)
Electricity Tariff (cUSD/KWh)	Phase 1 - 8.9917 Phase 2 – 5.7121	Hasang PPA Appx G-Attch A
Electricity supplied to grid per year (KWh)	242,240,000	Hasang PPA Appx A
Average fixed + variable O&M cost per year (USD)	3,716,000	150813_Hasang Operation_Budget rev 7
Project Life / assessment period (years)	15+15	Hasang PPA
Corporate income tax	25%	Law No. 36/2008 on Income Tax
Depreciation	30 Years	FSR

Interest rate on loans (real)	LIBOR[6] +Margin 1.35% for covered facility 3.62 for uncovered facility	Covered Facility Agreement Uncovered Facility Agreement
Debt to Equity Ratio	70:30	FSR
Project IRR	4.20%	Financial Model

The IRR of the project activity without taking into account CER revenues is 4.2 % which is below the chosen conservative benchmark, thus the project activity is found to be financially unattractive.
.

Sub-step 2d: Sensitivity Analysis
The key parameters/ assumptions that affect the Project IRR of the Project are:

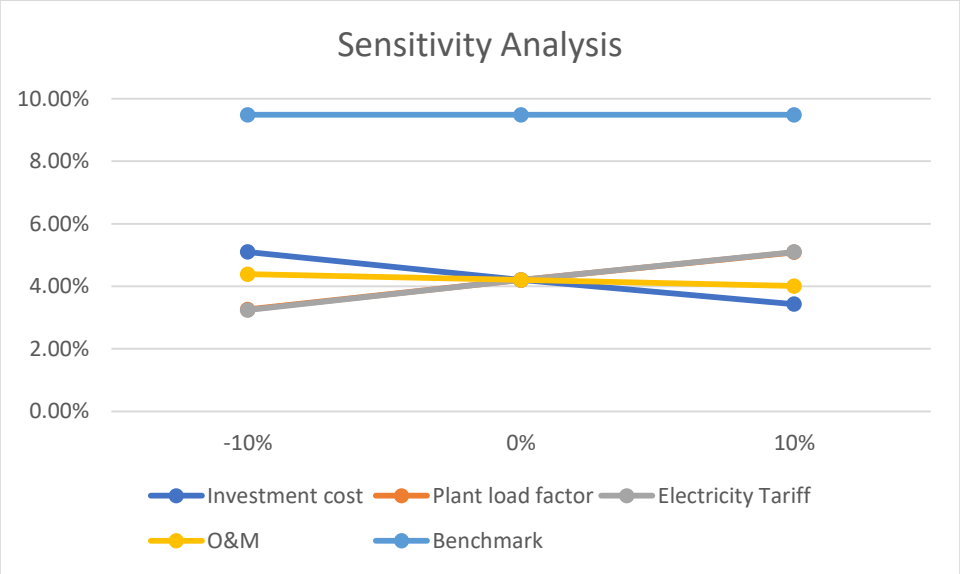
- Investment cost
- Plant Load Factor
- Electricity Tariff
- Total Operation and Maintenance cost

Parameters have been given a variation of ± 10% as per the investment guidance, the impacts on project IRR due to variations in these key parameters are shown in the below.

Table 4: Sensitivity Analysis

Parameter	% variation			% variation to cross benchmark
	-10%	0%	10%	
Investment cost	5.10%	4.20%	3.43%	-42.7%
Plant load factor	3.26%	4.20%	5.09%	67.5%
Electricity Tariff	3.24%	4.20%	5.10%	66.5%
O&M	4.39%	4.20%	4.01%	-339.3%

[6] September 2015 - https://www.macrotrends.net/2519/6-month-libor-rate-historical-chart



The Threshold value for each parameter is also calculated. The threshold value is the value at which the IRR meets the benchmark. It is considered unlikely that the assumed parameters will vary so much as to make the Project economically attractive:

- Investment Cost
  - The benchmark of 9.485% will be crossed when the investment cost is decreased by 42.7%. This scenario is unlikely to occur due to the construction and material prices steadily increasing in recent years along with prices in the wider economic situation as reflected in annual inflation rates. Hence the decrease of 42.7% in the investment cost is unlikely.
- Tariff
  - The benchmark of 9.485% will be crossed when the tariff is increased by 66.5%. This scenario is unlikely to occur as evidenced by the lower historical electricity tariffs signed by PLN for hydro power plant throughout the history of IPP hydro power development in Indonesia. Even for the small-scale renewable (hydro) power plants with capacity up to 10 MW of which the tariff has been promoted by Government of Indonesia, the highest tariff can be approved by PLN is up to 10.46 cent USD/kWh for medium voltage connection. Hence the increase of tariff by 66.5% is not likely.
- Load Factor
  - The load factor and installed capacity of the Project has been determined based on extensive hydrological and meteorological studies as well as detailed calculations of utilizing the river's energy to its optimum capacity and PLN's consideration for the grid system. These studies include 30 years of data and are based on best engineering practices. As such, even though a small increase could happen, an increase by 67.5% of the original value is very improbable.
- Operation and maintenance costs
  - Considering the annual inflation in the host country, it is highly unlikely that the O&M cost will decrease in future. The benchmark of 9.485% will be crossed when the operation and maintenance cost is decreased by 339.3%. This scenario is unlikely to occur due to the inflation in the host country.

Outcome of step 2: The proposed project is not the most financially attractive without CDM revenues (Option A). As per the tool, step 3 is skipped.

Step 4: Common practice analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity

As per paragraph 9 of the Tool 'Common practice' v3.1. the applicable geographical area is chosen as the entire Host Country, the Republic of Indonesia.

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

Output Range = 19.5 MW to 58.5 MW

Step 2:

(a) The projects are located in the applicable geographical area;

The geographical area considered is the Host Country, The Republic of Indonesia.

(b) The projects apply the same measure as the proposed project activity;

The project activity is a green-field hydro power project and uses measure (b) "Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies". Therefore, all projects applying same measure (b) as the proposed project activity are candidates for similar projects.

(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;

The project does not involve a technology switch measure, therefore all plants are considered.

(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;

The project activity produces electricity; therefore, all power plants that produce electricity are considered.

(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;

The projects outlined below are within the output range of 19.5 MW to 58.5 MW

(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity

The projects below all started commercial operation before the start date of the project activity in 2016.

Table 6: Similar Hydropower projects conforming to the above conditions[7]

Name	Developer	Type	CDM	COD	Capacity (MW)
Sumatera Grid					
PLTD Tegineneng (Sektor Bandar Lampung)	Private + Public	Diesel	No	2011	20.00
PLTD PT Burak Berawang Cemerlang, Paya Pasir (Sektor Medan)	Private + Public	Diesel	No	2013	20.00
PLTD PT Berkat Bima Sentana / PLTD Sewa 120 MW di Belawan (Sektor Medan)	Private + Public	Diesel	No	2013	20.00
PLTD PT Bima Golden Powerindo, Glugur (Sektor Medan)	Private + Public	Diesel	No	2013	20.00
PLTD PT Prastiwahyu Trimitra Engineering, Tamora (Sektor Medan)	Private + Public	Diesel	No	2013	20.00
PLTD PT Bima Golden Powerindo 2 (Sektor Pekanbaru)	Private + Public	Diesel	No	2011	24.00
PLTD PT Prastiwahyu Trimitra Engineering, Kualanamu (Sektor Medan)	Private + Public	Diesel	No	2013	30.00
PLTD PT Bima Golden Powerindo GI Bayu (Sektor Naganraya)	Private + Public	Diesel	No	2010	34.00
PLTD PT Kurnia Purnama Tama, GI Bireuen (Sektor Naganraya)	Private + Public	Diesel	No	2011	37.22
PLTD PT Bima Golden Powerindo GI BNA (Sektor Naganraya)	Private + Public	Diesel	No	2010	39.00
PLTD PT Sewatama GI Teluk Lembu (Sektor Pekanbaru)	Private + Public	Diesel	No	2010	40.00
PLTD Pauh Limo / PLTD KBT/ABT (Sektor Ombilin)	Private + Public	Diesel	No	2011	40.00
PLTD PT Bima Golden Powerindo, Paya Pasir (Sektor Medan)	Private + Public	Diesel	No	2012	40.00
PLTD Sutami (Sektor Bandar Lampung)	Private + Public	Diesel	No	2011	50.00
PLTD GI PIP / PLTD Sewatama (Sektor Ombilin)	Private + Public	Diesel	No	2013	50.00
PLTG Glugur GGL 1 JBE	PLN	Gas	No	1975	19.85
PLTG Talang Duku (Frame 5) #1	PLN	Gas	No	2011	20.00
PLTG Batanghari#3 (PLTG Eks Sunyaragi 3)	Private + Public	Gas	No	2011	20.00
PLTG Jakabaring #1	PLN	Gas	No	2013	20.00
PLTG Jakabaring #2	PLN	Gas	No	2013	

[7] Power plant list obtained from DNA Grid Emission Factor data

					20.00
PLTG Musi 2	Private + Public	Gas	No	2009	21.00
PLTG Keramasan #3	PLN	Gas	No	1983	21.35
PLTG Pauh Limo #3	PLN	Gas	No	1995	21.35
PLTG Pauh Limo #1	PLN	Gas	No	1983	21.50
PLTG Pauh Limo #2	PLN	Gas	No	1983	21.50
PLTG LM 2500 Talang Duku #2 (Sektor Keramasan)	Private + Public	Gas	No	2012	21.50
PLTG Teluk Lembu Unit 3	PLN	Gas	No	2011	21.60
PLTG Duri (PT IP)	PLN	Gas	No	2012	21.60
PLTG Sewa Duri PT PJB (Sektor Pekanbaru)	Private + Public	Gas	No	2012	21.60
PLTG Borang#1 / PLTG LM 6000 Merah Mata #1 (Sektor Keramasan)	*Private* + *Public*	Gas	No	2012	30.00
PLTG Borang#2 / PLTG LM 6000 Merah Mata #2 (Sektor Keramasan)	Private + Public	Gas	No	2012	30.00
PLTG Batang Hari #1	PLN	Gas	No	1994	30.88
PLTG Batang Hari #2	PLN	Gas	No	1995	30.88
PLTG LM 2500 Talang Duku #3 (Sektor Keramasan)	Private + Public	Gas	No	2013	35.10
PLTG Payo Selincah#1	Private + Public	Gas	No	2012	50.00
PLTG Payo Selincah#2	Private + Public	Gas	No	2012	50.00
PLTGU Riau Power (PLTGU Combine Cycle Teluk Lembu) (Sektor Pekanbaru)	Private + Public	GasU	No	2007	21.60
PLTGU Gunung Megang ST (PT. Meppogen)	IPP	GasU	No	2013	30.00
PLTGU Inderalaya GT 1.2	PLN	GasU	No	2004	40.00
PLTGU Gunung Megang GT #1 (PT. Meppogen)	IPP	GasU	No	2013	40.00
PLTGU Gunung Megang GT #2 (PT. Meppogen)	IPP	GasU	No	2013	40.00
PLTGU Keramasan #1	PLN	GasU	No	2014	40.00
PLTGU Keramasan #2	PLN	GasU	No	2014	40.00
PLTGU Sewa Inderalaya GT 1.1	Private + Public	GasU	No	2002	45.00
PLTP Ulu Betu#1	PLN	Geothermal	No	2012	55.00
PLTP Ulu Betu#2	PLN	Geothermal	No	2012	

					55.00
PLTA Sipansihaporas 1	PLN	Hydro	Yes	2004	33.00
PLTA Kota Panjang Unit 1	PLN	Hydro	No	1998	38.00
PLTA Kota Panjang Unit 2	PLN	Hydro	No	1998	38.00
PLTA Kota Panjang Unit 3	PLN	Hydro	No	1998	38.00
PLTA Renun 2	PLN	Hydro	Yes	2005	41.00
PLTA Renun 1	PLN	Hydro	Yes	2006	41.00
PLTA Singkarak #1	PLN	Hydro	No	1998	43.75
PLTA Singkarak #2	PLN	Hydro	No	1998	43.75
PLTA Singkarak #3	PLN	Hydro	No	1998	43.75
PLTA Singkarak #4	PLN	Hydro	No	1998	43.75
PLTA Besai #1	PLN	Hydro	No	2001	45.00
PLTA Besai #2	PLN	Hydro	No	2001	45.00
PLTA Asahan II (PT Inalum)	IPP	Hydro	Yes	2014	45.00
PLTMG PT Navigat (Sektor Keramasan)	Private + Public	Machine-Gas Power	No	2011	30.00
PLTMG PT PJBS TL. Lembu (Sektor Pekanbaru)	Private + Public	Machine-Gas Power	No	2013	30.00
PLTMG Payo Selincah	Private + Public	Machine-Gas Power	No	2014	30.00
PLTMG Navigat Balai Pungut / PLTMG 40 MW Balai Pungut (Sektor Pekanbaru)	Private + Public	Machine-Gas Power	No	2013	40.00
PLTMG PT Navigat (Sektor Belawan)	Private + Public	Machine-Gas Power	No	2012	49.50
PLTMG Hutan Alam Teluk Lembu (Sektor Pekanbaru)	Private + Public	Machine-Gas Power	No	2013	50.00
JAMALI GRID					
Sutami 1	PJB	Hydro	No	1973	35.00
Sutami 2	PJB	Hydro	No	1973	35.00
Sutami 3	PJB	Hydro	No	1974	35.00
Gresik 1	PJB	Gas	No	1977	20.10
Gresik 2	PJB	Gas	No	1977	20.10
Wlingi 1	PJB	Hydro	No	1978	27.00
Wlingi 2	PJB	Hydro	No	1980	27.00

Kamojang 1	IP	Geothermal	No	1982	30.00
Pesanggaran 1	IP	Gas	No	1985	21.35
Kamojang 2	IP	Geothermal	No	1987	55.00
Kamojang 3	IP	Geothermal	No	1987	55.00
Kedungombo	IP	Hydro	No	1992	22.50
Pesanggaran 2	IP	Gas	No	1993	20.10
Cikarang GTG 1	IPP	Gas	No	1993	34.40
Cikarang GTG 2	IPP	Gas	No	1993	34.40
Pesanggaran 3	IP	Gas	No	1994	42.00
Pesanggaran 4	IP	Gas	No	1994	42.00
Darajat 1	IP	Geothermal	No	1994	55.00
Cikarang GTG 3	IPP	Gas	No	1996	34.40
Cikarang GTG 4	IPP	Gas	No	1996	34.40
Cikarang GTG 5	IPP	Gas	No	1996	34.40
Cikarang GTG 6	IPP	Gas	No	1996	34.40
Pemaron 1	IP	Gas	No	2004	48.80
Pemaron 2	IP	Gas	No	2005	48.80
Pesanggaran Blok A	Private + Public	Diesel	No	2010	37.50
Pesanggaran Blok B	Private + Public	Diesel	No	2011	54.00
Pemaron Blok 3-4-5-6	Private + Public	Diesel	No	2012	37.60
Pemaron Blok 7-8	Private + Public	Diesel	No	2012	45.00
Pemaron Blok 9-10	Private + Public	Diesel	No	2012	45.00
Pesanggaran Blok C	Private + Public	Diesel	No	2013	50.00
Pesanggaran Blok D	Private + Public	Diesel	No	2013	45.00
Pesanggaran Blok F	Private + Public	Diesel	No	2013	45.00
Bekasi GTG 1A	IPP	Gas + Steam	Tidak	2013	40.00
Bekasi GTG 1B	IPP	Gas + Steam	Tidak	2013	40.00
Bekasi STG	IPP	Gas + Steam	Tidak	2013	50.00

Sulawesi					
Tello 2	PLN	Gas	no	1982	21.35
Telllo 5	PLN	Gas	no	1997	33.40
Tello 4	PLN	Gas	no	1997	33.40
Senkang GT 11	IPP	Gas	no	1997	45.00
Sengkang GT 12	IPP	Gas	no	1997	45.00
Sengkang ST18	IPP	Gas+Steam	no	1998	50.00
Palu	IPP	Coal	no	2006	30.00
Arena Maju Bersama	Private + Public	Diesel	no	2010	20.00
Bima Goltens Powerindo TL	Private + Public	Diesel	no	2010	34.00
Suluttenggo					
Lahendong I	PLN	Geothermal	no	2001	20.00
Lahendong II	PLN	Geothermal	no	2007	20.00
West Kalimantan					
Siantan	PLN	Gas	No	1997	34.00
Siantan 9	PLN	Diesel	No	2008	20.00

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation.

$$N_{all}=114$$

With the exclusion of 4 registered CDM projects.

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity.

$$N_{diff} = 114$$

Of the 114 projects identified above, 95 of them utilise different technology, therefore all projects with an energy source other than Hydropower have been excluded in line with paragraph 12 (a) of the Common Practice Tool

Of the 19 Hydro projects identified above, 13 projects have been developed by the public entity PT PLN. PT PLN is a state-owned company[8] that has the access to financing facilities such as government budget and related loans. Therefore, projects developed by them are less exposed to the investment risks faced by an IPP and in line with Paragraph 12 (d) of the tool are considered to have a different investment climate

Five projects have been developed by PT PJB (PT Pembangkitan Jawa Bali) which is a subsidiary of PT PLN[9] and supplies electricity demand in the Java-Bali region and hence has the same access to financing facilities such as government budget and related loans as PT PLN, and in line with Paragraph 12 (d) of the tool are considered to have a different investment climate

One of the identified projects is developed by PT Indonesia Power (IP) which is also a subsidiary of PT PLN[10]. Therefore, projects developed by them are less exposed to the investment risks faced by an IPP and in line with Paragraph 12 (d) of the tool are considered to have a different investment climate

Step 5: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

$$\mathbf{F} = 1 - (114/114) = \mathbf{0}$$
$$\mathbf{N_{all} - N_{diff}} = 114 - 114 = \mathbf{0}$$

Outcome of Step 4
As per paragraph 18 of the common practice guidance '*The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and N_{all}-N_{diff} is greater than 3.'*

This project is therefore not common practice and considered additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>>
Baseline emissions as per methodology is calculated as:

$$BE_y = EG_{PJ,y} * EF_{grid,CM,y}$$

Where:

BE_y	=	Baseline emissions in year y (tCO2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the Sumatera grid as a result of the implementation of the CDM project activity in year y (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

[8] https://web.pln.co.id/en/about-us/company-profile

[9] https://web.pln.co.id/en/about-us/subsidiary

[10] https://web.pln.co.id/en/about-us/subsidiary

Since the Indonesian Direktorat Jenderal Ketenagalistrikan has defined the combined margin CO_2 emission factor for the Sumatera grid, we will be using the delineated value of 0.893 $_tCO_2/MWh$[11]. Details of this calculation can be found in appendix 4.

Since the Project is a greenfield hydroelectric power project, we use equation 12 of the methodology:

$$EG_{PJ,y} = EG_{facility,y}$$

Where:

$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

$EG_{facility,y}$ = Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh/yr)

Project Emissions

For all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected

As per methodology, if the power density of the project activity (PD) is greater than 10 W/m^2:

$PE_{HP,y} = 0$

Where:

$PE_{HP,Y}$ = Project emissions of hydro power plant

The power density of the project activity (PD) is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$

Where:

PD = Power density of the project activity (W/m^2)

Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project activity (W)

Cap_{BL} = Installed capacity of the hydro power plant before the implementation of the project activity (W). Zero in this case as it is a new power plant.

A_{PJ} = Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)

A_{BL} = Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m2). Zero in this case if it is a new reservoir.

Note: The Project creates no new reservoir and does not use an existing reservoir. Power Density is Not Applicable for the Project.

[11] https://gatrik.esdm.go.id/frontend/download_index/?kode_category=emisi_pl

Leakage Emissions

As per methodology, no leakage emissions are considered because the power density is above 10W/m^2.

Emissions Reductions

$$ER_y = BE_y – PE_y$$

Where:

ER_y = Emission reductions in year y (t CO_2e/yr)
BE_y = Baseline emissions in year y (t CO_2/yr)
PE_y = Project emissions in year y (t CO_2e/yr)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	Calculation of combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system"
Source of data	Direktorat Jenderal Ketenagalistrikan Published data
Value(s) applied	0.893
Choice of data or measurement methods and procedures	The DNA calculated the grid factor according to the Tool to calculate the emission factor for an electricity system.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Further details can be found in appendix 4.

Data/Parameter	CAP_{BL}
Data unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity. For new hydro power plants, this value is zero
Source of data	-
Value(s) applied	0
Choice of data or measurement methods and procedures	Determine the installed capacity based on recognized standards
Purpose of data	Calculation of Power Density
Additional comment	-

Data/Parameter	A_{BL}
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero
Source of data	Project site
Value(s) applied	0 (No Reservoir)
Choice of data or measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc.
Purpose of data	As per methodology.
Additional comment	Calculation of Power Density

B.6.3. Ex ante calculation of emission reductions

Baseline Emissions

$$BE_y = EG_{PJ,y} \cdot EF_{grid,cm,y}$$

Parameter	Value	Unit	Source Document
Capacity after losses and auxiliary consumption	39	MW	PPA
Hours in a year	8760	Hours	
Availability rate	97	%	Rate_Utilization
Load factor	73.1	%	Calculated to meet PPA ECE
$EG_{PJ,y}$	242,240	MWh	PPA
$EF_{grid,cm,y}$	0.893	tCO_2/MWh	2018 Grid Emission Factor (Direktorat Jenderal Ketenagalistrikan)
BE_y	216,320	tCO_2e	

$EG_{PJ,y}$ =
Net Rated Capacity x Operating hours x Plant load factor
39 x 8760 x 73.1% = 249,732

Generation * Availability Rate
249,732 X 97% = 242,240

$EG_{PJ,y}$ = 242,240

BE_y = *$EG_{PJ,y}$ x $EF_{grid,CM,y}$*

BE_y = 242,240 x 0.893 = 216,320 tCO_2e

Please see Appendix 4 for further details on the calculation of $EF_{gric,CM,y.}$

Project Emissions

$$PE_y = 0$$

Power Density

Parameter	Value	Unit	Source Document
Cap_{PJ}	39,000,000	W	PPA
Cap_{BL}	NA	W	Greenfield Project
A_{PJ}	NA[12]	M^2	No Reservoir after
A_{BL}	NA	M^2	No Reservoir prior
PD	NA	W/m^2	

Emissions Reductions

$$ER_y = BE_y - PE_y$$

Parameter	Value	Unit
BE_y	216,320	tCO_2
PE_y	0	tCO_2
ER_y	216,320	tCO_2

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2020	216,320	0	0	216,320
2021	216,320	0	0	216,320
2022	216,320	0	0	216,320
2023	216,320	0	0	216,320
2024	216,320	0	0	216,320
2025	216,320	0	0	216,320
2026	216,320	0	0	216,320
2027	216,320	0	0	216,320
2028	216,320	0	0	216,320
2029	216,320	0	0	216,320
Total	**2,163,200**	**0**	**0**	**2,163,200**
Total number of crediting years	**10**			
Annual average over the crediting period	**216,320**	**0**	**0**	**216,320**

[12] There is no reservoir before the Project is implemented and there is also no reservoir after the Project is implemented. This is a pure run-of-river project and no water storage is required. The surface area at the site around the weir is about 14,200 m2. If this area is to be considered a reservoir, the power density will be 2841.54 W/m2.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$EG_{facility,y}$
Data unit	MWh/yr
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y.
Source of data	The main and check meters are placed immediately before the connection to the transmission lines. That is, it is within the switchyard of the Project site.
Value(s) applied	242,240
Measurement methods and procedures	Electricity meters will be installed as per requirements in the PPA. There will be main and check meters for each line, capable of monitoring export/import to and from the grid. The net electricity exported is the difference of export and import. The readings from both lines will be added to get the net export to grid. Data will also be cross checked with invoices.
Monitoring frequency	Monthly
QA/QC procedures	Meters will be calibrated periodically. Inspection will be performed by PLN as dictated by the requirements in the PPA. PPA Requirements: - Class 0.2 type metering equipment - Calibration and testing to be performed annually from the Commercial Operation Date In line with the PPA, the project must install Main and check meters, if tests show that the Main meter is inaccurate, and the check meter satisfies the applicable accuracy standard. Then the measurement of that check meter shall be used until the main meter is recalibrated.
Purpose of data	Calculating EGPJ ,y
Additional comment	EGfacility,y

Data/Parameter	Cap_{PJ}
Data unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data	Project site
Value(s) applied	39,000,000
Measurement methods and procedures	Determined in accordance with the nameplates of the turbines and generators of each unit supplied by the manufacturer.
Monitoring frequency	Yearly
QA/QC procedures	Photographs of the original turbine as well as the turbine name plate capacity will be taken and verified during the initial validation.
Purpose of data	Calculating Power Density
Additional comment	CapPJ

B.7.2. Sampling plan

>>
Not applicable

B.7.3. Other elements of monitoring plan

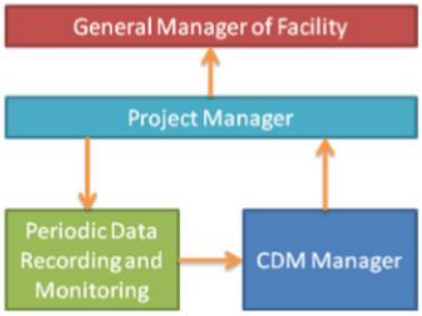
>>
All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. All measurements will be conducted with calibrated measurement equipment pertaining to relevant industry standards.

1. **Monitoring data**

Data parameters to be monitored are as in section B.7.1. of the PDD.

2. Operation and Management Organization for the Monitoring Plan

A CDM Manager will be formed to manage all issues related to CDM in the project activity. Supervising the CDM Manager is the project manager who is in charge of the project boundary of the facility. The CDM project manager will receive training in CDM monitoring.



3. **Installation and Maintenance of Monitoring Equipment**

All monitoring equipment will be installed as per national law and guidelines with respect to metering.

4. Data Recording and Reporting

The frequency of data recorded for each parameter is as stated in section B.7.1 of the PDD. A CDM project team is responsible for the monitoring of each parameter in a timely and correct manner. He/she will submit a report of all the parameters being monitored at the end of every month to the project manager.

5. Calibration, QA/QC of Monitoring Plan

The monitoring equipment will be calibrated periodically as stated by in section B.7.1. of the PDD and be calibrated as per national law. Manufacturers' specifications and instructions will be carefully recorded and followed.

The project manager is responsible in reviewing and checking through the monitoring reports submitted by the CDM Manager. He/she is also responsible for reviewing, recording and archiving calibration reports as well as making sure the calibration is performed in a timely and correct manner as per national law and manufacturer's instructions/specifications.

All data and monitoring reports as well as the monitoring manual, monitoring report template will be archived electronically and on paper. The General Manager of the whole facility will be responsible for reviewing the data and monitoring report every six months.

6. Measuring Instrument Failure / Emergency Procedures

Once a meter in fault, it shall be replaced immediately. The electricity generated during the period of erroneous measurement and replacement of the faulty meter shall not be counted towards the emissions reductions. The faulty meter shall be repaired and calibrated by appropriately qualified institutions.

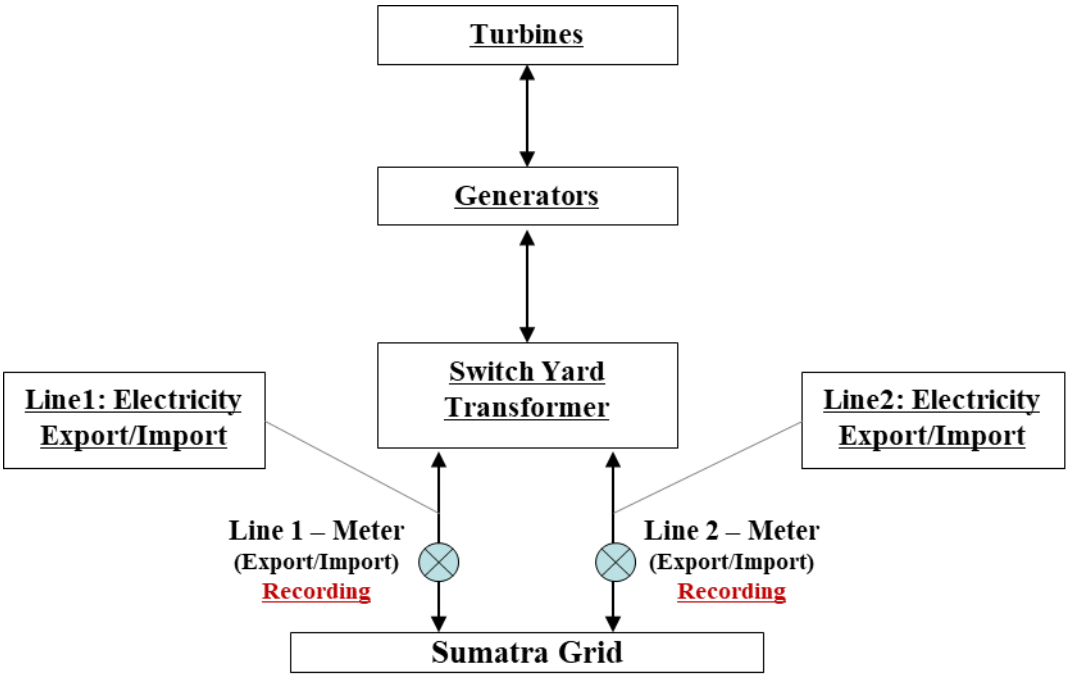
In line with the PPA, the project must install Main and check meters, if tests show that the Main meter is inaccurate, and the check meter satisfies the applicable accuracy standard. Then the measurement of that check meter shall be used until the main meter is recalibrated.

7. Monitoring Report

A CDM project manager will submit a monthly report to the project manager as stated in paragraph 4 above. A CDM project manager will submit another consolidated report of all activities related to CDM (monitoring, calibration etc) that were performed every six months starting from the crediting start date. This bi-annual report will be reviewed and approved by the Project Manager. A final yearly consolidated report will be produced that will be reviewed and approved by the General Manager.

This final yearly report is the official CDM monitoring report that will be submitted to the DOE (along with relevant data and evidence) every year for verification and issuance of CERs.

8. Monitoring Diagram



SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
24/10/2016 – Signing of equipment and construction contracts

C.2. Expected operational lifetime of project activity

>>
30 years 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Fixed Crediting Period

C.3.2. Start date of crediting period

>>
01/10/2019 (or the date of registration, whichever is later).

C.3.3. Duration of crediting period

>>
10 Years 00 Months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The Project has conducted a full Environmental and Social Impact Assessment (ESIA). The AMDAL was compiled and written in accordance with Indonesian Law. The AMDAL has been given full approval by the local government. In general, a run-of-river power plant (compared to a dam-based plant) has relatively little impact to the surrounding environment.

Below is a summary of the ESIA. All monitoring and mitigation measures adhere to National Law and Standards.

No.	Impact	Monitoring	Mitigation
1	Physical resettlement of six houses and one health clinic		The overarching aim of the resettlement plan will be to ensure that resettlement affected people's standard of living, security of tenure and livelihoods are at least restored, or where possible improved, to the standard they were before the Project.
2	Alteration of the hydrological regime of the Aek Kualu River Impacts on aquatic ecology and water quality	Visual assessment of the water features Water quality and groundwater quality monitoring Monitoring of the environmental flow Regular inspection of weir structural condition Hydrological monitoring to assess river flows	Assessment of the availability of spring fed water resources to ensure that the planned abstractions for construction water demand do not adversely impact on the local residents who are dependent on the springs for their water supply and that there is adequate flow maintained in these tributaries for environmental purposes. Avoid water wastage Minimise water usage in maintenance processes through best practice and use of water efficient technologies

No.	Impact	Monitoring	Mitigation
			Raise awareness of water usage with construction and operational employees Monitoring and prompt repairing of leaks Preventing pollution events by implementing the appropriate storage, use and disposal of chemicals, fuels / oils / lubricants and wastes. Implementation of earth control measures to minimise the likelihood of sediment mobilisation to surface water systems Roads should be sealed to minimise elevated sediment runoff
2	Impacts on terrestrial ecology, including clearance of land for access roads and work sites and land loss for spoil disposal sites	Monitoring of habitats and biodiversity at all stages of construction and operation. Soil erosion will be monitored at set intervals and after every significant rainfall and run-off event	All construction and operation working areas will be kept to a minimum size to reduce habitat loss Activity along access routes for construction and operation activities will be kept to a minimum. All off-road access will be prohibited or allowed along pre-defined routes that limit the extent of off-road activity. Plans will be implemented to minimise all construction traffic activities. Measures, such as water sprays, will be implemented for reduction of dust during the working period. All construction and operation activities will comply with the international guidelines on the prevention and management of alien plant and animal species across the Project During vegetation clearance or felling, any animals found should be removed and released to a safe refuge.

No.	Impact	Monitoring	Mitigation
			All workers engaged in the Project will be made aware of the environmental and ecological sensitivities (natural habitats and threatened and protected species) of the region, the Project site and the consequences of their own actions. Staff will be provided with relevant information through staff induction, toolbox talks, leaflets and office posters. A ban will be enforced on workers killing or trapping wild animals, for food or trade. Signage will be installed to reinforce the hunting ban throughout the Project area.
	Excavation works and requirement to manage spoil material	Site walkover Routine inspections Record volumes of spoil generated for spoil production and stockpiling	As practicable cutting and removal of the soil/rock mass will be performed from upper to lower portion to maintain the slope stability. As practicable the excavation work will only be carried out during dry season. After the excavation of slopes, timely sealing and protective measures will be adopted Reusing excavated spoil.
	Temporary nuisance caused by an increase in dust, noise and increased traffic on local roads	Construction vehicle checks Maintain record of high dust incidents Using sound level meter at the nearest residential properties to construction activities and compare it with NEQS and record in a monitoring report. Record and investigate complaints using sound level meter via the community grievance mechanism.	Dumping sites for excavated material have been selected as close as possible to the areas, where the majority of the excavation works will take place. Implement detailed Air Quality Management Plan (AQMP) to mitigate any potential negative risks to the environment, workers or the community resulting from air emissions during construction Implement Noise and Vibration Control Plan (NVCP) during construction to control noise and vibration caused by construction traffic and plant/equipment movements

No.	Impact	Monitoring	Mitigation
			The layout of the project site shall be designed to maximise on site efficiency and minimise the potential impacts on noise sensitive receptors. Positioning of temporary site compounds as far as reasonably practicable from sensitive receptors. Use of site terrain, material stockpiles and suitable work locations so as to screen work locations and maximise the distance between work activities and receptors Prioritise noisy activities to be undertaken in the daytime where feasible (i.e. avoid night working)
	Impact on landscape and visual amenity	Monitoring of visual receptors	Locate spoil disposal sites where they can be fully integrated into the surrounding topography with natural looking contours, and non-engineered slope profiles. Avoid siting in areas of forest: locate in palm oil or rubber plantations instead. Plant new forest species and allow secondary forest to regenerate on the finished spoil disposal sites. Minimise vegetation removed and protect vegetation to be retained during the construction of the HEPP, new roads and transmission line. Protect areas of secondary forest with a high diversity of plant species and locate construction sites, the accommodation camp and other temporary structures in palm oil and rubber plantation rather than forest. Store stripped soils carefully to protect fertility and structure for reuse at the end of construction. Store stone removed from the river margins for reinstatement at the end of construction. Organise site working and access

No.	Impact	Monitoring	Mitigation
			at the start of construction and maintain throughout to minimise unnecessary loss of screening vegetation.

No transboundary impact will occur.

D.2. Environmental impact assessment

>>
All potential impacts have been thoroughly considered. The scope of the Environmental Impact Assessment includes Environmental Impact Analysis, Environmental Monitoring Plan and Environmental Mitigation Plans. These studies have also been approved by the local government and are in accordance with all Indonesian Law. In addition, the PP and investors have undertaken further works to ensure that the social and environmental impacts of the Project are optimised.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>
A local stakeholder consultation meeting was held on Wednesday, 17th November 2011 12:00 to 15:00. 50 Stakeholders attended - including, various governmental officers from Toba Samosir Regency and the Nassau district; local people from village of Lumban Rau Utara, Lumban Rau Tenggara and Siantarasa; head of villages, village figures and non-governmental organization Forum Pembaruan Indonesia.

Stakeholders were identified through consultation with the local government. Afterwards invitation letters were sent out well before the date of the local stakeholder meeting. Stakeholders openly asked questions, gave comments during the meeting in the presence of other stakeholders. PP also responded in the presence of meeting attendees transparently and kept records of all that was said during the meeting. Lastly a feedback form was filled out by all participants to voice out any remaining concerns.

A technical description of the project activity was presented during the meeting. A presentation specific to the CDM standard was also presented. Lastly, local stakeholders filled out a short feedback form to test and affirm their understanding of the project.

E.2. Summary of comments received

>>
Hosts
Fumi Harahap (EON Carbon Sourcing)
Bayu Ardiyanto (PT Binsar Natorang Energi)
Indrawan (PT Binsar Natorang Energi)
Edward Syauli (PT Binsar Natorang Energi)
Martha Maulidia (Biosphere Capital, CDM consultant)

Summary of Stakeholder Consultation

- The stakeholders are well informed about Hasang HEPP project. Feedback were collected not only during the Q&A session but also from the feedback form distributed to the attendees.
- The stakeholders share their positive impression to the project
    - The project is environmentally friendly

  - The project will create job opportunities which will improve the living standard of the community
  - The project applies the Clean Development Mechanism guidelines
  - The project company will rehabilitate the road and provide street lighting for a certain section (Paridian to Dolok Barimbing) under the CSR initiative
- The stakeholders wish the project
  - To create job opportunities and give employment priority to the local people
  - To contribute to the development of the Nassau district as well as contribute to the district income
  - To coordinate with the government and local people on the activity
- The stakeholders express their willingness to fully support the development of Hasang HEPP and to PT Binsar Natorang Energi (PT BNE) as the developer
- Regent of Toba Samosir, Mr. Kasim Sumanjutak, expresses his willingness to support PT BNE in particular to obtain licenses where deemed necessary
- The public consultation is conducted under the CDM and World Commission on Dams principles.

Q&A Session

Representative from Department of Environment, Mining and Energy of Toba Samosir Regency
Q1: Energy project requires environmental impact assessment in accordance with Law Number 32 Year 2009 i.e. UKL/UPL or AMDAL study. For hydro power project with capacity less than 50 MW should carry out UKL/UPL, while above 50 MW should conduct AMDAL study. Have the EIA report be shared with the local government?
Q2: Hydro power plant will capture the water at the intake and reduce the water volume in the main river between intake and the power house. Can the remaining water sustain the water ecosystem e.g. fish?

Mr. Bayu Ardiyanto
A1: Hasang project developer PT BNE has carried out the AMDAL study. AMDAL documents would be shared with the Department of Environment, Mining and Energy of Toba Samosir Regency.
A2: Ecological flow has been considered and defined very carefully during the pre FS and FS study to preserve the water ecosystem.

Community Representative from Lumban Rau Utara Village
Q1: What are the benefits that will be received by the local people from the project developer?
Q2: How is the land compensation mechanism envisioned? Will Napakjoring community get electricity from the project?
Q3: What is the relation between the Project and another project nearby?

Mr. Bayu Ardiyanto
A1: BNE will rehabilitate the road access and provide street lighting between Paridian and Dolok Barimbing. The initial road rehabilitation will begin in 4th week of November by widening and clearing the road as well as identifying the damage areas. Extensive road rehabilitation will be carried out during the construction phase. In addition, the project will create employment opportunities and give priority to the local people based on the skill required. People will also receive benefit through the company CSR program.
Regent requested PT BNE to materialize the road rehabilitation from Paridian until Siantarasa village as soon as possible.
A2: Land needed for the project is currently under investigation. The land compensation will be in accordance with the local/national regulation. The electricity from Hasang will be fed to the PLN grid. Thus, PLN as the sole distributor will distribute power and this will be carried out according to the regional plan.
Regent communicated if there is any local people land required during the road access rehabilitation, it should not be compensated because it is dedicated for public infrastructure.

Ms. Fumi Harahap **A3**: No relation. **Regent** added to the forum that he is aware the management structure of PT BNE.
Head of village of Lumban Rau Utara **Q1:** How is the employment recruitment process? He shared his hope to PT BNE to coordinate with the head of village in the recruitment process. **Q2:** After the project is commissioned, he hopes that the project contributes to the Nassau district annual income. *Mr. Bayu Ardiyanto* **A1:** In the employment recruitment process, PT BNE will coordinate with the head of village by prioritizing the local people based on the required skills and the company requirements. Recruitment procedures will comply with the Employment Law. On the present activity i.e. topography study and soil investigation, PT BNE coordinated and consulted with the head of village to recruit workers to help in the activity. **Regent** communicated that topography study and site investigation are carried out by the expertise as they require certain skills and only few number of workers from the local people are utilized. **A2:** Government has regulated the retribution scheme for hydropower plant. PT BNE will comply with the regulation standard and will contribute to the sub-district income. CSR program for the local people is currently under further investigation. **Regent** supported the statement that there is regulation regarding project contribution to the sub-district income.
Local Resident from Lumban Rau Utara **Q1:** He requested that there should not be qualification in the employment recruitment process. *Mr. Bayu Ardiyanto* **A1:** As explained earlier, PT BNE will give priority to the local people to work in the power plant subject to fulfilling the required skills and company requirements.
Representative from Non-Governmental Organization Forum Pembaruan Indonesia He supports Hasang project. He recommended PT BNE to be transparent in carrying out any activity. He also stated that local people in the Nassau district have expressed their unhappiness to a nearby project. **Q1:** Will the employers receive employment insurance? **Q2:** Will there be any contribution to the Nassau district income from the project?
Mr. Bayu Ardiyanto and Ms. Fumi Harahap With regards to any activity on site, PT BNE always coordinates with the local people. PT BNE also supports community activity through the company CSR program. PT BNE is committed to support the development of the Nassau district **A1:** PT BNE will comply with the employment law in regards to employment standards and procedures in Hasang HEPP. EON will also look very closely in the implementation of the law. **A2:** Government has regulated the retribution scheme for hydropower plant. PT BNE will comply with the regulation standard and will contribute to the sub-district income. CSR program for the local people is currently under further investigation.
Representative Department of Forestry and Plantation Toba Samosir Regency **Q1:** According to the Law, Hasang is located in the forest zone (SK44). In fact, the land is belonged to the community. What is PT BNE strategy concerning the land compensation? **Q2:** What is the status of the forestry permit of Hasang? Please share the copy of the licenses. *Mr. Bayu Ardiyanto* **A1:** PT BNE obtains the forestry permit (lending and using permit) according to the Law Number 18 year 2011 and compensates the people"s land within the project area. **A2:** BNE has obtained the technical recommendation letter and forestry license from the forestry department of Toba Samosir Regency, technical recommendation letter and forestry license from forestry department of North Sumatera Province and currently awaiting for forestry license from the Ministry of Forestry Indonesia.

Regent shared the information that on 25-26 Nov, the House of Representative from the central government will visit Toba Samosir regency regarding termination of SK-44 regulation in the regency.
Local Representative from Lumban Rau Utara Village **Q1:** What will happen to the people plantation in Tondanan (intake area) which has been damaged due to nearby project? *Mr. Bayu Ardiyanto* **A1:** PT BNE will compensate the land because it will be utilized by the project.

Summary of Feedback Forms

- The stakeholders share their positive feedback
  - The project is environmental friendly
  - The project will create job opportunities which will improve the living standard of the community
  - The project applies the Clean Development Mechanism guidelines
  - The project will rehabilitate the road and provide street lightning for a certain section (Paridian to Dolok Barimbing) under the CSR initiative
- The stakeholders wish the project to
  - To create job opportunities and give the employment priority to the local people.
  - To contribute to the development of the Nassau district as well as contribute to the district income
  - To coordinate with the government and local people on the activity
- The stakeholders express their willingness to fully support the development of Hasang HEPP and to PT Binsar Natorang Energi (PT BNE) as the developer

E.3. Consideration of comments received

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The comments were mainly questions or clarifications or statements in support of the project. Thus, no technical adjustments to the Project are required. Follow ups to questions received were made as below:

Follow up action for Representative from Department of Environment, Mining and Energy of Toba Samosir Regency
Further clarification indicated that PT BNE has shared the complete document to the Department of Environment, Mining and Energy of Toba Samosir Regency in August 2011. BNE has sent an official letter to notify the Representative that the AMDAL report has been shared in the past.

Follow up action Representative Department of Forestry and Plantation Toba Samosir Regency
BNE has sent an official letter to the Representative with the copy of forestry license from forestry department of North Sumatera Province attached.

SECTION F. Approval and authorization

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The project participant is in the process of requesting a letter of approval from the Indonesian DNA.

Appendix 1. Contact information of project participants

Organization name	PT Binsar Natorang Energi
Country	Indonesia
Address	Pacific Century Place Building, 33th Floor, JL. Jenderal Sudirman Kavling 52 – 53, Kebayoran Baru, Jakarta Selatan 12190
Telephone	+62 811 1360 4739 +62 21 5093 9000
Fax	+62 21 5093 9008
E-mail	bwwoo@lxintl.co.kr binsar.ne@gmail.com
Website	www.lgicorp.com
Contact person	Woo, Byung-Wook

Appendix 2. Affirmation regarding public funding

Not applicable

Appendix 3. Applicability of methodologies and standardized baselines

Please refer to section B.2.

Appendix 4. Further background information on ex ante calculation of emission reductions

All grid emission factor calculations are taken from the calculations done by Direktorat Jenderal Ketenagalistrikan. The Indonesian DNA uses this calculation as their official grid emission factor for the Sumatera grid[13]. The most recent data published was a calculation from the year 2018. The Direktorat has provided a worksheet demonstrating their calculations, this has been provided to the DOE, along with a supporting letter confirming the calculations follows Tool 07 Methodological Tool: Tool to calculate the emission factor for an electricity system version 07.0.

Grid Emission Factor

Grid Emission Factor used in the calculation is the Combined Margin CO_2 emission factor for grid connected power generation in year y. The calculation is based on the latest available data published by the Direktorat Jenderal Ketenagalistrikan, calculated by the Ministry of Energy and Mineral Resources (MEMR).

According to Tool to calculate the emission factor for an electricity system version 07.0, the following steps were taken.

[13] https://gatrik.esdm.go.id/frontend/download_index/?kode_category=emisi_pl

STEP 1. Identify the relevant electricity systems
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional)
STEP 3. Select a method to determine the operating margin (OM)
STEP 4. Calculate the operating margin emission factor according to the selected method
STEP 5. Calculate the build margin emission factor
STEP 6. Calculate the combined margin (CM) emission factor

STEP 1. Identify the relevant electricity system

The Project is connected to the Sumatera grid. Thus, the Sumatera grid is identified as the relevant electricity system.

STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional)

For this grid calculation, Option I of "Only grid power plants are included in the calculation" is chosen, as information of the off-•grid power plants are not completely publicly accessible.

STEP 3. Select a method to determine the operating margin (OM)

To calculate the average OM emission factor of the Sumatera Grid, the ex-ante option is adopted using the data vintage of a 3-year generation weighted average, based on the most recent data available at the time of validation submission.

The MEMR has been considered the methods to determine the operating margin (OM) as following:

(a) Simple OM: The Low Cost/Must Run (LC/MR) of the power plants cannot be determined.

(b) Simple adjusted OM: The required of hourly LC/MR operation data of the power plants are not available.

(c) Dispatch data analysis OM: The required of hourly actual operation data of the power plants are not available.

(d) Average OM: Annual aggregated data from the grid on power generation, fuel type and fuel consumption of the power plants are available, which is calculated as Simple OM.

The Operating Margin emission Coefficient (EFgrid,OM,y) can be calculated based on Sim ple OM or Average OM, with consideration of the restrictions to use each approach. The selection of the most suitable method is based on the analysis of the proportion of low-•cost/must-•run generation sources in the concerning grid. The OM will be calculated ex-•ante.

STEP 4. Calculate the operating margin emission factor according to the selected method

Option D is selected. The average OM emission factor ($EF_{grid,OM\text{-}ave,y)}$ is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance for the simple OM, but also including the low-cost/must-run power plants in all equations.

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple OM CO_2 emission factor of power unit m 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)
$EF_{EL,m,y}$	=	CO2 emission factor of power unit m in year y (t CO2/MWh)
m	=	All power units serving the grid in year y except low-cost/must-run power units
y	=	The relevant year as per the data vintage chosen in Step 3

For this approach (simple OM) to calculate the operating margin, the subscript m refers to the power plants/units delivering electricity to the grid, not including low-cost/must-run power plants/units, and including electricity imports to the grid. Electricity imports should be treated as one power plant m.

Operating Margin will be calculated ex•ante, therefore the factor is calculated based on 3 recent years available data, which are 2016, 2017, and 2018 data.

The Operating Margin emission factors for 2016, 2017 and 2018 are calculated separately and then the three-• year average is calculated as a full-•generation weighted average of the emission factors.

The result of the Operation Margin Emission Factor of Sumatra calculation is 0.74 tCO2e/ MWh.

STEP 5. Calculate the build margin emission factor
The sample group of power units 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[14]

The set of power units described as (b) in the Sumatera Grid comprises the larger annual generation than that of (a), thus the sample group (b) is used for calculating the build margin emission factor for Sumatera Grid. Power plants registered as CDM project activities are excluded from the sample group m, since no plants in the resulting sample group were built more than 10 years ago. Also, since the 20% falls on part capacity of a unit, that unit is fully included in the calculation, leads to a 20.33% of the total generation.

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

[14] If 20% falls on part capacity of a unit, that unit is fully included in the calculation

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid, BM,y}$	=	Build margin CO2 emission factor in year y (tCO2/MWh)
$EG_{m, y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL, m, y}$	=	CO2 emission factor of power unit m in year y (tCO2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation is available

The CO2 emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in step 4 section 6.4.1 for the simple OM, using options A1, A2 or A 3, using for y the most recent historical year for which power generation data is available, and using for m the power units included in the build margin.

Based on sample group 'm' identified by MEMR, the ex•ante Build Margin Emission Factor is calculated to be 1.046 tCO2e/MWh.

STEP 7. Calculate the combined margin (CM) emission factor

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

Where:

$EF_{grid, CM, y}$	=	CM CO2 emission factor (tCO_2/MWh)
$EF_{grid, BM, y}$	=	BM CO2 emission factor (tCO_2/MWh)
$EF_{grid, OM, y}$	=	OM CO2 emission factor (tCO_2/MWh)
W_{OM}	=	Weighting of OM emissions factor (%)
W_{BM}	=	Weighting of BM emissions factor (%)

The following default values should be used for w_{OM} and w_{BM} in hydro project: 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. Thus, the values for the first crediting period are used in this calculation and the emission factor for the Sumatra Grid used will be:

0.893 tCO2e/MWh

A working spreadsheet from the Ministry of Energy and Mineral Resources has been provided to the DOE, a summary is provided below:

KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL
DIREKTORAT JENDERAL KETENAGALISTRIKAN

Perhitungan Faktor Emisi Ex-ante 2018
Sistem Inter Koneksi Sumatera

1. Identifikasi sistem interkoneksi tenaga listrik terkait

Data yang dibutuhkan :

Tahun
2016
2017
2018

2. Mengikutsertakan pembangkit *on-grid* dan *off-grid* dalam perhitungan

Opsi I : Pembangkit yang terhubung dengan sistem interkoneksi tenaga listrik *(on-grid)* diikutsertakan dalam perhitungan

~~Opsi II : Pembangkit *on grid* dan pembangkit yang tidak terhubung dengan sistem interkoneksi tenaga listrik *(off grid)* diikutsertakan dalam perhitungan~~

3. Menentukan metode *Operating Margin* (OM)

a. Simple OM	x
b. Simple adjusted OM	x
c. Dispatch data analysis OM	x
d. Average OM	√

4. Menghitung faktor emisi OM sesuai dengan metode yang telah ditentukan

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Average OM

Tahun	$EF_{grid,AverageOM,2016,2017,2018}$ (tCO_2/MWh)	Power Generation Nett - $EG_{m,2018}$ (MWh)	$EF_{grid,AverageOM,2018}$ (tCO_2/MWh)
2016	0.77	31,547,919.59	0.74
2017	0.72	31,311,996.73	
2018	0.73	32,783,819.87	

5. Identifikasi kelompok unit pembangkit yang termasuk dalam *Build Margin* (BM)

~~Kelompok I : Lima pembangkit terakhir yang telah dibangun dan beroperasi yang menyalurkan energi listrik ke sistem interkoneksi tenaga listrik~~

Unit Pembangkit	Tahun Operasi	*Power Generation Nett* - $EG_{m,2018}$ (MWh)
Deudap#07	2018-12-31	150.40
KOTA FAJAR CATERPILLAR 3512B S/N LY800208	2017-12-01	98.34
KOTA FAJAR CATERPILLAR 3512B S/N LY800196	2017-12-01	91.16
KOTA FAJAR CATERPILLAR 3512B S/N LY800197	2017-12-01	68.31
KOTA FAJAR CATERPILLAR 3512B S/N LY800198	2017-12-01	4.27

Total energi listrik tersalur oleh unit pembangkit	412.48	MWh
Total energi listrik tersalur ke sistem interkoneksi	32,783,819.87	MWh
Persentase	0.0012582%	< 20%

Kelompok II : Sejumlah pembangkit terakhir dibangun yang menyalurkan energi listrik sebesar ≥ 20% total yang disalurkan ke sistem interkoneksi tenaga l

Unit Pembangkit	Tahun Operasi	*Power Generation Nett* - $EG_{m,2018}$ (MWh)
Deudap#07	2018-12-31	150.40
KOTA FAJAR CATERPILLAR 3512B S/N LY800208	2017-12-01	98.34
KOTA FAJAR CATERPILLAR 3512B S/N LY800196	2017-12-01	91.16
KOTA FAJAR CATERPILLAR 3512B S/N LY800197	2017-12-01	68.31
KOTA FAJAR CATERPILLAR 3512B S/N LY800198	2017-12-01	4.27
KOTA FAJAR CATERPILLAR 3512B S/N LY800199	2017-12-01	92.58
KOTA FAJAR CATERPILLAR 3512B S/N LY800201	2017-12-01	66.63
KOTA FAJAR CATERPILLAR 3512B S/N LY800202	2017-12-01	94.04
KOTA FAJAR CATERPILLAR 3512B S/N LY800212 #	2017-12-01	78.67
TENAYAN UNIT #2	2017-10-17	335,092.00
PLTMG KKA	2017-09-30	115,599.74
TENAYAN UNIT #1	2017-09-22	432,009.00
TAPAK TUAN CATERPILLAR 3512B S/N LY800115	2017-09-01	550.59
TAPAK TUAN CATERPILLAR 3512B S/N LY800117	2017-09-01	596.52
TAPAK TUAN CATERPILLAR 3512B S/N LY800152	2017-09-01	588.04
Seurapong#07	2017-04-01	422.80
~~PLTP PGE Area Ulubelu Unit 4~~	~~2017-03-26~~	
MPP LAMPUNG TM#1 (sewa PT PLN BATAM)	2017-02-04	136,323.44
SEWA MPP BATAM #01	2017-02-01	189,806.68
SEWA MPP BATAM #02	2017-02-01	189,806.69
SEWA MPP BATAM #03	2017-02-01	94,071.83
MPP PLTG Medan Unit #1	2016-12-30	101,210.79
MPP PLTG Medan Unit #2	2016-12-30	85,915.85
MPP PLTG Medan Unit #3	2016-12-30	96,996.83
MPP PLTG Duri Unit #2	2016-12-22	126,406.38
MPP PLTG Duri Unit #3	2016-12-22	111,945.96
PLTG SW MPP BALAI PUNGUT (PT PLN BATAM	2016-12-20	330,597.17
Sumsel-5 #1	2016-12-20	617,531.83
Sumsel-5 #2	2016-12-20	705,385.59
MPP LAMPUNG TM#2 (sewa PT PLN BATAM)	2016-12-14	143,853.44
MPP LAMPUNG TM#3 (sewa PT PLN BATAM)	2016-12-14	147,931.59
MPP LAMPUNG TM#4 (sewa PT PLN BATAM)	2016-12-14	131,542.84
MPP PLTG Lampung Unit #1	2016-12-14	134,685.71
MPP PLTG Lampung Unit #2	2016-12-14	145,160.08
MPP PLTG Lampung Unit #3	2016-12-14	150,006.50
MPP PLTG Lampung Unit #4	2016-12-14	129,651.91
MPP PLTG Duri Unit #1	2016-11-29	92,244.83
~~PLTP PGE Area Ulubelu Unit 3~~	~~2016-07-26~~	
Sebalang #2	2016-06-30	379,989.26
Keban Agung #1	2016-05-01	753,029.00
Keban Agung #2	2016-05-01	786,759.00
~~PLTA Wampu #01~~	~~2016-05-01~~	
~~PLTA Wampu #02~~	~~2016-05-01~~	
~~PLTA Wampu #03~~	~~2016-05-01~~	

Total energi listrik tersalur oleh unit pembangkit	6,666,456.29	MWh
Total energi listrik tersalur ke sistem interkoneksi	32,783,819.87	MWh
Persentase	20.33%	

6. Menghitung faktor emisi BM

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Unit Pembangkit	*Power Generation Nett* - $EG_{m,2018}$ (MWh)	$EG_{m,2018}$ x $EF_{EL,m,2018}$ (tCO_2)	$EF_{grid,BM,2018}$ (tCO_2/MWh)
Deudap#07	150.40	131.51	
KOTA FAJAR CATERPILLAR 3512B S/N LY800208	98.34	71.36	
KOTA FAJAR CATERPILLAR 3512B S/N LY800196	91.16	66.51	
KOTA FAJAR CATERPILLAR 3512B S/N LY800197	68.31	50.41	
KOTA FAJAR CATERPILLAR 3512B S/N LY800198	4.27	3.78	
KOTA FAJAR CATERPILLAR 3512B S/N LY800199	92.58	67.68	
KOTA FAJAR CATERPILLAR 3512B S/N LY800201	66.63	47.93	
KOTA FAJAR CATERPILLAR 3512B S/N LY800202	94.04	67.95	
KOTA FAJAR CATERPILLAR 3512B S/N LY800212 #	78.67	5.69	
TENAYAN UNIT #2	335,092.00	434,176.37	
PLTMG KKA	115,599.74	60,845.59	
TENAYAN UNIT #1	432,009.00	600,428.12	
TAPAK TUAN CATERPILLAR 3512B S/N LY800115	550.59	395.46	
TAPAK TUAN CATERPILLAR 3512B S/N LY800117	596.52	428.17	
TAPAK TUAN CATERPILLAR 3512B S/N LY800152	588.04	422.37	
Seurapong#07	422.80	344.56	
~~PLTP PGE Area Ulubelu Unit 4~~			
MPP LAMPUNG TM#1 (sewa PT PLN BATAM)	136,323.44	101,325.25	
SEWA MPP BATAM #01	189,806.68	220,836.57	
SEWA MPP BATAM #02	189,806.69	220,836.57	
SEWA MPP BATAM #03	94,071.83	77,133.83	
MPP PLTG Medan Unit #1	101,210.79	77,014.34	
MPP PLTG Medan Unit #2	85,915.85	65,590.04	**1.05**
MPP PLTG Medan Unit #3	96,996.83	73,760.13	
MPP PLTG Duri Unit #2	126,406.38	88,560.05	
MPP PLTG Duri Unit #3	111,945.96	78,502.02	
PLTG SW MPP BALAI PUNGUT (PT PLN BATAM	330,597.17	183,919.58	
Sumsel-5 #1	617,531.83	706,587.30	
Sumsel-5 #2	705,385.59	846,064.52	
MPP LAMPUNG TM#2 (sewa PT PLN BATAM)	143,853.44	101,325.25	
MPP LAMPUNG TM#3 (sewa PT PLN BATAM)	147,931.59	101,325.25	
MPP LAMPUNG TM#4 (sewa PT PLN BATAM)	131,542.84	101,325.25	
MPP PLTG Lampung Unit #1	134,685.71	97,512.20	
MPP PLTG Lampung Unit #2	145,160.08	105,194.53	
MPP PLTG Lampung Unit #3	150,006.50	108,744.32	
MPP PLTG Lampung Unit #4	129,651.91	93,849.17	
MPP PLTG Duri Unit #1	92,244.83	65,368.63	
~~PLTP PGE Area Ulubelu Unit 3~~			
Sebalang #2	379,989.26	531,853.60	
Keban Agung #1	753,029.00	889,756.42	
Keban Agung #2	786,759.00	939,102.38	
~~PLTA Wampu #01~~			
~~PLTA Wampu #02~~			
~~PLTA Wampu #03~~			

7. Menghitung faktor emisi *Combined Margin* (CM)

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

$EF_{grid,AverageOM,2018}$ (tCO_2/MWh)	W_{OM} (%)	$EF_{grid,BM,2018}$ (tCO_2/MWh)	W_{BM} (%)	$EF_{grid,CM,2018}$ (tCO_2/MWh)
0.74	0.5	1.046	0.5	0.893
0.74	0.75	1.046	0.25	0.816

Appendix 5. Further background information on monitoring plan

Please refer to section B.7.

Appendix 6. Summary report of comments received from local stakeholders

Please refer to section E.

Appendix 7. Summary of post-registration changes

"Corrections" proposed in this version 4 of the PDD are as below:

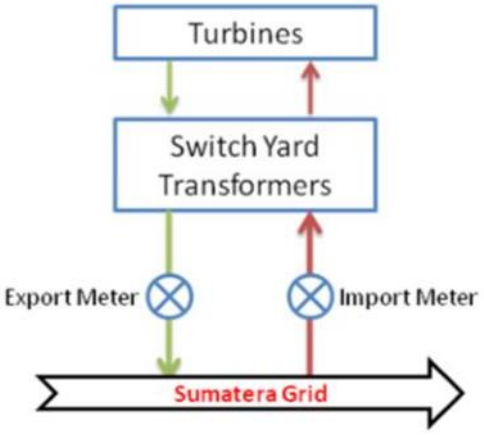
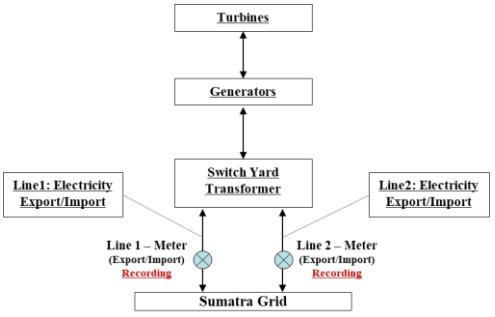
Incorrect information on the registered PDD version 3 was found during the verification of the 1st monitoring period, 23/12/2020 - 31/12/2020, and request for corrections are submitted with the monitoring report as part of the request for issuance (post-registration change - issuance track) as applicable from the monitoring period.

The information regarding the corrections submitted is as below:

- Measurement methods and procedures:

PDD Section	Registered PDD version 3	Changes (Revised PDD version 4)
B.7.1. Data and parameters to be monitored	Electricity meters will be installed as per requirements in the PPA. There will be two meters, one that measures the export to the grid and another that measures the import from the grid. The net electricity exported is the difference between these two meters. Data will also be cross checked with invoices.	Electricity meters will be installed as per requirements in the PPA. There will be main and check meters for each line, capable of monitoring export/import to and from the grid. The net electricity exported is the difference of export and import. The readings from both lines will be added to get the net export to grid. Data will also be cross checked with invoices.

- Monitoring Diagram:

PDD Section	Registered PDD version 3	Changes (Revised PDD version 4)
B.7.3. Other elements of monitoring plan - 8.Monitoring Diagram		

- Contact information of project participants:

PDD Section	Registered PDD version 3		Changes (Revised PDD version 4)	
Appendix 1. Contact information of project participants	E-mail	bwwoo@lgi.co.kr	E-mail	bwwoo@lxintl.co.kr

Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

Version	*Date*	*Description*
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document