15 MW Nam Hinboun Downstream Hydropower Project

Document Prepared by Kosher Climate India Private Limited

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Project Title	15 MW Nam Hinboun Downstream Hydropower Project
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1 PROJECT DETAILS

1.1 Summary Description of the Project

Nam Hinboun Downstream Hydropower Project (hereafter referred to as the "the project") is developed by Rasita Power Co., Ltd. in Songhong village, Hinboun District, Khammouane province, Lao PDR. The primary purpose of the project is to generate electricity to the Lao Power Grid.

Total installed capacity of the project is 15MW, provided by two (2) bulb turbine and the unit capacity is 7.5MW. Project is commissioned on 01/02/2021 with an average annual output of 79,740 MWh.

The project is expected to constantly contribute clean energy to the Lao Power Grid. It not only conforms to the present situation, but also can adapt to future changes in the electricity market. The baseline scenario of the project is continuation of the present situation, i.e electricity supplied from the power grid. By displacing part of the power generated by thermal power plants, the project is therefore expected to reduce CO_2 emissions by an estimation of 44,192 tCO_2e per year during the first crediting period.

The project is not only supplying renewable electricity to grid, but also producing positive environmental and economic benefits and also, promotes the local sustainable development in the following aspects:

- During the construction period, plenty of job opportunities were provided to local residents,
- The infrastructure has been greatly improved. The enhancement of the transportation and electricity system brings substantial benefits to local villagers;
- The use of fossil fuel will be reduced because of displacement by grid electricity, this reduces the fossil fuel-based electricity generation;
- Provide clean & cheap electricity in this region, promote the sustainable development in this region and slowing down the increasing trend of GHG emissions.

1.2 Sectoral Scope and Project Type

Sectoral Scope : 01- Energy Industries (Renewable/non-renewable sources)
Project Type : Renewable Energy Project

The project is not AFOLU project and is not a grouped project.

1.3 Project Eligibility

The Project is a 15 MW small-scale grid connected electricity generation project using hydro power in Lao PDR which is a Least developed Country (LDC)[1] as per the UN. As per VCS standard V-4.3, section 2.1 -Table 1, the small-scale hydro power project activity in LDC does not fall under excluded project activities. Hence, the project activity is eligible under VCS.

1.4 Project Design

☒ The project includes a single location or installation only

☐ The project includes multiple locations or project activity instances, but is not being developed as a grouped project

☐ The project is a grouped project

The project has been designed to include a single installation of an activity.

Eligibility Criteria

The project is not a grouped project. Thus, this section is not applicable.

1.5 Project Proponent

Organization name	Rasita Power Co. Ltd.
Contact person	Mr. Outdone Somphone
Title	General Manager
Address	Songhong Village, Hinboun District, Khammouane Province, Lao PDR
Telephone	+856 20 55511731
Email	rasita@live.cn

1.6 Other Entities Involved in the Project

Organization name	Kosher Climate India Private Limited
Role in the project	Project Representative
Contact person	Vamsi Krishna M

[1] https://unctad.org/topic/least-developed-countries/list

Title	Director
Address	Zee Plaza, No.1678, 27th Main Rd, Near KLM Mall, Sector 2, HSR Layout, Bengaluru, Karnataka 560102, India
Telephone	+91 99453 43475
Email	vamsi@kosherclimate.com narendra@kosherclimate.com

1.7 Ownership

The project owner is Rasita Power Co., Ltd. The business license of the project owner are the evidences for legislative right. Besides, the project allotment license, the equipment purchasing contract and the power purchase agreement are the evidences for the ownership of the plant equipment and power generating.

1.8 Project Start Date

01/02/2021 (Commercial Operation Date)

1.9 Project Crediting Period

Project Owner has chosen the renewable crediting period with first crediting of 7 Years which starts from 01/02/2021 to 31/01/2028 with an option of two times of renewable up to 21 years.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	**Estimated GHG emission reductions or removals (tCO_2e)**
Year 1 (01/02/2021 to 31/01/2022)	44,192
Year 2 (01/02/2022 to 31/01/2023)	44,192
Year 3 (01/02/2023 to 31/01/2024)	44,192
Year 4 (01/02/2024 to 31/01/2025)	44,192

Year 5 (01/02/2025 to 31/01/2026)	44,192
Year 6 (01/02/2026 to 31/01/2027)	44,192
Year 7 (01/02/2027 to 31/01/2028)	44,192
Total estimated ERs	309,343
Total number of crediting years	7
Average annual ERs	44,192

1.11 Description of the Project Activity

The project activity is a run-of-river Hydro power project with a total installed capacity of 15 MW provided by two (2) bulb turbine with unit capacity is 7.5MW each. The project is promoted by Rasita Power Co., Ltd.

The Project activity is a new facility (Greenfield) and the electricity generated by the project will be exported to the electricity grid. The project will therefore displace an equivalent amount of electricity which would have otherwise been generated by fossil fuel dominant electricity grid. The Project Proponent plans to avail the VCS benefits for the project.

In the Pre- project scenario, the entire electricity delivered to the grid by the project activity, would have otherwise been generated by the operation of grid-connected power plant. The scenario prior to the start of implementation of the project activity is generation of electricity, dominated by thermal power plants, thus leading to GHG emissions. The baseline scenario is the same as the scenario prior to the start of implementation of the project activity.

The project shall result in replacing anthropogenic emissions of greenhouse gases (GHG's) estimated to be approximately 44,192 tCO_2e per year, thereon displacing 79,740 MWh/year amount of electricity from the gird over the 7 years crediting period.

The hydro project structure consists of release sluice, main powerhouse, and right-bank non overflow dam, etc.

Table.1: Main Technical Parameters of the project

Turbine		
Item	Value	Unit
Number of units	2	set
Rated Capacity	7.732	MW
Normal Pool level	144	m
Rated Head	5	m

Turbine speed	107.1	rpm
Rated flow	173.65	M3/s
Turbine Type	Bulb	
Lifetime	25	Years
Generator		
Item	Value	Unit
Number of Units	2	set
Rated Capacity	7.5	MW
Generator Rated Power Factor	0.85	-
Lifetime	20x	Years

1.12 Project Location

The project is located in the Hinboun District, Khammouane province, Lao PDR.

Table.2: Project Location

Project Location	Latitude	Longitude
Songhong and Samakhixai Villages, Hinboun District, Khammouane, Lao PDR	17°43′38″ N	104°34′19″ E

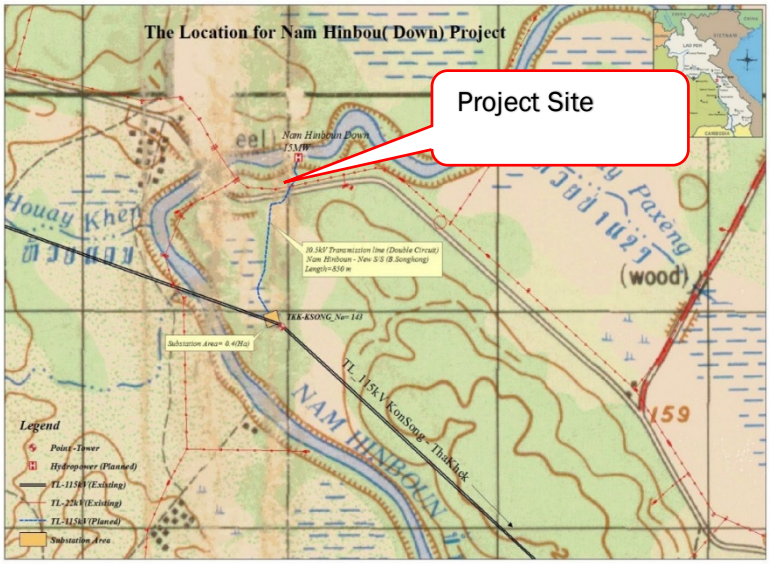


Fig.1 Project Location

1.13 Conditions Prior to Project Initiation

The project is a Greenfield hydro power project and does not involve generation of GHG emissions for the purpose of their subsequent reduction, removal or destruction. Thus prior to project initiation, there was nothing at site.

In the absence of project activity, the continuation of current practise i.e., generation of equivalent amount of electricity would have been generated from grid connected fossil fuel dominated power plants. Thus, for project activity 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.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project has received all the necessary approvals for the development and commissioning of the proposed 15MW hydro power project from the respective nodal agencies and is in compliance to the local laws and regulations. The list of applicable laws & regulations and the project compliance against it are given below:

Laws & Regulation	Project Compliance
Law on Electricity (amended version) No. 03/NA, dated 20/12/2011;	Project received Approval from Ministry of Mine and Energy that confirms the project compliance with these Laws & Regulation. The project also signed PPA with Electricite du Laos, a state-owned enterprise which is also a
Decree on Sustainable Hydropower Development of the Lao PDR No. 03/GoL., dated 12/01/2015;	

	approval for electricity connection with the grid.
Law on Environmental Protection (EPL), No. 02-99/NA, dated 3/4/99;	Project received Environmental clearance from Water Resources and Environment Agency (WREA) based on the IEE report submitted that confirms the project compliance with these laws & regulation.
National Policy on Environmental and Social Sustainability of the Hydropower Sector in Lao PDR	

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project is not registered under any other GHG programs. The project is seeking registration only in VCS program.

1.15.2 Projects Rejected by Other GHG Programs

The project is not rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

1.16.2 Other Forms of Environmental Credit

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

Social well-being: The project would help in generating employment opportunities during the construction and operation phases. The project activity will lead to development in infrastructure

in the region like development of roads and also may promote business with improved power generation.

Economic well-being: The project is a clean technology investment in the region, which would not have been taken place in the absence of the VCS benefits the project activity will also help to reduce the demand supply gap in the state.

The project activity will generate power using hydro energy-based power generation which helps to reduce GHG emissions and specific pollutants like SOx, NOx, and SPM associated with the conventional thermal power generation facilities.

Technological well-being: The successful operation of project activity would lead to promotion of hydro power generation and would encourage other entrepreneurs to participate in similar projects.

Environmental well-being: Hydro energy being a renewable source of energy, it reduces the dependence on fossil fuels and conserves natural resources which are on the verge of depletion. Due to its zero emission the Project activity also helps in avoiding significant amount of GHG emissions.

1.17.2 Sustainable Development Contributions Activity Monitoring

The project supplies clean electricity from the hydro power plant to the National grid hence displacing the electricity generated from grid connected fossil fuel power plants and thereby avoiding the equivalent Carbon dioxide which is a greenhouse gas. In the absence of the project activity, there won't be any avoidance of carbon dioxide.

During the construction, operation and maintenance of the hydro power plant, the project created many direct and indirect new job opportunities mostly to the local people in the project region. In the absence of the project activity, there would be no new jobs created in the project area.

As a part of regional development efforts associated with the project, PP has supported many education, health & infrastructure related needs for local people. These are funded from the revenue generated from the operation of the project activity. In the absence of project activity, there would be no revenue generated from the project and hence the activity would have not occurred in the absence of the project activity.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
Sequential row number	*SDG Target number*	*Number and text of SDG indicator or, if no official SDG indicator is applicable, user-defined indicator*	*Indicate the project's contribution to the SDG Indicator (implemented activities to increase or decrease)*	*Brief description of the quantifiable impact of the project's activities related to the SDG indicator, during the monitoring period.*	*Brief description of the cumulative quantifiable impact of the project's activities related to the SDG indicator, over the project lifetime.*
1)	7	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix.	Implemented activities to increase	Project target to generate and feed 79,740 MWh/year to the national grid and thus expected to increase the share of renewable energy by 19,93,500 MWh to the national grid for its lifetime During the reported monitoring period (01/02/2021 to 31/07/2022), the net renewable electricity supplied to grid is 103,365 MWh	In the absence of the project activity 79,740 MWh/year of electricity would have been generated by the fossil fuel dominated grid. The project supplied 103,365 MWh renewable electricity to grid since the COD.
2)	8	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.	Implemented activities to increase	Project creates 20 employments in the plant During the reported monitoring period (01/02/2021 to 31/07/2022), the number of new employment generated is 19.	Project creates 20 new employment and generates income for the people during the project lifetime. The project generated 19 new employment opportunities since the COD.

4)	13.0	13.2 Integrate climate change measures into national policies, strategies, and planning	Implemented activities to decrease	Project target to reduce 44,192 tCO2 emissions per year in the host country and expected to reduce 1,104,797 tCO2 emission reductions to in the host country for its lifetime During the reported monitoring period (01/02/2021 to 31/07/2022), the emission reduction achieved is 58,277 tCO2	In the absence of the project activity 44,192 tCO2/year emission reductions would have been generated from the fossil fuel dominated power plants in the host country. The project achieved 58,277 tCO2 emission reduction since the COD.

1.18 Additional Information Relevant to the Project

Leakage Management

Not Applicable

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Further Information

Not Applicable

2 SAFEGUARDS

2.1 No Net Harm

The project activity involves major construction activity and primarily requires the installation of the turbines, interfacing the generators with the State Electricity Board by setting up HT transmission lines and installation of other accessories. Hydro Power project activity operations do not result in direct air pollution, noise pollution. Thus, there is no any significant impact due to implementation of project activity on air, water, soil quality and ambience are envisaged due to the project activity.

Safe-guarding Principles: The project does not involve and is not complicit in involuntary resettlement.

Relevance to the Project Activity: As per the final project design, there is no relocation involved. The project is being a run of river project, there is no considerable change in the water storage area. Hence, no negative impact due to the project.

2.2 Local Stakeholder Consultation

The details of stakeholder meetings are as follows:

Date of meeting: 12/07/2017

Location: Khamkeo village, meeting room, Hinboun district, Kanmouane province, Lao PDR

Stakeholders were invited to attend the meeting through different means including:

- Personal face to face invitations to government officer
- E-mail correspondence
- Invitation letter posted on the village Bulletin Board

Local people were invited to the meeting via personal face to face invitations and posters. Local government officers were invited to the meeting via face-to-face invitations and invitation letter. In addition, NGOs were invited to the meeting via e-mails sent.

Finally, 43 stakeholders participated in the meeting. The meeting was opened by the introduction of the project developers and the representative from the project owner company. The objective of the meeting was based on the non-technical summary, Environmental Management Plan and draft Passport Report of the project. Also, how the project might have some environmental effects, how these issues will be mitigated by the investor and also climate change and how the project will help the fight against climate change were discussed.

During the invitation process and the stakeholder meeting, the evaluation forms were handed out and the stakeholder were asked for their comments and requests about the project. The questions of the stakeholders were responded during the consultation meeting and their requests were assessed.

The question raised by the villagers are summarised in the table below:

Table.3: Stakeholder Comments

Stakeholder Comment	Explanation (Why? How?)	Remarks
Is the air in local context polluted?	Project Owner's representative confirmed that there would be no negative permanent effect to locals during the project construction and operation phase, instead there might be only minor temporally impact due to dust emission while the mitigation measure would be adopted.	The following mitigation measures followed during the construction to avoid dust: Localized sprinkling of water to supress the dust and suspended particles
How is the air in local context before and during the construction?	The sources of air emission and fugitive dust will likely be from the drilling, crushing, and hauling associated with the construction activities. However, the dam construction is not directly linked to industrial processes, and thus the impact of emission from specific contaminants, organic chemical compounds and particulate matters will be minimized except where the work involves welding and aerosol spraying. Furthermore, the representative mentioned that a series of mitigation measure would be prepared for the local people to improve their local air.	The following mitigation measures followed during the construction to avoid dust: Localized sprinkling of water to supress the dust and suspended particles
Does this project affect the quality and quantity of water?	Water quality issue in this stretch of the Nam Hinboun is complex as it involves many factors. The NHDHP will concern with ensuring that its activities will not lead to worsening the water quality of the river through	All the mitigation measures mentioned are followed during the construction

	applying the following measures: Strictly control the use of fuel and other hydrocarbon products such as grease, oils and lubricants to prevent leachate or run-off that can cause soil and water contamination. Fuel and hydrocarbon products should be stored in specially built containers in bounded areas with an impermeable base. Washing of vehicles or equipment will be required to designated wash down areas. These systems need to be maintained throughout the operation phase to enable the treatment of wastewater from all permanent site facilities. Long term monitoring would be essential for the successful management and mitigation of the impacts relating to waterborne disease in the local communities, both upstream and downstream of the sites. Therefore, there would be in or impact on the water utilization for nearby villages.	
Does this project affect the protection of biodiversity?	The project area is of predominantly secondary and disturbed forestland and patches of remnant woodland. There is no presence of primary forest nor are there any NPAs, PPAs or DPAs located within or nearby the Project area. These village conservation forests will, among other uses, provide habitats for wildlife and healthy forest ecosystem services. It is important for the project to make sure that threats to species will not be resulted from the presence of the construction workforce. At the same time, presence of the workforce should not result in increased pressures on the local harvest and use of NTFPs. For this reason, direct project impact on sensitive forest areas and	NA

	resources will be minimal during the construction phase and negligible during operation.	
Do the project conditions affect the soil situation?	According to the IEE, to prevent soil erosion, the following measures will be undertaken, for example: (1) Schedule construction activities during the dry season (low flows), where possible; (2) Implement appropriate erosion control and drainage management measures to minimize the potential impacts associated with land clearance; (3) Minimize cleared areas and revegetate exposed sites with grass or plants to reduce sediment run-off, etc. Thus, status of soil erosion will be mitigated.	All the mitigation measures mentioned are followed during the construction: - During site operations it was ensured that length and steepness of slopes is minimised - Construction debris and excavated materials was used for filling of low lying areas. - Excavation activities were avoided during months for rainfall - Run-off control measures such as temporary bunding and slit traps were employed.
Does the pollution from the project include sound or light pollution?	For this, main resources of noise are dam construction blasting, drilling, dredging, operation of heavy machinery and equipment, transport operation. The mitigation's as follows: All construction equipment and machinery shall comply with noise emission standard. Avoid night shift work and work on Sundays unless special permit is granted. Use of PPE among workers and on-site personnel exposed to noisy work. The project doesn't exist light pollution. Therefore, this project will not cause light pollution and significant noise pollution.	NA
Will the implementation of the project help improve the working environment and quality of the workers?	The working environment of the workers will strictly implement as following measures: Promotion of preventive measures, eg, use of condoms. Regular site clean-ups, draining water bodies that can harbor disease vector (mosquito). Conduct hygiene and sanitation	NA

	awareness programmed. Support local initiatives on disease prevention campaigns. Siting fuel depot away from the living buildings and residential areas.	
Will the project provide jobs and generate incomes?	Project Owner's representative mentioned that all the construction works would be open for local construction company, and would request the company to recruit locally.	NA

Ongoing communication with stakeholders:

The project proponent has a grievance mechanism. Stakeholders can anytime provide their inputs or concerns over the project through any of the following means:

- Complaint register- Stakeholders can provide the grievance in writing in the grievance register maintained at the site.
- Telephone access: Stakeholders can provide their grievances through calling site telephone ie, 00856-21-450062
- Email access: Stakeholders can provide their grievance through email using the email ID: 644520857@qq.com

The site manager is responsible for addressing the grievances received from stakeholders. The same is informed during the stakeholder consultation meeting. This mechanism will ensure to continue to engage with local stakeholder in an ongoing proactive manner

2.3 Environmental Impact

The project activity has no significant impact on the environment.

2.4 Public Comments

No comments received during the 30 days public commenting period.

2.5 AFOLU-Specific Safeguards

Not Applicable

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Title: "Small-scale methodology for grid-connected renewable electricity generation"-AMS I.D[2]

[2] https://cdm.unfccc.int/UserManagement/FileStorage/2P7FS6ZQAR84LG3NMKYUH50WI9ODBC

Version: 18.0

Type I: Energy industries (renewable / non- renewable sources)

Tools used along with the above methodology are mentioned below:

- Tool to calculate the emission factor for an electricity system - Version 07.0[3]
- Demonstration of additionality of small-scale project activities – Version 13.1[4].
- Investment analysis, version 12.0[5]

3.2 Applicability of Methodology

The project activity involves generation of grid connected electricity from hydro energy. The project activity has a proposed capacity of 15 MW which will qualify for a small scale CDM project activity under Type-I of the small-scale methodologies. The project status is corresponding to the methodology AMS I.D version 18.0 and applicability of methodology is discussed below.

Applicability Criteria	Applicability status
1. This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: (a) Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The project activity involves setting up of a renewable energy (hydro) generation plant that exports electricity to the fossil fuel dominated electricity grid. Thus, the project meets this applicability conditions "a"
(a) Illustration of respective situations under which each of the methodology (i.e., AMS-I. D: Grid connected renewable electricity generation", AMS-I.F: Renewable electricity generation for captive use and mini-grid" and AMS-I.A: Electricity generation by the user) applies is included in Table 2	According to the point 1 of the Table 2 in the methodology – "Project supplies electricity to a national/ regional grid" is applicable under AMS I.D. As the project activity supplies the electricity to Lao PDR Grid system grid which is a regional grid, the methodology AMS-I.D. is applicable.
This methodology is applicable to project activities that: (a) Install a Greenfield plant; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); (d) Involve a rehabilitation of (an) existing plant(s); or (e) Involve a replacement of (an) existing plant(s)	The Project activity involves the installation of new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity. Thus, Project activity is a Greenfield plant and satisfies this applicability condition (a).
4. Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:	As the project activity is a run-off river type hydro power plant, this criterion is not relevant for the project activity.

[3] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-21-v1.pdf

[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v12.pdf

(a) The project activity is implemented in existing reservoir, with no change in the volume of the reservoir; or (b) The project activity is implemented in existing reservoir, where the volume of the reservoir(s) is increased and the power density as per definitions given in the project emissions section, is greater than 4 W/m^2. (c) The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m2	
5. If the new unit has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The rated capacity of the project activity is 15 MW with no provision of Co-firing fossil fuel. Hence, meeting with this criterion.
Combined heat and power (co-generation) systems are not eligible under this category	This is not relevant to the project activity as the project involves only hydro power generating units.
In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	There is no other existing renewable energy power generation facility at the project site. Therefore, this criterion is not applicable.
In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement power plant/unit shall not exceed the limit of 15 MW.	The project activity is a new installation, it does not involve any retrofit measures nor any replacement and hence is not applicable for the project activity.
In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as "AMS-I.C.: Thermal	This project is a hydro power project activity and hence this criterion is not applicable.

energy production with or without electricity" shall be explored	
In case biomass is sourced from dedicated plantations, the applicability criteria in the tool "Project emissions from cultivation of biomass" shall apply.	This project is a hydro power project activity and hence this criterion is not applicable.
In addition, the above applicability conditions, the applicability conditions of tool referred in the methodology AMS I.D, version 18.0 has been referred here under:	
Tool 07: Tool to calculate the emission factor for an electricity system Version 7.0	
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes of grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g.: demand-side energy efficiency projects).	The project activity is a greenfield hydro power generation plant and hence, according to the applied methodology, 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".
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, the conditions specified in "Appendix 2: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	Since the project activity is grid connected, this condition is applicable and the emission factor has been calculated accordingly.
In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	The project activity is located in Lao PDR, a non-Annex I country. Therefore, this criterion is not applicable for the project activity

Under this tool, the value applied to the CO_2 emission factor of bio fuels is zero.	The project activity is a grid connected hydro power project and therefore, this criterion is not applicable for the project activity
TOOL 21: Demonstration of additionality of small-scale project activities- Version 13.1	
The use of the methodological tool "Demonstration of additionality of small-scale project activities" is not mandatory for project participants when proposing new methodologies. Project participants and coordinating/managing entities may propose alternative methods to demonstrate additionality for consideration by the Executive Board	Since the applied technology is not a new methodology project proponent has applied this tool for the demonstration additionality in compliance with the tool. Refer to section 3.5, for the detailed applicability of this tool and additionality assessment. Hence this tool is applicable.
TOOL 27: Investment analysis, version 12	
This methodological tool is applicable to project activities that apply the methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", the guidelines "Non-binding best practice examples to demonstrate additionality for SSC project activities", or baseline and monitoring methodologies that use the investment analysis for the demonstration of additionality and/or the identification of the baseline scenario.	PP used "demonstration of additionality of small-scale project activities" (formerly named as "Non-binding best practice examples to demonstrate additionality for SSC project activities" to demonstrate additionality of the project. Hence, using Tool 27 for conducting investment analysis is appropriate.
In case the applied approved baseline and monitoring methodology contains requirements for the investment analysis that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	The applied methodology AMS I.D does not contain requirement for the investment analysis. Hence this criterion is not applicable

3.3 Project Boundary

As per applicable methodology AMS-I.D. Version 18, "The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the project power plant is connected to."

Thus, the project boundary includes the Hydro Turbine Generators and the Lao grid system.

The project does not involve any other emissions sources not foreseen by the methodologies. The greenhouse gases and emission sources included in or excluded from the project boundary are shown in table below.

The table below provides an overview of the emissions sources included or excluded from the project boundary for determination of baseline and project emissions.

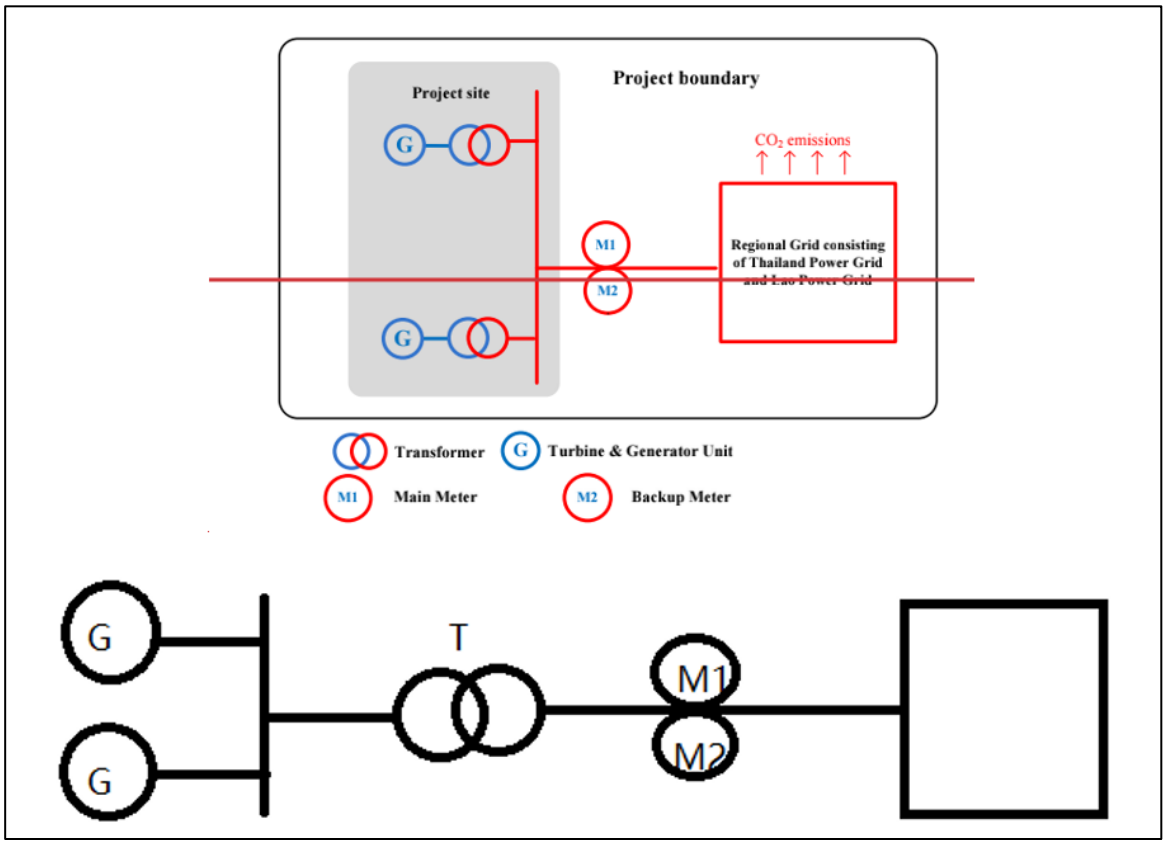


Fig. 2 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Source 1	CO_2	Yes	Main Emission Source
		CH_4	No	Minor Emission Source
		N_2O	No	Minor Emission Source
		Other	No	Project activity does not emit CO_2
Project	Source 1	CO_2	No	Project activity does not emit CH_4
		CH_4	No	Project activity does not emit N_2O
		N_2O	No	Main Emission Source
		Other	No	Minor Emission Source

3.4 Baseline Scenario

As per the approved consolidated Methodology AMS I.D (Version 18.0) para 19: "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 the "Tool to calculate the emission factor for an electricity system".

The project activity involves setting up of hydro project to harness the power of hydro energy to produce electricity and supply to the grid. In the absence of the project activity, the equivalent amount of power would have been supplied by the national grid, which is fed mainly by fossil fuel fired plants. f

The project is run-of-river hydropower project. As described in Section B.3 of the PDD, the project electricity system is a regional grid consisting of Thailand Power Grid and the Lao Power Grid. In the absence of the project, the local was/will be supplied by the above-mentioned regional grid. Thus, the baseline scenario of the project is continuation of the present situation, i.e., electricity supplied from the regional power grid.

The combined margin of the grid used for the project activity is as follows:

Parameter	Value	Nomenclature
$EF_{grid,CM,y}$	0.5542 tCO_2/MWh	Combined margin CO_2 emission factor for the project electricity system in year y
$EF_{grid,OM,y}$	0.5542 tCO_2/MWh	Operating margin CO_2emission factor for the project electricity system in year y
$EF_{grid,BM,y}$	0 tCO_2/MWh	Build margin CO_2emission factor for the project electricity system in year y

3.5 Additionality

The additionality of a VCS Project shall be demonstrated by applying the following approach having two components:

(i) A Legal Requirement Test; and
(ii) An Additionality Test

The project activity is a Type A project and hence requires undergoing a Legal Requirement Test. However, the projects as in the project activity are not mandated by law or regulations and are entirely a voluntary action.

The project activity does not fulfil the criteria of positive list as provided in CDM Tool 32: "Methodological Tool – Positive List of Technologies" and hence additionality of the project activity is demonstrated through a project specific additionality test.

For the demonstration and assessment of additionality, Tool 21 "demonstration of additionality of small-scale project activities", Version 13.1 has been applied. As per the para 10 of the tool, project owner shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

Investment Barrier: a financially more viable alternative to the project activity would have led to higher emissions

Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity as so would have led to higher emissions:

Barrier due to prevailing practice: or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions.

Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

The project investor has selected Investment barrier to demonstrate in a conservative and transparent manner that the proposed VCS project activity is financially unattractive.

To conduct the investment analysis, Methodological tool: Investment analysis, version 12, EB 116 Annex 2[6] has been referred.

Considering the fact that the alternative to the project is the supply of electricity from the grid & the choice of the developer is to invest or not to invest, benchmark analysis has been considered appropriate for demonstration of additionality, which is in conformity with "Investment Analysis" Annex 2 EB 116.

Apply benchmark analysis

As per para 15 of Tool 27: Investment analysis, Version 12 states that Required/expected returns on equity are appropriate benchmarks for equity IRR. The project participant has chosen benchmark analysis to demonstrate the additionality of the project. The project is promoted by private limited company and hence the return on equity and the risks associated with the investments for their shareholder is of primary concern. Hence, in order to analyze the financial viability of the project activity, the prime financial indicator that has been used is the post-tax equity IRR of the project activity.

Selection of Appropriate Benchmark

The benchmark has been considered in accordance with Guidance 19 of EB 112 Annex 2, "The values in the table in the Appendix may also be used, as a simple default option".

Methodology deployed for arriving at a suitable value of Benchmark using Default Value has been described below:

- As the proposed project activity generates power utilizing hydro energy, Group 1 as per para 5a of Appendix of EB 116 Annex 2 has been identified as a suitable category.
- The investment analysis has been carried out in Nominal terms. Accordingly, Default value as given in table under the Appendix, Tool 27 has been adjusted by adding suitable forecasted inflation rate taken from IMF world Economic database as no inflation forecast or inflation target published by Lao PDR
- Average forecasted inflation rate for the host country (Lao PDR) published by the IMF (International Monetary Fund) World Economic Outlook for the next five years has been considered

The decision-taken for the project is on 13th August 2017. Hence applicable inflation rate has been chosen from the IMF databases accordingly for the estimation of resultant benchmark.

The benchmark has been computed in the following manner:

Default Value Benchmark:

The cost of equity is determined by selecting the values provided in the table of the Appendix, i.e., Default values for cost of equity (expected return on equity) in the 'Methodological tool: Investment analysis.

The Required return on equity (benchmark) was computed in the following manner:

Nominal Benchmark[7] = {(1+Real Benchmark) * (1+Inflation rate)}-1

Where:

Default value for Real Benchmark = 20.68% (CDM Tool 27: Investment Analysis, version 12)
Inflation Rate forecast for by (International Monetary Fund) World Economic Outlook database for Lao PDR.
Benchmark estimation:

[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v11.0.pdf

[7] As per Pg. 320 of Corporate Finance, Second Edition of Aswath Damodaran

The Cost of Equity has been considered using the "Methodological tool: Investment analysis" available at the time of decision making as well as the latest available value. As a conservative approach, the minimum value of benchmark has been considered as calculated using these 2 approaches.

Table under Appendix in EB116, Annex 2 specifies default value of expected return on equity in real terms for Energy Industries in Lao PDR = **20.68%**[8]

Thus, minimum cost of equity considered for calculation of Benchmark = 20.68%

5-year inflation Forecast for Lao PDR as IMF World Economic Outlook available at the time of investment decision and corresponding benchmark values is

Inflation forecast for 5 years	Source
3.30%	World Economic Outlook database: April 2017[9]

Corresponding benchmark values applicable at the time of investment decision time:

Nominal Benchmark = {(1+20.68%) * (1+3.30%)}-1 = 24.66%

Calculation and comparison of financial indicators

The period considered for Post Tax Equity IRR calculations is 25 years, which corresponds to the operational lifetime of the project activity.

Depreciation, and other non-cash items related to the project activity, which have been deducted in estimating gross profits on which tax is calculated, is added back to net profits for the purpose of calculating the financial indicator.

Varying and fixed Input values considered for the IRR calculation are provided below.

Particulars	Value	Unit	Source/Remarks
Capacity of the project	15	MW	Feasibility Report dated June 2016
Annual Net generation	79.740	GWh	Feasibility Report dated June 2016
Project cost	36700.00	k USD	Feasibility Report dated June 2016
Debt	64%	%	Feasibility Report dated June 2016
Equity	36%	%	Feasibility Report dated June 2016
Debt	23488.00	Mn USD	Calculated
Equity	13212.00	Mn USD	Calculated
Interest rate	7.00%	%	Feasibility Report dated June 2016
Debt Repayment tenure	10	years	Feasibility Report dated June 2016
Moratorium	0	year	Feasibility Report dated June 2016
Repairs (% of annual income)	1.5%	%	Feasibility Report dated June 2016
Annual Labour Cost	4.4180	k USD	Feasibility Report dated June 2016
Annual Material Cost	0.8	USD/kW	Feasibility Report dated June 2016
Reservoir area annual maintenance cost	0.2	USD/MWh	Feasibility Report dated June 2016
Other Expenses	5.0	USD/kW	Feasibility Report dated June 2016
Tariff	6.25	USC/kWh	Feasibility Report dated June 2016
1st Year tariff	7	USC/kWh	PPA

[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v11.0.pdf

[9] https://www.imf.org/en/Publications/WEO/weo-database/2017/April/weo-report?c=544,&s=PCPI,PCPIPCH,PCPIE,PCPIEPCH,&sy=2017&ey=2022&ssm=0&scsm=1&scc=0&ssd=1&ssc=0&sic=0&sort=country&ds=.&br=1

% reduction in tariff till 10th year	1%	USC/kWh	PPA
Tariff from year 11 to 30	5.74	USC/kWh	PPA
Depreciation Rate (Book)	4.00%	%	Feasibility Report dated June 2016
Salvage Value	10%	%	Feasibility Report dated June 2016
Income tax rate	24%		Feasibility Report dated June 2016

IRR for total project capacity

Project proponent also calculated the Post tax Equity IRR by integrating the total cash flows of all three projects to check the viability of the project against the benchmark value. Still, it is evident that the combined project is also not financially viable as the equity IRR is still less below the benchmark

Post Tax Equity IRR for the project activities against the benchmark values are shown in table below. Thus, it is evident that the project is not financially attractive as the equity IRR is less below the benchmark value.

Post Tax Equity IRR	12.34%
Benchmark	24.66%

Sensitivity Analysis

The robustness of the conclusion drawn above, namely that the project is not financially attractive, has been tested by subjecting critical assumptions to reasonable variation. As required by Annex 2 of EB 116, only variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation. PP has identified the total revenue from the project activity is dependent on the Tariff, Plant Load Factor, Project Cost and O&M Costs constitute more than 20% of the project costs. These factors have been subjected to a 10% variation on either side and the results of the sensitivity analysis indicate that even after applying such variation the EIRR does not cross the benchmark.

Variation %	-10%	Normal	10%	Variation required to reach benchmark	Value required to reach benchmark
Tariff	10.42%	12.34%	14.27%	63.20%	11.420
PLF	10.43%	12.34%	14.26%	63.40%	130.295
Project Cost	14.44%	12.34%	10.63%	-39.20%	22313.60
O&M Cost	12.41%	12.34%	12.27%	NA	NA

An analysis has been done to identify the percentage variation at which the financial indicators will equal/breach the benchmark and the probability of its occurrence. Based on sensitivity analysis it can be concluded that the proposed project activity is additional with reasonable variation in values and is not likely to reach the benchmark value. The occurrence of these events is unlikely for the following reasons:

a) **Tariff:** The Tariff rate of electricity used for investment analysis is sourced from the FSR applicable at the time of investment decision. Furthermore, the project will breach the benchmark value at a tariff variation provided in the table above for respective tables. However, the actual tariff based on the PPAs signed is close to the estimated tariff and much below the tariff value required benchmarking value. With the

updated tariff as per addendum to the PPA (ie, fixed tariff of 5.89 USC/kWh for 30 years), the IRR is reduced to 10.73%. Hence, increase in tariff is unlikely.

b) **PLF:** The PLF value considered is based on FSR which is the Third Party PLF report. The increase in PLF value to breach the benchmark is unlikely as the PLF is estimated with the estimated annual radiation assessment and equity IRR. The PLF values are less than the benchmark value and given the analysis above it shows that PLF will not breach the benchmark value for any of the projects.

c) **Project Cost:** The project cost considered for investment analysis is sourced from FSR which is based on the negotiations with Supplier. A variation for IRR to breach benchmark is not possible as the project is already commissioned. The actual cost incurred in commissioning of the project is slightly lesser than value considered in the IRR sheet. However, even with the actual project cost, the IRR is still well below the benchmark. Hence there is no impact on additionality

d) **O&M Costs:** The sensitivity analysis reveals that O&M will breach the benchmark at negative values and is hypothetical case. Since the O&M cost is subject to escalation (as evidence by the O&M agreement) and subject to inflationary pressure, any reduction in the O&M costs is highly unlikely.

Conclusion

Even with the changes of +/- 10% of the variation, the IRR is still less than the benchmark. Hence, the project is additional.

3.6 Methodology Deviations

There is no methodology deviation

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions include only CO_2 emissions from electricity generation in power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,y} \qquad \text{(Equation 1)}$$

Where:

BE_y = Baseline emissions in year y (t CO2)

$EG_{PJ,y}$ = 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)

$EF_{grid,y}$ = 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" (t CO2/MWh)

If the project activity is the installation of a greenfield power plant, then:

$$EG_{PJ,y} = EG_{PJ,facility,y} \qquad \text{(Equation 2)}$$

Where:

$EG_{PJ,facility,y}$ = Quantity of net electricity generation supplied by the project plant/unit to the grid in year y (MWh). The expected annual net electricity generation as per the FSR is 79,740 MWh

Calculate the $EF_{grid,y}$

The emission factor should be calculated in a transparent and conservative manner according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system" (Version 07.0).

The data used for calculation are from an official source (where available) and publicly available. The calculation processes are as follows:

STEP1: Identify the relevant electricity system;
STEP2: Choose whether to include off-grid power plants in the project electricity system (optional); STEP3: Select a method to determine the operating margin (OM);
STEP4: Calculate the operating margin emission factor according to the selected method;
STEP5: Calculate the build margin (BM) emission factor;
STEP6: Calculate the combined margin (CM) emissions factor.

STEP 1: Identify the relevant electricity system

As descripted in Section B.3., there are no transmission constraints between Lao and Thailand, the project electricity system is a regional grid consisting of Thailand Power Grid and Lao Power Grid. And as electricity imported from Malaysia, China and Vietnam Power Grid[10], these three Power Grids are considered as connected electricity system.

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

According to "Tool to calculate the emission factor for an electricity system" (Version 07.0), there are two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.

Option I is chosen for emission factor calculation.

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

According to "Tool to calculate the emission factor for an electricity system" (Version 07.0), there are four methods for calculating the $EF_{grid,OM,y}$:

(a) Simple OM, or (b) Simple adjusted OM, or

(c) Dispatch data Analysis OM, or

(d) Average OM

The method (d), average OM, is selected.

[10] According to Annual Report 2019, 2018, 2017, issued by EGAT, the Thailand import power from Lao PDR and Malaysia. Lao is considered as part of the project electricity system, and Malaysia is considered as the connected electricity system. Vietnam and China are also considered as connected electricity system for the power supply to Lao according to the Annual Repot 2019 by the Lao Power Grid Electric du Lao (EDL).

$EF_{grid,OM\text{-}ave,y}$ is calculated using ex ante option: a 3-year generation-weighted average in 2019, 2018, 2017, without requirement to monitor and recalculate the emissions factor during the crediting period.

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

The average OM emission factor is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance as described under Step 4 in the "Tool to calculate the emission factor for an electricity system" (Version 07.0) for the simple OM, but also including the low-cost / must-run power plants in all equations.

According to "Tool to calculate the emission factor for an electricity system" (Version 07.0), there are two options based on different data for calculating average OM:

Option A: Based on the net electricity generation and a CO2emission factor of each power unit;

Or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

For the project, the necessary data for Option A is not available, so Option B was used.

Under this option, the average OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, including low-cost/must-run power plants/units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OM\text{-}ave,y}=\frac{\sum_i (FC_{i,y}\times NCV_{i,y}\times EF_{CO2,i,y})}{EG_y}$$

$EF_{grid,OM\text{-}ave,y}$ $FC_{i,y}$ = Average operating margin CO2 emission factor in year y (tCO 2 /MWh)
FCi, y = Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO2,i,y}$ = CO2emission factor of fossil fuel type i in year y (tCO2/GJ)
EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh)
I = All fossil fuel types combusted in power sources in project electricity system in year y
y = The data available in the most recent 3 years

According to the "Tool to calculate the emission factor for an electricity system" (Version 07.0), electricity imports from the connected electricity systems $EG_{import,y}$ are included in the EGy

The calculation value of average OM emission factor is 0.5542 tCO2/MWh and the detailed calculating procedures please refer to ER calculation sheet.

Step 5. Calculate the build margin (BM) emission factor

To calculate the build margin (BM) emission factor, the data for determine the sample group of power units m about the most recently units in the electricity system is needed. However, as an international project system, it's difficult to obtain the information for all the units in both Lao and Thailand (power generation data, commissioning date, and the fuel consumption). The data requirements for the application for calculate the build margin (BM) emission factor cannot be met.

As the Simplified CM is adopted in the step 6, the weighting of build margin emissions factor is 0.

STEP 6: Calculate the combined margin (CM) emissions factor

According to "Tool to calculate the emission factor for an electricity system" (Version 07.0), the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or

(b) Simplified CM.

According to "Tool to calculate the emission factor for an electricity system" Version 07.0, the simplified CM can be used if:

(a) The project activity is located in: (i) a Least Developed Country (LDC); or in (ii) a country with less than 10 registered CDM projects at the starting date of validation; or (iii) a Small Island Developing States (SIDS); and

(b) The data requirements for the application of Step 5 above cannot be met.

The project located in Lao, which is a Least Developed Country, therefore the criteria (a) is met; As mentioned in step 5, the data requirements for the application for calculate the build margin (BM) emission factor is not available, therefore the criteria (b) is also met.

The Simplified CM method is calculated as follow:

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

Where:

w_{OM} = Weighting of operating margin emission factor (%)

w_{BM}= Weighting of build margin emission factor (%).

The weighs w_{OM} and w_{BM}, for simplified CM by default, are wOM=1 and wBM= 0.

Hence calculation value of CM emission factor is 0.5542 tCO2/MWh

Hence the baseline emission factor is calculated as below:

BE_y= 79,740 × 0.5542 = 44,192 tCO2

4.2 Project Emissions

The project activity is a hydro power project activity and as per the para 39 of the applied methodology the Emissions from water reservoirs of hydro power plants shall be determined considered following the procedure described in the most recent version of "ACM0002: Grid-connected electricity generation from renewable sources". As per ACM0002: Grid-connected electricity generation from renewable sources V.20.0", paragraph 35

$$PE_y=PE_{FF,y}+PE_{GP,y}+PE_{HP,y} \qquad \text{(Equation 1)}$$

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

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

Where:

PD = Power density of the project activity (W/m2)

$CapPJ$ = Installed capacity of the hydro power plant after the implementation of the project activity (W) (ie, 15,000,000 W)

$CapBL$ = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero

APJ = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m2) (ie, as per the satellite map it is 159,835 m^2)

ABL = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m2). For new reservoirs, this value is zero

PD = (15,000,000-0)/(159,835-0) = 93.85 W/m2

as per the above calculation, the PD is greater than 10W/m^2, thus $PE_{HP, y}$= 0.

Then PEy= 0 tCO2.

4.3 Leakage

No leakage emissions are considered.

4.4 Estimated Net GHG Emission Reductions and Removals

The ex-ante emission reductions (ERy) for the project activity are calculated as follows

$$ER_y = BE_y - PE_y - LE_y$$

Where,

ER_y = Emission Reduction in year y (tCO_2)

BE_y = Baseline emission in year y (tCO_2)

PE_y = Project emissions in year y (tCO_2)

LE_y = Leakage Emissions in year y (tCO_2)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 1 (01/02/2021 to 31/01/2022)	44,192	0	0	44,192
Year 2 (01/02/2022 to 31/01/2023)	44,192	0	0	44,192
Year 3 (01/02/2023 to 31/01/2024)	44,192	0	0	44,192

Year 4 (01/02/2024 to 31/01/2025)	44,192	0	0	44,192
Year 5 (01/02/2025 to 31/01/2026)	44,192	0	0	44,192
Year 6 (01/02/2026 to 31/01/2027)	44,192	0	0	44,192
Year 7 (01/02/2027 to 31/01/2028)	44,192	0	0	44,192
Total	309,343	0	0	309,343
Total number of crediting years	7			
Annual average over the crediting period	44,192	0	0	44,192

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	***FCi,y***
Data unit	mass or volume unit of the fuel *i*
Description	Amount of fossil fuel type *i* consumed in the project electricity system in year *y*
Source of data	- Fuel consumption in Lao PDR is calculated based on the Sustainability Report 2020, Banpu Power Public Company Limited.[11] Fuel consumption in Thailand is from "Energy Balance of Thailand 2020", EGAT
Value applied:	See the Table 5 and 6 in Appendix 1
Justification of choice of data or description of measurement methods and procedures applied	Data are from Banpu Power Public Company Limited (shareholder of Hongsa power plant) and Thailand authority, EGAT
Purpose of Data	Calculation of baseline emissions

[11] https://www.banpupower.com/wp-content/uploads/2021/05/SD_Report_2020_EN_Final.pdf

Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	$EF_{CO2,i,y}$
Data unit	tCO2/TJ
Description	The CO2 emission factor per unit of fuel i in year y
Source of data	- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4
Value applied:	See the Table 5, 6 in Appendix 1.
Justification of choice of data or description of measurement methods and procedures applied	No specific local value available, the value form IPCC 2006, Guidelines for National Greenhouse Gas Inventories was adopted.
Purpose of Data	Calculation of baseline emissions
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	EGy
Data unit	GWh
Description	Net electricity generated and delivered to the grid by all power sources serving the system, including low-cost/must-run power plants/units, in year y.
Source of data	- The data of the electricity generated and delivered to Lao PDR National Power Grid are from Electricity Statistic (2020), EDL - The data of the electricity generated and delivered to Thailand National Power Grid are from Annual Report (2020& 2019), EGAT - The data of the electricity generated and delivered by Lao IPP directly supply to Thailand are from Electricity Statistic (2020), EDL
Value applied:	See the Table 1, 2, 3 in Appendix 1.
Justification of choice of data or description of measurement methods and procedures applied	Data used are from Thailand authority, EGAT and Lao authority, EDL.
Purpose of Data	Calculation of baseline emissions
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	$EG_{import,y}$
Data unit	MWh
Description	The electricity (MWh) imported from Malaysia, China and Vietnam Power Grid in year y.
Source of data	- Annual report (2020, 2019, 2018), EGAT - Electricity Statistic (2020, 2019, 2018,), EDL
Value applied:	See the Table 4 in Appendix 1.
Justification of choice of data or description of measurement methods and procedures applied	Data used are from Thailand authority, EGAT and Lao authority, EDL.
Purpose of Data	Calculation of baseline emissions
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	$EF_{grid,OM,y}$
Data unit	tCO_2/MWh
Description	Operating Margin CO2 emission factor in year y
Source of data	Calculated.
Value applied:	0.5542
Justification of choice of data or description of measurement methods and procedures applied	Calculated as per “Tool to calculate the emission factor for an electricity system, version 07” as 3-year generation weighted average using data for the years 2018, 2019 & 2020
Purpose of Data	Baseline Emission calculation
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	Build Margin CO2 emission factor in year y

Source of data	Calculated
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Calculated as per "Tool to calculate the emission factor for an electricity system, version 07"
Purpose of Data	Baseline Emission calculation
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	Combined Margin CO2 emission factor in year y
Source of data	Calculated
Value applied:	0.5542
Justification of choice of data or description of measurement methods and procedures applied	The combined margin emissions factor is calculated as follows: $EF_{grid,CM,y} = EF_{grid,OM,y} * WOM + EF_{grid,BM,y} * WBM$ Where: $EF_{grid,BM,y}$= Build margin CO2 emission factor in year y (tCO2/MWh) $EF_{grid,OM,y}$= Operating margin CO2 emission factor in year y (tCO2/MWh) WOM = Weighting of operating margin emissions factor (%) = 100% (for simplified CM) WBM= Weighting of build margin emissions factor (%) = 0% (for simplified CM)
Purpose of Data	Baseline Emission calculation
Comments	This parameter is fixed ex-ante for the entire crediting period

Data / Parameter	Cap_{PJ}
Data unit	MW

Description	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data	Project site
Value applied:	15
Justification of choice of data or description of measurement methods and procedures applied	Use the data in the FSR at start of the project. Measure by check the nameplate after operation
Purpose of Data	Project emission
Comments	-

5.2 Data and Parameters Monitored

Data / Parameter	$EG_{PJ, y}$
Data unit	MWh/y
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y in MWh
Source of data	Monthly joint meter reading reports
Description of measurement methods and procedures applied	The difference of final value of export and import is used for monthly values of net electricity supplied to the grid by the project activity and same value will be considered for ER calculations.
Frequency of monitoring/recording	Continuous measurement & Monthly recording
Value applied:	79,740
Monitoring equipment	The electricity exported / supplied by the plant to pooling substation and further to substation. This meter also measures electricity imported by the plant from the grid. The energy meter details are given below;

Energy Meter	Meter details
Main	Sl No: 219014734 Accuracy class: 0.2s Make: EDMI

	Backup	Sl No: 219014735 Accuracy class: 0.2s Make: EDMI
QA/QC procedures applied	The meters are approved, tested & sealed by the State Utility. The meters are in the custody of State Utility. The frequency of calibration is once in 5 years. The monthly electricity supplied/exported by the project activity in the JMR report is cross checked with the monthly invoices of sale. In the absence or delay in the meter calibration appropriate Guidelines will be applied appropriately to confirm the conservativeness of metering. The metering arrangement, accuracy class of meters, calibration frequency is under control of state electricity board and PP does not have any control on it. PP is getting value of net electricity supplied to grid and the same is considered the monitoring parameter. The billing is raised based on substation meters.	
Purpose of data	Calculation of baseline emissions	
Calculation method	Net electricity supplied to the grid by the project plant in a given month = Export(kWh)– Import (kWh)	
Comments	Data will be archived in paper & electronic form for two years after the end of crediting period or of the last issuance of VERs for this project activity, whichever occurs later.	

5.3 Monitoring Plan

The purpose of the monitoring plan is to ensure that the monitoring and calculation of emission reductions of the project within the crediting period is complete, consistent, clear and accurate. The plan will be implemented by the project owner with the support of the grid corporation.

1. Monitoring organization

The monitoring process will be carried out and responsibility by the project owner. A monitoring panel will be established by the plant managers to be in charge of monitoring the data and information relating to the calculation of emission reductions with the cooperation of the Technical and Financial Department. A VCS manager will be assigned full charge the monitoring works. The operation and management structure is shown below:

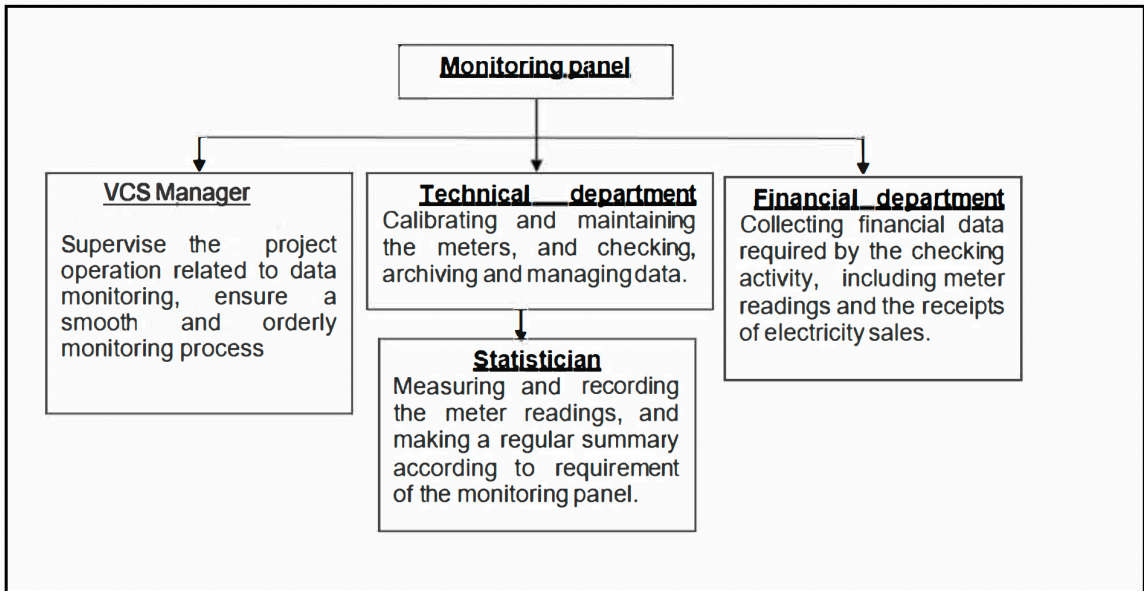


Fig. 3 Organization structure of the monitoring activity

2. Monitoring apparatus and installation

The meter(s) will be installed at the project site, to monitoring the input/output electricity at the grid side. The meter(s) will be installed in accordance with relevant national or international standard. The serial numbers of meters are provided section 6.1 below.

3.Data collection:

The specific steps for data collection and reporting are listed below:

a) During the crediting period, both the grid company and the project owner will record the values displayed by the main meter.

b) Simultaneously to step a), the project owner will both record the values displayed by the backup meters.

c) The meters will be calibrated according to the relevant regulation and request of EDL

d) The main meter's readings will be cross-checked with record document confirmed by EDL.

e) The project owner and the grid company will record both output and input power readings from the main meter. These data will be used to calculate the amount of net electricity delivered to the grid.

f) The project owner will be responsible of providing copies of record document confirmed by EDL to the DOE for verification.

If the reading of the main meter in a certain month is inaccurate and beyond the allowable error or the meter doesn't work normally, the grid-connected power generation shall be determined by following measures:

g) Read the data of the backup meters.

h) If the backup meter's data is not so accurate as to be accepted, or the practice is not standardized, the project owner and the grid corporation should jointly make a reasonable and conservative estimation

method which can be supported by sufficient evidence and proved to be reasonable and conservative when verified by DOE.

i) If the project owner and the grid corporation don't agree on an estimated method, arbitration will be conducted according the procedures set by the agreement to work out an estimation method.

4. Calibration

The calibration frequency of the monitoring meters will be annually. The accuracy of the monitoring meters will not less than 0.5. Calibration of Meters should be implemented according to relevant standards and rules accepted by the grid company EDL. After the examination, the meters should be sealed. The lift of the seals requires the presence of both the project owner and the grid company. One party must not lift the seals or fiddle with the meters without the presence of the other party.

All the meters installed shall be tested by a qualified metering verification institution commissioned jointly by the project owner and the grid company within 10 days after:

1) Detection of a difference larger than the allowable error in the readings of both meters;

2) The repair of all or part of meter caused by the failure of one or more parts to operate in accordance with the specifications.

5. Data management system

Physical document such as the plant electrical wiring diagram will be gathered with this monitoring plan in a single place. In order to facilitate auditors" access to project documents, the project materials and monitoring results will be indexed. All paper-based information will be stored by the technical department of the project owner and all the material will have a copy for backup. All data, including calibration records, will be kept until 2 years after the end of the total crediting period.

6. Monitoring Report

During the crediting period, at the end of each year, the monitoring officer shall produce a monitoring report covering the past monitoring period. The report shall be transmitted to the General Manager who will check the data and issue a final monitoring report in the name of the project participants. Once the final report is issued, it will be submitted to the DOE for verification.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	$EG_{PG,y}$
Data unit	MWh/y
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y in MWh.

Value applied:	103,365
Comments	Data will be archived in paper & electronic form for two years after the end of crediting period or of the last issuance of VERs for this project activity, whichever occurs later. Monitoring period: 01/02/2021 to 31/07/2022 The energy meter and calibration details are given below:

Energy Meter	Meter details	Calibration Date	Validity date
Main	Sl No: 219014734 Accuracy class: 0.2s Make: EDMI	01/02/2021 (COD)	31/12/2026
		21/09/2022	20/09/2027
Backup	Sl No: 219014735 Accuracy class: 0.2s Make: EDMI	01/02/2021 (COD)	31/12/2026
		21/09/2022	20/09/2027

6.2 Baseline Emissions

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

Where:

BEy: Baseline emissions in year y (tCO2e/yr)

$EG_{PJ,\,y}$: Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the VCS 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" (tCO2e/MWh).

Period	$EG_{PJ,y}$ (MWh)	$EF_{grid,CM,y}$ (tCO2/MWh)	BEy (tCO_2)
1-Feb-2021 to 31-Dec-2021	61,609	0.5542	34,143
1-Jan-2022 to 31-July-2022	41,756	0.5542	23,141
Total	**103,365**	**0. 5542**	57,284

6.3 Project Emissions

Not Applicable, since emissions from the project activity is zero.

6.4 Leakage

Not Applicable, since leakage emissions are zero.

6.5 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2021	34,143	0	0	34,143
2022	23,141	0	0	23,141
Total	**57,284**	**0**	0	**57,284**

It is to be noted here that as per the estimated emission reduction to be achieved from the project activity for the current monitoring period is 66,106 tCO_2e, whereas actual emission reductions achieved are 57,284 tCO2e, which is approximately 13% lower than the estimated emission. Hence no additional justification is required

APPENDIX 1: BACKGROUND INFORMATION ON CALCULATION OF GRID EMISSION FACTOR

The calculation process of Operating Margin Emission Factor is shown in the table below:

Table 1 Electricity generated and delivered to Laos National Power Grid

Item	2020		2019		2018	
	EDL	IPP&SPP	EDL	IPP&SPP	EDL	IPP&SPP
	GWh	GWh	GWh	GWh	GWh	GWh
Lao domestic power consumption	2,821.71	8,620.76	2,713.81	5,452.45	3,181.77	6,205.00
Sum Up	**11442.47**		**8166.26**		**9386.77**	

Sources from: Electricity Statistic (page 9-11, 2020), EDL

Table 2 Electricity generated and delivered to Thailand National Power Grid

Item	2020			2019			2018		
	EGAT	IPP	SPP	EGAT	IPP	SPP	EGAT	IPP	SPP
	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Natural gas	41,738.99	28,472.62	42,423.82	38,828.25	39,265.45	43,023.09	37,903.77	38,397.08	39,339
Coal (bituminous & lignite)	16,550.45	16,762.57	1,746.17	16,074.20	15,816.72	2,028.78	15,903.31	15,887.85	2,150.58

Renewable energy (hydropower and others)	4,139.35	-	3,933.16	6,042.72	-	4,398.13	7,360.00	-	2,483
Hydropower	-	-	29.37	-	-	35.26	-	-	38
Solar power and wind power	-	-	3,903.79	-	-	4,362.87	-	-	2,445
Fuel oil and palm oil	584.29	-	207.16	932.07	-	207.16	28.67	-	245
Diesel oil	154.09	33.93	-	127.89	14.84	-	108.60	7.76	-
Biomass	-	-	5,169.72	-	-	5,276.95	-	-	4,847
Other	457.13	-	-	311.27	-	-	210.75	-	-
Sum up	63,624.30	45,269.12	53,480.03	62,316.40	55,097.01	54,934.11	61,515.10	54,292.69	49,064.33
Total	1,62,373.45			172,347.52			164,872.12		

Sourced from: Annual Report (page 133, 2020, page 134, 2019; page 132, 2018), EGAT

Table 3 Electricity generated and delivered by Lao IPP directly supply to Thailand

Item	**2020**	**2019**	**2018**
	GWh	**GWh**	**GWh**
Thailand imports from Lao (Lao IPP directly supply to Thailand)	29446.64	25407.09	26386.04
Sum up	29446.64	25407.09	26386.04

Sourced from: Annual Report (page 133, 2020 &page 134, 2019; page 132, 2018), EGAT

Table 4 Power import from the connected system

Item	2020	2019	2018
	GWh	GWh	GWh
Lao imports from Vietnam(1)	26.34	25.58	26.32
Lao imports from China (1)	95.98	14.24	48.08
Thailand imports from Lao (Lao IPP directly supply to Thailand) (2)	29446.64	25407.09	26386.04
Thailand imports from Malaysia (2)	126.05	118.39	119.57
Sum up	29,695.01	25,565.30	26,580.01

Sourced from:

(1) Electricity Statistic (Page 12, 2020; page 11, 2019; page 11, 2018;), EDL
(2) Annual Report (page 133, 2019, page 134, 2019; page 132, 2018), EGAT

Table 5 Calculation of CO_2 Emission within Lao PDR

There is only one thermal power generation plant in Lao (Hongsa power plant), and the power generated will be supplied to EDL (Lao grid) and EGAT (Thai grid) separately. Since the fuel consumption of the power station cannot be obtained, a conservative way (using power generation max efficiency of thermal power) is adopted to calculate the fuel consumption of the power station. Emission from Hongsa power plant calculated as follows:

Year		**2018**	**2019**	**2020**
Installed capacity (MW) (1)	A	1,878	1,878	1,878
Load Factor (2)	B	89.65%	82.18%	82.33%
Power generation of Hongsa (GWh)	C=A*B*8760/1000	14,748.57	13,519.66	13,544.34
Efficiency (3)	D	48%	48%	48%
Total calorific Value (GJ)	E=C/D*3600	110,614,294	101,397,464	101,582,541
Net Calorific Value (4) (GJ/t)	F	5.50	5.50	5.50
Fuel Consumption (t)	G=E/F	20,111,689.80	18,435,902.60	18,469,552.94
$EF_{CO2,lignite,y}$ (5) (tCO_2/TJ)	H	90.90	90.90	90.90
Emission (tCO_{2e})	I=E*H/1000	10,054,839	9,217,030	9,233,853

Sourced from:

(1) Electricity Statistic (page 6, 2020), EDL
(2) Sustainability Report 2020 of Banpu Power Public Company Limited (shareholder of Hongsa power plant), Page 61

(3) IPCC Technology-specific Cost and Performance Parameters, Table A.III.1, max value of plant efficiency for coal-PC, Page 1333
(4) IPCC 2006, Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.2, page 1.18

(5) *IPCC 2006, Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4, page 1.23*

Table 6 Calculation of CO_2 Emission within Thailand

Fuel Type	Fuel Consumption		Fuel Specific EF	Net Calorific Value	GHG emission
	$FC_{i,y}$ (1)		$EF_{CO2,m,i,y}$ (2)	$NCV_{i,y}$ (3)	$FC_{i,y}$ x $EF_{CO2,m,i,y}$ x $NCV_{i,y}$
	Unit	FC/Unit	tCO_2/TJ	GJ/Unit	tCO_2
2020					
Natural Gas	ktoe	24,738	54.3	41.868	56,240,171
Lignite	ktoe	3,275	90.9	41.868	12,463,999
Bituminous	ktoe	3,299	89.5	41.868	12,361,967
Briquettes	ktoe	774	87.3	41.868	2,829,029
Diesel (HSD)	ktoe	26	72.6	41.868	79,030
Fuel oil	ktoe	27	75.5	41.868	85,348
Municipal wastes and biomass fraction	ktoe	7,679	46.2	41.868	14,853,502
Paddy husk	ktoe	698	-	-	-
Bagasse	ktoe	4,165	-	-	-
Agricultural waste	ktoe	2,672	-	-	-
MSW	ktoe	144	-	-	-
Biogas	ktoe	522	84.7	41.868	1,851,127
Sum (2020)					**100,764,172**
2019					
Natural Gas	ktoe	25,965	54.3	41.868	59,029,672
Lignite	ktoe	3,938	90.9	41.868	14,987,245
Bituminous	ktoe	3,098	89.5	41.868	11,608,782
Briquettes	ktoe	590	87.3	41.868	2,156,495
Diesel (HSD)	ktoe	38	72.6	41.868	115,505
Fuel oil	ktoe	26	75.5	41.868	82,187
Municipal wastes and biomass fraction	ktoe	6,682	46.2	41.868	12,925,003
Paddy husk	ktoe	837	-	-	-
Bagasse	ktoe	3,852	-	-	-
Agricultural waste	ktoe	1,957	-	-	-
MSW	ktoe	36	-	-	-
Biogas	ktoe	525	84.7	41.868	1,861,765
Sum (2019)					**102,766,656**
2018					
Natural Gas	ktoe	25,614	54.3	41.868	58,231,697
Lignite	ktoe	3,510	90.9	41.868	13,358,362
Bituminous	ktoe	3,329	89.5	41.868	12,474,382
Briquettes	ktoe	634	87.3	41.868	2,317,318
Diesel (HSD)	ktoe	35	72.6	41.868	106,387
Fuel oil	ktoe	15	75.5	41.868	47,416
Municipal wastes and biomass fraction	ktoe	7,457	46.2	41.868	14,424,087
Paddy husk	ktoe	691	-	-	-
Bagasse	ktoe	4,365	-	-	-
Agricultural waste	ktoe	2,334	-	-	-
MSW	ktoe	67	-	-	-

Fuel Type	Fuel Consumption		Fuel Specific EF	Net Calorific Value	GHG emission
	$FC_{i,y}$ (1)		$EF_{CO2,m,i,y}$ (2)	$NCV_{i,y}$ (3)	$FC_{i,y}$ x $EF_{CO2,m,i,y}$ x $NCV_{i,y}$
	Unit	FC/Unit	tCO_2/TJ	GJ/Unit	tCO_2
Biogas	ktoe	590	84.7	41.868	2,092,270
Sum					**103,051,919**
2017					
Natural Gas	ktoe	26,399	54.3	41.868	60,016,342
Lignite	ktoe	3,409	90.9	41.868	12,973,976
Bituminous	ktoe	3,190	89.5	41.868	11,953,523
Briquettes	ktoe	737	87.3	41.868	2,693,791
Diesel (HSD)	ktoe	35	72.6	41.868	106,387
Fuel oil	ktoe	24	75.5	41.868	75,865
Municipal wastes and biomass fraction	ktoe	8,192	46.2	41.868	15,845,799
Paddy husk	ktoe	717	-	-	-
Bagasse	ktoe	4,786	-	-	-
Agricultural waste	ktoe	2,587	-	-	-
MSW	ktoe	102	-	-	-
Biogas	ktoe	653	84.7	41.868	2,315,681
Sum					**105,981,364**

Sources from:

(1) Energy Balance of Thailand 2020, EGAT, table 43, Page 50
(2) IPCC 2006, Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4, page 1.23 and 1.24
(3) Unit converter and glossary, International Energy Agency.
https://www.iea.org/reports/unit-converter-and-glossary

Table 7 Calculation of $EF_{grid,OM\text{-}ave,y}$

Year	Electricity generated and delivered to the power grid system (GWh)	Emission in the power grid system (tCO_2e)	OM Emission Factor (tCO_2/MWh)
2018	200,804	113,106,758	0.5633
2019	206,078	115,198,394	0.5590
2020	203,511	109,998,025	0.5405
Sum up	**610,429**	**338,303,177**	**0.5542**

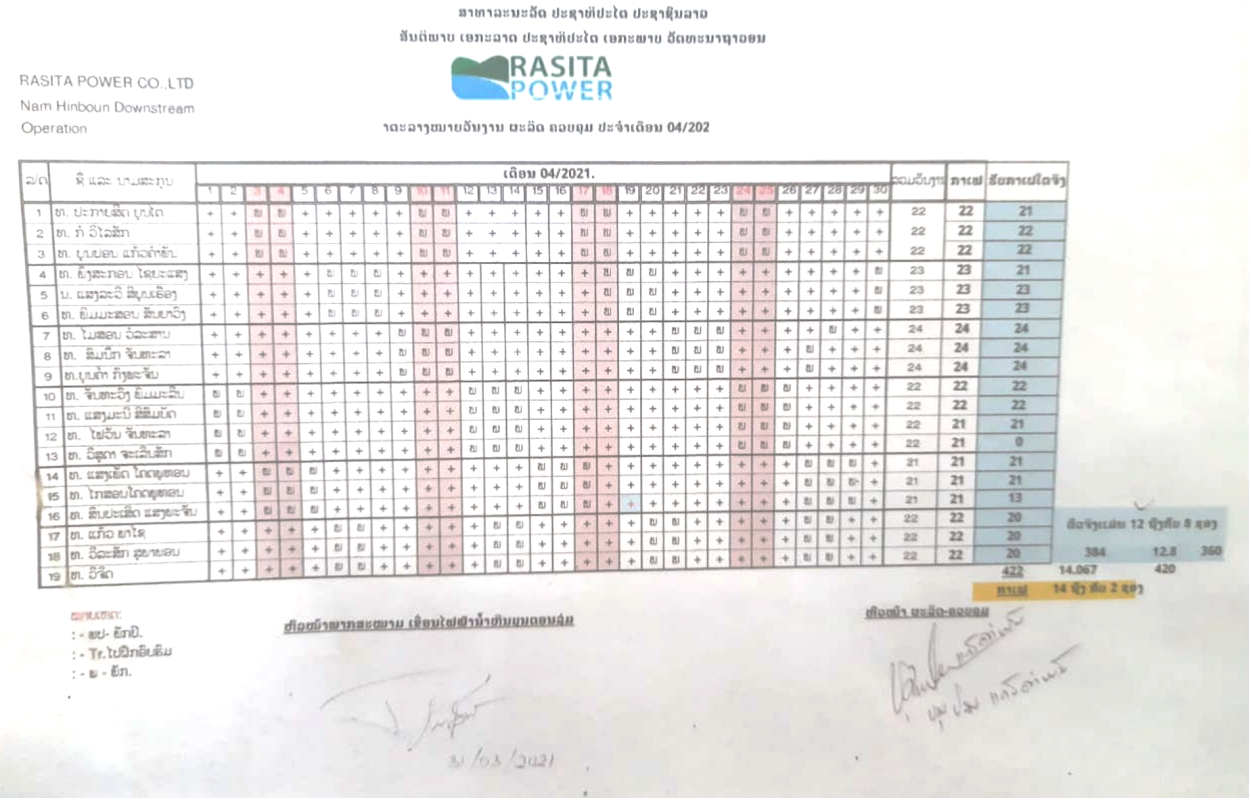
Based on the equation and above data, the average OM is 0.5542 tCO_2/MWh.
$EF_{grid,OM,y}$ = $EF_{grid,OM\text{-}ave,y}$ = 0.5542 tCO_2/MWh.

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

= 1×0.5542 tCO_2e/MWh = 0.5542 tCO_2e/MWh.

APPENDIX 2: SUPPORTING DOCUMENTS FOR SDG BENEFITS

Site Attendance sheet as proof the employment generation



RASITA POWER CO.,LTD
Nam Hinboun Downstream
Operation

RASITA POWER

เดือน 04/2021.