



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

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**SECTION A. General description of project activity****A.1. Title of the project activity:**

Title: Fiji Nadarivatu Hydropower Project
Version N.º: 6
Completion Date: 20/09/2012

A.2. Description of the project activity:

The Fiji Nadarivatu Hydropower Project (called hereafter “the project activity”) is a 44MW run-of- river hydropower scheme located on Nadrau plateau in the interior of Viti Levu, the main Island of Fiji. This project will be constructed and operated by the Fiji Electricity Authority (FEA).

The scenario existing prior to the start of the implementation of the project activity: The location of the proposed project is covered by the FEA grid. Over the past 10 years electricity demand in Fiji has seen a significant increase and FEA has consistently used new diesel power stations to meet demand.

The project scenario: The proposed project activity is a new project activity (which started on 8th September 2008, when the civil construction contract with Sinohydro Corporation was signed), which aims to construct and operate a run-of-river hydropower project and it will be an environmentally friendly solution to meeting current and growing energy demand. The total capacity of the proposed project is 44MW. The scheme involves taking water from a 31 meter (m) weir in the head waters of the Sigatoka River catchment at the confluence of the Qaliwana and Nukunuku Creeks, through a tunnel and penstock to a power station on the banks of the Ba River. It will not produce CO₂ emissions during the process. The expected annual electricity supplied to the FEA grid is 92.957GWh. The project will increase the percentage of renewable energy generation in FEA’s portfolio to 64% and further reduce Fiji’s dependence on diesel powered electricity generation and reduce the need for new diesel power stations. The proposed project activity will contribute to meeting the current and future demand for electricity in Fiji through a sustainable energy solution. This will contribute to a secure, continuous and reliable power supply for Fiji, enabling continued economic growth and development for the country.

The baseline scenario: The baseline scenario of the proposed project activity is that the 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 baseline scenario of the proposed project is therefore the same against the scenario prior to the start of the implementation of the project activity, i.e. supply of electricity from the FEA grid and addition of diesel generation capacity to the FEA grid to meet growing demand.

The proposed 44MW run-of-river hydropower scheme will have an annual energy production of approximately 101GWh and will supply to the FEA grid 92.957GWh, operating on average 8 hours per day, which will generate estimated emissions reductions in the order of 47,361 tonnes of CO₂e annually during the first seven-year crediting period. The project started construction in May 2009 and is planned to be finished in April 2012. The operation phase will start in May 2012 end.



Contribution of the Project Activity to Sustainable Development: The project has positive impacts with respect to the environment through offsetting fossil fuel use and lowering greenhouse gas emissions. The project will generate ‘green’ power through zero-emission hydro technology (run-of-river dam with very small impacts on the environment) and therefore reduce CO₂ emissions as compared to the business as usual scenario.

Socially it will provide jobs to local communities during and after construction and provide long-term income to the surrounding villages from the 99-year land lease in an area where permanent and reliable sources of employment are scarce. The project will also provide reliable electricity supply and good upkeep and maintenance of roads in and out of the Nadrau plateau (more than 24km of public road). Eight villages (Lewa, Buyabuya, Naiyaca, Marou, Nagatagata, Drala, Vatutokotoko and Koro) and two settlements (Taunabe and Nakeito) will benefit directly from the improved road and electricity infrastructure.

For the local economy, the road will assist in better access to markets for the agricultural produce from these villages. Technologically the project contributes through training to Fijian power utility professionals working for FEA who will gain experience in hydro power installation, commissioning, operation and maintenance and technology transfer to Fiji from China. Finally, for the national economy it satisfies growing energy demands without increasing dependence on expensive fossil fuels, allowing the country to continue its economic development and contributing to poverty alleviation.

A.3. Project participants:

Name of Party Involved (*) (host) indicates a host Party)	Private and/or public entity(ies) Project Participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Fiji (host)	Fiji Electricity Authority (FEA) (as project owner)	No

() In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.*

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Longitude East 177°58’43” and Latitude South 17°44’60”

A.4.1.1. Host Party(ies):

Republic of the Fiji Islands and Rotuma

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

Viti Levu Island

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

Nadrau Plateau, Nadarivatu District

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

The proposed project activity is located on Nadrau Plateau in the Nadarivatu District, in the interior of Viti Levu, the main island of Fiji. Water will be diverted from the Sigatoka River to the Ba River. The Sigatoka River flows from the Nadrau Plateau to the south coast of Viti Levu. The Ba River flows parallel to the Sigatoka River from Nadrau Plateau to the south before flowing northward to the north coast of Viti Levu. The Korolevu Weir will be located immediately downstream of the confluence of the Qaliwana River and Nukunuku Creek, in a narrow V-shaped valley in the high reaches of the Sigatoka River catchment. The purpose of the weir is to impound and divert water through the tunnel and penstock to the power station which will be located on the banks of the Ba River, at Buyabuya village. The Sigatoka and Ba Rivers, and their tributaries, drain the west and south flanks of the plateau. In the vicinity of the proposed project the topographical relief is over 600m, from the Ba River (Elevation 200+/- m) to the top of Lewa Ridge (Elevation 800+/- m) dividing the Qaliwana and Ba watershed. The ground conditions at the weir site are basaltic pillow lavas, massive flows (columnar/blocky) and volcanic flow breccia (volcanic agglomerate), underlain at depth by sedimentary rocks. From a foundation strength and stability perspective, the basalt flow breccias and pillow lavas are expected to provide a suitable foundation for the weir. The project activity site is located between Longitude East 177°58'43" to 177°58'48" and Latitude South 17°44'60" to 17°45'47" as shown in Figure A. 1.

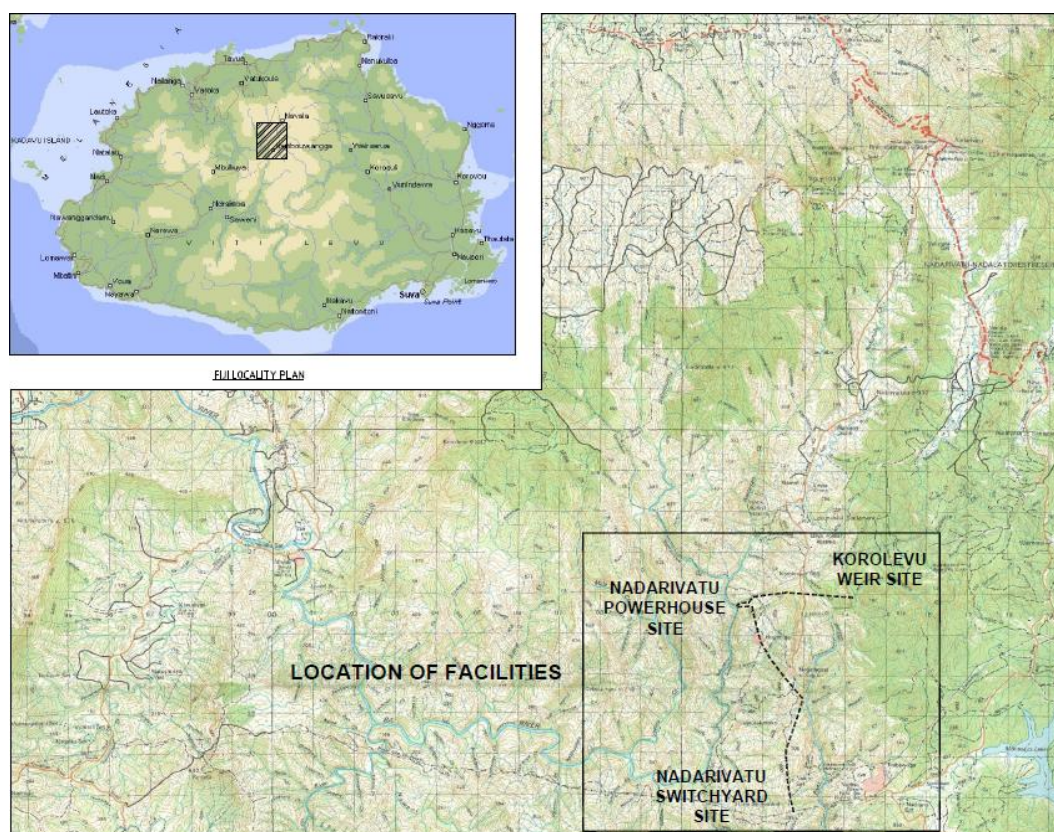


Figure A. 1: Location of the Nadarivatu Hydropower Scheme, Viti Levu, Fiji

**A.4.2. Category(ies) of project activity:**

Sectoral Scope 1: Energy Industries (renewable / non-renewable sources)

A.4.3. Technology to be employed by the project activity:

The scenario existing prior to the start of the implementation of the project activity: The location of the proposed project is covered by the FEA grid. Over the past 10 years electricity demand in Fiji has seen a significant increase (5% per annum) and FEA has consistently used construction of new diesel power stations to meet demand.

The proposed scenario: The proposed Fiji Nadarivatu Hydropower Project is a run-of-river scheme diverting water from the head waters of the Sigatoka River via a weir, tunnel and penstock, to a 44MW power station at the Ba River. This is represented schematically in Figure A. 2. The main items of equipment such as turbines, generators, governors etc. are imported from China. The details of the scheme are as follows:

- A 31m weir at the junction of the Qaliwana and Nukunuku Rivers will provide 1,009,000m³ of live storage;
- The 15 m³/s flow is routed through a 2km tunnel and 1.4km penstock to the power house;
- A 44MW, 336m head power station will be situated on the Ba River. The power station will have two 22 MW five vertical Pelton turbine generators;
- The total energy production of the scheme is expected to be 101 GWh/annum in a mean year.
- The project scope includes the transmission link to the Vuda-Wailoa 132kV transmission line and FEA will handle the communications and SCADA upgrade at the Vuda National Control Centre themselves.

The main technologies of the project are detailed in the Table A. 1. These technologies are considered to be environmentally safe as the plant is a run-of-river project with a weir. The plant can therefore be constructed and operated in a manner which does not involve land clearing or development, as in the case of accumulation reservoir types of projects. This is in addition to the fact that power is generated by a renewable resource and resulting in zero emissions.

Table A. 1. Project technologies

Technology	Description
Turbines/Generator (Turbine type: CJA475-L-170 Generator Type: SF22-14/3600)	2 x 22MW vertical pelton multi-jet turbine generators. The turbine/generator will be of the vertical-shaft, single-runner, impulse, five-jet Pelton type with governor controlled needles and jet deflectors. The nominal operating speed of the turbine will be 428.6-rpm. The turbine runner will be specified to be made of chrome alloy cast steel, either of the 13Cr-4Ni type, or the 13Cr-6Ni type with integrally cast disc and buckets.
Governor	The governor will be of the digital microprocessor based, PID electro-hydraulic type with speed and acceleration sensing, speed regulation, nozzle servomotor opening limitation, unit frequency-phase follow-up control, adaptive parameters, and self-diagnostic and stabilizing functions. Each turbine will be fitted with a fully independent turbine governor and oil system.

Substation, transmission and controls	• 132kV Substation • 132kV interconnection Switching station • 5.4km of 132kV Transmission Line • Controls and power supplies to the weir structure. • Controls, communications and interface with transmission line systems and to the National Control Centre in Vuda.
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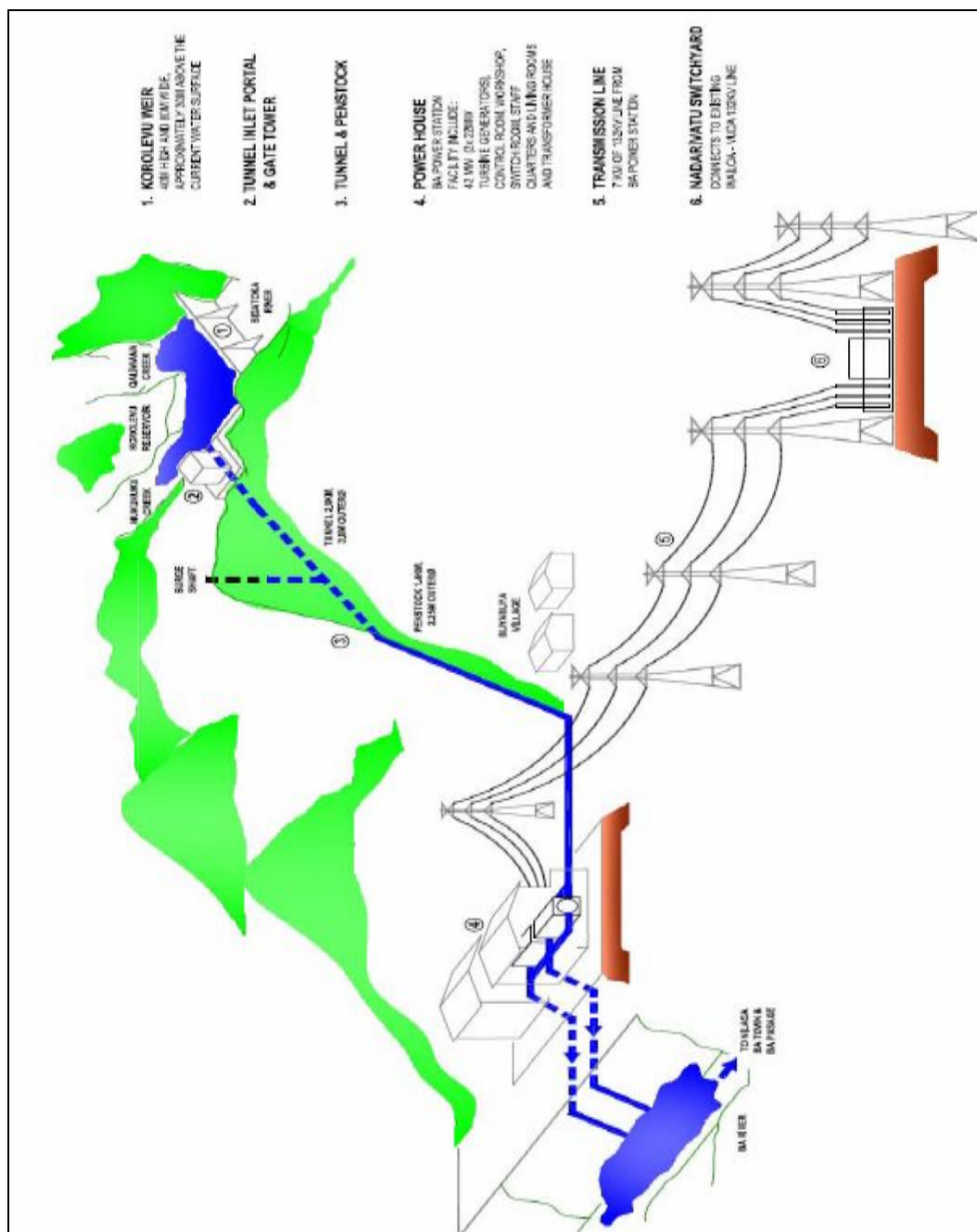


Figure A. 2. Nadarivatu Hydropower Scheme



The proposed 44MW run-of-river hydropower scheme will have an annual energy production of, approximately 101GWh and will supply to the FEA grid 92.957GWh operating on average 8 hours per day. The project started construction in May 2009 and is planned to be finished in April 2012. The operation phase will start in May 2012.

The baseline scenario: The baseline scenario of the proposed project activity is that the 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 baseline scenario of the proposed project is therefore the same against the scenario prior to the start of the implementation of the project activity, i.e. supply of electricity from the power stations connected to the FEA grid with addition of diesel generation capacity to the FEA grid to meet growing demand.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

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The annual emission reductions of the proposed project are estimated to be 47,361 tCO₂e as shown in Table A. 2. This project will employ a renewable crediting period and the total emission reductions are estimated to be 331,527 tCO₂e for the first seven year crediting period.

Table A. 2. Estimation of emission reductions of the project for the first seven-year crediting period

Years	Estimation of annual emission reductions in tonnes of CO ₂ e
1 April 2013 – End of March 2014	47,361
1 April 2014 – End of March 2015	47,361
1 April 2015 – End of March 2016	47,361
1 April 2016 – End of March 2017	47,361
1 April 2017 – End of March 2018	47,361
1 April 2018 – End of March 2019	47,361
1 April 2019 – End of March 2020	47,361
Total estimated reductions (tCO₂e)	331,527
Total number of crediting years	7
Annual average of estimated reductions over the crediting period	47,361

A.4.5. Public funding of the project activity:

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There is no public funding from Annex I Parties for the proposed project.

**SECTION B. Application of a baseline and monitoring methodology****B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:**

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Methodology: ACM0002, “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”, Version 12.1.

As the project total installed capacity is 44MW (above the 15MW CDM small/large scale project threshold) and employs a renewable source of energy (hydropower) to be exported to a national grid system, the proposed project should be considered under the above methodology and the accompanying tools:

- “*Methodological Tool: Demonstration and assessment of additionality*” (Version 06.0.0)
- “Tool to calculate the emission factor for an electricity system” (Version 02)

The above methodology and tools are available at:

<http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

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The following reasons justify the applicability of the approved consolidated baseline methodology ACM0002 (Version 12.1) to this project activity:

- The project activity is the installation of a new run-of-river hydropower plant. The power supply will be transmitted to FEA network via the Viti Levu Grid.
- The proposed project results in a new weir. The installed capacity is 44MW (2*22MW). The surface area¹ at full level is 0.09 km², so the power density is 488.88 W/ m², much higher than the required 4 W/ m².
- The geographical and system boundaries for the relevant electricity grid (FEA) can be clearly identified and information on the characteristics of the grid was made available by the Fiji Electricity Authority.
- The proposed project activities do not involve switching from fossil fuels to renewable energy sources at the site of the project activity.
- The proposed project does not involve any capacity addition, retrofit or replacements.

The following reasons justify the applicability of the chosen methodological tools:

- i. ‘*Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)*’ is required to be applied for demonstrating and assessing the additionality of a project activity under methodology ACM0002 (Version 12.1), therefore is mandatory for the proposed project.

¹ The maximum holding pond area is 9ha, as specified in Table 2 of the Consolidated Environmental Impact Report



- ii. *Tool to calculate the emission factor for an electricity system (version 02)* is used to determine the CO₂ emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the “operating margin” (OM) and “build margin” (BM) as well as the “combined margin”. The tool is required for calculating the baseline emission of a new grid connected renewable power plant as for the proposed project under ACM0002 (Version 12.1).

Reasons justifying the exclusion of the following methodological tools with regard to the proposed project:

- i. *Combined tool to identify the baseline scenario and demonstrate additionality (version 02.2)* is clearly indicated in ACM0002 (Version 12.1) for retrofit or replacement of existing grid-connected renewable power plant/unit. The proposed project is a newly built hydropower project, and thus the combined tool is not applicable to the proposed project.
- ii. *Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion (version 02)* is to calculate project and/or leakage CO₂ emissions from the combustion of fossil fuels. The proposed project is a newly built hydropower project whose power density is 488.88 W/ m², according to the adopted approved consolidated baseline methodology ACM0002 (Version 12.1), the project emission $P_{E,y}$ is 0, and combustion $PEFF,y$ is also 0. So this tool is not applicable to the proposed project.

B.3. Description of the sources and gases included in the project boundary:
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In the proposed project activity, the generated electricity from the project will be delivered to the FEA grid network on Viti Levu. As per guidance set out in ACM0002 (Version 12.1), the spatial extent of the project boundary includes the Nadarivatu Hydropower Scheme (the project activity) and all power plants connected physically to the FEA grid on Viti Levu, to which the CDM project power plant is connected to. The FEA grid on Viti Levu is defined as the project electricity system, which is mainly comprised of a range of diesel plants, plus three hydropower plants and one wind power plant. The project boundary is represented in the flow diagram in Figure B. 1.

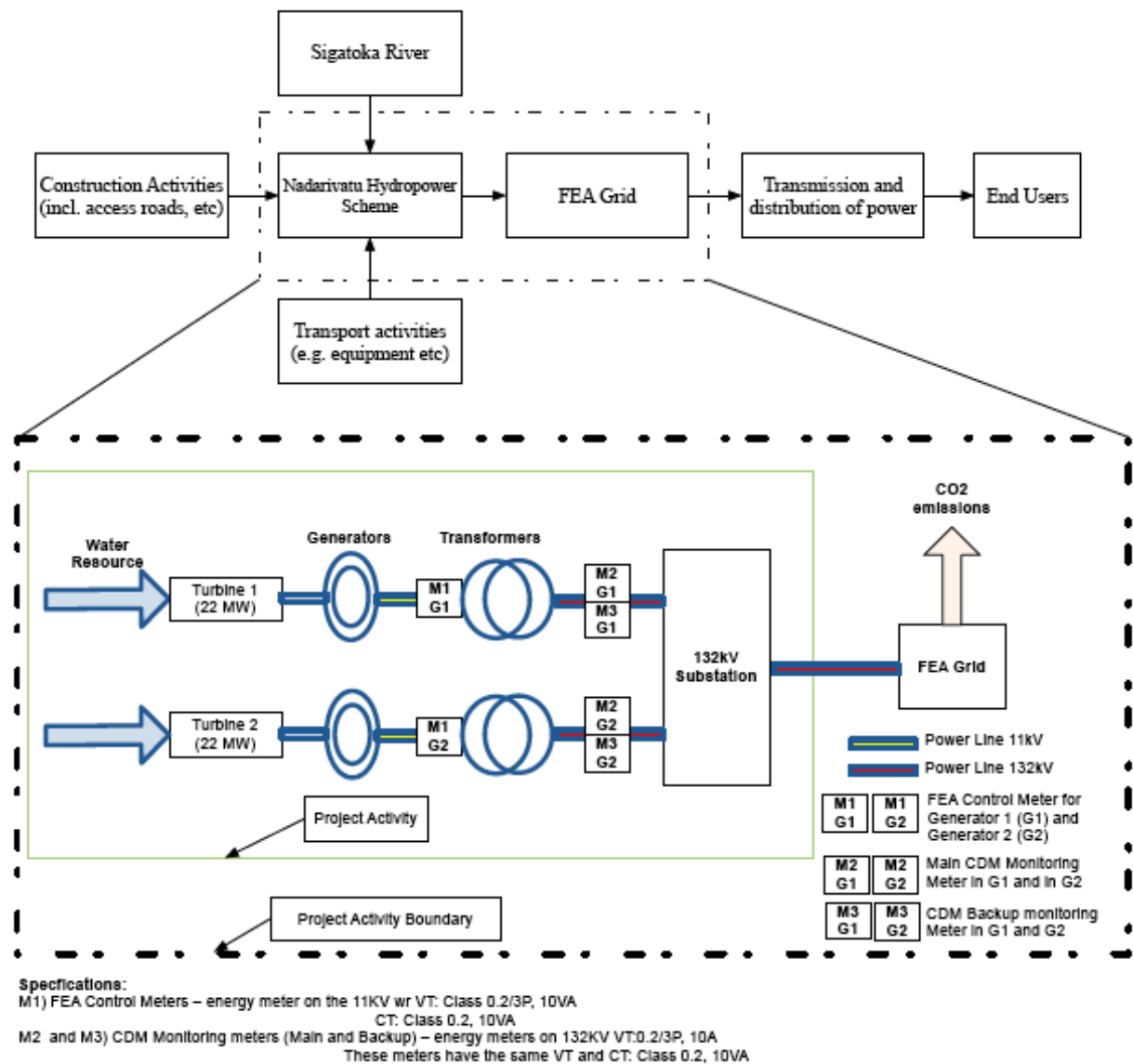


Figure B. 1. Project Activity boundary

The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table B. 1.

**Table B. 1. Emission sources included in or excluded from the project boundary**

	Source	Gas	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 and the only gas identified in the baseline methodology
		CH ₄	No	Minor emission source and not required by the methodology
		N ₂ O	No	Minor emission source
Project activity	For hydro power plants, emissions of CH ₄ from reservoir	CO ₂	No	Zero CO ₂ emissions; grid-connected electricity generation from renewable energy
		CH ₄	No	The project activity involves a newly built weir with power density of 488.88W/m ² , thus since the power density of the weir is greater than 10 W/m ² , CH ₄ project emissions are not considered according to ACM0002.
		N ₂ O	No	Minor emission sources

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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The project activity is the installation of a new grid-connected renewable power plant with a new run-of-river weir, from which the electricity generated will be transmitted to the FEA grid on Viti Levu. According to the approved consolidated baseline methodology ACM0002 (Version 12.1) the baseline scenario is the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by 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”

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

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Table B. 2 demonstrates the project implementation timeline.

Table B. 2. Project timeline

Year	Date	Milestone
2007	October 09	Fiji Nadarivatu Hydro PIN prepared 9 th October 2007 with assistance from World Bank.



	November 05	FEA Board gave serious consideration to CDM with approval for FEA to engage with World Bank to process further CDM for the Nadarivatu Project (<i>CDM Serious Consideration</i>)
	November 12	Project Technical Design Finalised.
2008	April	Nadarivatu Hydropower Scheme Consolidated EIA finalised and submitted for approval to the Department of Environment (DoE)
	July 16 & 17	Major Projects Sub-Committee of the FEA Board approval for Nadarivatu Hydro Project to proceed after all investment criteria is met and recommended for full Board approval on meeting of 17 July 2008. CDM income is also factored into Financial Analysis (<i>CDM Decision Making</i>)
	September 08	Civil construction and power house and transmission works contract signed by FEA and Sinohydro Corporation of China. (<i>Starting Date of the Project Activity</i>)
	October 22	Approval of the Nadarivatu Hydropower Scheme Consolidated EIA and the Environmental Management Plan by the Department of Environment, Ministry of Local Government, Urban Development, Housing and Environment
	December 01	ANZ Bank agree to co-finance project with a US \$30 million loan
2009	January 19	Loan Agreement with China Development Bank (US \$70 million)
	January 30	Letter of Intent to register a CDM project sent to Fiji DNA (<i>CDM Continuing Action</i>)
	February 17	Owners Engineer Contract with MWH of New Zealand
	March 24	CDM Project Notification to Fiji DNA (<i>CDM Continuing Action</i>)
	April 15	Devaluation of Fiji dollar by 20% – revised business plan – CDM financing becomes even more important
	May	Construction started on site with excavation of areas for housing and temporary facilities.
	August 19	Tariff Determination
2010	November 26	FEA Board decision to continue with project despite devaluation of Fiji dollar – CDM financing plays important role in decision (<i>CDM Continuing Action</i>)
	February 25	Contract with CDM Consultant (IT Power) (<i>CDM Continuing Action</i>)
	April 16	Submission of the Prior Consideration with the UNFCCC (<i>CDM Continuing Action</i>)
	May 07	Public Stakeholder Consultation meeting and presentation (<i>CDM Continuing Action</i>)
	May 26	Acknowledgement of Prior Consideration received from UNFCCC
	October	Building of powerhouse starts
	November 10	Contract with the DOE (JCI)
	December 22	PDD submitted to DOE



2011	January 24	PDD uploaded for GSC
	February 03	Application for LoA to Fiji DNA
	December 01	LoA Fiji has been issued.

The Fiji Nadarivatu Hydropower Project is a new project according to the UNFCCC terminology as it started on 8th September 2008 (therefore after 2nd August 2008) with the signature of the contract for provision of civil construction works signed between FEA and Sinohydro Corporation.

Additionality of the proposed project activity is demonstrated using the *Methodological Tool: Demonstration and assessment of additionality (Version 06.0.0)*. The steps are described below.

Step1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a): Define alternatives to project activity

In the absence of the proposed project activity, the following alternatives are likely to be considered:

- Alternative 1: The proposed project activity undertaken without being registered as a CDM project activity, i.e. to build a new hydropower plant with an installed capacity of 44 MW without CDM incentive.
- Alternative 2: Construction of a diesel power plant with equivalent installed capacity or annual electricity generation.
- Alternative 3: Construction of a power plant using other renewable energy with equivalent installed capacity or annual electricity generation.
- Alternative 4: Continuation of the current situation: current electricity service provided by the FEA grid on Viti Levu

Assessment of Alternatives

Alternative 1 is not a credible or realistic alternative as, according to the investment analysis presented below in this section, without assistance of CDM, the project would not have been approved by the FEA Board as it would not have been financially attractive for investment.

Alternative 2 is not a realistic scenario because FEA has never built a diesel power plant of equivalent installed capacity (44MW) and has only one diesel power station capable of producing the same annual diesel generation. FEA's portfolio of diesel power plants does not typically include large diesel power stations and therefore building a new diesel power plant with equivalent installed capacity or annual electricity generation as the 44MW proposed hydropower plant is not a realistic scenario.

Alternative 3, although consistent with current applicable laws and regulations, is not a credible or realistic alternative due to the following reasons:

- a) Wind resource potential is low in Fiji (typically between 3 and 6 m/s) with a limited number of sites presenting suitable wind resource characteristics and lack of data to identify new sites. Further limitations are placed on wind power development by limited land availability (land ownership divided amongst many villages, land used predominantly for agriculture),



environmental and ecological concerns (conservation of fauna and flora) and the cyclone prone weather of Fiji which limits the size of turbines which can be installed and also increases the cost of purchase, installation and maintenance of wind turbines. The only current wind farm in Fiji of total capacity 10MW (using 275kW wind turbines) produces just 11.3GWh per year². Thus a wind power development would be a more expensive proposition, while not being able to achieve the same installed capacity or guarantee the same energy generation output as the proposed hydropower activity;

- b) Solar photovoltaic (PV) developments require too much land in order to install the same capacity as the proposed hydropower project – 44 MW of solar PV would require at least 21km² of land to yield the same energy output. Therefore land availability would be a serious constraint. Solar PV would also have massively higher costs;
- c) Biomass power projects would be more expensive to develop. Again, there would be the issue of limited land availability and land leases over large areas which could be expensive and difficult to arrange. Biomass production is also currently not high enough to support larger-scale projects (above 20 MW) and therefore a biomass project would not be able to generate the same electricity production as the proposed activity;
- d) Gasification of bagasse has been carried out in Fiji for a number of years but sugarcane production is falling and therefore also the amount of bagasse available for power generation. Therefore although this technology is feasible it would not be able to provide the capacity and energy yield as required;
- e) Geothermal power has potential in some areas of Fiji. However, the cost of exploratory drilling to confirm the resource and the subsequent feasibility studies and construction of a geothermal power plant would be more expensive than hydro and the capacity in MW would be lower (estimated to be likely between 5-15MW for a geothermal site)³. Geothermal is more of a long-term prospect to be developed in future when resource and costs are confirmed;
- f) Ocean and wave power have not been researched and studied sufficiently in Fiji to be able to determine accurately their potential, while ocean power technologies are still at the prototype stage and would not be able to guarantee the energy output required, as well as also being very expensive.

As opposed to the other renewable energy technologies, hydro is a technology proven to work in Fiji and supported by the NEP⁴ for electricity production. Local people are familiar with it and it requires less land per MW installed than any of the other renewable energy technologies. This is an important factor in Fiji where land availability is limited by cultural (grave sites and sacred tribal sites), environmental (virgin forests, conservation areas) and socio-economic considerations (land leases, food production, small-scale farming). The proposed hydro power project maximises the renewable energy MW installed while minimising the land needed.

Alternative 4, continuation of the current situation: electricity service is provided by the FEA grid on Viti Levu, (no project activity or other alternatives is undertaken). This is a credible scenario where FEA

² Butoni Wind Farm Fiji, Hasumukh Patel, Chief Executive Office, Fiji Electricity Authority, August 2009

³ PIREP Pacific Regional Energy Assessment –Fiji National Report, SPREP, 2004

⁴ National Energy Policy, Department of Energy, Ministry of Energy & Mineral Resources, Fiji Islands, November 2006



does not invest in hydropower development and instead continues to supply the demand from the existing power stations, running at higher capacity where needed. Since 1983 most of the power stations constructed by FEA to meet demand have been thermal power plants fuelled by diesel or HFO. FEA is therefore familiar with the technology and running costs for diesel power stations and has been using them as its first option to supply electricity demand. This alternative is consistent with current laws and regulations.

Drawing from the above summary, Alternative 4, continuation of the current situation is the only currently realistic alternative to the proposed hydropower activity and therefore generation from the existing grid which is predominantly diesel-based (as shown in the calculation of the Built and Operating margin) is used as the baseline scenario.

Sub-step 1.b: Consistency with Mandatory Laws and Regulations

The identified alternative to the project proceeding with carbon revenue from the CDM is Alternative 4 and this alternative is compliant with Fiji legal and regulatory requirements.

Step2: Investment Analysis

The purpose of this step is to determine whether the proposed project activity is economically or financially less attractive than at least one other alternative identified in step 1, without the revenue from the sale of certified emission reductions (CERs). The following sub-steps are taken to conduct the analysis.

Sub-Step 2a: Determine Appropriate Analysis Method

This project activity is a large scale project, and thus additionality has to be demonstrated as per the ‘*Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)*’, also referred herein as the Additionality Tool. This tool provides three methods for carrying out the Investment Analysis: Simple cost analysis (Option I); Investment comparison analysis (Option II) and Benchmark analysis (Option III).

The project activity generates financial and economic benefits through the sale of electricity as well as the revenues from the CDM and therefore Option I ‘Simple cost analysis’ is not applicable.

Option II “investment comparison analysis” is only applicable when the alternatives are also investment projects. In this case, the identified alternative baseline scenario of the project activity, i.e. continuing to supply power from the FEA grid, is not an investment project. Therefore Option II is not applicable either.

Therefore in this case, since the alternative scenario is the continuation of the current situation with electricity supplied by the existing FEA grid, Option III – Benchmark analysis will be used to demonstrate the additionality of the proposed project activity.

Sub-step 2b: Option III. Apply Benchmark Analysis

The ‘*Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)*’ stipulates that the project developer should identify the financial/ economic indicator, such as IRR, most suitable



for the project type and decision context. As prescribed by the Additionality Tool itself, the project developer has chosen project IRR to demonstrate the additionality.

The project IRR needs to be compared with a benchmark to prove the financial unattractiveness of the project. The Additionality Tool and the “*Guidelines on the Assessment of Investment Analysis*” (Ver. 05) allow for internal company benchmarks to be applied in cases where there is only one possible project developer. This is the case for the proposed activity, where FEA are the only possible developer of the proposed CDM project.

FEA is the only possible project developer due to the poor investment environment in Fiji caused by political instability after the 2006 coup and downturn in the economy – as demonstrated by the withdrawal from the project of the World Bank, the European Investment Bank and the original Joint-Venture partner of the project, Pacific Hydro (see Project timeline provided in Table B.2).

The applicable IRR benchmark for the proposed project is therefore derived from the FEA standard procedure to use 8% IRR (Project IRR, after Tax) as a benchmark for assessing all investment projects. The FEA IRR benchmark (based on the internal Weighted Average Capital Cost) is used as standard by FEA to evaluate its investment decisions. The FEA Board stipulates that investment decisions are dependent on a project achieving a minimum 8% IRR according to standard FEA project discounted cost analysis over 40 years. Therefore the IRR benchmark for the proposed project is 8% (Project IRR, after Tax), a value less than this means that the project is financially unattractive. Information regarding the FEA IRR benchmark is available on request from FEA and can be validated by the DOE.

The application of this Board decision to all FEA investment projects after 2005 can be demonstrated, for example, by the SEL joint venture project (2005) and the Heavy Fuel Oil project at Kinoya (2007), both evaluated against the IRR benchmark of 8%. The discounted cost analysis used for calculation of the IRR for these two examples, as well as for the proposed hydropower project, is the standard discounted cost method used for evaluation of all FEA projects. Therefore the 8% IRR benchmark proposed in this analysis has been used for similar projects with similar risks, developed by the same company as stated in the “*Guidance on the Assessment of Investment Analysis*”.

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

The project IRR is calculated as follows.

**Table B. 3: Main parameters for calculation of IRR**

Item	Unit	Value as per FEA Board Decision Paper no. 4980	Value as per FEA Board Decision Paper no. 5360	Values used in the PDD
Installed capacity	MW	44	44	44
Energy generation	GWh	76 in 2011 101 from 2012 onwards	25 in 2011 101 from 2012 onwards	25 in 2011 101 from 2012 onwards
Electricity losses	%	8	8	8
Electricity to the Grid	GWh	70 in 2011 93 from 2012 onwards	23 in 2011 93 from 2012 onwards	23 in 2011 93 from 2012 onwards
Discount rate / WACC	%	8	8	8
Inflation	%	3	3	3
Tax	%	31	28 with 10 year accelerated depreciation provision ⁵	28 with 10 year accelerated depreciation provision ⁶
Emission factor	-	0.656 – the only information available at the time and therefore used at the time of the investment decision	0.656 – the only information available at the time and therefore used at the time of the investment decision (0.5095 is the new value calculated in the present PDD)	0.5095 – this was the value used in the IRR calculation for the demonstration of additionally as this is the value calculated in the present PDD
CER administration costs	% of CER revenue	5	5	5
CER value	Euro	9	9	9
Exchange rate FJD / EUR	-	-	0.463	0.463
Exchange rate FJD / USD	-	0.7	0.5	0.5
Capital cost	Million FJD	227 – Value before devaluation in April 2009	300 – after devaluation in April 2009	300 – after devaluation in April 2009

⁵ Fiji Tax Authority Decision, 2004 Budget⁶ Fiji Tax Authority Decision, 2004 Budget



Residual Value Factor ⁷	Times	10	12	12
Economic modelling	Years	40	40	40
Electricity fees / kWh	FJD cents / kWh	22 and increases by 4% in 2012, and 4% every fifth year thereafter	24.5 from September 2009, increasing by 4% in 2012, and 4% every fifth year thereafter	24.5 from September 2009, increasing by 4% in 2012, and 4% every fifth year thereafter
Fixed O&M/MW/year	FJD / MW / year	5,000	5,000	5,000
Variable O&M	% of gross revenue	10%	3% - 2011 10% thereafter	3% - 2011 10% thereafter

Note: Decision Paper 4980 of 17 July 2008 reports the first decision of FEA Board to take the project forward given the conditions at the time. With the devaluation of the Fiji dollar in 2009 the Decision Paper 4980 had to be revised, and some of the parameters changed (as it can be seen in the table above). This revision was conducted and discussed by FEA Board and they decided to take the project forward once again – Decision Paper 5360.

The IRR with and without CERs revenue is listed in Table B. 4. As it can be seen, the IRR of the project with (5.64%) or without CERs revenue (5.90%) is below the benchmark (8%). In conclusion, the project presents barriers to investment..

Table B. 4 Comparison of IRR with and without CERs revenue

Item	Without CER revenue	With CER Revenue	Benchmark
Project IRR	5.64%	5.90%	8%

Sub-step 2d. Sensitivity analysis

The sensitivity analysis is used to show whether the conclusion regarding the financial attractiveness will fluctuate given reasonable variations in the critical assumptions. For the project, three parameters are selected as sensitive factors to analyse the financial attractiveness:

- Capital expenditure;
- Annual O&M costs;
- Electricity supplied to the grid;
- Electricity tariff.

Assuming the above factors vary in the range of -10% to +10%, the IRR of the proposed project without CERs revenue varies to a different extent, as shown in Table B. 5 below:

⁷ The Residual Value Factor is 1/discount rate

Table B. 5: Sensitivity analysis

Item					
% Change	-10%	-5%	0	+5%	+10%
Capital expenditure	6.33%	5.97%	5.64%	5.33%	5.05%
Annual O&M cost	5.72%	5.68%	5.64%	5.60%	5.56%
Electricity supplied to the grid	4.98%	5.31%	5.64%	5.96%	6.27%
Electricity tariff	5.61%	5.63%	5.64%	5.65%	5.66%

The sensitivity analysis shows that independently of the decrease or increase in capital costs, O&M cost, quantity of electricity supplied to the grid or electricity tariff, the project never reaches the 8% benchmark.

Therefore, the sensitivity analysis concludes that the project activity is not financially attractive for the main assumptions of the Benchmark analysis.

Step3: Barrier Analysis

In accordance with the ‘*Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)*’, either the investment analysis or the barrier analysis steps could be used. Thus, this step is omitted in this PDD.

Step4: Common Practice Analysis

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

Other activities similar to the proposed project activity are defined as any grid-connected hydropower projects located on Viti Levu Island in Fiji with similar installed capacities as the proposed project. According to FEA data, there are currently three hydropower plants operational on Viti Levu:

- Wailoa - 80MW
- Wainikasou - 6.4 MW
- Nagado - 2.4MW

The Wailoa hydropower plant has two times the capacity of the Nadarivatu hydropower plant and was constructed in 1983. This hydropower plant employs a similar technology as the Nadarivatu Hydro Power Scheme but was constructed in 1983 before the signature of the Kyoto Protocol and thus could not access the CDM flexible mechanism. Since 1983 until present, there have been no further hydropower plants of this size built in Fiji, therefore construction of large hydropower has not been the common practice and the technological competence and know-how gained at the time of the Monasavu construction has been lost. Since Monasavu is double the size of the Nadarivatu Hydropower scheme and it was built more than 25 years ago using the technology of the time, this project is not comparable to the project activity.

The Wainikasou and Nagado hydro schemes are smaller scale hydro schemes built in 2004 and 2006, respectively. These two schemes, located in Viti Levu island, are run-of-river hydro power schemes that were bundled and taken forward as a small-scale CDM hydropower project. This CDM project has been



approved by the UNFCCC⁸. Although these two projects are run-of-river hydro projects they are small scale projects (6.4 MW and 2.8 MW for a total of 9.2 MW) and thus not considered similar activities to the project activity here in consideration. Furthermore, the *'Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)'* states that CDM project activities (registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process) are not to be included for analysis.

Sub-step 4b. Discuss any similar options that are occurring

Calculation of N_{all} and N_{diff}

Step 1: Applicable output range as +/- of the design output or capacity of the proposed project activity

Proposed project activity: 44MW

Applicable capacity range: 22MW – 66 MW

Step 2: Identify all plants that deliver the same output or capacity within the applicable output range calculated in Step 1⁹

As hydropower plants registered as CDM projects are not to be included in this step, the only hydropower plant that could be considered is the Wailoa hydropower plant.

Wailoa hydropower plant has a capacity of 80MW which is out of the applicable output range calculated in Step1. Thus N_{all} is Zero.

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity.

$N_{diff} = 0$

Step 4: Calculate factor $F = 1 - N_{diff}/N_{all}$

$F = 0$

Thus $F = 0$, which is smaller than 0.2, and $N_{all} - N_{diff} = 0$, which is greater than 3, and therefore the proposed project activity is not a “common practice”.

As per *'The Methodological Tool: Demonstration and assessment of additionality (version 06.0.0)'*, ***“If Sub-steps 4a and 4b are satisfied, i.e.(i) similar activities cannot be observed or (ii) similar activities are observed, but essential distinctions between the project activity and similar activities can reasonably be explained, then the proposed project activity is additional)”***.

Having satisfied sub-steps 4a and 4b, it is concluded that the proposed project activity is additional.

⁸ UNFCCC website, <http://cdm.unfccc.int/Projects/projsearch.html>, <http://cdm.unfccc.int/Projects/DB/TUEV-SUED1124483924.62/view>

⁹ Registered CDM project activities and projects activities undergoing validation shall not be included in this step

B.6. Emission reductions:**B.6.1. Explanation of methodological choices:**

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In order to calculate the baseline, project and leakage emissions and emission reductions, methodology ACM0002 (Version 12.1.0) is used in conjunction with the “*Tool to calculate the emission factor for an electricity system (Version 02)*” including the following steps:

1. Calculation of baseline emissions;
2. Calculation of project emissions;
3. Calculating leakage emissions;
4. Calculating emission reductions.

1. Baseline emissions

In accordance with ACM0002 (Version 12.1.0), baseline emissions include only CO₂ emissions from electricity generation in fossil fuel fired (diesel) power plants that are displaced due to the project activity, calculated as follows:

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

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 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*’ (tCO₂/MWh)

The project activity is the installation of a new grid-connected renewable power plant (greenfield renewable energy power plant) at a site where no renewable power plant was operated prior to the implementation of the project activity, therefore:

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

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).

The calculation of the baseline emission factor is performed using the “*Tool to calculate the emission factor for an electricity system*”, which provides a step-wise approach as follows:

Step 1 - Identify the relevant electric power system

- 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 - Identify the group of power units to be included in the build margin (BM)
Step 6 - Calculate the build margin emission factor
Step 7 - Calculate the combined margin (CM) emissions factor

Step1: Identify the relevant electric power system

As per section B.4., the identified business as usual scenario is the continued generation of power by the FEA grid on Viti Levu, and the baseline emissions are those produced as a result of this. Thus, the FEA grid on Viti Levu is identified as the relevant electric power system.

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

Project participants may choose between the following 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.

This PDD chooses **Option I** because the project electricity grid is reliable and stable, therefore the off-grid power plants contribute only an insignificant amount of electricity to the power system on Viti Levu and there is limited data available for the off-grid power generation.

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

The operating margin emission factor ($EF_{OM,y}$) is calculated based on one of the following four methods:

- 1) Simple OM, or
- 2) Simple adjusted OM, or
- 3) Dispatch data analysis OM, or
- 4) Average OM.

The Simple OM method can only be used where low-operating cost/"must run" power plants¹⁰ constitute less than 50% of total grid generation. According to the historical generating capacity data of FEA in the last 5 years, power generation from hydropower plants accounted for a 50%¹¹ or more of the total generation capacity (see Table B. 6).

Table B. 6. Contribution of low cost and "must run" sources to overall power generation in Fiji

Year	2005	2006	2007	2008	2009	Average
Percentage share of low cost and "must run" power station, namely predominantly	50.9%	50.3%	70.8%	69.9%	64.2%	61.2%

¹⁰ As defined in the "Tool to calculate the emission factor for an electricity system" (Version 2) Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

¹¹ Fiji Electricity Authority electricity generation data by source.



hydropower plants and wind plants						
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On the basis of the information provided in Table B. 6, option 1) Simple OM is not applicable for calculating the project's operating margin emission factor ($EF_{OM,y}$). Therefore, the project will use option 4) Average OM to calculate the OM emission factor.

According to the “*Tool to calculate the emission factor for an electricity system*”, the average OM can be calculated using either of the two following data vintages:

- (1) Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period, or;
- (2) Ex-post option: the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor in year y is usually only available later than six months after the end of year y , alternatively the emission factor of the previous year ($y-1$) may be used. If the data is usually only available 18 months after the end of year y , the emission factor of the year proceeding the previous year ($y-2$) may be used. The same data vintage (y , $y-1$ or $y-2$) should be used throughout all crediting periods.

Based on the most recent statistics available at the time of PDD submission, the first data vintage (option 1 – Ex-ante) for the calculation of OM emission factor is chosen for this project. The years used are therefore 2007 to 2009 (3 year period).

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

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

Thus the Average OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit of net electricity generation (tCO₂/MWh) of all generating power plants serving the system, including low-cost / must-run power plants / units. It may be calculated by using either:

- Option A : Based on net electricity generation and a CO₂emission factor of each power unit¹²; 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 (Option B only to be used if data for Option A is not available).

¹² Power units should be considered if some of the power units at the site of the power plant are low-cost/must-run units and some are not. Power plants can be considered if all power units at the site of the power plant belong to the group of low-cost/must-run units or if all power units at the site of the power plant do not belong to the group of low-cost/must-run units.



In Fiji, the Fiji Electricity Authority has provided the data for the calculation using Option A, thus this is the Option used in this PDD.

Therefore, the Average OM emission factor($EF_{OM, simple, y}$) 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:

$$EF_{OM, average, y} = \frac{\sum_m EG_{m, y} \times EF_{EL, m, y}}{\sum_m EG_{m, y}}$$

Where:

$EF_{OM, average, y}$	Average operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{EL, m, y}$	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)
m	All power units serving the grid in year y , including low-cost/ must-run power units;
y	The relevant year as per the vintage chosen in Step 3.

The calculation of the CO₂ emission factor of each power unit m in year y ($EF_{EL, m, y}$) can be calculated using Option A1, A2 or A3. These options should be used according to the following:

- Option A1 – if for a power unit m data on fuel consumption and electricity generation is available;
- Option A2 – If for a power unit m only data on electricity generation and the fuel types used is available; and
- Option A3 – if for a power unit m only data on electricity generation is available.

In this PDD both option A1 and A3 were used. In these two cases $EF_{EL, m, y}$ was calculates as follows:

Option A1:

$$EF_{EL, m, y} = \frac{\sum_i FC_{i, m, y} \times NCV_{i, y} \times EF_{CO_2, i, y}}{EG_{m, y}}$$

Where:

$EF_{EL, m, y}$	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh);
$FC_{i, m, y}$	Amount of fossil fuel type i consumed by power unit m in year y (mass or volume unit)
$NCV_{i, y}$	Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)



$EF_{CO_2,i,y}$	CO ₂ emission factor of fossil fuel type i in year y (tCO ₂ /GJ);
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
i	All fossil fuel types combusted in power unit m in year y ;
y	The relevant year as per the vintage chosen in Step 3.

Option A3: in case only generation data is available for a power unit m , $EF_{EL,m,y} = 0$ tCO₂/MWh can be assumed as a simple and conservative approach.

$$EF_{OM,average,y} = \underline{0.2488 \text{ tCO}_2\text{e/MWh}}$$

Annex 3 presents the detailed datasheets and calculations.

Step 5: Identify the group of power units to be included in the build margin (BM)

The sample group of power units m used to calculate the build margin emission factor 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 (if 20% falls on part capacity of a unit, that unit is fully included in the calculation).

The set of power units that comprises the larger annual generation should be used.

In this case (b) the set of power capacity additions comprising 20% of the system generation in MWh and that have been built most recently comprise the larger annual generation, therefore set (b) has been used for the sample group of power units m .

In terms of vintage of data, one of the following two options can be chosen:

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

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

This PDD chooses Option 1.

Step 6: Calculate the build margin emission factor

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:

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

Where:

$EF_{grid,BM,y}$	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh);
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y in (MWh);
$EF_{EL,m,y}$	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh).
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

The CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in step 4 (a) for the simple OM, using Options A1, A2 or A3, 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.

In this PDD, the A1 Option of the simple OM method was chosen for this calculation.

$$EF_{Grid,BM,y} = \underline{\underline{0.7701 \text{ tCO}_2\text{e/MWh}}}$$

Annex 3 presents the detailed datasheets and calculations.

Step 7: Calculate the combined margin emissions factor

The combined margin emission factor is calculated as follows:

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

Where:

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

The default values used for w_{OM} and w_{BM} for this PDD are 0.5 and 0.5.

Based on $EF_{OM,average,y}$ and $EF_{grid,BM,y}$ calculated in the previous steps, the combined margin emission factor is:

$$EF_{grid,CM,y} = 0.5 \times 0.2488 + 0.5 \times 0.7701 = \underline{\underline{0.5095 \text{ tCO}_2/\text{MWh}}}$$

Table B. 7. Summary of the OM, BM and CM

Parameter	Value
Operating margin emission factor ($EF_{OM,average,y}$, in tCO ₂ /MWh)	0.2488
Build margin emission factor ($EF_{grid,BM,y}$, in tCO ₂ /MWh)	0.7701
Baseline emission factor ($EF_{grid,CM,y}$, in tCO ₂ /MWh)	0.5095

Annex 3 presents the detailed datasheets and calculations.

The OM and BM emission factors fixed for the duration of the first crediting period yield a baseline emissions factor fixed for the first crediting period. These parameters will be re-calculated at any renewal of the crediting period using the above steps and the latest data available then.

The baseline emission (BE_y) is calculated by multiplying the baseline emission factor ($EF_{grid,CM,y}$) with the annual electricity supplied by the project activity to the FEA grid ($EG_{facility,y}$).

2. Project emissions

As per the guidance in the consolidated approved methodology ACM0002 (Version 12.1), there are no expected project emissions for hydropower plants which have a run-of-river weir (reservoir) with a power density larger than 10W/m².

The project activity has a total installed capacity of 44 MW (or 44,000,000 W) and its run-of-river weir has a surface area of 9ha (90,000m²). The power density of the project activity is given by:

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

Where:

PD = Power density of the project activity, in W/m²

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

Cap_{BL} = Installed capacity of the hydropower plant before the implementation of the project activity (W). For new hydropower plants, this value is zero.

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 (m²)



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 (m^2). For the new reservoir, this value is zero

The power density of the project activity is therefore:

$$PD = 44,000,000 \text{ (W)} / 90,000 \text{ (m}^2\text{)} = \mathbf{488.88 \text{ W/m}^2}$$

Since $PD = 488.88 \text{ W/m}^2 > 10 \text{ W/m}^2$, therefore $PE_y = 0$

3. Leakage

According to the ACM0002 (Version 12.1), no leakage is considered for the proposed project activity. Therefore: $LE_y = 0$

4. Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr)

BE_y = Baseline emissions in year y (tCO_2e/yr)

PE_y = Project emissions in year y (tCO_2e/yr)

LE_y = Leakage emissions in year y (tCO_2e/yr)

Since both project emissions (PE_y) and leakage emissions (LE_y) are zero, the emission reductions (ER_y) are equal to the baseline emissions (BE_y), i.e. the product of baseline emission factor ($EF_{grid,CM,y}$) and the annual net electricity supplied by the project activity to the FEA grid ($EG_{facility,y}$).

$$ER_y = BE_y = EF_{grid,CM,y} \times EG_{facility,y}$$

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

Data / Parameter:	NCV _{i,y}
Data unit:	GJ per mass or volume of fuel
Description:	Net calorific value (energy content) of fossil fuel type i in year y
Source of data used:	IPCC default values
Value applied:	See Annex 3 for values applied
Justification of the choice of data or	Data is collected from IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2



description of measurement methods and procedures actually applied :	(Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as national/or local data is unavailable.
Any comment:	Lower limit value of the 95% confidence intervals has been used.

Data / Parameter:	$FC_{i,m,y}$
Data unit:	Litres, tonne or m ³
Description:	The amount of fossil fuel type i consumed by power unit m in year y
Source of data used:	Fiji Electricity Authority
Value applied:	Refer to Annex 3 for details
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data are used from the Fiji Electricity Authority (FEA), the only source for this information.
Any comment:	

Data / Parameter:	$EF_{CO_2,i,y}$
Data unit:	tCO ₂ /GJ
Description:	CO ₂ emission factor of fossil fuel type i used in power unit m in year y
Source of data used:	IPCC default values
Value applied:	Please refer to Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data is collected from IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as national/or local data is unavailable
Any comment:	Lower limit value of the 95% confidence intervals has been used

Data / Parameter:	$EG_{m,y}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power unit m in year y , including low-cost/must-run power plants/units, in year y
Source of data used:	Fiji Electricity Authority
Value applied:	Please refer to Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data are used from the Fiji Electricity Authority (FEA), the only source for this information.
Any comment:	



Data / Parameter:	Installed Capacity
Data unit:	MW
Description:	Installed capacity of FEA grid
Source of data used:	Fiji Electricity Authority
Value applied:	Please refer to Annex 3 for details
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data are used from the Fiji Electricity Authority (FEA), the only source for this information.
Any comment:	

B.6.3. Ex-ante calculation of emission reductions:

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As discussed in B.6.1, the emission reductions (ER_y) are equal to the baseline emissions (BE_y), i.e. the product of baseline emission factor ($EF_{grid,CM,y}$) and the annual net electricity supplied by the project activity to the FEA grid ($EG_{facility,y}$).

The default values used for w_{OM} and w_{BM} for this PDD are 0.5 and 0.5. Based on $EF_{OM,average,y}$ and $EF_{grid,BM,y}$ calculated in afore steps, the combined margin emission factor is:

$$EF_{grid,CM,y} = 0.5 \times 0.2488 + 0.5 \times 0.7701 = 0.5095 \text{ tCO}_2/\text{MWh}$$

The net electricity supplied by the proposed project activity to the FEA grid, as estimated by the EPC Nadarivatu Design Report and the Nadarivatu Consolidated Environmental Impact Assessment (EIA), is 101,000MWh per annum. Therefore, the emission reductions per year are:

$$ER_y = BE_y = EF_{grid,CM,y} \times EG_{facility,y} = 0.5095 \times 92957 = 47,361 \text{ tCO}_2$$

Emission reductions in the first crediting period of the proposed project are tabulated in section B.6.4.

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

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The project activity's estimated emission reductions in its first crediting period are 47,361 tCO₂ per annum, as presented in the following Table B. 8.

**Table B. 8. Emission reductions estimation for the first crediting period of the project activity**

Period	Estimation of the project activity emissions (tCO ₂ e)	Estimation of baseline (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of emission reductions (tCO ₂ e)
1 April 2013 – End of March 2014	0	47,361	0	47,361
1 April 2014 – End of March 2015	0	47,361	0	47,361
1 April 2015 – End of March 2016	0	47,361	0	47,361
1 April 2016 – End of March 2017	0	47,361	0	47,361
1 April 2017 – End of March 2018	0	47,361	0	47,361
1 April 2018 – End of March 2019	0	47,361	0	47,361
1 April 2019 – End of March 2020	0	47,361	0	47,361
Total Emission Reductions (tCO₂e)	0	331,527	0	331,527

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

Following approved methodology ACM0002 (Version 12.1), the parameter that is required to be monitored to establish the emission reductions is the net electricity supplied by the project activity to the Fiji Electricity Authority grid network on Viti Levu.

B.7.1 Data and parameters monitored:

B.7.1 Data and parameters monitored:	
Data / Parameter:	$EG_{facility, y}$
Data unit:	MWh/yr
Description:	Quantity of net electricity generation supplied by the project plant/unit to the Fiji Electricity Grid in year y



Source of data to be used:	On-site measurement by project participant
Value of data applied for the purpose of calculating expected emission reductions in section B.6	The quantity of net electricity supplied to the Viti Levu Grid by the proposed project is envisaged to be 101,000 MWh per annum once fully operational.
Description of measurement methods and procedures to be applied:	Quantity of net electricity generation supplied by the proposed project activity will be monitored continuously by multifunction metering modules at the substation at the Nadarivatu Hydropower plant. There will be four multifunction metering modules (two main and two back-up modules located after the transformers for each turbine) which will measure continuously and cumulatively. The data is recorded automatically according to a defined frequency at least monthly and sent to a Station Control Panel. For convenience of CER calculation and monitoring, the recording frequency will be set to at least monthly. The data is measured by kilowatt hour meter(s) at the project site. Multifunction meter modules will be suitable for accurately measuring 3-phase, 50-Hz quantities. The maximum allowable error shall not exceed $\pm 0.25\%$ of full scale at 25°C. The modules will have electrical isolation between input, output, power supply, and the case ground connection. The module will have a minimum dielectric test voltage rating of 1500-V AC rms for 1 minute. This equipment conforms with International Electrotechnical Commission (IEC) or ANSI/IEEE standards.
QA/QC procedures to be applied:	• Continuous measurement and monthly recording will take place • A second meter (backup metering system) will be installed which can be used in the event of failure of the first (main metering system). • The data from electricity sales receipts will be cross checked against meter readings taken at the project site. • All data collected as part of monitoring should be archived electronically and be kept for at least 2 years after the end of the last crediting period. • Monthly net generation data will be approved and signed off by the Project Director prior to being accepted and stored. • Testing as per manufacturer's recommendation (every year or at least once every three years) • Uncertainty level: low
Any comment:	



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 to be used:	Monitored on-site by project participant
Value of data applied for the purpose of calculating expected emission reductions in section B.6	44,000,000 W
Description of measurement methods and procedures to be applied:	The installed capacity will be checked with the name plate of the turbines installed. This will be monitored annually.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	AP_{PJ}
Data unit:	m^2
Description:	Determine the area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data to be used:	On-site measurement by project participant
Value of data applied for the purpose of calculating expected emission reductions in section B.6	90,000 m^2
Description of measurement methods and procedures to be applied:	The area of the reservoir measured in the surface of the water should be measured from topography maps from the Fiji Lands Department and some survey data of areas accessible to the catchment and the water inundated area to generate a formula for the relationship between water level and volume. This is then further translated to a corresponding Surface area and the results are tabulated and put into a graph. This will be measured annually.



QA/QC procedures to be applied:	
Any comment:	

B.7.2. Description of the monitoring plan:

>>

The Fiji Nadarivatu Hydropower Project adopts the approved consolidated monitoring methodology ACM0002 (Version 12.1) '*Consolidated monitoring methodology for grid-connected electricity generation from renewable sources*' to determine the emission reductions from the net electricity generation from the hydropower plant. The monitoring plan is outlined below.

1) Monitoring team and responsibilities

The CDM monitoring team and allocation of responsibility to ensure compliance with the monitoring requirement of the methodology will be set up and staff will be appointed to undertake the data-recording monitoring and reporting of the generation and emission reductions of the project activity. The following table (Table B. 9) and Monitoring Organisational Chart (Figure B.2) outlines the position and responsibilities of staff appointed as well as the activities that will be carried out by the staff (Table B. 10)..

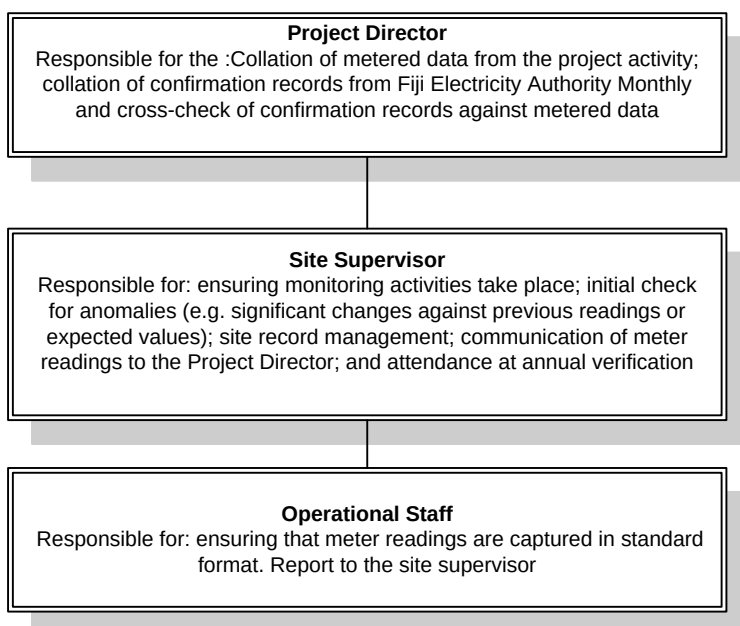
**Figure B. 2. Monitoring Organisational Chart**

**Table B. 9. Staff position and responsibilities**

Position	Responsibilities
Operational staff	Ensure meter readings are captured in standard format
Site supervisor	- Ensuring monitoring activities take place - Initial check for anomalies (e.g. significant changes against previous readings or expected values) - Site record management - Communication of meter readings to the Project Director - Attendance at annual verification
Project director	- Collation of metered data from the project activity - Collation of confirmation records from Fiji Electricity Authority - Monthly cross-check of confirmation records against metered data
CDM Consultant	Responsible (only) for external audit of the CDM monitoring procedure

Table B. 10. Task appointment

	Task Description	Operator	Supervisor	Project Director	CDM Consultant
<u>Monitoring Activity</u>					
1	Recording of monitored data	✓			
<u>Quality Assurance & Quality Control</u>					
2	Verification of data monitored (consistency and completeness)		✓		
3	Ensuring adequate training of staff		✓		
4	Ensuring adequate maintenance		✓		
	Ensuring calibration of monitoring instruments		✓		
5	Data archiving: ensuring adequate storage of data monitored (integrity and backup): 2 years after the end of the crediting period			✓	
6	Identification of non-conformance and corrective/preventive actions and monitoring plan improvement		✓		
7	Emergency procedures		✓		
8	External audit				✓
<u>Calculation of GHG emission reductions and reporting</u>					
9	Data processing and calculation of emission reductions			✓	
10	Monitoring report: management review of monitoring report (internal audit)			✓	

2) Installation of CDM Monitoring Meters

Net electricity generation of the project will be measured and monitored through the use of multifunction metering modules, recording exports to the grid and imports from the grid before the substation at the Nadarivatu hydropower plant. Net generation supplied by the proposed project is calculated as exports minus imports. Four multifunction meter modules will be installed: 2 main meters and 2 backup meters

after the transformers at each turbine. The multifunction meter modules shall be suitable for accurately measuring 3-phase, 50-Hz quantities with a maximum allowable error that shall not exceed $\pm 0.25\%$ of full scale at 25°C. The meter modules will have electrical isolation between input, output, power supply, and the case ground connection. The modules will have a minimum dielectric test voltage rating of 1500-V AC rms for 1 minute. The main meter and backup meter will be installed at the input of the substation of the hydropower plant. The following diagram (Figure B.3) illustrates the location of the monitoring meters.

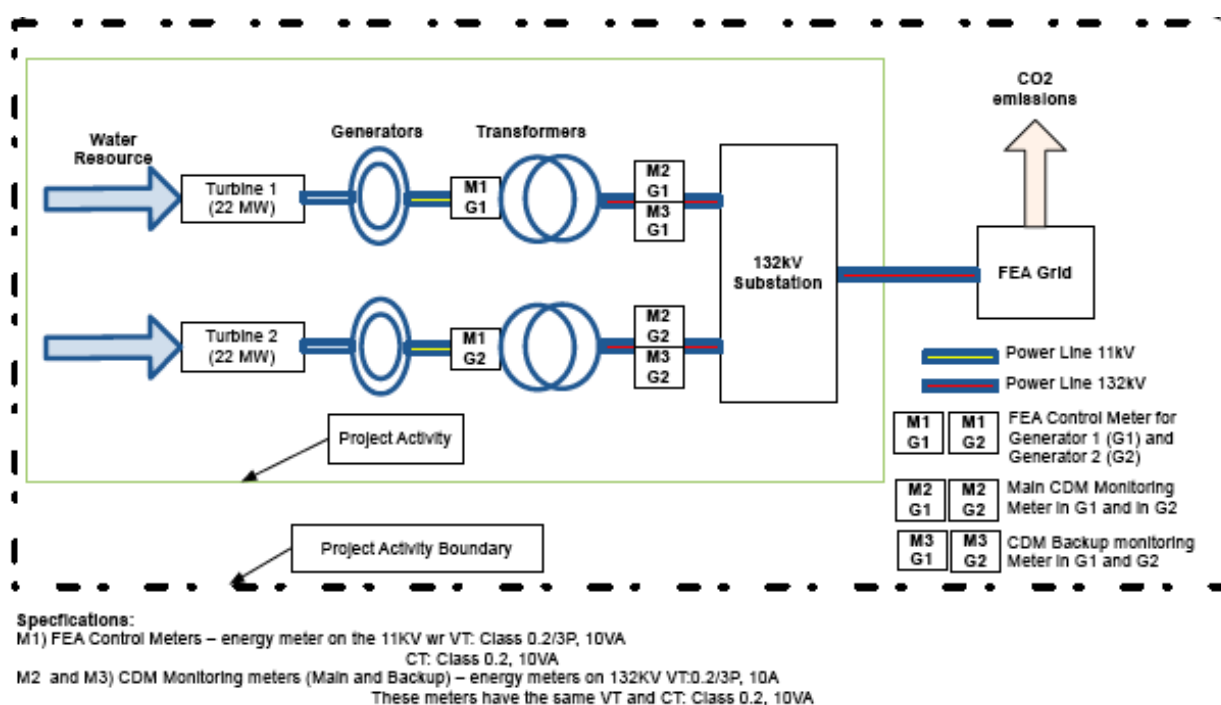


Figure B. 3. Location of the monitoring meters

3) Testing and maintenance

The meters shall be jointly inspected and sealed on behalf of the parties concerned and shall not be interfered with by either party in the absence of the other party or its accredited representatives.

Testing is carried out annually (according to manufacturers' recommendation) by qualified FEA staff with the records being supplied to Nadarivatu Hydropower Plant Director. These records will be maintained by the project owner and the FEA testing Division.

All the meters installed shall be tested by Nadarivatu Hydropower Plant within 10 days after either the detection of a difference larger than the allowable error in the readings of all meters or the repair of all or part of meter caused by the failure of one or more parts to operate in the light of applicable specifications.



In case any errors are detected, the party owning the meter shall be responsible for repairing, recalibrating or replacing the meter. The other party shall be given notice beforehand to allow them to send a representative to attend any corrective activities.

In the event that any previous month's reading of the electricity meters is inaccurate by more than the allowable error, or otherwise the reading indicates any malfunction of the meter, the net electricity supply shall be determined by:

- first, reading the backup meter, unless a test by either party reveals it is inaccurate;
- if the backup system is not within acceptable limits of accuracy or is performing improperly, the project owner and the Nadarivatu Hydropower Director shall jointly prepare an estimate of the correct reading and provide sufficient evidence that this estimation is reasonable and conservative when DOE undertakes verification

The starting time and the ending time of the malfunction period should be recorded carefully and the report needs to be archived and provided to DOE for verification.

4) Monitored data

Net electricity generated by the proposed project will be monitored continuously by the main multifunction metering module and the backup multifunction metering module that will be installed at the hydropower plant. The data measured by the back-up multifunction metering module will be used to check the data measured at the main meter. The data is recorded automatically at a defined frequency. The recording frequency will be set to be at least monthly. The data will also be read and recorded monthly by the operator and supervisor and kept by the project director. The net generation output registered by the meters alone will suffice the purpose of billing and emission reduction verification provided that the errors in the meters are within the allowable limits.

The installed capacity of the hydro power plant after implementation of the project activity will be determined yearly based on recognized standards. This data will be recorded on an electronic and paper registry.

The area of the reservoir measured in the surface of the water will activity will be measured yearly by recurring to topographic surveys, maps and/or satellite pictures. This data will be recorded on an electronic and paper registry.

5) Quality control

Monthly net on-grid supplied electricity for the purpose of emission reduction calculations will be cross-checked against sales receipts issued by Fiji Electricity Network Authority, approved and signed off by the Project Director prior to being accepted and stored. In addition, internal auditing will be performed to assess the monitoring process and results.

6) Identification of non-conformities

A verification of inconsistencies of data recorded will be performed periodically. Any discrepancies (completeness, calculation errors, transcription errors, instrument calibration issues) will be analysed and actions will be taken to correct the problem.

7) Emergency procedure



In the event that the metering system suffers any failure, damage or unexpected problems, or if any errors in the main metering system are detected during calibration and maintenance procedures, the electricity exported will be identified as follows:

- Using the results of the backup system
- Should the backup system is not within acceptable limits of accuracy or is performing improperly, the project owner and the Nadarivatu Hydropower Director shall use the data recorded by the FEA Control Meter to jointly prepare an estimate of the correct reading and provide sufficient evidence that this estimation is reasonable and conservative when DOE undertakes verification

8) Data management

All paper-based documentation will be collated centrally and well kept by the Project Director. Monitoring results will be indexed.

All data including calibration records will be kept for two years after the end of the total crediting period of the CDM project.

9) Ensuring adequate training of Staff

To assure adequate training of staff, the following actions will take place:

- All new staff will undergo “on job training” covering the monitoring requirements;
- The monitoring plan will be made available to each staff involved in the monitoring in local language. A copy will be located at the control room at the site.
- During the training staff will be required to sign training attendance list;
- All training records shall be documented inclusive training attendance, training memo and training material, if any.
- Type of training required will be indicated from Training Need Analysis conducted yearly. The record of training and awareness should be kept for at least 2 years after the crediting period.

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

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Date of completion of the current version of baseline study and monitoring methodology: 20/09/2012.

The names of the responsible persons are:

**Ms. Claudia Raimundo, Ms. Katerina Syngellakis, Mr. José Mestre,
IT Power Ltd**

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Tel: +44 (0)1256 392700

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Email: claudia.raimundo@itpowergroup.com

The above persons and IT Power Ltd are not project participants.

**SECTION C. Duration of the project activity / crediting period****C.1. Duration of the project activity:****C.1.1. Starting date of the project activity:**

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As per guidance of the EB41 meeting report, the project activity is deemed to have started on 1st September 2008, as this is when the project proponent signed the contract for the construction of the project.

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

>>

40 years

C.2. Choice of the crediting period and related information:**C.2.1. Renewable crediting period:****C.2.1.1. Starting date of the first crediting period:**

>>

01/04/2013, or registration date, whichever is later.

C.2.1.2. Length of the first crediting period:

>>

7 years, 0 months

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

>>

C.2.2.2. Length:

>>

SECTION D. Environmental impacts

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D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

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Different effects on the environment could occur during construction and operation phases of the project. Construction related effects are primarily erosion, and sediment and other contaminant-laden discharges to the water ways, affecting water quality. During operation, the primary effects are around the changes in the flow regime in the Ba and Sigatoka Rivers, that potentially impact on river habitat, sediment



transport, water quality and riparian groundwater levels. These effects were identified in the Environmental Impact Report (EIA) carried out for this project.

With this project:

- The reservoir will inundate the river channel margins only, where invasive weed species are most prevalent due to the scouring effects of flood waters. There will be no inundation of mature forest.
- There will be no inundation of houses, settlements, farms or other productive land uses. There is no requirement to relocate families or communities.
- The reservoir will inundate the river channel margins only, where invasive weed species are most prevalent due to the scouring effects of flood waters. There will be no inundation of mature forest.
- The five land owning units (Mataqali) have meaningfully engaged in the land lease process and were at the time in which the EIA was conducted in the final stages of signing a permanent lease to allow FEA access to construct and operate the scheme.
- The habitats of the giant honeyeater, masked shining parrot and Samoan flying fox will not be affected by construction or inundation.
- Discharges of sediment will affect water quality and stream bed habitat immediately downstream of the Ba and Sigatoka Rivers during construction. This will be for the duration of the construction period, and may result in sedimentation but will not have long term effects.
- The diversion of water from the Qaliwana and Nukunuku Creeks will create uniformly low river flows downstream in the Sigatoka River. This will affect river flow for at least 12 kilometres, until further flow from other catchments reduces the impact.
- Changes to ecosystems and fish populations will be experienced immediately downstream in the Sigatoka River as a result of the low flow periods. This includes more sedimentation and more algae growths, and potentially less fish.
- Pulses of water from the power station may affect fording and other river uses downstream in the Ba River. This is minor given that there is low population for several kilometres downstream and low river use.
- Changes to erosion and deposition patterns are also expected in the Ba River, but to a minor extent given that the river bed is mainly boulders and bedrock for several kilometres.
- Disturbance to traditional village life, and in particular to Buyubuya Village, during construction as a result of the works and influx of workers to the district

Table D. 1 summarises the expected impacts for the construction and operation phases of the project:

Table D. 1. Expected impacts from the construction and operation phases of the Nadarivatu Hydropower Scheme (outlined and summarised in the Nadarivatu Hydropower Scheme Consolidated EIA)

<i>Expected Impacts in the Construction Phase</i>	<i>Expected Impacts in the Operation Phase</i>
The EIA identified the following key environmental effects that could result of the construction phase of the project (namely construction of the weir, tunnel and power house):	vi. Daily variations in river flow for downstream users in the Ba River (up to 15m ³ /s increase in discharge during generation);
i. Runoff of suspended solids and other	vii. Changes in flow conditions in the Ba River

pollutants in to the Ba Rive and Sigatoka River resulting from earthworks, working in the river bed, concrete batching and tunnel dewatering; ii. Noise and vibration effects from construction, excavation/blasting on local populations; iii. Traffic impacts, dust and general nuisances on local population resulting from general construction activities; iv. Spills and pollution arising from the transport and storage of fuels and chemicals and vehicle/plant refuelling; v. Impacts on village life from an influx of resident workers	viii. affecting sediment movement and instream ecology; Changes in median and low flow river conditions on the Sigatoka River, affecting instream ecology and sediment movement.
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Mitigation and Abatement measures proposed

The EIA of this project proposes the following mitigation and abatement measure summarised in Table D. 2.

Table D. 2. Proposed Mitigation and Abatement Measures (outlined and summarised in the Nadarivatu Hydropower Scheme Consolidated EIA)

Proposed Mitigation and Abatement Measures	Short Description of the measures
A comprehensive Environmental Management Plan is proposed as a tool for ongoing control and review of mitigation measures, this forms Section 10 of the Nadarivatu Environmental Impact Assessment report and is described in detail in Annex F of the same report.	A comprehensive Environmental Management Plan (EMP) has been proposed to control activities associated with the project, which could have adverse effects. The EMP sets out the environmental and social principles to be applied to the project, based on the impact assessment carried out the EIA and the proposed mitigation measures. The plan is designed to cover the construction and operational impacts. The EMP encompasses: <u>1) Construction and Workers Camp Management Plan, that contains:</u> • Construction Management Plan: This plan will control the adverse impacts associated with erosion and sediment discharges from all earthworks activities. • Camp Management Plan: This plan will outline the operational controls on various aspects of the project including traffic management, noise and vibration management and operation of the workers camps. • Social Management Plan: This plan will address on-site and off-site social issues especially regarding health and social issues arising



Proposed Mitigation and Abatement Measures	Short Description of the measures
	from the influx of workers and camp followers. 2) <u>Environmental Supervision during Construction</u> Supervision of compliance with the EMP by contractors will be the responsibility of the Supervision Engineer. The Environmental Unit in FEA will have oversee the performance of the Supervision Engineer, review supervision reports on environment and make recommendations as needed during the construction process. The Environmental Unit will provide the necessary information and reports to DoE. Regardless of the above scheme, DoE will carry out its own monitoring and inspection of the project. 3) <u>Socioeconomic Management Plan:</u> This plan identified all necessary activities, institutional arrangements and budget to maximise benefits for the local communities, including: • Communication and Environmental Education and Awareness Programme (responsibility of the Supervising Engineer) • Infrastructure programme for local communities, including rural electrification (FEA) • Health programme (Contractor) • Traffic safety and regulations (Contractor) • Grievance mechanism (FEA) 4) <u>Environmental Monitoring Plan</u> Detailed water quality, ecology and hydrological monitoring programs are included in the EMP to assess the impacts on water quality and ecology from construction and operation. It covers: • Water quality, fish and instream habitat monitoring during construction; • Water quality, fish and instream habitat monitoring during operation. • Flow monitoring in the Sigatoka and Ba Rivers. • Cross-section surveys of the Ba River. Monitoring locations are based on baseline monitoring sites. Environmental monitoring during construction will be implemented by the Supervision Engineer. During operation, FEA will carry out the monitoring plan. 5) <u>Ecological Flows and Management of Water Releases</u> During operation the EMP shall provide for control of catchments hydrology and sediment management at the weir and discharges from the weir and power station. The EMP includes the recommendations in the EIA to mitigate environmental impacts and comply with the conditions of Environmental Approvals.
Pro-active community liaison and management	Social impacts should be mitigated through ongoing communications with the villagers, including:



Proposed Mitigation and Abatement Measures	Short Description of the measures
of potential social impacts.	• Feedback to the community regarding the issues and concerns raised. • Developing village protocol that could serve as a guideline for outside workers. • Education and orientation of outside workers to Fijian culture and social norms before the start of work. • Awareness and education of hazards and nuisances (such as noise and dust) during construction. • Awareness and education of villagers regarding the operational regime and the consequential changes in the Ba River. • Timing and location of noisy or dusty construction methods to be sensitive to village life. Work to be carried out in daylight, in typical working hours. Concrete batching plants and other noisy equipment to be located as far as practical from villages.
Optimised scheme design.	The following proposed design features reduce or mitigate potential impacts on the environment: • Minimising the amount of inundation levels in the Qaliwana and Nukunuku Creeks, while maximising potential power generation. This was achieved by optimising the location of the weir and the weir height, and removing the 60m high dam from the original scheme. • Avoiding the inundation of settlements, dwellings and productive agricultural or industrial land. • Avoiding the inundation of archaeological sites along the Nukunuku Creek, by removing the weir at the Nukunuku Creek near Lewa, from the original scheme. • Pools formed at the base of the weir can be used for fish capture and transfer methods to be used in future if necessary.
Management of workers and work camp effects.	The following mitigation is proposed to control the adverse issues arising from the operation of the workers camps: • The take of water from streams for water supplies should leave residual flows in the watercourses. • Any water supply sources in the Ba catchment should be located so that it does not adversely affect the Buyabuya village supply. • Sewerage disposal methods should be designed to the standards outlined in the Australia / New Zealand Standard for the Management of on Site Sewage Systems AS/NZ1547: 2000. • All solid wastes shall be removed from site and disposed of at a municipal landfill. • Water takes should leave a residual flow in the creek. • Abstraction should be to holding tanks to buffer peak demands.
Hydrological controls on the scheme during	The proposed Nadarivatu scheme construction and operation shall consider the following provisions for control of catchment hydrology, and any



Proposed Mitigation and Abatement Measures	Short Description of the measures
construction and operation.	requirements for compliance of proposed minimum flows and discharges to natural water: <i>Sigatoka Catchment</i> • During weir construction there shall be suitable by-pass of Qaliwana and Nukunuku Creek flow i.e. the natural flow regime should be unaffected by the construction of the weir. • Post weir construction and during initial filling of the weir, suitable provision via sluice gates shall enable a minimum of 200 L/s flow continuation to the Sigatoka River below the weir, at catchment input flows of 200 L/s and above. • The sluice gates shall be in operation over the full range of weir storage, and shall provide 200 L/s to the river as a continuous residual flow when applicable. • Monitoring of catchment input flow to the weir, and residual flow released, shall be provided by continuous measurement / recording. Residual flows released shall be reduced in conjunction with monitored input flow to the weir. • Provision is to be made for suitable release of flood flows down the river. • The take of water from the weir for scheme operation shall be up to 15000 L/s. <i>Ba Catchment</i> The effective operation of the Ba Power Station discharge to the Ba River shall include the following provisions: • The discharge of water to the Ba River for scheme operation shall be up to 15000 L/s. • Flow from the Ba Power Station to the Ba River shall be ramped up and down at a rate no greater than 1000 L/s flow per minute, to avoid unnecessary sediment transport during median to mean flows, and to avoid sudden loss of habitat from stream flow reduction. • Appropriate early warning system in place at Ba Power house to warn of impending hydropower discharges to the Ba River. • Sediment concentrations from the Ba power station should remain below 17mg/L for Ba River flows at / or below the natural mean (estimated at 2822 L/s). Flow monitoring prior to, during and after power scheme construction should provide for compliance and operational requirements. Several survey cross-section on the Ba and Sigatoka Rivers are to be completed.
Erosion and sediment	Erosion and sediment discharges will be managed through the Construction



Proposed Mitigation and Abatement Measures	Short Description of the measures
control measures.	Environmental Management Plan. Key mitigation measures are: • Phasing of work, a key erosion control and earthworks principle, to reduce the amount of area that is disturbed at any one time should be undertaken. The potential effects from erosion and sedimentation should therefore be restricted to the areas exposed. • There should be no earthworks in the bed of watercourses other than that required for the weir and intake construction and the construction of the power station. Culverts should be placed in the initial stages of the development to minimise vehicle movements through watercourses during the earthworks. All earthworks in or adjacent to watercourses should utilise sediment and erosion control measures as prescribed in the Construction Environmental Management Plan of the EMP. Emphasis should be placed on reducing flow velocities and retaining sediment on site, particularly at locations where the surface water discharges to the drainage network and on steeper slopes.

Since the EIA was carried out in 2007 and 2008, the design of the project has not changed and neither has the Fiji National Environmental legislation with which the proposed activity is compliant. Along with the above mitigation measures, the project owner also commits to achieve with the EMP the environmental and management standards set out by the Department of Environment of the Fiji Government (Environmental Management Act 2005) and Health and Safety at Work standard enacted by the Parliament of Fiji (Health and Safety at Work Act, 1996).

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

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The Environmental Impact Assessment Report (EIA) was found to be satisfactory and was approved by the Ministry of Local Government, Urban Development, Housing and Environment, Department of Environment on the 22nd October 2008. The Environmental Management Plan outlined in the EIA was also approved on the same date subjected to some conditions outlined in the letter of approval.

The Environmental Management Plan was subsequently revised to include and specify the Department of Environment (DOE) conditions including the preparation and implementation of a Construction Workers & Camp Management Plan (CWCMP). A Road Safety Audit was also conducted and submitted to the Tavua Local Authority.

**SECTION E. Stakeholders' comments**

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

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FEA are committed to consulting with land owners throughout construction and operation. Stakeholders' consultations were undertaken from the beginning of the project, starting in 2005. Consultations covered the communities affected by the project, as well as the relevant government agencies and local authorities. There have been three distinctive consultation strategies with the hydropower project:

- Government Land Acquisition Task Force meetings – FEA Lands Department, Native Land Trust Board, CEO's of government ministries and representatives from the villages and settlements. The Task Force was set up to negotiate access to land, land leases, compensation and to discuss other needs and issues of the locals and FEA.
- Interviews, participant observation, village meetings and other techniques by a social scientist as part of the Social Impact Assessment study during the initial EIA study in 2004.
- Stakeholder group meetings – sharing the draft EIA with staff from government agencies.

Some specific examples of consultation meetings with local stakeholders include:

- 1) Consultation meetings with ten communities on the Nadrau Plateau between the 18th and 26th January 2005. These communities included men and women in Nadala, Navai and Nadrau villages who had worked on the Monasavu Project. They were asked to share their experiences during discussion recounting both the positive and negative impacts of Monasavu. They also suggested measures that could be taken to avoid or mitigate the negative social impacts of the proposed FEA project.
- 2) Consultation with civil servants at the Nadarivatu Government Station on 25th January 2005, including the Assistant District Officer, Agriculture Officer and Forestry Officer and the Sister at the Health Centre.
- 3) A stakeholders' group meeting carried out on 6 September 2006 and attended by representatives of the government agencies. Some time was taken to discuss the hydrological effects of the scheme, using flow duration curves, and discussion centred around the downstream water availability and sediment movement effects in both the Sigatoka and Ba Rivers.
- 4) A stakeholders' group meeting carried out on 7th May 2010, covering the progress on the project and specifically explaining the CDM process. The meeting was advertised in two national newspapers two weeks in advance and was open for any interested members of the public to attend. The meeting was attended by representatives of government agencies, the Native Land Trust Board (NLTB), landowners and village representatives. A questionnaire was distributed during this workshop to obtain the opinion of the participants on the Nadarivatu project. The meeting also had a question and answer session and invited open discussion on the project.

E.2. Summary of the comments received:

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During the 2005 consultations, the following comments were received:

Experience from the working Conditions at Monasavu

- Boarding arrangements were made at the camp. Food was of good quality and liquor was freely available at the camp site. There was a lot of drinking, dancing and partying during the



weekends. The security arrangement at the camp was lax; outsiders could easily move in and out of camp without being questioned. This brought a lot of undesirable elements to the camp site, especially during drinking, dancing and partying.

- The workers were paid weekly. In some cases, the family rarely saw the first week wage since workers returned home after second week. First week's wage was used up on merry making. The family got the benefit of the wage paid during the second week.
- At the decommissioning of Monasavu Camps, all sleeping and bedding gears were burnt without any consideration to the workers or those who had used the gears. They should have been given away to the workers or people who were using them while camping.
- The housing structures were sold (auctioned) without any consideration to the landowners. They could have been converted to some useful social amenity.
- When the Monasavu camp was decommissioned the entire place was left in a mess. The entire campsite was strewn and speckled with rubbish, used spare parts, spent oil and grease, broken machinery, discarded bedding gear, timber pieces, etc. The villagers would like to see that the camp site is properly decommissioned, rehabilitated, and left spick-and-span.

Experience of social problems during Monasavu construction

Partly because of the living and working conditions described above, Monasavu faced a number of social problems. These problems, among others, included family estrangement, divorce, unwanted and teenage pregnancies, abortions, drunkenness, drinking brawls, accidents, long absences from home (some workers did not return home even after the fortnight break), and in some cases the family did not get the benefit of the first week's wages. Traffic Hazard at Monasavu: A number of serious accidents took place at Monasavu. This was attributed to drinks, overworking, over-speeding, road conditions, and lack of awareness.

Positive Aspects of Monasavu

- Monasavu had better working conditions than Vaturu in terms of food, residence, transportation, uniforms, safety gears, OHS compliance, etc.
- The Monasavu Employment brought cash to the villages. The cash flow improved for many the standard of living, though not for all. The improvement in the standard of living was reflected in improved housing, household goods and appliances, tools and implements, education, sanitation and hygiene, etc.
- There was also opportunity to learn and improve one's skills. The community was enriched by skill transfer and by training on the job. It helped many people to remain on the farm and improve their farm conditions.

Lessons Learned: Mitigative measures suggested for the Nadarivatu project

1. There should be no camp for local residents i.e. those who reside in the project area should daily travel to and from work.
2. Women to work only from 8.00 am to 4.00 pm. There should be no women in the camp area after four (like what was done during Vaturu dam construction.).
3. The camp sites should be well fenced for security reasons; strict security arrangement should be put in place. Individual workers should always wear ID cards; no outsiders should be allowed at the camp (Vatukoula's case was cited as an example of tight security arrangement).
4. Use of liquor should be regulated. Provisions of Liquor Act should be enforced. Drinking should be allowed only at the camp; no drinking in the villages at any time and under no circumstances.



5. Encourage rural banking- make the recently launched ANZ Rural Banking Facility available on payment days close to the disbursement site. If the employees agree, certain percentage of wages/salary could be directly banked by the employer.
6. Camp sites should be located away from the villages.
7. All OHS precautions to be enforced at the work place.
8. Workers especially from outside should be educated and made aware of village protocol, the easy going pastoral life of the residents in the project area, and the groups that are vulnerable to accidents and mishaps.
9. Before the project starts there should be community awareness program to make people aware of the positive and negative impacts and consequences of the proposed project.

All of these comments were taken into account for the civil and power construction contracts and the Environmental Management Plan. In particular, the measures suggested for workers camp and working conditions were integrated into the Nadarivatu project workers conditions and workers camp management plan.

At the 2006 stakeholder meeting the following discussions / comments were conducted / received:

- 1) Discussed that growers require water in the Sigatoka Valley for vegetable and fruit growing. Concerned that there would be less water in the river for them. At median flow it is approximately 7% change at the Sigatoka River mouth. Riparian groundwater levels will have a minor impact. Overall SKM's assessment is that downstream impacts in the valley will be minor; although upstream in the headwaters it will be noticeable. There were no records available regarding who is using water, how much water and where this water is from, therefore it is difficult to assess actual impacts.
- 2) Discussed monitoring requirements, such as cross sectional surveys of the river to more accurately predict changes in river depth / flow. Navigation in the river is already being affected by sedimentation. Will this scheme make it worse? SKM discussed that sediment movement was looked at in the EIA studies based on changes in river flows and flushing events, and that the impacts appear minor, although no data on sediment has been gathered. Will make sure this is assessed in the final document. Contribution / impacts from the scheme may be minor or unmeasurable against all of the other impacts on sedimentation / sediment movement in the catchment.
- 3) Concerns were raised about the effect of more flow in the Ba River. Discussed the predicted changes in flow in the Ba River, and mentioned that they will be similar to the existing scheme. Approximately 9% increase in median flow. Ministry of Agriculture is responsible for, and pays for, dredging of Ba and Sigatoka River mouths – will SEL pay for any increased dredging requirements? Discussed that SKM does not have any data on current sediment movements in the Ba. Discussed it would be difficult to isolate the hydropower scheme's influence compared to other instream and land uses. Discussed monitoring that could assist to measure the impacts from the scheme, including sediment movements and surveys of river beds to more accurately determine changes to downstream flow / depth.

At the 2010 stakeholder meeting, a questionnaire was distributed to obtain the opinion of the participants on the Nadarivatu Hydropower Project. The questions asked and answers received were as follows:



Question 1 - Are you aware that the demand for electricity in Fiji is growing by 6% every year?

YES	10
NO	2

Question 2 - Are you aware of the fact that the FEA Grid has many diesel power plants that generate a large amount of pollutants?

YES	11
NO	1

Question 3 - Are you aware of any FEA renewable energy projects for generating electricity?

YES	11
NO	1

The participants answering YES to Question 3, identified the following FEA renewable energy projects:

RE Project	No. of people
Butoni Wind Farm	6
Cogeneration project at FSC	1
Wainikasau Hydro	3
Monosavu hydro	7

Question 4 - Do you think the construction of this project will have adverse impacts on the ambient environment (air, noise, water)?

YES	6
NO	6

Comments received from the stakeholders who replied YES to Question 4 were:

- Particularly the diversion of the course of the river
- Tunnelling and excavations
- Only at the beginning stages through construction, when modifications to the land and river will be made.
- Noise generation may affect nearby inhabitants as well as marine life
- For any new project development there is bound to be adverse environmental impacts, thus monitoring is important to ensure compliance to EMP parameters
- There will be some environmental impacts that may need to be managed (e.g. Birdlife, fish, impact on soil erosion)
- Water pollution, noise and change in lifestyle

Question 5 - Do you agree that the proposed project will contribute to the construction of a "green energy" source in the local area and thus help reduce the emissions of CO₂, etc?

YES	12
NO	0



Question 6 - Do you think the construction of this project will create any negative impacts on you and your family?

YES	0
NO	12

Question 7 - Do you think the construction of this project will create any positive impacts on you and your family?

YES	11
NO	1

The participants answering YES to Question 7, identified the following positive impacts:

Positive impact	No of people
Reduce the level of CO2 emitted into the atmosphere	4
Reduce the amount of diesel imported from overseas countries	1
Electricity bill will fall	1
Less role of diesel	2
Reduction in fuel costs will lead to reduction in electricity costs	1
Electricity / power for households hence meet educational / personal / family needs	1
Employment opportunities and spin-offs	3
Aid in combating / reducing global warming and provide a safer living environment	1
In terms of the future generation, they will be safe indirectly by the lesser impact of climate change e.g. rise of sea level	1
Landowners will also share the benefit	1
Clean Environment	1
Less power cuts	1
Improvement to infrastructure	1
The realisation that domestic power is sources from RE, thus this could be a catalyst/methodology for environmental awareness within the family	1
We will have a constant power supply since the demand is growing every year	1

Question 8 - What are your main concerns during the construction and operation of the Nadarivatu Hydropower project?

1 = no concern

5 = very great concern

Level of concern	1	2	3	4	5
Concern	No of people				



Noise	5	2	3	1	1
Air pollution	8	1	1	0	2
Equipment Safety	5	4	3	0	0
Wastewater discharge / pollution of rivers	4	2	2	2	2
Electromagnetic interference	5	3	1	1	1
Views of the landscape	3	2	3	1	3
Traffic / road safety	5	3	2	0	1
Children's safety	6	3	0	1	1

Question 9 - Do you support the Nadarivatu Hydropower project and what is the reason for your answer?

YES	12
NO	0
UNDECIDED	0

Reasons given:

- It will provide a new source of electricity for Fiji and this is needed for the country's development
- It will save diesel and reduce the amount of diesel that has to be imported into Fiji
- It is a renewable energy project and so is good for the environment because it reduces CO2 emissions
- It is a renewable energy project and promotes sustainable development for Fiji
- Through the CDM Project, landowners will benefit through a new revenue stream created by the land lease agreement
- It is a good approach towards the reduction of greenhouse gases by a small country
- Safer for the country (Fiji)
- Increases savings for FEA and the country (Fiji)
- It will reduce social problems

As can be seen from the results of the questionnaire, all the stakeholders consulted support the development of the Nadarivatu Hydropower project.

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

>>

Due account was taken of the comments in the following manner:

- 1) The recommendations on working conditions, hours, campsite location, health and safety and community awareness were all taken into account in the Environmental Management Plan (EMP) and particularly the Camp Workers and Camp Management Plan and other appendices of the EMP.
- 2) Navigation in the river being affected by increased sedimentation. The final EIA assessed this possibility and concluded that the effects appear to be minor. It is also difficult to assess the



contribution / impacts from the scheme against all of the other impacts on sedimentation and sediment movement in the catchment.

- 3) Concerns for air and river pollution, impacts on flora and fauna, traffic/road safety, visual impacts on landscape, children's safety and equipment safety are all taken into account in the EMP and the associated appendices. A road audit was also specifically undertaken.

Overall the comments received on the project were positive and the recommendations from stakeholders' previous experience of the Monasavu Hydropower scheme provided valuable input into the design of the Nadarivatu Project. The stakeholders have now all indicated that they support the construction of the hydropower station.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding from Annex I Parties involved in the proposed project activity.

**Annex 3****BASELINE INFORMATION*****1) Baseline information provided from FEA from 2007-2009*****Thermal Power Plants: data supplied by FEA (2007-2009)**

Plant	Technology	Installed Capacity (MW)	Electricity Generated (MWh)			Fuel Type	Fuel Consumption (l)			Year Plant Online
			2007	2008	2009		2007	2008	2009	
Kinoya 1	Internal Combustion	28	104760	59666	85929	Diesel	25139905	14995457	21243564	2001
Kinoya 2	Internal Combustion	20	30534	96923	113918	HFO	6639212	21516870	24103656	2007
Vuda	Internal Combustion	22.4	63729	52464	53818	Diesel	15940489	13059021	13379843	76 to 2001
Nadi	Internal Combustion	2	41	336	106	Diesel	1865	100295	85684	68 to 2009
Sigatoka	Internal Combustion	4	8314	7626	8016	Diesel	2299300	2109218	2145350	2003
Deuba	Internal Combustion	4.2	1041	2346	2195	Diesel	289344	767526	603274	2007
Rakiraki	Internal Combustion	2	4438	3498	2239	Diesel	1274700	1053600	660500	2008
Korovou	Internal Combustion	0.87	283	173	33	Diesel	97592	63481	10711	2007
Rokobili	Internal Combustion	8	723	341	0	Diesel	198490	85240	0	2003
Monasavu	Internal Combustion	0	0	0	0	Diesel	0	0	0	2003



Plant	Technology	Installed Capacity (MW)	Electricity Generated (MWh)			Fuel Type	Fuel Consumption (l)			Year Plant Online
			2007	2008	2009		2007	2008	2009	
Vatuwaqa	Internal Combustion	0	0	0	0	Diesel	0	0	0	2003
Total		91.47	213863	223373	266254		51880897	53750709	62232582	

Renewable Power Plants: data supplied by FEA (2007-2009)

Plant	Technology	Installed Capacity (MW)	Electricity Generated (MWh)			Fuel Type	Fuel Consumption (tons)			Year Plant Online
			2007	2008	2009		2007	2008	2009	
Wailoa	Hydro	80	481098	462986	436081	Water				1983
Wainikasu & Nagado	Hydro	9.2	26001	31416	24048	Water				2004 & 2006
Buttoni	Wind	10	3351	4604	7210	Wind				2007
FSC Lautoka	Biomass	6	8720	11549	7068	Sugarcane fibre	84624	89703	87011	2007
Total		114.2	519170	510555	474406					

Total Installed capacity and energy generation: data supplied by FEA (2007-2009)

	Installed Capacity (MW)	Electricity generated (MWh)		
		2007	2008	2009
Thermal Power Plants	91.47	213863	223373	266254
RE Power Plants	114.2	519170	510555	474406
Total	205.67	733033	733928	740660

**2) Calculation of the Operation Margin Emission Factor for the Fiji Electricity Authority grid:**

$$EF_{OM}$$

2007

Power Plants (m)	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10 ⁻⁹
Kinoya 1	25139905	41.4	72600	0.83	20,866,121	62716.05
Kinoya	6639212	41.4	72600	0.83	5,510,546	16562.72
Vuda	15940489	41.4	72600	0.83	13,230,606	39766.44
Nadi	1865	41.4	72600	0.83	1,548	4.65
Sigatoka	2299300	41.4	72600	0.83	1,908,419	5736.02
Deuba	289344	41.4	72600	0.83	240,156	721.82
Rakiraki	1274700	41.4	72600	0.83	1,058,001	3179.97
Korovou	97592	41.4	72600	0.83	81,001	243.46
Rokobili	198490	41.4	72600	0.83	164,747	495.17
Monasavu	0	41.4	72600	0.83	0	0.00
Vatuwaqa	0	41.4	72600	0.83	0	0.00
Wailoa	0	0	0		0	0.00
Wainikasu & Nagado	0	0	0		0	0.00
Buttoni	0	0	0		0	0.00
FSC Lautoka (kg)	84624	5.9 ³	84700	1000	84,624,000	42289.15
Total						171715.45

Source:

¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”

2008

Power Plants (m)	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10 ⁻⁹
Kinoya	14995457	41.4	72600	0.83	12,446,229	37408.885



Power Plants (m)	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
Kinoya	21516870	41.4	72600	0.83	17,859,002	53677.732
Vuda	13059021	41.4	72600	0.83	10,838,987	32578.094
Nadi	100295	41.4	72600	0.83	83,245	250.20405
Sigatoka	2109218	41.4	72600	0.83	1,750,651	5261.8265
Deuba	767526	41.4	72600	0.83	637,047	1914.7327
Rakiraki	1053600	41.4	72600	0.83	874,488	2628.3961
Korovou	63481	41.4	72600	0.83	52,689	158.36486
Rokobili	85240	41.4	72600	0.83	70,749	212.64663
Monasavu	0	41.4	72600	0.83	0	0
Vatuwaqa	0	41.4	72600	0.83	0	0
Hydro – Wailoa	0	0	72600		0	0
Hydro - Wainikasou & Nagado)	0	0	72600		0	0
Buttoni	0	0	72600		0	0
FSC Lautoka (kg)	89703	5.9 ³	84700	1000	89,703,000	44827.28
Total						178918.16

Source:

¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”

2009

Power Plants (m)	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10⁻⁹
Kinoya	21243564	41.4	72600	0.83	17632158.1	52995.92
Kinoya	24103656	41.4	72600	0.83	20006034.4	60130.94
Vuda	13379843	41.4	72600	0.83	11105269.6	33378.44
Nadi	85684	41.4	72600	0.83	71117.72	213.75
Sigatoka	2145350	41.4	72600	0.83	1780640.5	5351.96
Deuba	603274	41.4	72600	0.83	500717.42	1504.98
Rakiraki	660500	41.4	72600	0.83	548215	1647.74



Power Plants (m)	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
Korovou	10711	41.4	72600	0.83	8890.13	26.72
Rokobili	0	41.4	72600	0.83	0	0.00
Monasavu	0	41.4	72600	0.83	0	0.00
Vatuwaqa	0	41.4	72600	0.83	0	0.00
Hydro – Wailoa	0	0	0		0	0.00
Hydro - Wainikasou & Nagado)	0	0	0		0	0.00
Buttoni	0	0	0		0	0.00
FSC Lautoka (kg)	87011	5.9 ³	84700	1000	87011000	43482.01
Total						198732.46

Source:

¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”

OM

	2007	2008	2009
Total OM (tCO ₂ /y)	0.2343	0.2438	0.2683
Total Net generation (MWh/y)	733033	733928	740660
Average OM (tCO₂/MWh)	0.2488		

**3) Calculation of the Build Margin Emission Factor for the Fiji Electricity Authority grid: EF_{BM}** **2007**

Power Plants (m) ⁴	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10 ⁻⁹
Kinoya 1	25139905	41.4	72600	0.83	20866121.18	62716.05
Sigatoka	2299300	41.4	72600	0.83	1908419	5736.02
Rokobili	198490	41.4	72600	0.83	164746.7	495.17
Monasavu	0	41.4	72600	0.83	0	0.00
Vatuwaqa	0	41.4	72600	0.83	0	0.00
Korovou	97592	41.4	72600	0.83	81001.36	243.46
Kinoya 2	6639212	41.4	72600	0.83	5510545.57	16562.72
Deuba	289344	41.4	72600	0.83	240155.52	721.82
Buttoni	0	0	0	0	0	0.00
FSC Lautoka	84624	5.9 ³	84700	1000	84624000	42289.15
Rakiraki	1274700	41.4	72600	0.83	1058001	3179.97
Total						131944.36

Source:¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”⁴ Plants correspondent to 20% of generation capacity built most recently**2008**

Power Plants (m) ⁴	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10 ⁻⁹
Kinoya 1	14995457	41.4	72600	0.83	12446229.45	37408.89
Sigatoka	2109218	41.4	72600	0.83	1750650.94	5261.83
Rokobili	85240	41.4	72600	0.83	70749.2	212.65
Monasavu	0	41.4	72600	0.83	0	0.00
Vatuwaqa	0	41.4	72600	0.83	0	0.00
Korovou	63481	41.4	72600	0.83	52689.23	158.36
Kinoya 2	21516870	41.4	72600	0.83	17859002.43	53677.73
Deuba	767526	41.4	72600	0.83	637046.58	1914.73
Buttoni	0	0	0	0	0	0.00



Power Plants (m) ⁴	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
FSC Lautoka	89703	5.9 ³	84700	1000	89703000	44827.28
Rakiraki	1053600	41.4	72600	0.83	874488	2628.40
Total						146089.86

Source:

¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”

⁴ Plants correspondent to 20% of generation capacity built most recently

2009

Power Plants (m) ⁴	Fuel Consumption (l)	NCV (TJ/Gg) ¹	CO ₂ emission factor of the fossil fuel type (kgCO ₂ /TJ) ²	Density (kg/l)	Fuel used (kg)	Carbon emission (tCO ₂)
	A	B	C	D	E=A*D	F=(B*C*E)*10⁻⁹
Kinoya 1	21243564	41.4	72600	0.83	17632158.12	52995.92
Sigatoka	2145350	41.4	72600	0.83	1780640.5	5351.96
Rokobili	0	41.4	72600	0.83	0	0.00
Monasavu	0	41.4	72600	0.83	0	0.00
Vatuwaqa	0	41.4	72600	0.83	0	0.00
Korovou	10711	41.4	72600	0.83	8890.13	26.72
Kinoya 2	24103656	41.4	72600	0.83	20006034.48	60130.94
Deuba	603274	41.4	72600	0.83	500717.42	1504.98
Buttoni	0	0	0	0.83	0	0.00
FSC Lautoka	87011	5.9 ³	84700	1000	87011000	43482.01
Rakiraki	660500	41.4	72600	0.83	548215	1647.74
Total						165140.26

Source:

¹ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

² IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

³ IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories for “other solid biomass”

⁴ Plants correspondent to 20% of generation capacity built most recently

**BM**

	2007	2008	2009
Total BM (tCO ₂ /y)	0.8136	0.7824	0.7288
Total Net generation (MWh/y)	162164	186726	226607
BM (tCO₂/MWh)	0.7701		

4) Calculation of the Combined Margin Emission Factor for the Fiji Electricity Authority grid:

$$EF_{CM}$$

$$EF_{CM} = 0.5 \times OM + 0.5 \times BM = \underline{\underline{0.5095 \text{ tCO}_2/\text{MWh}}}$$



Annex 4

MONITORING INFORMATION

Please refer to Section B.7.2 for details of monitoring.

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