Monitoring report form for CDM programme of activities (Version 03.0)

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

MONITORING REPORT		
Title of the PoA	PoA for Promotion of the Improved Water Mills (IWM) in Nepal	
UNFCCC reference number of the PoA	9889	
Version numbers of the PoA-DD applicable to this monitoring report	10.0	
Version number of this monitoring report	03	
Completion date of this monitoring report	13/08/2020	
Monitoring period number	03	
Duration of this monitoring period	01/01/2019 to 31/12/2019	
Monitoring report number for this monitoring period	01 of 01	
Coordinating/managing entity	Alternative Energy Promotion Centre (AEPC)	
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)
	Nepal	Yes
Applied methodologies and standardized baselines	AMS-I.B. ver. 12 - Mechanical energy for the user with or without electrical energy	
Sectoral scopes	Energy industries (renewable/non-renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	**CPA-1: 7,728 tCO_2 e** **CPA-2: 3,674 tCO_2 e** **Total: 11,402 tCO_2 e**
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	**CPA-1: 11,022 tCO_2 e** **CPA-2: 11,273 tCO_2 e** **Total: 22,295 tCO_2 e**	

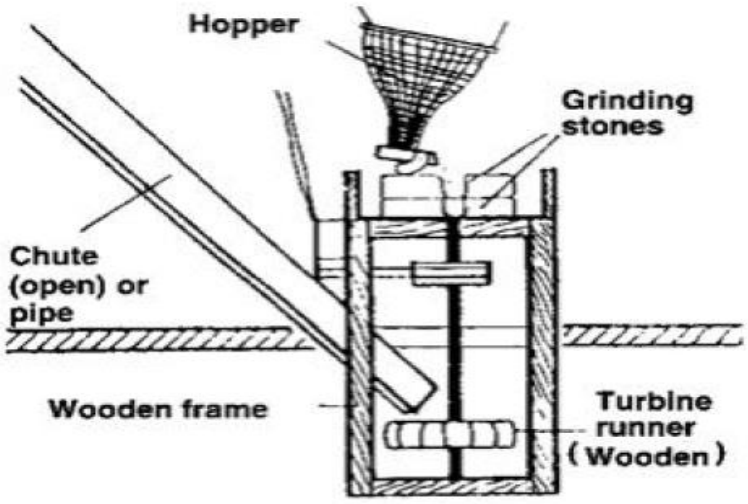
PART I Monitoring of programme of activities (PoA)

SECTION A. Description of PoA

A.1. General description of PoA

The PoA for Promotion of the Improved Water Mills (IWM) in Nepal is a program of Alternative Energy Promotion Centre (AEPC) and was registered on 9th September 2015. With financial assistance from Government of Nepal (GoN) and donor agencies, Regional Service Centres (RSCs) are assisting AEPC as a service centre to implement the IWM Programme. The main objective/goal of the IWM Project of AEPC in Nepal is to promote dissemination of IWM replacing existing low powered, less efficient Traditional Water Mills (TWMs) to the existing owners or new installers[1] (potential diesel mill owners) in Nepal and to avoid possible switchover/installation to diesel based mills by new installer (potential diesel mill owners) to meet high powered milling requirements. The project activity will contribute towards improving livelihoods of the rural households through improved access to energy services from the renewable energy based IWMs, and meeting the increasing motive power needs of off-grid rural communities of hills and mountains. The small-scale CPAs under the programme will be implemented, coordinated, managed and maintained by AEPC in Nepal. The aim of the PoA is to enhance the penetration of efficient IWMs and avoidance of diesel based mills. The IWMs with increased efficiency and cost effective services to the users will help avoid installation of diesel based mills in the hilly areas.

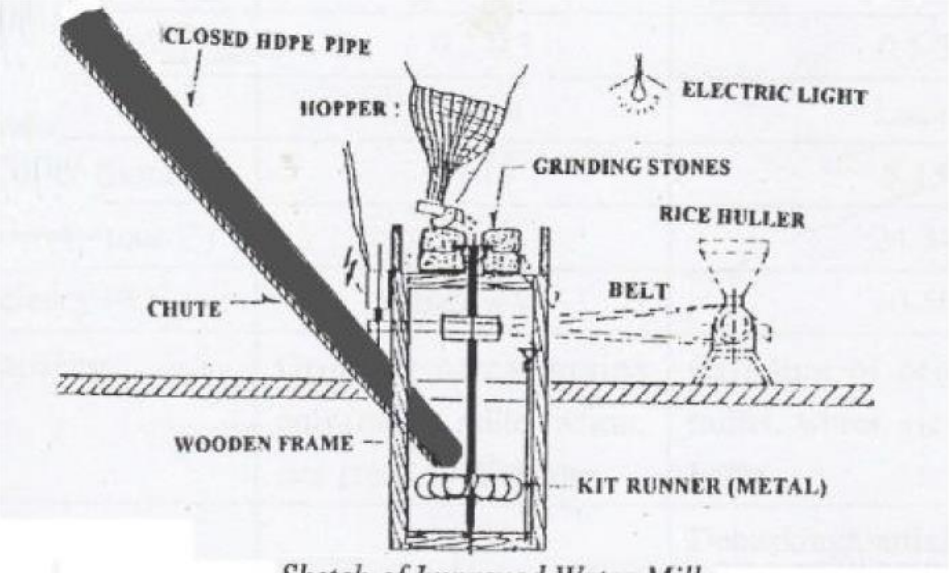
In the hilly areas of the country, TWMs or Ghattas are located on the banks of water sources with one mill typically serving 20 - 50 households. For TWM, with their low efficiency, it is hard to cope with the increasing processing needs (e.g. grinding, hulling, oil expelling, etc.) of the rural communities. As a consequence, number of diesel powered mills are growing in rural areas and increasingly taking over processing tasks as many communities still don't have access to national grid. In order to avoid possible switchover/installation of the proliferating Diesel Mills (DMs) by existing TWM owners and/or new installer in the hilly areas, where there used to be TWMs, an improved version of TWM is being promoted in Nepal. The IWM is a modified/improved version of TWM, which is more efficient. The project will support installation of IWMs (long shaft and short shaft) in various parts of Nepal replacing TWMs. IWM technology has improved performance and is more reliable compared to TWMs. Due to the increased performance, the scope of services of the mills can be widened. The technology has been tested extensively and has already proven its effectiveness by fulfilling the requirement of the rural communities. The objective of the IWM Programme is to further up-scale IWM to improve livelihoods of water mill owners and users, and strengthen capacity of institutional set up for the sustainability of IWM sector as a renewable energy solution in rural Nepal.



Traditional Water Mill

Under IWM Programme, standard low capacity TWMs of capacity 0.35 kW would be replaced by energy efficient IWMs (short shaft and long shaft) of installed capacity ranging from 1.39 kW (minimum

value, more than 97% of Short Shaft IWMs will be above this value) to 2.83 kW (on minimum value, more than 97% of Long Shaft IWMs will be above this value) SSC-CPAs will include installation of high capacity IWMs replacing traditional low powered, less efficient water mills which will avoid installation of diesel mills to meet increasing high power requirements.



Sketch of Improved Water Mill
(Grinder at the Top of the Runner while the Huller Installed Aside)

The IWM is a modified version of the TWM which translates into a higher processing capacity and possibility of providing a diverse range of services like hulling, oil expelling, saw milling, etc. Thus IWM increase energy output helping both hullers and millers. TWM is characterised by lower efficiency and inability to provide desired level of power for the end use. Hence the new installers and/or existing TWM owners are installing diesel run mills, which provide higher quantum of power with the similar size unit. The proposed IWM will do the same job of the TWM by improving the flat paddled wooden runner. The increased power output will result in faster milling and shorter waiting times for users. The metallic shaft and pulley for power takeoff allow the usage of a range of other appliances including electrification in addition to traditional grinding. These reduce the drudgery of hand processing of paddy and oil seed. In case of long shaft IWMs electrical energy could also be generated as one of the end-uses; however, the electricity and mechanical energy are not generated simultaneously. Normally, mechanical energy is used during the day time for agroprocessing and electricity is generated during evening for lighting. The turbine that generates mechanical and electrical energy is the same. During day time, the turbine is connected with the pulley that conveys power to milling unit while in the evening the pulley is connected with the generator to generate electricity. Although there is possibility for the generation of electrical energy, only mechanical energy generated by IWMs will be counted towards emission reductions.

Basic technical features of the Traditional and Improved Water Mills	
Traditional Water Mill	**Improved Water Mills**
Wooden water wheel with flat paddles	Metal runners with buckets
Wooden hub covers the wooden vertical shaft	Metal vertical shaft
Wooden open chute of uniform cross-section	6"-8" diameter, HDPE pipes (with nozzle)
Runner mounted on to a wooden frame	Runner mounted on to a wooden frame
	A pulley and belt system is introduced for power transmission (except for short shaft, for grinding)
Requires high flow of water to run TWM	Low amount of water suffices to run IWM
Grinding of cereal grains only maize, millet, wheat, rice, etc. with 10-20 kg per hour output	Grinding of cereal, 20-50 kg per hour paddy hulling, 50-70 kg per hour oil expelling, 1-3 kW electricity generation

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA # [add number]	10.0	Energy industries (renewable/non-renewable sources)	AMS-I.B. ver. 12 - Mechanical energy for the user with or without electrical energy

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Version of the PoA-DD	Title and reference number of the corresponding generic CPA	Crediting period type and duration	Covered in this monitoring report? (yes/no)
PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA 1 (9889-0001)	10.0	PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA # [9889-XXXX]	09 Sep 2015 - 08 Oct 2022 (Renewable)	Yes
PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA 2 (9889-0002)	10.0	PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA # [9889-XXXX]	1 Feb 2017 – 14 Feb 2024 (Renewable)	Yes

A.2. Coordinating/managing entity

Alternative Energy Promotion Centre

SECTION B. Implementation of PoA

B.1. Description of implemented PoA

The PoA has the start date of 05 October 2011 and two CPAs implemented under the PoA are to be verified during this monitoring period. The approved SSC baseline and monitoring methodology applied to a SSC-CPA included in the PoA is AMS.I.B, titled "**Mechanical energy for the user with or without electrical energy**", version 12.There are 2,199 IWMs installed in CPA-1. These IWMs were installed between 9 October 2011 to 13 March 2014. Untill now, there are 1138 IWMs installed in CPA-2. Those IWMs were installed between 14 March 2014 and 17 October 2015. The detail of each CPA is given in the following tables:

Table 1: Detail of CPA-1 under PoA for Promotion of the Improved Water Mills (IWM) in Nepal.

Name of District	No of IWMs installed			Name of District	No of IWMs installed		
	Long Shaft	Short Shaft	Total		Long Shaft	Short Shaft	Total
Achham	4	73	77	Kaski	0	5	5
Baitadi	3	138	141	Kavre	6	32	38
Bajhang	4	115	119	Lamjung	1	11	12
Bajura	1	23	24	Makwanpur	6	41	47
Chitwan	1	17	18	Nuwakot	5	86	91
Dadeldhura	0	48	48	Okhaldhunga	13	126	139
Dailekh	4	136	140	Pyuthan	0	2	2
Darchula	0	125	125	Ramechhap	3	8	11
Dhading	9	40	49	Rasuwa	1	74	75
Dolakha	4	53	57	Rolpa	5	41	46
Dolpa	1	18	19	Rukum	1	57	58
Doti	3	133	136	Salyan	7	87	94
Gorkha	6	29	35	Sindhuli	27	92	119

Jajarkot	5	112	117	Sindhupalchowk	5	84	89
Jumla	3	41	44	Solukhumbu	0	11	11
Kailali	1	16	17	Surkhet	12	63	75
Kalikot	0	113	113	Udaypur	1	7	8
				Total	**160**	**2039**	**2199**

Table 2: Detail of CPA-2 under PoA for Promotion of the Improved Water Mills (IWM) in Nepal.

Name of District	**No of IWMs installed**			**Name of District**	**No of IWMs installed**		
	Long Shaft	**Short Shaft**	**Total**		**Long Shaft**	**Short Shaft**	**Total**
Achham	0	45	45	Manang	0	7	7
Baglung	0	3	3	Mustang	0	5	5
Baitadi	0	87	87	Myagdi	0	5	5
Bajhang	0	37	37	Nuwakot	0	15	15
Bajura	0	46	46	Okhaldhunga	3	14	17
Chitwan	1	17	18	Palpa	0	1	1
Dadeldhura	0	20	20	Panchthar	0	1	1
Dailekh	0	17	17	Parbat	0	1	1
Darchula	0	49	49	Ramechhap	3	5	8
Dhading	1	2	3	Rasuwa	0	13	13
Dhankuta	2	1	3	Rolpa	4	46	50
Dolakha	3	17	20	Rukum	0	46	46
Ilam	0	11	11	Salyan	2	59	61
Jajarkot	1	80	81	Sindhuli	5	25	30
Kailali	0	104	104	Sindhupalchowk	2	26	28
Kalikot	6	69	75	Solukhumbu	2	26	28
Kaski	0	48	48	Surkhet	2	12	75
Kavre	1	5	6	Udaypur	0	3	3
Khotang	0	6	6	Syangja	0	1	1
Makwanpur	8	54	62	**Total**[1]	**46**	**1092**	**1138**

AEPC is the coordinating/managing entity of this PoA. The PoA is being supported by the GoN and several international Development Partners (DP). The support mainly covers technical assistance and financial inputs to cover subsidy amount. AEPC is responsible for coordinating national level financial institutions and other relevant government agencies promoting the IWM technology. AEPC has established a Central Renewable Energy Fund (CREF) with one handling Bank and few partner banks to channel the subsidy and credit through a revolving fund. AEPC is responsible for carrying out performance reports to ensure the monitoring requirements of the CDM PoA are met. AEPC conduct third party monitoring (User Survey) to ensure whether the monitoring requirement are met and monitor the paratemeters stipulated in PoA DD.

The technologies used in this PoA are long shaft and short shaft IWMs installed with the standard set for those IWMs. Monitoring of each CPAs under the PoA was done as stipulated in the registered CPA-DDs. User survey was conducted to the sampled IWM owners and user for each CPAs individually.

The detail of the sampling and user survey for each CPAs are described in section E.3 of this MR. The total emissions reductions achieved during this monitoring period from the CPAs specified in table 1 and table 2 above is 11,402 tCO_2e.

[1] One of the IWM with tag no AEPC/IWM/002/1010 initially installed as long shaft was affected in the earthquake and is now running in short shaft mode. This has been accounted appropriately as 45 long shaft IWM and 1093 short shaft IWMs in the emission reduction calculations. This has been confirmed in this monitoring period as well.

B.2. Post-registration changes to PoA

B.2.1. Corrections

N/A

B.2.2. Inclusion of monitoring plan

N/A

B.2.3. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

As per the page 51 of the originally registered PoA DD, IWMs has to be selected randomly from the entire population using simple random sampling whereas the monitoring plan sections of the registered PoA-DD and CPA-DD mentioned that for the IWM types, development regions and ecological belts has to be considered to get best representative values. Further, the sampling plan in the CPA-DDs refer to the PoA-DD, Appendix 5. Considering these inconsistency in registered PoA DD/CPA-DDs regarding sampling, changes has been made to apply stratified random samling approach based on the Sampling and survey guidelines v.3 (EB 75, Annex 8) instead of simple random sampling to make the sampling consistent. The monitoring for the covered monitoring period has been conducted following the stratified sampling approach.

The permanent changes to the registered monitoring plan is approved by the UNFCCC on 10th June 2019 and the version number of the new PoA-DD is 10.0, dated 22/04/2019.

B.2.4. Changes to programme design

N/A

B.2.5. Changes specific to afforestation or reforestation activities

N/A

PART II Monitoring of CPAs

Since, the technologies implemented in all CPAs are similar, so the implementation of the monitoring of the CPAs are similar which are described below further.

SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

This monitoring report presents the details of 2 CPAs proposed for verification in this monitoring period. All the IWMs included in these CPAs are the improved version of traditional water mills that transform the potential energy of water into mechanical energy. That mechanical energy can be used for the agro-processing in rural areas. The CPAs have the IWMs installed with long shaft and short shaft. The summery of the technical description of the IWMs is given below:

Component & description	Material	Dimension
1. Fali – a device used to hold shaft through key to the upper grinding stone of Short Shaft IWM	Mild steel	L150 x W60 x D20 fabricated out of 20 x 20 section rods welded together; Central rectangular hole size L38 x W20
2. Short Shaft – a device used to hold runner and transmit power to grinder at the top.	Mild steel	Dia. 38 x L1220 shaft; Key shape at top to tightly fit into the hole in Fali 38 x 20; 2 nos. Dia. 13.5 holes at right angle to hold runner hub; 1 no. Dia 20.5 hole from bottom to insert Takkar pin, with a lateral hole of Dia 10.5 for guide pin to fix the Takkar pin
3. Long Shaft – a device used to hold runner and transmit power to driver pulley at the top	Mild steel	Dia. 50 x L1800 shaft; 2 nos. Dia. 13.5 holes at right angle to hold runner hub; 1 no. Dia 20.5 tapered hole from bottom to insert Takkar pin, with a lateral hole

		of Dia 10.5 for guide pin to fix the Takkar pin
4. Runner (Nepal Yantra Shala Model) – a device with 14 buckets to convert hydraulic power to mechanical power	Mild steel	Outer Dia. 600 runner; Dia. 240 bucket Dia. 115 x L165 x 4mm thick for runner hub, 6mm thick side plate; Dia. 55 x L48 x 8mm thick for SS shaft hub; Dia. 68 x L48 x 8mm thick for LS shaft hub Dia. 10 rod for runner to hub connection; Thickness 3 x 20 strip for runner outer re-inforcing strip 2.5 sheet for bucket
5. Runner (Bhagawati Metal Model) – a device with 17 buckets to convert hydraulic power to mechanical power	Mild steel	Outer dia. 702 runner Dia. 250 bucket Dia. 270 x L165 x 4mm thick for runner hub, 6mm thick side plate Dia. 55 x L48 x 8mm thick for SS shaft hub Dia. 68 x L48 x 8mm thick for LS shaft hub Dia. 10 rod for runner to hub connection Thickness 3 x 20 strip for runner outer re-inforcing strip 2.5 sheet for bucket
6. Runner (Banepa Model) – a device with 15 buckets to convert hydraulic power to mechanical power	Mild steel	Outer dia. 686 runner Dia. 267 bucket Dia. 152 x L165 x 4mm thick for runner hub, 6mm thick side plate Dia. 55 x L48 x 8mm thick for SS shaft hub Dia. 68 x L48 x 8mm thick for LS shaft hub Dia. 10 rod for runner to hub connection Thickness 3 x 20 strip for runner outer re-inforcing strip 2.5 sheet for bucket
7. Takkar (Pivot Model)-kind of bottom bearing of IWM in the form of a pivot rotating on a Chakati		<u>SS IWM Takkar:</u> Tapering out from top (Dia. 19) to bottom (Dia. 21) Bottom pin L20 x Dia. 23 co-axial with upper part <u>LS IWM Takkar:</u> Tapering out from top (Dia. 25) to bottom (Dia. 28) in LS IWM Takkar Bottom pin L28 x Dia. 28 co-axial with upper part Both type Takkar to be hardened by heating up to 500 deg cel and cooling in oil bath
8. Chakati (Pivot Model) – kind of bottom bearing fixed base plate of IWM in the form of a Chakati on which pivot rotates		L130 x W40 x 5 thickness bottom plate with holes to screw it to wooden frame of the IWM structure L40 x W 40 x 10 thickness top plate concentric with the bottom plate, with middle conical hole for Takkar to rest & rotate Chakati to be hardened by heating up to 500 deg cel and cooking in a oil bath
7. Takkar (Ball Model) – kind of bottom bearing of IWM in the form of a ball rotating on a Chakati		Tapering out from top (Dia. 18.6) to bottom (Dia. 21), welded to a forged hard metal plate 10 thickness with socket at bottom for metal ball of Dia. 16 Takkar to be hardened by heating up to 500 deg cel and cooling in oil bath
8. Chakati (Ball Model) – kind of bottom bearing fixed base plate of IWM in the form of a Chakati on which Takkar rotates with a Ball in between		L130 x W40 x 5 thickness bottom plate with holes to screw it to wooden frame of the IWM structure L40 x W 40 x 10 thickness top plate concentric with the bottom plate, with spherical depression of 4mm depth at the center for holding the Ball on which Takkar rests & rotates Chakati to be hardened by heating up to 500 deg cel and cooking in a oil bath

Maximum of 3000 IWMs can be included in each CPAs. The CME ensured that maximum of 2200 IWMs will be included in each CPAs. The implementation status recorded for the IWMs in each CPAs till this monitoring period is as follows:

CPAs	Types of IWM		Total
	Long Shaft	Short Shaft	
CPA-1	160	2039	2199
CPA-2	45	1093	1138
Total	205	3132	3337

The IWMs constructed will continuously be included in CPA-2 till the numbers reach up to 2200. The IWMs constructed after that period will be part of the next CPA (CPA-3).

All the IWMs implemented under the CPAs of the PoA are maintained by AEPC as a CPA implementer. Each IWM included in the CPA have a unique identification numbers (AEPC-IWM-XXX-XXXX). These unique identification numbers will prevent double counting of IWM in the PoA as well as in other IWM projects. Since all the IWMs implemented under all CPAs of the PoA are centrally maintained, possibility of the double counting of the IWMs between and within CPAs is avoided.

C.2. Location of CPAs

All the specific case CPAs are implemented across Nepal in different districts. The geographical coordinates of Nepal are:

Latitude – North 26.20 degree to North 30.45 degree
Longitude – East 80.07 degree to East 88.20 degree

The table 1 and table 2 above provides the overview of the IWMs implemented under two CPAs in different districts of Nepal. Please see section B.2 of this MR.

C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents

N/A

C.3.2. Corrections

N/A

C.3.3. Changes to the start date of the crediting period

N/A

C.3.4. Inclusion of monitoring plan

N/A

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

Refer to section B.2.3.

C.3.6. Changes to project design

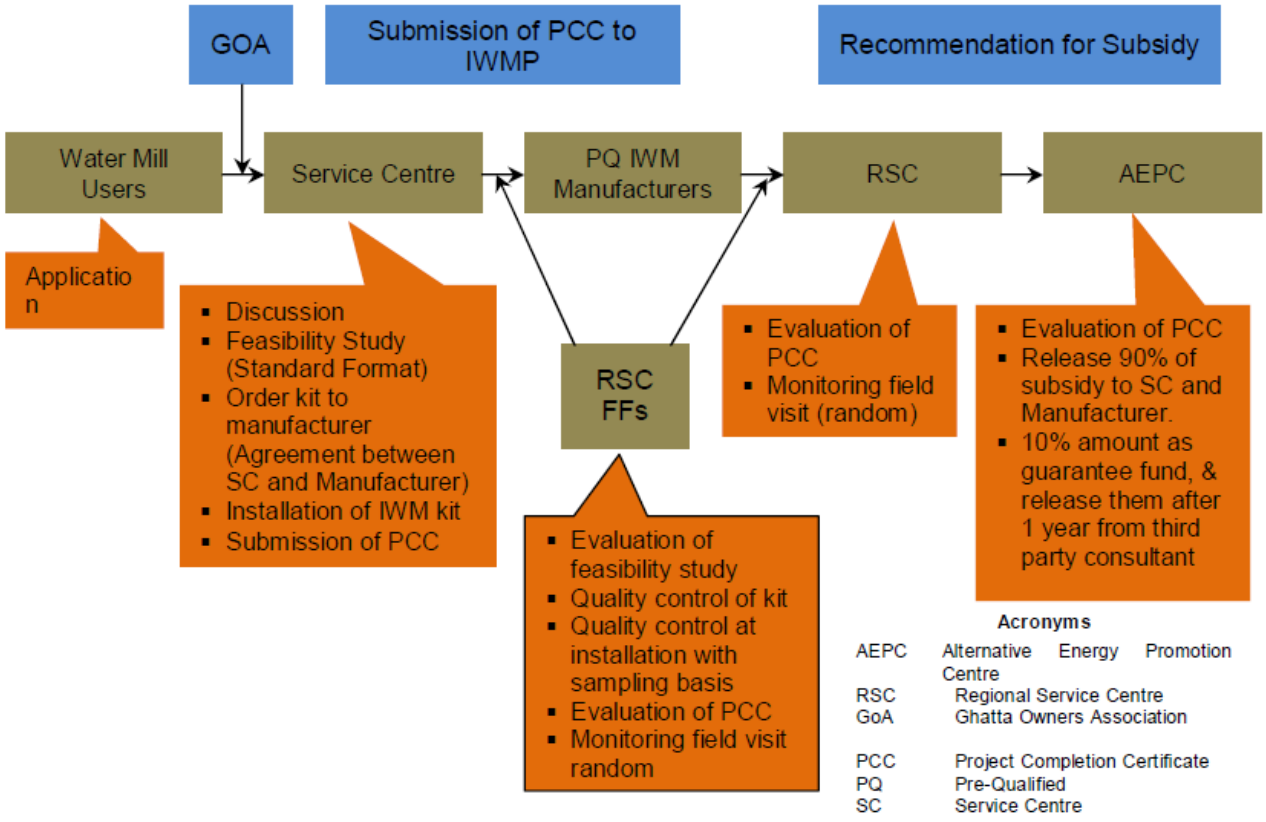
N/A

C.3.7. Changes specific to afforestation or reforestation CPA

N/A

SECTION D. Description of monitoring system of CPAs

As a CME as well as CPA implementer, AEPC maintains the database of the IWMs installed by the pre-qualified companies. On the behalf of AEPC, Regional Service Centres (RSCs), national level non-governmental organization facilitates in implementing PoA. RSCs facilitates and provides technical assistance to Manufacturers to processes the subsidy applications and recommend AEPC for subsidy reimbursement to the users. It also assists in conducting quality control and regular monitoring of the installed IWMs. The Monitoring Survey is conducted every year as a basis for emission reduction calculation. The third party (consultant) conducts the Monitoring Survey. Based on the survey, AEPC prepares monitoring report and maintain all required documents for verification. The roles and responsibilities of each entity are shown below:



SECTION E. Data and parameters

E.1. Data and parameters fixed ex ante

Data/Parameter	IC_{TWM}
Unit	kW
Description	Traditional Water Mill (TWM) installed capacity, kW
Source of data	Study report- Determining the capacity of Long Shaft and Short Shaft Improved Water Mill (IWM), Final Report, Energy Development Services Pvt. Ltd. May 2012
Value(s) applied	0.35 (during the study the average capacity of TWM was found to be 0.35 kW)
Choice of data or measurement methods and procedures	Standard installed capacity of TWMs in Nepal
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	IC_{IWM}
Unit	kW
Description	Improved Water Mill (IWM) installed capacity
Source of data	Mill specifications
Value(s) applied	Minimum value of 1.39 kW for short shafts and Minimum value of 2.83 kW for long shaft IWMs are used on conservative basis as more than 97% of SS and LS IWMs are with installed capacity above these values (as per the third part study report).
Choice of data or measurement methods and procedures	Based on eligibility criterion 5, the capacity of SS and LS IWM is 1.39 and 2.83 KW respectively have been fixed on conservative basis.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	EF_{Diesel}
Unit	kg CO_2/kWh
Description	Emission Factor of diesel based power generators. For diesel based mills
Source of data	Version 3 of AMS I.F
Value(s) applied	1.2
Choice of data or measurement methods and procedures	1.2 for 100% load, 1.4 for 50 % load and 2.4 for 25% load. As the emission factor for diesel is more conservative with 100% load, this has been chosen for emission factor for diesel.
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	AMS.I.B (Version 12) para 16 (a), option (i) allows the project participant to determine the emission factor for diesel generator systems according to procedures specified in "AMS-I.A: Electricity generation by users". AMS I.A. (version 16) allows, with adequate justification, in paragraph 9, for a small scale project proponent to use a higher emission factor from Table I.F.1 under category AMS I.F. "Renewable energy generation for captive use and mini-grid". Since the maximum capacity of the Diesel Mills prevalent in Nepal is of 12 kW (the baseline study conducted on May 2012 comes up with a finding that the diesel mills in Nepal have the capacity range between 10hp to 16 hp, taking the unit conversion from hp to kW as 0.75, the corresponding kW for 16 hp diesel mill is 12 kW). Hence, the corresponding most conservative (100% loading consideration) emission factor of 1.2 Kg CO_2/kWh has been chosen (refer table below taken from AMS.I.F, version 03).

Table 2. Emission factors for diesel generator systems (in kg CO2e/kWh[a]) for three different levels of load factors[b]

Cases	Mini-grid with 24 hour service	(a) Mini-grid with temporary service (4-6 hr/day); (b) Productive applications; (c) Water pumps	Mini-grid with storage
Load factors [%]	**25%**	**50%**	**100%**
<15 kW	2.4	1.4	1.2
>=15 <35 kW	1.9	1.3	1.1
>=35 <135 kW	1.3	1.0	1.0
>=135<200 kW	0.9	0.8	0.8
> 200 kW[c]	0.8	0.8	0.8

[a] A conversion factor of 3.2 kg CO_2 per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories);

[b] Values derived from figures reported in RETScreen International's PV 2000 model retrieved from: <http://retscreen.net/>;

[c] Default values.

Data/Parameter	**N**
Unit	-
Description	Sample size of Monitoring Survey
Source of data	CPA database
Value(s) applied	50
Choice of data or measurement methods and procedures	The sample size has been determined as per sample size calculation done in appendix 5 in the PDD with minimum 90% confidence interval and 10% error margin.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Design of statistically sound and random sampling methodology for proper representation

E.2. Data and parameters monitored

Data/Parameter	$Q_{OP,i}$
Unit	Number
Description	Number (quantity) of IWMs of type i operating under the project activity
Measured/calculated/ default	Calculated
Source of data	Ex post monitoring survey based on calculated number

Value(s) of monitored parameter	CPA-1: Long Shaft: 83.33% (out of sampled IWM) Short Shaft: 95.45% (out of sampled IWM) CPA-2: Long Shaft: 100 % (out of sampled IWM) Short Shaft: 93.48 % (out of sampled IWM)
Monitoring equipment	Monitoring Sample survey
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	number of IWM found to be operating from the total number of IWM surveyed
QA/QC procedures	Samples will be selected randomly for long shaft and short shaft (two strata)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	$OH_{i,y}$
Unit	Hrs
Description	Operating hours of IWM for mechanical power generation
Measured/calculated/ default	Calculated
Source of data	Ex post monitoring survey
Value(s) of monitored parameter	CPA-1: Long Shaft: 10.40 hours daily (235 operational days per year) Short Shaft: 10.14 hours daily (274.40 operational days per year) CPA-2: Long Shaft: 9 hours daily (247.5 operational days per year) Short Shaft: 9.53 hours daily (277.86 operational days per year)
Monitoring equipment	Monitoring Sample survey
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	number of hours operating
QA/QC procedures	Samples will be selected randomly for long shaft and short shaft (two strata)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

Data/Parameter	$Q_{T,i}$
Unit	Number
Description	Number (quantity) of IWMs of type i installed under the project activity
Measured/calculated/ default	Calculated
Source of data	Testing and Commissioning report/database

Value(s) of monitored parameter	CPA-1: Long Shaft: 160 Short Shaft: 2039 CPA-2: Long Shaft: 45 Short Shaft: 1093
Monitoring equipment	Project implementing agency records
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	number of IWM installed
QA/QC procedures	Total number of IWM installation can be checked with IWM subsidy list
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	N/A

E.3. Implementation of sampling plan

Since the monitoring parameters for all CPAs implemented under the PoA are same, the CME adopts a common monitoring framework for all the specific case CPAs implemented under the PoA. Annual monitoring was conducted through the monitoring surveys where the following parameters were monitored as stipulated in the Appendix 5 of the PoA-DD.

1.Daily operating hours of IWM for agro processing (generation of mechanical power)
2. Number of IWM operating in each CPA

The coordinating/managing entity opted for a monitoring system where each CPA within the PoA is monitored. The monitoring parameter stipulated in the PoA DD is the “daily operating hours” and the systems operating under the CPAs. In order to monitor this parameter, CME commissioned an independent consultant through a competitive bidding process. The consultant, aligning with the monitoring requirements of the PoA estimated the sample required for the monitoring, drafted the questionnaires and mobilized the team for on-site survey. Having accumulated the information from the on-site survey, the consultant team prepared the reports for each CPA and submitted the same to the AEPC.

(a) Sample Size Determination

Sample size was determined using stratified random sampling consistent with the monitoring plan of the PoA-DD and respective CPA-DDs and guidelines for sampling and surveys for CDM project activities and programme of activities (version 03). The strata for the survey are long shaft and short shaft IWMs. The sampling was performed within the level of precision of 10% and a confidence level of 90%.

The sample size calculation was carried out using formula as provided in the guidelines.

Sample Size for the Proportional Parameter (Number of IWMs operating)

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where,
n = sample size
N = Total number of IWM users (Entrepreneurs) (For CPA-1: 2199; For CPA-2: 1138)
1.645 = Represent 90% confidence required
0.1 = Represent the 10% relative precision

$V = \frac{SD^2}{\bar{p}^2} = \frac{\text{overall variance}}{\bar{p}^2}$ and $\bar{p}$ is the overall proportion.

As per the CPA DD, the estimates for the parameters above shall be adjusted taken the results of the previous monitoring period(s) into account. The overall proportion and overall variance is calculated as follows:

$$SD^2 = \frac{(g_a \times p_a(1-p_a)) + p_b(g_b \times (1-p_b)) + (g_c \times p_c(1-p_c)) + \cdots + (g_k \times p_k(1-p_k))}{N}$$

$$\bar{p} = \frac{(g_a \times p_a) + (g_b \times p_b) + (g_c \times p_c) + \ldots + (g_k \times p_k)}{N}$$

For the calculation of sample for this monitoring period, following values are taken:

Parameters	Symbol	Values		Reference
		CPA-1	CPA-2	
Total Number of IWM in the CPA	N	2199	1138	Database of CPA-1 and CPA-2
Number of long shaft IWM	g_a	160	45	Database of CPA-1 and CPA-2
Expected operational proportion for long shaft	p_a	50%	50%	Previous IWM User Survey result for CPA-1 and CPA-2
Number of short shaft IWM	g_b	2039	1093	Database of CPA-1 and CPA-2
Expected operational proportion for short shaft	p_b	95.12%	87.23%	Previous IWM User Survey recult for CPA-1 and CPA-2

Substituting the values in the above equations following results were found:

Parameters	CPA-1	CPA-2
Overall variance SD^2	0.06	0.12
Overall Proportion, P	0.92	0.86
V value (SD^2/P^2)	0.07	0.16
Total number of sample required	19.47	41.46
Sample required for long shaft	2	2
Sample required for short shaft	19	41
Total sample (Round UP)	**21**	**43**

Sample Size for the Mean Value Parameter (Daily Operation Hours of IWM for mechanical power generation)

$$n \geq \frac{1.645^2 \, NV}{(N-1) \times 0.1^2 + 1.645^2 \, V}$$

Where,
V = (SD/Mean)
n = Sample Size
N = Total number of IWM users (Entrepreneurs) (For CPA-1: 2199; For CPA-2: 1138)
1.645 = Represent 90% confidence required
0.1 = Represent the 10% relative precision

Overall standard deviation and overall are calculated using following equations

$$SD = \sqrt{\frac{(g_a \times SD_a^2) + (g_b \times SD_b^2) + (g_c \times SD_c^2) + \ldots + (g_k \times SD_k^2)}{N}}$$

$$\text{mean} = \frac{(g_a \times m_a) + (g_b \times m_b) + (g_c \times m_c) + \ldots + (g_k \times m_k)}{N}$$

Where:

mean = Weighted overall mean

m_i = Mean of the i^{th} group where i=1,…,k

For the calculation of sample for this monitoring period, following values are taken:

Parameters	**Symbol**	**Values**		**Reference**
		CPA-1	**CPA-2**	
Total Number of IWM in the CPA	N	2199	1138	Database of CPA-1 & CPA-2
Number of long shaft IWM	g_a	160	45	Database of CPA-1 & CPA-2
Number of short shaft IWM	g_b	2039	1093	Database of CPA-1 & CPA-2
Operation hours per day				
Expected mean for long shaft	m_a	11	12	Previous IWM User Survey for CPA-1 and CPA-2
Expected mean for short shaft	m_b	9.9	10.29	Previous IWM User Survey for CPA-1 and CPA-2
Expected standard deviation for long shaft	SD_a	2.62	0	Previous IWM User Survey for CPA-1 and CPA-2
Expected Standard deviation for short shaft	SD_b	2.84	2.26	Previous IWM User Survey for CPA-1 and CPA-2
Operational days per year				
Expected mean for long shaft	m_a	315	265	Previous IWM User Survey for CPA-1 and CPA-2
Expected mean for short shaft	m_b	265.64	273.71	Previous IWM User Survey for CPA-1 and CPA-2
Expected standard deviation for long shaft	SD_a	21.21	21.21	Previous IWM User Survey for CPA-1 and CPA-2
Expected Standard deviation for short shaft	SD_b	60.52	47.70	Previous IWM User Survey for CPA-1 and CPA-2

Substituting the values in the above equations following results were found:

Parameters	**CPA-1**	**CPA-2**
Operational hours per day		
Overall Standard Deviation, SD	2.82	2.21
Overall Mean, m	9.98	10.36
V value $(SD/P)^2$	0.08	0.05
Total number of sample required	21.74	12.25
Sample required for long shaft	2	1
Sample required for short shaft	21	13
Total sample (Round UP)	**23**	**14**
Operational days per year		
Overall Standard Deviation, SD	58.56	46.94
Overall Mean, m	269.23	273.37
V value $(SD/P)^2$	0.05	0.03
Total number of sample required	12.73	7.93
Sample required for long shaft	1	1
Sample required for short shaft	13	8
Total sample (Round UP)	**14**	**9**

Among the above sample size calculation, the conservative sample size for CPA-1 is 23 (short shaft: 21 and long shaft: 2) and for CPA-2 is 43 (short shaft: 41 and long shaft: 2). Since the PoA-DD and CPA-DD has set the minimum sample size of 33, the sample for both CPAs are enlarged to meet the sample calculation above for the particular period. The sample for the CPA-1 and CPA-2 are enlarged to 50 addressing the non responses also. Hence the same was retained for the monitoring surveys for both, the proportional parameter and the mean value parameter.

(b) Allocation of samples

The samples are allocated proportionally to the types of IWMs (i.e. long shaft and short shaft) based on proportion of IWMs installed in these two strata randomly. The tables below depict the sample allocation against the installed IWMs in respective CPAs.

Sample allocation for monitoring

CPAs	Number of IWMs			Sample calculated			Sample adjusted		
	SS	LS	Total	SS	LS	Total	SS	LS	Total
CPA-1	160	2039	2199	21	2	23	44	6	50
CPA-2	45	1093	1138	41	2	43	46	4	50

(c) Survey

Survey was conducted in the month of March to June, 2020. Out of 100 total sample provisioned for the survey for CPA-1 and CPA-2, total of 79 samples (38 samples for CPA-1 and 41 Samples for CPA-2) were covered before the lockdown was started on 24 March 2020 due to COVID-19 pandemic. Remaining 21 samples were surveyed in June through telephonic inquiry due to the restriction of long travel in the country and for the safety measures for COVID-19 pandemic. Enumerators were trained on structured questionnaires and mobilized in the field for data collection. The results from the monitoring for the operational status of the CPAs are given below:

Operational Status of the IWMs

Particulars	CPA-1	CPA-2
Sample taken for long shaft IWM	6	4
Operational status of long shaft IWM	83.33%	100%
Average operational hours of long shaft IWM	10.4	9
Average operational days in a year	235	247.5
Sample taken for short shaft IWM	44	46
Operational status of short shaft IWM	95.45%	93.48%
Average operational hours for short shaft IWM	10.14	9.53
Average operational days per year	274.4	277.86

(d) Quality Assurance/Quality Control

Efforts were made to ensure the quality of the data collected from the field. QA/QC measures were implemented to attain the desired 90/10 confidence/precision for the parameters under consideration. In order to assure the quality of data collected, the questionnaires were pre-tested prior to their introduction in the field. Similarly, as a part of the quality assurance, a thorough check of the questionnaires filled up by the enumerators is also part of the survey however no any inconsistency was identified during the survey. Following precision were achieved for the surveyed data:

SN	Parameters	Precision achieved (%)		Remarks
		CPA-1	CPA-2	
1	Operational status	5.35	8.77	< 10% (met the rquirement)
2	Operation hour per day	2.56	4.92	< 10% (met the rquirement)
3	Operation days per year	4.24	5.81	< 10% (met the rquirement)

So, the required precision has been met by the survey data.

SECTION F. Calculation of emission reductions or net anthropogenic removals

F.1. Calculation of baseline emissions or baseline net removals

According to paragraph 16(a) of approved methodology AMS.I.B (Version 12), the baseline emissions (BE_y) are calculated using either of the two approaches below:

i. The power requirements times hours of operation per year times the emission factor for diesel generator systems, determined according to procedures specified in "AMS: Electricity generation by the user"

ii. The fossil fuel consumption per hour, conservatively converted to diesel fuel hourly consumption rate, times hours of operation per year times the default value for the emission coefficient for diesel fuel i.e. 0.0032 t CO_2 per kg of diesel fuel.

For the purpose of calculation of the emission displacement, option (i) has been chosen. Since the TWM itself has certain power output required for milling purpose and IWM provides the additional power required for high capacity milling, the emission reduction is calculated only for the additional capacity. The additional capacity of the IWMs installed is calculated as given in the equation below:

$$IC_{add} = IC_{IWM} - IC_{TWM}$$

Where,
IC_{IWM} - IWM installed capacity, kW (for long shaft: 2.8 kW and for short shaft: 1.39 kW)
IC_{TWM} - TWM installed capacity, kW (0.35 kW)
IC_{add} – Additional Installed Capacity, kW

As per option (i) para 16(a) AMS.I.B (version 12), the baseline emission is calculated as the product of power requirement, operation hoursof IWM for mechanical power generation and emission factor of diesel. Following formula was used to calculate the baseline emission.

$$ER_y = \sum_{i=1}^{n} \frac{Q_{OP,i} * IC_{add,i} * OH_i * EF_{Diesel}}{1000}$$

Where,

$Q_{OP,i} = Q_{T,i} - Q_{NW,i}$

ER_y :Emission Reductions in year y (tCO2e)

$Q_{OP,i}$:Number (quantity) of IWMs of type I operating under the project activity /units (can betaken up as directly monitored value OR can be calculated as above, if monitored value of $Q_{NW,I}$ is availble). Once all of the project IWMs are installed, $Q_{OP,i}$ is a constant value independent from y.

i :Counter for equipment type

n : 2 (for long shaft and short shaft)

$Q_{T,i}$ Number (quantity) of IWMs of type i installed under the project activity (units).

$Q_{NW,i,y}$ Number (quantity) of IWMs of type inot working under the project activity (units).

$OH_{i,y}$ Operating hours of IWMfor mechanical power generation

EF_{Diesel} Emission Factor of diesel based power generators, as per table I.F,1 of AMS-I.F as guided by the para 9 of AMS.I.A as referred in AMS I.B. (kg CO_2/kWh)

Substituting the values for each parameters from the above equations for long shaft and short shaft, the respective emission reduction for each CPA is calculated as under:

Total emission reduction for CPA-1 for the monitoring period: 7,728 tCO_2e

Total emission reduction for CPA-2 for the monitoring period: 3,674 tCO_2e

Detail of the calculation is given in emission reduction calculation sheet.

F.2. Calculation of project emissions or actual net removals

N/A

F.3. Calculation of leakage emissions

N/A

F.4. Calculation of emission reductions or net anthropogenic removals

CPA UNFCCC reference number	Baseline GHG emissions or baseline net GHG removals ($t CO_2e$)	Project GHG emissions or actual net GHG removals ($t CO_2e$)	Leakage GHG emissions ($t CO_2e$)	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)		
				Before 01/01/2013	From 01/01/2013	Total amount
9889-0001	7,728	0	0	0	7,728	7,728
9889-0002	3,674	0	0	0	3,674	3,674
Total	**11,402**	**0**	**0**	**0**	**11,402**	**11,402**

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period ($t CO_2e$)	Amount estimated ex ante for this monitoring period in the CPA-DD ($t CO_2e$)
9889-0001	7,728	11,022
9889-0002	3,674	11, 273
Total	**11,402**	**22,295**

F.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the CPA-DD"

For the ex-ante calculation in CPA-DD, the equations given in section F.1 were used where following assumption were made:

$$IC_{add} = IC_{IWM} - IC_{TWM}$$

IC_{IWM} - IWM installed capacity, kW (for long shaft: 2.8 kW and for short shaft: 1.39 kW)
IC_{TWM} - TWM installed capacity, kW (0.35 kW)

$Q_{OP,i}$:Number (quantity) of IWMs of type I operating under the project activity /units (Total: 2200 IWM for CPA-1 in which 440 long shaft and 1760 short shaft and total 2250 IWMs for CPA-2 where 1800 IWMs are short shaft and 450 IWMs are long shaft)

EF_{Diesel} Emission Factor of diesel based power generators (1.2 kg CO_2/kWh as per AMS I.F)

Using the equation below for baseline emission calculation,

$$ER_y = \sum_{i=1}^{n} \frac{Q_{OP,i} * IC_{add,i} * OH_i * EF_{Diesel}}{1000}$$

Baseline emission for CPA-1 : 11,022 tCO_{2eq}/Year
Baseline Emission for CPA-2: 11,273 tCO_{2eq}/Year

Since project emission and leakage are not applicable for this PoA, they are taken as zero. So, the ex-ante emission reduction were calculated as follows for the CPAs which are applicable for this monitoring period:

Emission Reduction for CPA-1: Baseline Emission-Project Emission-Leakage = 11,022 tCO_{2eq}/year
Emission Reduction for CPA-2: Baseline Emission-Project Emission-Leakage = 11,273 tCO_{2eq}/year

So total ex-ante emission reduction in this monitoring period = 11,022+11,273 = 22,295 tCO_{2eq}

F.6. Remarks on increase in achieved emission reductions

N/A

F.7. Remarks on scale of small-scale CPAs

The PoA has the eligibility creiteria for meeting the small scale threshold for each CPAs included in the PoA. The PoA is under Type I project. As per the small scale threshold for type I project, the CPA should not exceed maximum threshold capacity of 15 MW in total. As the maximum number of IWMs in each CPAs to meet the threshold small scale size is fixed as 3000 in PoA-DD, both the CPAs (CPA-1: 2199 and CPA-2: 1138) have lower number of IWM installed than the threshold capacity. Hence the small scale threshold has been met by both CPAs during the monitoring period.

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Document information

Version	*Date*	*Description*
03.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for programmes of activities” (CDM-EB93-A07-STAN); • Add a section on remarks on the observance of the scale limit of small-scale CPAs during the crediting periods; • Add "changes specific to afforestation or reforestation activities/CPA" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R PoAs between two commitment periods; • Make structural and editorial improvements.
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