Monitoring report form for CDM programme of activities

(Version 02.0)

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	8.0	
Version number of this monitoring report	01	
Completion date of this monitoring report	14/05/2018	
Monitoring period number	01	
Duration of this monitoring period	09/09/2015 to 31/12/2017	
Monitoring report number for this monitoring period	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
Sectoral scopes	Energy industries (renewable/non-renewable sources)	
Applied methodologies and standardized baselines	AMS-I.B. ver. 12 - Mechanical energy for the user with or without electrical energy	
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: 17,497 tCO_2 e** **CPA-2: 4,338 tCO_2 e** **Total: 21,835 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: 25,517 tCO_2 e** **CPA-2: 10,315 tCO_2 e** **Total: 35,832 tCO_2 e**	

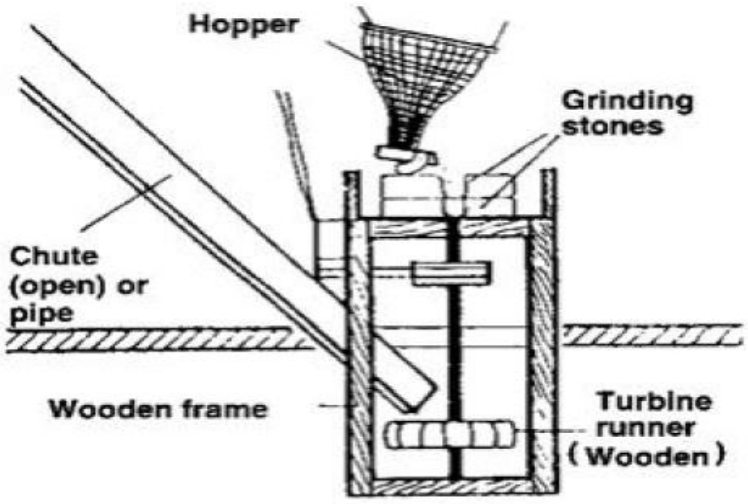
PART I Monitoring of programme of activities (PoA)

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.

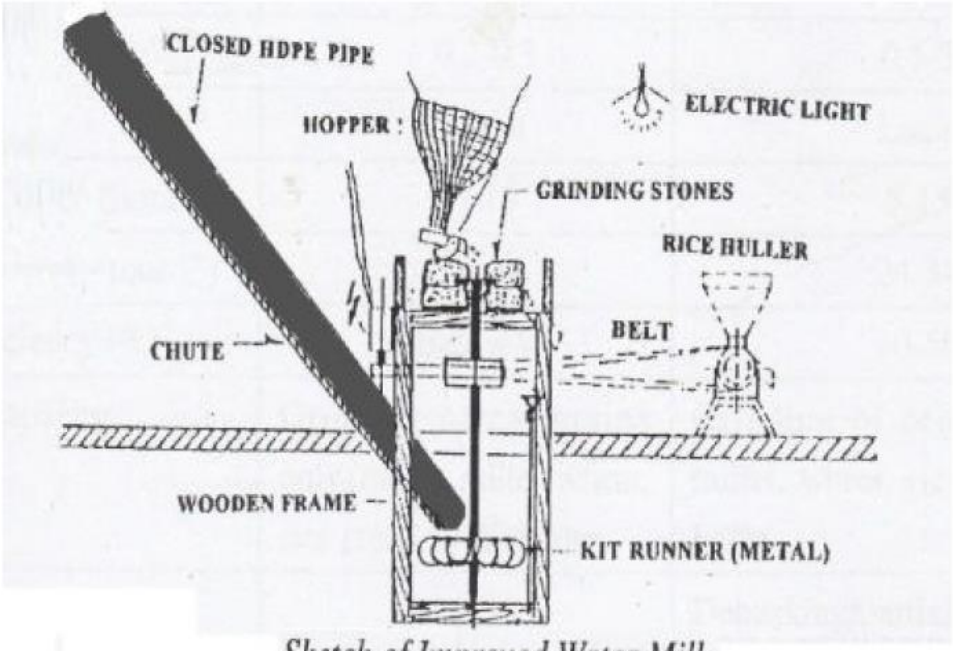
In the hilly areas of the country, TWMs or Ghattas are located on the banks of water sources with one mill typically serving 20 - 50 households. For TWM, with their low efficiency, it is hard to cope with the increasing processing needs (e.g. grinding, hulling, oil expelling, etc.) of the rural communities. 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]	8.0	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	Title and reference number of the corresponding generic CPA	Version of the PoA-DD	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)	PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA # [9889-XXXX]	8.0	09 Sep 2015 - 08 Sep 2022 (Renewable)	Yes
PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA 2 (9889-0002)	PoA for Promotion of the Improved Water Mills (IWM) in Nepal, CPA # [9889-XXXX]	8.0	1 Feb 2017 – 31 Jan2024 (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 1193 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**	**46**	**1092**	**1138**

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 applied standards or tools

N/A

B.2.4. Changes to programme design

N/A

PART II Monitoring of CPAs

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 registered 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.

Monitoring Survey was conducted to capture the operational status of IWM and operation hours of the IWMs in each CPAs. The results from the monitoring for the operational status of the CPAs are given below:

Operational Status of the IWMs for 2015 - 2016

Particulars	**CPA-1**
Sample taken for long shaft IWM	3
Operational status of long shaft IWM	100%
Average operational hours of long shaft IWM	9.16 hours
Average operational days in a year	192
Sample taken for short shaft IWM	42
Operational status of short shaft IWM	90.48%
Average operational hours for short shaft IWM	10.78 hours
Average operational days in a year	261.13

Operational Status of the IWMs for 2017

Particulars	**CPA-1**	**CPA-2**
Sample taken for long shaft IWM	3	2
Operational status of long shaft IWM	100%	100%
Average operational hours of long shaft IWM	12.7	12
Average operational days in a year	246.7	207.5
Sample taken for short shaft IWM	42	43
Operational status of short shaft IWM	90.48%	83.72%
Average operational hours for shaft shaft IWM	11.5	14.3
Average operational days per year	241	269.7

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	46	1092	1138
Total	206	3131	3437

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 or standardized baselines

N/A

C.3.2. Corrections

N/A

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

CPA-1 was included on 9 September 2015 whereas the crediting period start date mentioned is 9 October 2015. All the IWMs included in this CPA were commissioned before 9 September 2015, crediting period start date is changed to 9 September 2015 and the same is used for the ER calculation. Similar is the case for CPA-2 where inclusion date is 1 February 2017 and crediting period start date indicated as 15 Feb 2017. The former is used for the calculation of ER. So, it is proposed that crediting period start date has to be changed accordingly.

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 applied standards or tools

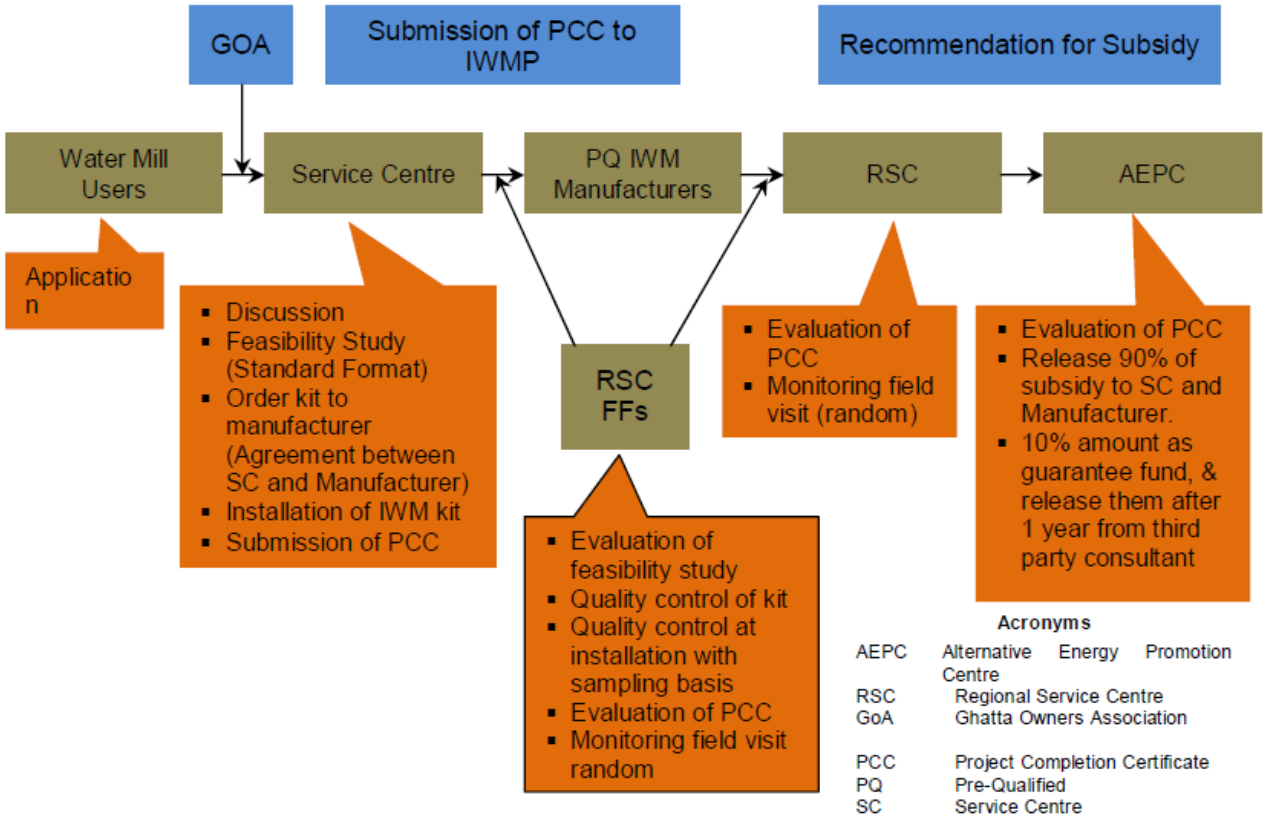
N/A

C.3.6. Changes to project design

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	33
Choice of data or measurement methods and procedures	The sample size has been determinedas per sample size calculation done in appendix 5 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	**For 2015 - 2016** CPA-1: Long Shaft: 100% (out of sampled IWM) Short Shaft: 90.48% (out of sampled IWM) **For 2017** CPA-1: Long Shaft: 100% (out of sampled IWM) Short Shaft: 90.48% (out of sampled IWM) CPA-2: Long Shaft: 100% (out of sampled IWM) Short Shaft: 83.72% (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 and covering five development regions and two ecological regions to get the best representative
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

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	**For 2015 - 2016** CPA-1: Long Shaft: 9.16 hours daily (192 operational days per year) Short Shaft: 10.78 hours daily (261 operational days per year) **For 2017** CPA-1: Long Shaft: 12.7 hours daily (246.7 operational days per year) Short Shaft:11.5 hours daily (241 operational days per year) CPA-2: Long Shaft: 12 hours daily (207.5 operational days per year) Short Shaft: 14.3 hours daily (269.7 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 and covering five development regions and two ecological regions to get the best representative
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

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: 46 Short Shaft: 1092
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	

E.3. Implementation of sampling plan

(a) Sample Size Determination

Sample size was determined using simple random sampling consistent with the monitoring plan of the registered PoA-DD and respective CPA-DDs and guidelines for sampling and surveys for CDM project activities and programme of activities (version 03). 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)

$$n \geq \frac{1.645^2 N * p(1-p)}{(N-1) * 0.1^2 * p^2 + 1.645^2 p(1-p)}$$

Where,
n = sample size
N = Total number of IWM users (Entrepreneurs) (For CPA-1: 2199; For CPA-2: 1138)
p = our expected proportion (0.9, being conservative and assuming 90% of the installed IWM will be in use; however, the IWM Users' Survey 2012/13 conducted by an independent third party has revealed that the 98.59% of IWM surveyed were operational).
1.645 = represents the 90% confidence required
0.1 = represents the 10% relative precision (0.1x0.5 = 0.05 = 5% points either side of p)

Substituting the values in the above equation gives n = 29.67 which was rounded up to value 30. Although the sample size was determined to be 30, additional 50% of 30 samples have been considered to ensure the better representation and address the non-responses. Hence a total of 45 samples were considered for the survey for each CPAs.

Sample Size for the Mean Value Parameter (Daily Operation Hours of IWMfor 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)
SD = Standard deviation = 2.25 hrs (this value was revealed by the study conducted by independent consultant)
Mean = Mean operational hoursfor agro processing = 9.52 hrs (this value was revealed by the study conducted by independent consultant)
1.645 = Represent 90% confidence required
0.1 = Represent the 10% relative precision

Substituting the values in the above equation gives n = 15.02 which was rounded up to value 16. Among the above formulae the sample size calculated from the former equation results in more conservative sample size i.e.45 (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

Samples are allocated in three different ways to maintain the representativeness. First, samples are allocated proportionally to the types ecological belts; development regions and the types of IWMs (i.e. long shaft and short shaft) based on proportion of IWMs installed in these two areas. The tables below depict the sample allocation against the installed IWMs in respective CPAs.

Sample allocation of CPA-1 according to ecological belts

Ecological Zones	No of Districts	Total IWM Installed	Percentage of IWM	Sample Size
Accessible Hill	27	1,638	74.5	34
Remote Hill	7	561	25.5	11
Total	**34**	**2,199**	**100**	**45**

Sample allocation for CPA-1 according to ecological belts, development regions and IWM type

Ecological Zone									
Accessible Hill (Mountain)									
Strata	**Long Shaft**				**Short Shaft**				
	No. of IWM	**%**	**Sample Size**	**Adjusted Sample**	**No of IWM**	**% of IWM**	**Sample Size**	**Adjusted Sample**	**Total IWM**
Eastern	14	8.9	0.4	0	144	91.14	3.6	4	158
Central	83	13.8	1.7	2	512	86.20	10.3	10	594
Western	7	13.0	0.1	0	47	87.04	0.9	1	54
Mid Western	32	7.4	0.7	1	398	92.56	8.3	8	430
Far Western	10	2.5	0.2	0	392	97.51	7.8	8	402
Total	**146**			**3**	**1493**			**31**	**1638**
Remote Hill									
Strata	**Long Shaft**				**Short Shaft**				

	No. of IWM	%	Sample Size	Adjusted Sample	No of IWM	% of IWM	Sample Size	Adjusted Sample	Total IWM
Mid-Western	9	3.1	0.2	0	284	96.9	5.8	6	293
Far Western	5	1.9	0.1	0	263	98.1	4.9	5	268
Total	**14**			**0**	**547**			**11**	**561**

Sample allocation of CPA-2 according to ecological belts

Ecological Zones	No of Districts	Total IWM Installed	Percentage of IWM	Sample Size
Accessible Hill	31	807	70.9	32
Remote Hill	12	331	29.1	13
Total	**43**	**1,138**	**100**	**45**

Sample allocation for CPA-2 according to ecological belts, development regions and IWM type

Ecological Zone									
Accessible Hill									
Strata	**Long Shaft**				**Short Shaft**				
	Number of IWM	**Percent of IWM**	**Sample Size**	**Adjusted Sample Size**	**Number of IWM**	**Percent of IWM**	**Sample Size**	**Adjusted Sample Size**	**Total IWM**
Eastern	8	14.5	0.3	0	47	85.5	1.7	2	55
Central	23	12.4	0.9	1	162	87.6	6.1	6	185
Western	0	0.0	0.0	0	62	100.0	3.0	3	62
Mid-Western	8	2.7	0.3	0	284	97.3	11.7	12	292
Far Western	0	0.0	0.0	0	213	100.0	8.0	8	213
Total	**39**			**1**	**768**			**31**	**807**
Remote Hill									
Strata	**Long Shaft**				**Short Shaft**				
	Number of IWM	**Percent of IWM**	**Sample Size**	**Adjusted Sample Size**	**Number of IWM**	**Percent of IWM**	**Sample Size**	**Adjusted Sample Size**	**Total IWM**
Eastern	0	0.0	0.0	0	11	100.0	0.0	0	11
Western	0	0.0	0.0	0	17	100.0	0.0	0	17
Mid-Western	7	4.1	0.3	0	164	95.9	6.7	7	171
Far Western	0	0.0	0.0	0	132	100.0	6.0	6	132
Total	**7**			**0**	**324**			**13**	**331**

(c) Selection of Districts

The districts having installed IWM equal to or greater than the sample size required for the stratum will be considered as eligible. Firstly eligible district will be identified and the district will be selected from each stratum considering the proportionate representative and eligibility.

Sample selection for the CPA-1 in 2015 - 2016

Accesible Hill			
Region	**Districts**	**Installed IWM**	**Sample Size**
Eastern	Solukhumbu	11	4
Central	Sindhuli	119	12
Western	Gorkha	35	1
Mid-Western	Dailekh	140	9
Far-Western	Doti	136	8
Sub-total			**34**
Remote Hill			
Mid Western	Kalikot	113	6
Far-Western	Bajhang	119	5
Sub-total			**11**
Total			**45**

Sample selection for the CPA-1 in 2017

Accesible Hill			
Region	**Districts**	**Installed IWM**	**Sample Size**
Eastern	Okhaldhunga	139	4
Central	Sindhuli	119	12
Western	Kaski	5	1
Mid-Western	Salyan	94	9
Far-Western	Baitadi	141	8
Sub-total			**34**
Remote Hill			
Mid Western	Jajarkot	117	6
Far-Western	Darchula	125	5
Sub-total			**11**
Total			**45**

Sample selection for the CPA-2 in 2017

Accesible Hill			
Region	**Districts**	**Installed IWM**	**Sample Size**
Eastern	Okhaldhunga	17	2
Central	Makwanpur	15	7
Western	Kaski	48	3
Mid-Western	Salyan	61	12
Far-Western	Baitadi	87	8
Sub-total			**32**
Remote Hill			
Mid Western	Jajarkot	81	7
Far-Western	Darchula	49	6
Sub-total			**13**
Total			**45**

(d) Survey

Survey was conducted in the month of February to April, 2018 for the monitoring period 2017 whereas it was conducted in the month of February to April 2017 for the monitoring period 2015-2016. Enumurators were trained on structured questionnaires and mobilized in the field for data collection.

(e) 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, a thorough check of the questionnaires filled up by the enumerators was done during the field survey and any inconsistency was corrected immediately.

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: 17,497 tCO_2e

Total emission reduction for CPA-2 for the monitoring period: 4,338 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	17,497	0	0	0	17,497	17,497
9889-0002	4,338	0	0	0	4,338	4,338
Total	**21,835**	**0**	**0**	**0**	**21,835**	**21,835**

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 (t CO_2e)
9889-0001	17,497	25,517
9889-0002	4,338	10,315
Total	**21,835**	**35,832**

F.6. Remarks on increase in achieved emission reductions

N/A

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Document information

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