ENERGY EFFICIENCY FROM SHOWER AERATION TECHNOLOGY

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Relationship to Approved or Pending Methodologies

No approved or pending methodology under the VCS Program or an approved GHG program can reasonably be revised to meet the objective of this proposed methodology. All existing and pending VCS, CDM and CAR methodologies under sectoral scope 3 have been reviewed. All corresponding methodologies have been grouped and listed below. None of the six similar methodologies listed below could be revised without the addition of significant new procedures or scenarios. Greatest similarity can be found in the *CDM AMS-II.M. – Demand-side energy efficiency activities for installation of low-flow hot water savings devices Version 1.0 methodology*. This methodology comprises activities for direct installation of low-flow hot water savings devices that are used in residential buildings. In order to meet the eligibility requirements of this methodology low-flow devices are required to permanently replace baseline faucets. The AMS-II.M methodology is restricted to residential buildings and low-flow devices which permanently replace baseline faucets. It was determined that AMS-II.M could not be sufficiently revised to apply to a removable shower flow restrictor aerator device which could be installed in non-residential buildings.

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Program	Sectoral Scope	Title	Similarity
CDM	3	*AM0017 - Steam system efficiency improvements by replacing thermal energy traps and returning condensate --- Version 2.0*	Not Similar
CDM	3	*AM0018 - Baseline methodology for thermal energy optimization systems --- Version 2.2*	Not Similar
CDM	3	*AM0020 – Baseline methodology for water pumping efficiency improvements Version 2.0*	Not Similar
CDM	3	*AM0046 –Distribution of efficient light bulbs to households Version 1.0*	Similar
CDM	3	*AM0060 – Power saving through replacement of energy efficient chillers Version 1.1*	Not Similar
CDM	3	*AM0068 - Methodology for improved energy efficiency by modifying ferroalloy production facility --- Version 1.0*	Not Similar
CDM	3	*AM0086 – Installation of zero energy water purifier for safe drinking water application – Version 1.1.0*	Not Similar
CDM	3	*AM0088 - Air separation using cryogenic energy recovered from the vaporization of LNG --- Version 1.0*	Not Similar
CDM	3	*AM0091 – Energy efficiency technologies and fuel switching in new buildings*	Not Similar
CDM	3	*AM0105 – Energy efficiency in data centres through dynamic power management*	Not Similar
CDM	3	*AMS-II.C.- Demand-side energy efficiency activities for specific technologies --- Version 13.0*	Similar
CDM	3	*AMS-II.E. – Energy efficiency and fuel switching measures for buildings Version 10.0*	Not Similar
CDM	3	*AMS-II.F. - Energy efficiency and fuel switching measures for agricultural facilities and activities --- Version 9.0*	Not Similar
CDM	3	*AMS-II.G. - Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass --- Version 2.0*	Not Similar
CDM	3	*AMS-II.J. Demand-side activities for efficient lighting technologies Version 4.0*	Not Similar
CDM	3	*AMS-II.K. Installation of co-generation or tri-generation systems supplying energy to commercial building Version 2.0*	Not Similar
CDM	3	*AMS-II.L. Demand-side activities for efficient outdoor and street lighting technologies Version 1.0*	Not Similar
CDM	3	*AMS-II.M. – Demand-side energy efficiency activities for installation of low-flow hot water savings devices Version 1.0*	Similar
CDM	3	*AMS – II.N. – Demand-side energy efficiency activities for installation of energy efficient lighting and/or controls in buildings*	Similar
CDM	3	*AMS – II.O. – Dissemination of energy efficient household appliances Version 1.0*	Similar
CDM	3	*AMS – II.P. Energy efficient pub-set for agriculture use Version 1.0*	Not Similar
CDM	3	*AMS – II.Q. Energy efficiency and/or energy supply projects in commercial buildings Version 1.0*	Similar

Program	Sectoral Scope	Title	Similarity
CDM	3	*AMS – III.AE. Energy efficiency and renewables energy measures in new residential buildings Version 1.0*	Not Similar
CDM	3	*AMS – III.AL. Conversion from simple cycle to combine cycle power generations*	Not Similar
CDM	3	*AMS – III.AV. Low greenhouse gas emitting water purification systems Version 2.0*	Not Similar
CDM	3	*AMS – III.X. Energy Efficiency and RFC-134a Recovery in Residential Refrigerators Version 2.0*	Not Similar
VCS	3	*VM0008- Methodology for weatherization of single and multi-family buildings v1.0*	Not Similar
VCS	3	*VM0013 - Calculating Emission Reductions from Jet Engine Washing v1.0*	Not Similar
VCS	3	*VM0018 – Energy Efficiency and Solid Waste Diversion Activities within a Sustainable Community*	Not Similar

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1 SOURCES

This methodology aims to comply with the principles of:

- ISO 14064: Part 2, "Specification with guidance at the project level for the quantification, monitoring and reporting of greenhouse gas emission reductions and removal enhancements" (ISO, 2006).
- VCS, "VCS Standard: VCS Version 3", (VCS, VERSION 3) a.k.a. "VCS Version 3"

The approach within has been based on elements of the following methodologies:

- CDM "AMS-II.M. – Demand-side energy efficiency activities for installation of low-flow hot water savings devices Version 1".
- Voluntary Gold Standard "Indicative Program, Baseline and Monitoring Methodology for Large Scale Supply and Distribution of Efficient Light Bulbs. Showerheads and Other Water Saving Products to Households Version 02"

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

This methodology provides a framework for the quantification of emission reductions associated with the direct installation of a flow restrictor aeration device (a "device"), which fixes between a shower hose and showerhead. The device reduces water flow through the showerhead while maintaining an equivalent level of service perceived by the user. The reduced volume of hot water flowing to the shower results in reduced energy required to heat the water and consequently GHG emission reductions. The level of emission reductions achieved depends on the type of water heater, typically electric, natural gas or oil.

Additionality	Project Method
Crediting Baseline	Project Method

3 DEFINITIONS

Device
A flow restrictor aeration device which reduces water-flow in a showerhead while maintaining an equivalent level of service

Equivalent Level of Service
Same functional comfort and cleaning performance under baseline and project condition

4 APPLICABILITY CONDITIONS

This methodology is applicable to the quantification of direct and indirect reductions of GHG emissions arising from reduced hot water consumption as a result of the installation of a water aerating device on a showerhead. Applicable facilities include all buildings where showering facilities are in place.

The project proponent must apply the latest version of the CDM Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality at the project level.

The following guidance provides further clarification on project activities, approach and applicability:

- Only retrofit projects are eligible; greenfield projects are not included under this methodology. The baseline is contingent on the use of existing showerheads.
- The project proponent shall implement a quality control system for ensuring correct installation and only project units that meet correct installation criteria are eligible. The project proponent is to determine a process to monitor the installed devices to ensure that they remain correctly installed for the duration of the project.
- The project proponent must demonstrate that the project location is within a geographical area where water is heated via the use of electricity and/or fossil fuels.
- Through independent third party testing the project proponent must demonstrate that the device provides an equivalent level of service to the baseline, where equivalent level of service is defined as same functional comfort and cleaning performance.

5 PROJECT BOUNDARY

The project boundary is the location of each installed device and the associated water heating system.

Figure 1: Baseline Life Cycle Chart

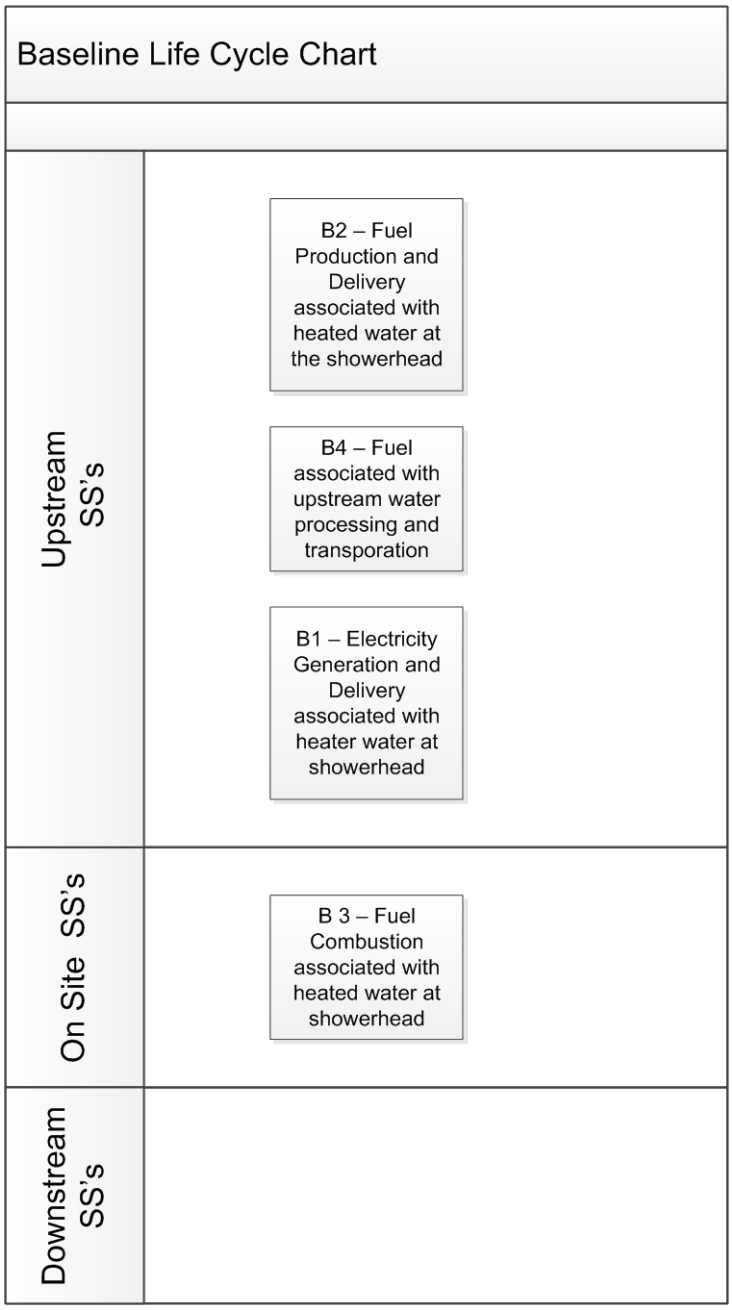

Figure 2: Project Life Cycle Chart

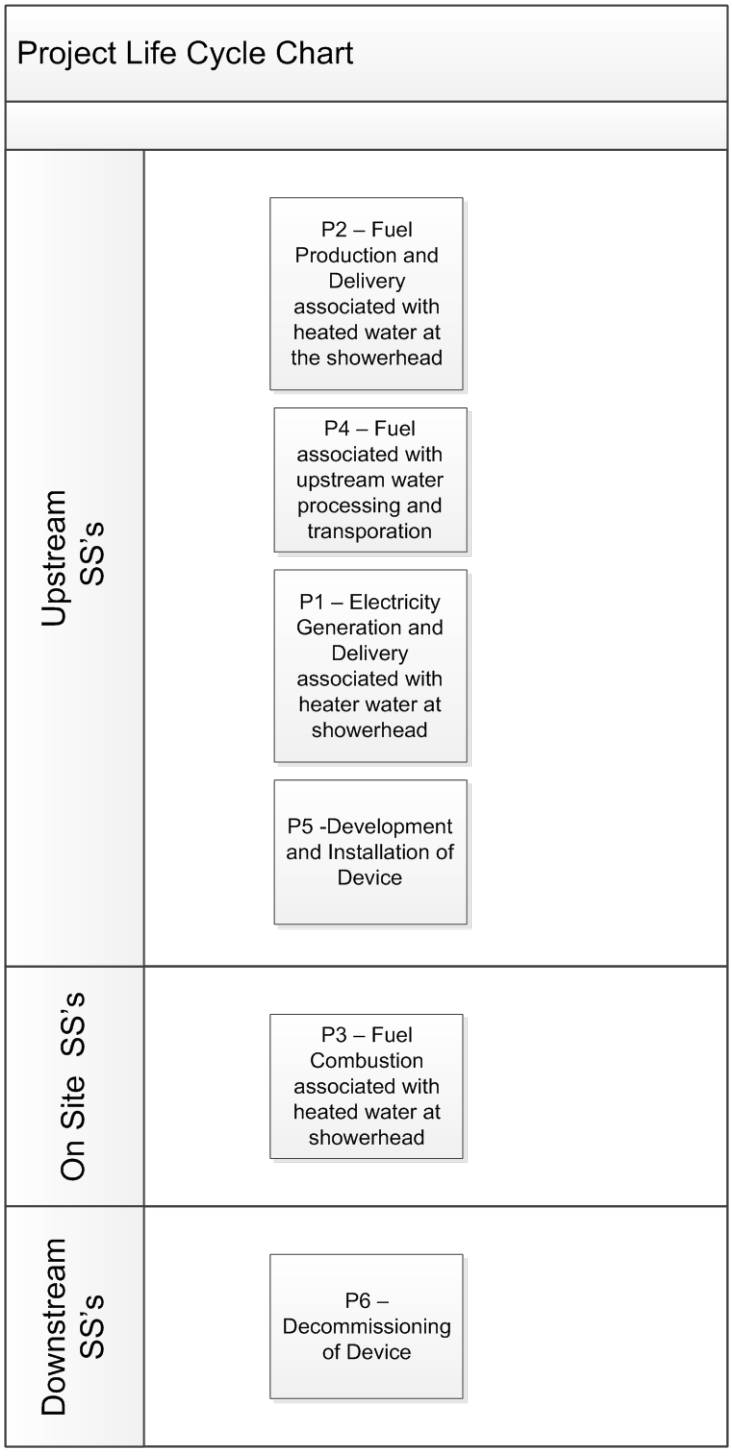

Table 1: Baseline and Project Emission Sources

Source		Gas	Included?	Justification/Explanation
Baseline	B1 – Electricity Generation and Delivery associated with heated water at showerhead	CO_2	Yes	CO_2 emissions from grid connected electricity generation shall be accounted for. Emissions from CH_4 and N_2O are excluded. Baseline emissions from CH_4 and N_2O will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	B2 – Fuel Production and Delivery associated with heated water at showerhead	CO_2	No	Excluded emissions will be negligible. Baseline emissions from this source will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	B3 – Fuel Combustion associated with heated water at showerhead	CO_2	Yes	CO_2 emissions from fuel combustion shall be accounted for. Emissions from CH_4 and N_2O are excluded. Baseline emissions from CH_4 and N_2O will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	B4 – Fuel Associated with upstream water processing and transportation	CO_2	No	Excluded emissions will be negligible. Baseline emissions from this source will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	

Source		Gas	Included	Justification/Explanation
Project	P1 – Electricity Generation and Delivery associated with heated water at showerhead	CO_2	Yes	CO_2 emissions from grid connected electricity generation shall be accounted for. Emissions from CH_4 and N_2O are excluded. Baseline emissions from CH_4 and N_2O will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	P2 – Fuel Production and Delivery associated with heated water at showerhead	CO_2	No	Excluded emissions will be negligible. Baseline emissions from this source will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	P3 – Fuel Combustion associated with heated water at showerhead	CO_2	Yes	CO_2 emissions from fuel combustion shall be accounted for. Emissions from CH_4 and N_2O are excluded. Baseline emissions from CH_4 and N_2O will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	P4 – Fuel Associated with upstream water processing and transportation	CO_2	No	Excluded emissions will be negligible. Baseline emissions from this source will be greater than project emissions; exclusion of this emission source is conservative.
		CH_4	No	
		N_2O	No	
	P5 – Development and Installation of Device	CO_2	No	Excluded emissions will be negligible.
		CH_4	No	
		N_2O	No	
	P6 – Decommissioning of Device	CO_2	No	Excluded emissions will be negligible.
		CH_4	No	
		N_2O	No	

6 PROCEDURE FOR DETERMINING THE BASELINE SCENARIO AND PROCEDURE FOR DEMONSTRATING ADDITIONALITY

The project proponent must follow the step-wise approach specified in the latest version of the CDM Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality. The tool shall be applied with baseline alternatives and project scenarios categorized by project units. The cost savings associated with energy efficiency shall be included in the investment analysis.

The baseline scenario shall be determined by analyzing, at minimum, existing and future regulatory requirements at all jurisdictional levels to ensure that each project proactively exceeds all current regulations in the projects designed geographic area(s).

In addition to a regulatory review, the project proponent shall also provide evidence to support that market conditions are such that application of the project technology is not common practice within the project geographic area. This would include forward aggressive demand-side management programs.

7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

7.1 Baseline Emissions

This methodology applies a project specific approach to determine baseline emissions.

$$V_{water,\,B} = Q_{water,\,B} \times t$$

$$E_{Electricity,\,B} = V_{water,\,B} \times R_{water,\,electricity} \times \left(T_{exit,\,B} - T_{enter,\,B}\right) \times \frac{C_p}{n_{eff}}$$

$$E_{Fuel,\,B} = V_{water,\,B} \times R_{water,\,fuel} \times \left(T_{exit,\,B} - T_{enter,\,B}\right) \times \frac{C_p}{n_{eff}}$$

$$BE_{shower} = \sum \left[\left(E_{fuel,\,B} \times EF_{CO2,fuel} \times GWP_{CO2} \right); \left(E_{electricity,\,B} \times EF_{CO2,fuel} \times GWP_{CO2} \right); \right]$$

$$BE_{y} = BE_{shower} \times N_{shower}$$

Where:

N_{shower} = Number of showers per year

BE_{shower} = Baseline emissions per shower

BE_{Y} = Baseline emissions in year y

$V_{Water,\,B}$ = Total volume of water consumed per shower under the baseline condition (L).

$Q_{water,\,B}$ = Flow rate of water through a showerhead under baseline condition, where baseline condition is established through local/regional documentation.

t = Duration of shower (min)

$T_{exit,\,B}$ = Temperature of water exiting showerhead under baseline condition (degrees Celsius)

$T_{enter\,B}$ = Temperature of water entering water heater under baseline condition (degrees Celsius)

$R_{water,\,electricity}$ = Percent of water heated by electricity

$R_{water,\,fuel}$ = Percent of water heated by fuel

Cp = Volumetric heat capacity of water

n_{eff} = Water heater efficiency

$E_{Electricity,\,B}$ = Energy of electricity consumed by water heater to heat water used by the showerhead under baseline condition (kWh)

$E_{Fuel,B}$ = Energy of fuel consumed by water heater to heat water used by the showerhead (GJ)

BE_{shower} = Baseline emissions per shower

$EF_{CO2,Fuel}$ = Fuel combustion emission factor for CO_2 (kg CO_2/GJ)

$EF_{CO2,Electricity}$ = Electricity combustion emission factor for CO_2 (kg CO_2/kWh)

GWP = Global warming potential (tonnes $_{CO2e}$)

7.2 Project Emissions

$V_{water,P} = Q_{water,P} \times t \times N_{shower}$

$E_{Electricity,P} = V_{water,P} \times R_{water,electricity} \times (T_{exit,P} - T_{enter,P}) \times \frac{C_p}{n_{eff}}$

$E_{Fuel,P} = V_{water,P} \times R_{water,fuel} \times (T_{exit,P} - T_{enter,P}) \times \frac{C_p}{n_{eff}}$

$PE_y = \sum [(E_{fuel,P} \times EF_{CO2,fuel} \times GWP_{CO2});(E_{electricity,P} \times EF_{CO2,electricity} \times GWP_{CO2});]$

$PE_y = PE_{shower} \times N_{shower}$

Where:

$V_{Water,P}$ = Total volume of water consumed by showerheads in each project unit in year y under project condition (L)

$Q_{water,P}$ = Average flow rate of water through a showerhead and device under project condition (L/min)

t = Duration of shower (min)

N_{shower} = Number of showers per year

$T_{exit,P}$ = Temperature of water exiting showerhead under project condition (degree Celsius)

$T_{enter\ P}$ = Temperature of water entering water heater under project condition (degree Celsius)

$R_{water,electricity}$ = Percent of water heated by electricity

$R_{water, fuel}$ = Percent of water heated by fuel

Cp = Volumetric heat capacity of water

n_{eff} = Water heater efficiency

$E_{Electricity, P}$ = Energy of electricity consumed by water heater to heat water used by the showerhead in project condition (kWh)

$E_{Fuel, P}$ = Energy of fuel consumed by water heater to heat water used by the showerhead in project condition (GJ)

PE_Y = Project emissions in year y

$EF_{CO2,Fuel}$ = Fuel combustion emission factor for CO_2 (kg CO_2/GJ)

$EF_{CO2,Fuel}$ = Electricity combustion emission factor for CO_2 (kg CO_2/kWh)

GWP = Global warming potential (tonnes $_{CO2e}$)

7.3 Leakage

There are no anticipated sources of emissions leakage.

7.4 Summary of GHG Emission Reduction and/or Removals

$ER_y = BE_y - PE_y$

Where:

ER_Y = Net GHG emissions reductions and/or removals in year y

BE_Y = Baseline emissions in year y

PE_y = Project emissions in year y

8 MONITORING

8.1 Data and Parameters Monitored

The following data parameters are to be monitored in accordance with the VCS methodology and the project document.

Data Unit / Parameter:	$Q_{water,\ B}$
Data unit:	L/min
Description:	Average flow rate of water through a showerhead under baseline condition
Source of data:	Monitored flow rate of water through a showerhead for a statistically representative sample of instances or the use of a conservative assumption supported by geographically specific available and reputable reference(s). Documentation from government or private research often provides average flow data for a given region.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$Q_{water,\ P}$
Data unit:	L/min
Description:	Average flow rate of water through a showerhead under project condition
Source of data:	Monitored flow rate of water through a showerhead for a statistically representative sample of instances or the use of a conservative assumption supported by geographically specific available and reputable reference(s)
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	**t**

Data unit:	Min
Description:	Average shower duration
Source of data:	Monitored shower duration for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Documentation from government or private research often provides average shower duration for a given region.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$N_{showers}$
Data unit:	number of showers/instance/year
Description:	Average number of showers in a particular instance on an annual basis
Source of data:	Monitored number of showers per instance on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Documentation from government or private research often provides average flow number of showers per person or per household for a given region.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$T_{exit, B}$
Data unit:	Degree Celsius
Description:	Temperature of water exiting showerhead under baseline condition

Source of data:	Monitored water temperature on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Documentation from government or private research often provides average water temperature for a given region.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$T_{exit, P}$
Data unit:	Degree Celsius
Description:	Temperature of water exiting showerhead under project condition
Source of data:	Monitored water temperature on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Unless the project changes the water temperature, this should be the same as $T_{exit, B}$
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$T_{enter, B}$
Data unit:	Degree Celsius
Description:	Temperature of water entering water heater under baseline condition
Source of data:	Monitored water temperature on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s).

Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$T_{enter, P}$
Data unit:	Degree Celsius
Description:	Temperature of water entering water heater under project condition
Source of data:	Monitored water temperature on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Documentation from government or private research often provides average ground water temperature for a given region.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$R_{water, electricity}$
Data unit:	%
Description:	Ratio of water heated by electricity
Source of data:	Calculated percent of water heated by electricity within the project. Each project instance must provide project specific fuel source data which will be used to calculate percent of water heated by a particular electricity generation mix within the project.
Justification of choice of data or description of measurement methods and procedures applied:	Parameter value is a function of data collected during the project.
Any comment:	Not available at project validation

Data Unit / Parameter:	$R_{water, fuel}$
Data unit:	%
Description:	Ratio of water heated by fuel
Source of data:	Calculated percent of water heated by a particular fuel within the project. Each project instance must provide project specific fuel source data which will be used to calculate percent of water heated by a particular fuel within the project.
Justification of choice of data or description of measurement methods and procedures applied:	Parameter value is a function of data collected during the project.
Any comment:	Not available at project validation

Data Unit / Parameter:	Cp
Data unit:	GJ/(L °C)
Description:	Volumetric heat capacity of water
Source of data:	Constant
Justification of choice of data or description of measurement methods and procedures applied:	The volumetric heat capacity of water is a scientific constant. The value is 4.184^6 GJ/(L °C)
Any comment:	Available at point of validation.

Data Unit / Parameter:	n_{eff}
Data unit:	%
Description:	Water heater efficiency
Source of data:	Monitored water heater efficiency on an annual basis for a statistically representative sample of instances or the use of a conservative assumption supported by available and reputable reference(s). Documentation from government or private research often provides water heater efficiencies.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Assumption based on reputable reference(s) will be available at validation.

Data Unit / Parameter:	$EF_{CO2, Fuel}$
Data unit:	kg CO_2 per GJ
Description:	CO_2 Emission Factor for fuel source
Source of data:	For fuel combustion for the appropriate geographic area, the project proponent must identify the most appropriate emission factors for the source of thermal energy used under the project and baseline condition.
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice. The example provided is one of the most comprehensive fuel emission factor databases available.
Any comment:	Available at validation

Data Unit / Parameter:	$EF_{CO2, Electricity}$
Data unit:	kg CO_2 per kWh
Description:	CO_2 Emission Factor for electricity
Source of data:	Literature based on data as obtained from local authorities or where such data is either not available or where available but suspect then as calculated according to the CDM “Tool to calculate the emission factor for an electricity system”
Justification of choice of data or description of measurement methods and procedures applied:	The project proponent must choose the values in a conservative manner and justify the choice.
Any comment:	Available at validation

8.2 Description of the Monitoring Plan

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with minimal need for assumptions and contingency procedures. The project proponent shall develop a database containing all relevant project data. At a minimum, project data captured shall include documentation of all parameters required by the methodology. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project database should include the following information for each project instance:

- Geographic location
- Applicability project type/sector
- Participant contact information
- Unique identifier for each project instance (facility or household)
- Date of device installation
- All applicable parameters specific to the project instance including shower temperature, duration and number of showers per household or facility, hot water heating source, hot water heater efficiency
- All other applicable ongoing monitoring information as required by the monitoring plan

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigor of the management system for the data, the easier it will be to conduct a verification of the project.

In case of doubt regarding appropriateness of the proposed sample, project proponents should refer to the latest version of the CDM *General Guidelines on Sampling and Surveys for Small Scale Project Activities and PoAs*.

Record keeping practices should include:

- Electronic recording of values of logged primary parameters for each measurement interval;
- Offsite electronic back-up of all logged data; and
- The project proponent shall keep all documents and records in a secure and retrievable manner for at least two years after the end of the project crediting period.

QA/QC should also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

- Protecting monitoring equipment (sealed meters and data loggers);
- Protecting records of monitored data (hard copy and electronic storage);

- Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
- Comparing current estimates with previous estimates as a 'reality check';
- Provide sufficient training to project participants to install and maintain the device;
- Establish minimum experience and requirements for operators in charge of project and monitoring; and
- Performing recalculations to make sure no mathematical errors have been made.

Confidence Interval

- The confidence interval shall set to be 95%.

Project Monitoring Sample Size

- The sample should be selected at random across all instances taking into account the project type as described in the project applicability section.
- The project proponent shall have a documented procedure for determining the sample to be taken when monitoring project sites and submit to the verification bodies.
- When and where necessary, stratified random sampling will be conducted on homogeneous sub-populations. The criteria for sub-population grouping is are based on appropriate codification.