SAFE DRINKING WATER SUPPLY PROJECT IN THE RURAL AREA OF SENEGAL

Document Prepared by Guangzhou Iceberg Environmental Consulting Services

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Co., Ltd.

Project Title	Safe Drinking Water Supply Project in the Rural Area of Senegal
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1 PROJECT DETAILS

1.1 Summary Description of the Project

This project, as a safe drinking water supply project, aims to solve the problem of domestic water supply for local rural residents in Senegal. Most of the villages involved are located in remote areas, far away from the cities with centralized water supply. Since it is difficult to extend the urban pipeline network to them, there was no qualified water supply facilities in these villages before the implementation of the project activity. The water supply facilities in these villages were seriously inadequate and backward, coupled with the rapid population growth, leading to a serious shortage of water for living and other uses. The basic living conditions of the people were not met.

Before the implementation of the project, local people would have used fossil fuels and non-renewable biomass (NRB) to boil water as means of water purification. Due to low income, people would continue to use them to purify water without the project activity.

The project includes construction of wells as well as water disinfection and distribution system. The project covers villages in 12 of the 14 regions of Senegal, with a total of 1,340 water supply points. The capacity of project can meet the water demand of over 1,000,000 people.

The project selects groundwater with good quality as water source, and water disinfectant is used for purify the water. Hence the project will reduce the GHG emissions by reducing fossil fuels and non-renewable firewood combustion for water boiling as means of water purification.

The annual total GHG emission reduction of project is 298,820 tCO_2e. The crediting period is expected to be 7 years, twice renewable to a total of 21 years. The total GHG emission reduction of 7 years is 2,091,740 tCO_2e.

1.2 Sectoral Scope and Project Type

The project is categorised under type/category as below:

a) Sectoral scope: 03 - Energy demand

b) Type: II – Energy efficiency improvement projects

The project is not a grouped project.

1.3 Project Eligibility

The project involves introduction of low greenhouse gas emitting water purification systems to provide safe drinking water (SDW) which falls into the category of efficiency improvements in thermal applications and reduces the use and demand of fossil fuel and non-renewable biomass that would have been used to boil the water. The applied methodology for the project is AMS–III.AV: “Low greenhouse gas-emitting safe drinking water production systems (version 08)”. According to Section 2.1.1 of VCS Standard (Version 4.3), project activity does not fall under the excluded list of projects. Therefore it is eligible under the scope of VCS Program.

1.4 Project Design

☐ The project includes a single location or installation only

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

☐ The project is a grouped project

Eligibility Criteria

Not applicable because the project activity is not a grouped project.

1.5 Project Proponent

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1.6 Other Entities Involved in the Project

No other entity is involved in the project.

1.7 Ownership

The project ownership belongs to Guangzhou Iceberg Environmental Consulting Services Co., Ltd (hereinafter referred to as Iceberg). Carbon transfer agreements were signed between the users’ representatives and Iceberg.

1.8 Project Start Date

23/03/2021, when the project was accepted by Senegalese government and started to operate

1.9 Project Crediting Period

7 years, twice renewable to a total of 21 years, crediting period is from 23/03/2021 to 22/03/2042.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year 1	298,820
Year 2	298,820
Year 3	298,820
Year 4	298,820
Year 5	298,820
Year 6	298,820
Year 7	298,820
Total estimated ERs	2,091,740
Total number of crediting years	7
Average annual ERs	298,820

1.11 Description of the Project Activity

The project includes construction of wells as well as water disinfection and distribution system.

The capacity of the project can meet the water demand of over 1,000,000 people.

Technology

Water source: Underground water

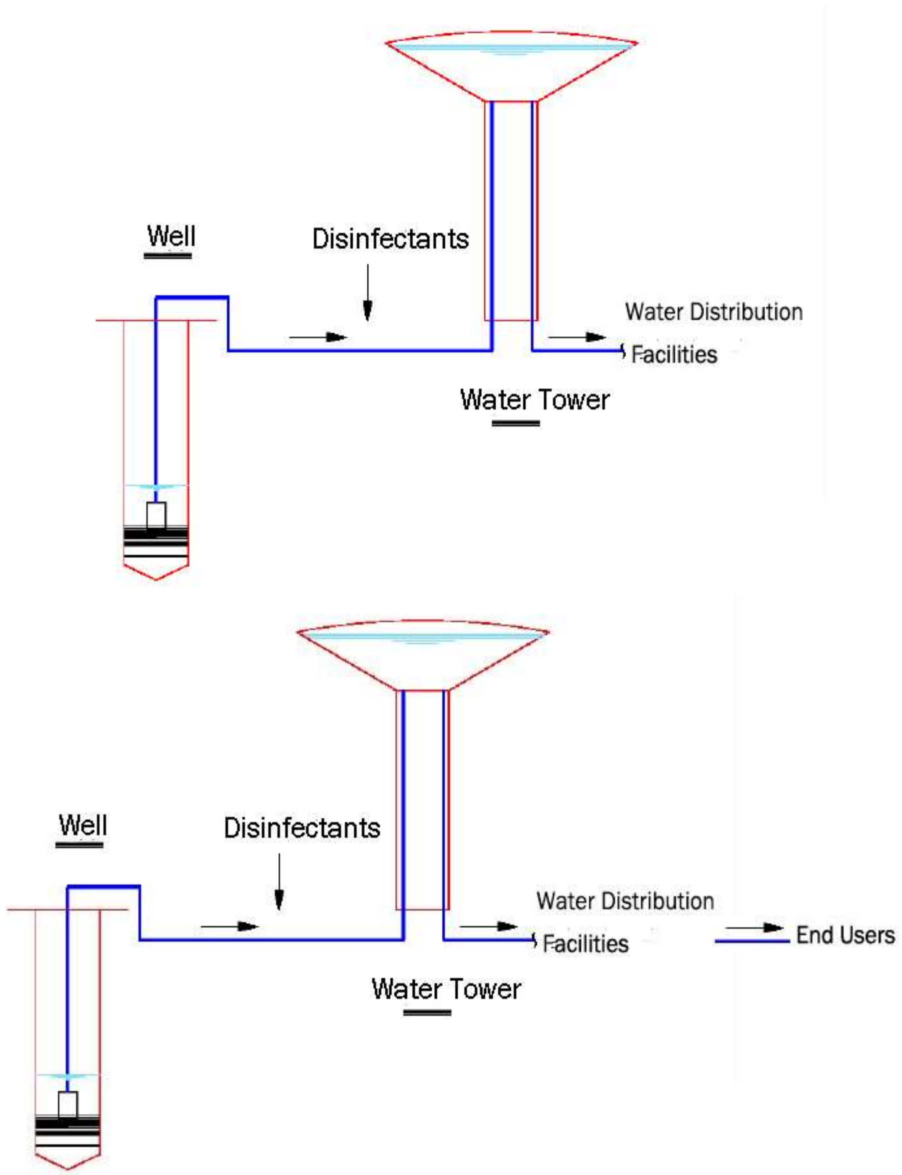


Figure 1: Process flow diagram

Each of new well systems is typically 40m in length and 30m in width, covering an area of 1200m^2. The main buildings and structures include water wells, water towers, pump rooms and communication rooms.

Table 1: Main buildings and structures in a typical well area (single system)

No.	Name	Building area or specifications	Structure type	Number
1	water well	/	/	1
2	water tower	V=150~200m^3	Steel concrete	1

3	pump room	22.0m²	Brick and mortar	1
4	communication room	21.6m²	Brick and mortar	1

The total length of the newly laid water transmission and distribution pipeline is about 1800Km, using PVC-U water supply pipe, pipe diameter is de160～de63. The project has a total of 1,340 water supply points, which are basic units for end users to collect water from the project. The capacity of project can meet the water demand of 1,000,000 people.

Most of the villages involved in this project are located in remote areas, which are far away from the cities that use centralized water supply. So it is difficult to extend the urban pipeline network to them. The project reduces the use and demand for fossil fuels and non-renewable biomass that would have been used to boil water as a means of water purification in the absence of the project. This directly leads to reduction of greenhouse gas emissions.

1.12 Project Location

The project is located in 12 of the 14 regions throughout Senegal, namely Diourbel, Fatick, Kaolack, Kolda, Tambacounda, Thiès, Ziguinchor, Matam, Kaffrine, Louga, Saint-Louis and Sé dhiou.

Table 2: Geographical coordinates of involved regions

Orientation	Latitude/Longitude
East	11°51′43″W
West	17°09′45″W
South	12°19′53″N
North	16°41′13″ N

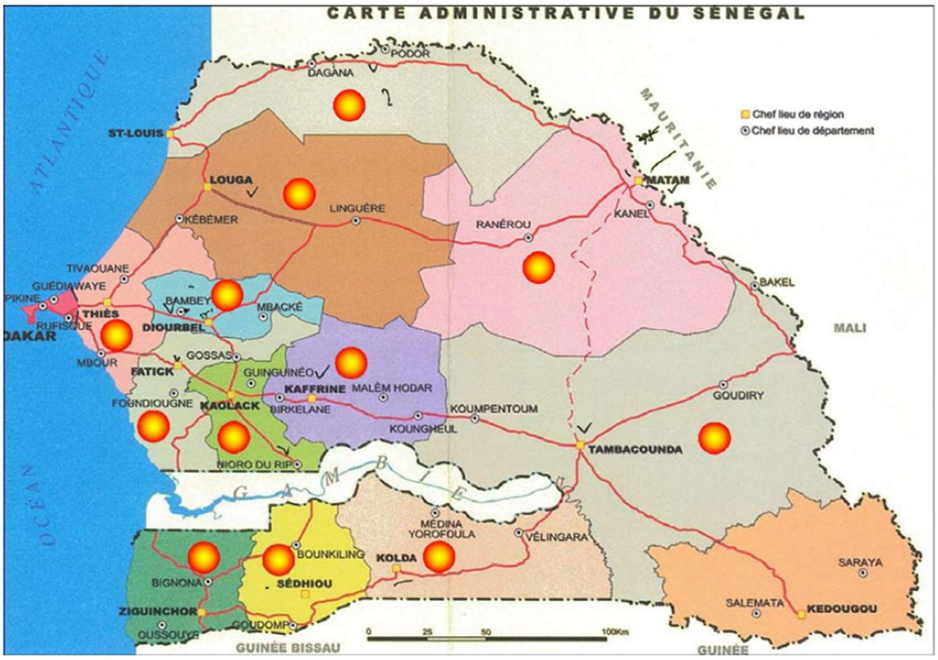


Figure 2: Map of the 12 regions throughout Senegal

1.13 Conditions Prior to Project Initiation

Prior to the implementation of the project activity, there was no public distribution network supplying SDW to the project boundary according to the field investigation. Most villagers would have used fossil fuels and non-renewable biomass to boil water as a means of water purification, which is also the baseline scenario described in Section 3.4 of the PD.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project is a voluntary action. After searching, there is no mandatory law or requirement in Senegal for the installation of water purification technologies[1].

1.15 Participation under Other GHG Programs

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

The project has not been registered, nor is it seeking registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

[1] https://africanlii.org/

The project has not been rejected by any other GHG program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project is not included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

The project has not sought or received another form of GHG-related credit, including renewable energy certificates.

1.17 Sustainable Development Contributions

Before the implementation of the project, the villages either had insufficient water supply capacity, or the facilities were old and not working properly, or even some villages had no water supply facilities at all, and the water shortage problem was very serious.

The source of drinking water was mostly from untreated river water or unprotected wells. There was basically no potable water that meets WHO standards. People mostly used fossil fuels and non-renewable biomass to boil water for disinfection. The project provides people with clean drinking water. It achieves several sustainable development goals:

Goal 3: Good health and well-being

The project provides safe and sufficient water facilitates, which is a key measure to prevent not only diarrhoeal diseases, but acute respiratory infections and numerous neglected tropical diseases. When people boil water, the firewood generates high PM2.5 and CO smoke. The project reduces people’s exposure to harmful air.

Goal 5: Gender equality

The project reduces women and children’s drudgery through time savings in reducing time spent cutting, collecting, and carrying firewood from trees far away from households. These tasks, if being undertaken without relief, are a major cause of gender inequality.

Goal 6: Clean water and sanitation

Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks. The clean water provided by SDW system improves the current situation.

Goal 8: Decent work and economic growth

The project will continue to operate for a long time, providing a large number of local jobs and driving local economic development.

Goal 9: Industry, Innovation, and Infrastructure

This water supply project is an important infrastructure to ensure the economic and social development of Senegal. The construction promoted the development of related industries.

Goal 13: Climate action

The average annual GHG emission reduction from the project is expected to be 298,820 tCO_2e in 7 years due to less non-renewable firewood combustion for boiling water.

Goal 15: Life on land

The project helps local people consume less firewood and it results in a reduction of GHG emissions compared to the baseline scenario. It also helps reduce deforestation and protect biodiversity and natural habitats in Senegal.

No nationally stated sustainable development priority has been identified in Senegal. So no contribution on this point is achieved by the project.

1.18 Additional Information Relevant to the Project

Leakage Management

Not applicable. According to section 5.4 of applied methodology, where relevant leakage relating to the non-renewable woody biomass shall be assessed as per the relevant procedures of AMS-I.E. The project adopts a net gross adjustment factor of 95% to account for leakage.

Commercially Sensitive Information

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

Further Information

No further information.

2 SAFEGUARDS

2.1 No Net Harm

The construction and operation of this project will have a certain impact on the surrounding environment. Please refer details to Section 2.3.

There is no potential negative socio-economic impact of the project.

2.2 Local Stakeholder Consultation

A local stakeholder consultation meeting was held in 2017, which is before the start of the construction of the project. Stakeholders were identified as those whom directly or indirectly affected by the project. Invitation letters were sent to the leaders of villages, officers and other related organizations. Why and how the project would be constructed and and supply SDW were explained explicitly to the attendees. The attendees raised questions about the project and the questions were well answered. They totally understood the benefits to them, and expressed their support to the project.

2.3 Environmental Impact

Environmental impact during construction and countermeasures

(1) Noise impact and countermeasures

Construction noise mainly comes from the construction machinery and construction materials transportation. In order to reduce the environmental impact of noise from the construction, no noise was generated in the area of 200m from the residential buildings. At the same time, the construction equipment and methods were considered, and low-noise machinery was used as much as possible.

(2) Dust impact and countermeasures

During the construction of the project, the piling of excavated soil, the dust caused by wind and mechanical dust in the dry season might affect the surrounding environment.

In order to reduce the impact of dust on the surrounding environment, in the case of continuous sunny weather and wind, the dust was removed during the construction. In the case of windy weather, some water was sprinkled on the surface of the soil pile to prevent dust.

(3) Water environment impact and countermeasures

The impact on water environment during construction mainly includes construction personnel's domestic sewage and civil construction mud wastewater.

In order to reduce the impact of construction wastewater on the surrounding environment, simple toilets and septic tanks were built at the construction site to unify the treatment of domestic wastewater before discharging the supernatant. The mud wastewater generated during the construction period was settled in the simple sedimentation tank before being discharged.

(4) Impact of solid waste and countermeasures

A large amount of construction waste, construction waste and construction personnel's household waste were generated during construction.

The project contractor transported the discarded soil in time according to the disposal plan of the discarded soil, and did not overload the soil during the process of loading and transporting, and did not spill the soil along the loading truck, and did remove the soil from the wheels before the vehicle leaves the site.

Environmental impact and countermeasures during operation

(1) Water environment impact and countermeasures

The domestic sewage in the well area mainly comes from the bathroom. A septic tank and a soakaway well are installed in the well area, which are required to have a certain distance from the water supply system. The remaining sludge from the domestic sewage are used as fertilizer for plant greening.

(2) Noise impact and countermeasures

The noise during the operation of the water supply system mainly comes from the operation of the generator. In order to minimize the impact of noise on the surrounding environment, the following damping and protection measures are conducted:

① Give priority to low-noise electromechanical equipment in the selection of equipment.

② Take measures such as sound dissipation, damping and vibration damping.

③ Appropriate greening around the pump room to reduce the impact of noise on the surrounding environment.

④ Reasonable arrangement of building layout, so that the pump room is far away from environmentally sensitive points.

(3) Impact of solid waste and countermeasures

Solid waste during operation is mainly domestic garbage. The domestic garbage are cleaned and transported by the sanitation department and then sanitary landfill is carried out.

2.4 Public Comments

Not applicable as the project description has not been uploaded for public comments.

2.5 AFOLU-Specific Safeguards

This section is not applicable as the project is a non-AFOLU project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Applied Methodology:

AMS-III.A.V: Low greenhouse gas emitting safe drinking water production systems, Version: 08.0

3.2 Applicability of Methodology

The project activity meets each of the applicability conditions:

No.	Applicability criterion	How the project complies
1	This methodology comprises introduction of low greenhouse gas emitting water purification systems to provide safe drinking water (SDW). Water purification technologies that involve point-of use (POU) or point-of-entry (POE) treatment systems for residential or institutional applications such as systems installed at a school or a community centre are included. The examples include, but are not limited to, water filters (e.g. membrane, activated carbon, ceramic filters), solar energy powered ultraviolet (UV) disinfection devices, solar disinfection techniques, photocatalytic disinfection equipment, pasteurization appliances, chemical disinfection methods (e.g. chlorination), combined treatment approaches (e.g. flocculation plus disinfection). The methodology is also applicable to water kiosks that treat water using one or more of the following technologies: chlorination, combined flocculant/disinfection powders and solar disinfection.3 In case the water kiosk is using solar disinfection, project proponents need to implement measures to prevent recontamination (e.g. disinfecting	The project has built wells as well as water disinfection and distribution system. The project selects groundwater with good quality as water source, and water disinfectant is use for water purification. This technology falls into the category of low greenhouse gas emitting water purification system.

	containers, sealing containers and hygiene training).	
2	Soil filtration schemes (boreholes, wells) that include container disinfection (e.g. chlorination) may be applied. Project proponents shall demonstrate ex ante that rehabilitation and/or construction of the wells complies with relevant national and/or international standards and that measures are taken to ensure that water and well are not contaminated.	The project includes construction of wells as well as water disinfection and distribution system. The project was accepted by Senegalese government in March of 2021, which shows it meets the related national standards of Senegal. In addition, water quality tests have been conducted to confirm that the water and wells are not contaminated. The test results will be submitted in verification
3	Prior to the implementation of the project activity, a public distribution network supplying SDW to the project boundary does not exist.	According to the research, most of the villages involved in the project are located in remote areas, far away from cities that use centralized water supply. It is difficult to extend the urban pipeline network to this area. so there were no qualified water supply facilities before the implementation of the project.
4	It shall be demonstrated based on laboratory testing or official notifications (for example notifications from the national authority on health) that the application of the project technology/equipment achieves compliance either with: (i) the Comprehensive Protection performance target as per “Evaluating household water treatment options: Health based targets and microbiological performance specifications” (WHO, 2011) and “International Scheme to Evaluate Household Water Treatment Technologies” (WHO, 2014); or (ii) an applicable national standard or guideline. Applicable national standard should be based on laboratory efficacy testing that, at a minimum, includes quantitative microbial measures of pre- and post-treatment challenge waters that are representative of potential drinking water sources, and that	The water quality has been tested in laboratory, which demonstrates it meets the relevant requirements of (i) the Comprehensive Protection performance target as per “Evaluating household water treatment options: Health based targets and microbiological performance specifications” (WHO, 2011) and “International Scheme to Evaluate Household Water Treatment Technologies” (WHO, 2014); or (ii) an applicable national standard or guideline. The evidences will be submitted during verification.

	includes measured reductions based on at least one pathogen class (bacteria, viruses, protozoa).	
5	In cases where the life span of the water treatment technologies is shorter than the crediting period of the project activity, there shall be documented measures in place to ensure that end users have access to replacement purification systems of comparable quality.	In cases where the life span of the water treatment devices is shorter than the crediting period of the project activity, documented measures will be provided by project implementer to replace the old devices with new devices which will meet the requirement of the applied methodology. The evidences will be submitted during verification if applicable.
6	It should be demonstrated that the project appliances use technologies that meet the technology standards as per paragraph 4(b), and that they deliver microbiologically safe drinking water.	The water quality has been tested in laboratory, which demonstrates the wells supply microbiologically safe drinking water. The evidences will be submitted during verification.

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Emission from use of non-renewable biomass/Fossil fuel	CO_2	Yes	Major source
		CH_4	No	Minor source
		N_2O	No	Minor source
		Other	No	Minor source
Project	Emission from use of nonrenewable biomass/Fossil fuel	CO_2	Yes	Major source
		CH_4	No	Minor source
		N_2O	No	Minor source
		Other	No	Minor source

According to the applied methodology, the project boundary includes the physical, geographical sites of the wells, water disinfection and distribution system constructed by the project activity as well as the households where the consumers of safe water provided by the systems are located, which is located in 12 of the 14 regions throughout Senegal, namely Diourbel, Fatick, Kaolack, Kolda, Tambacounda, Thiès, Ziguinchor, Matam, Kaffrine, Louga, Saint-Louis and Sé dhiou.

The map of the project boundary is shown below:

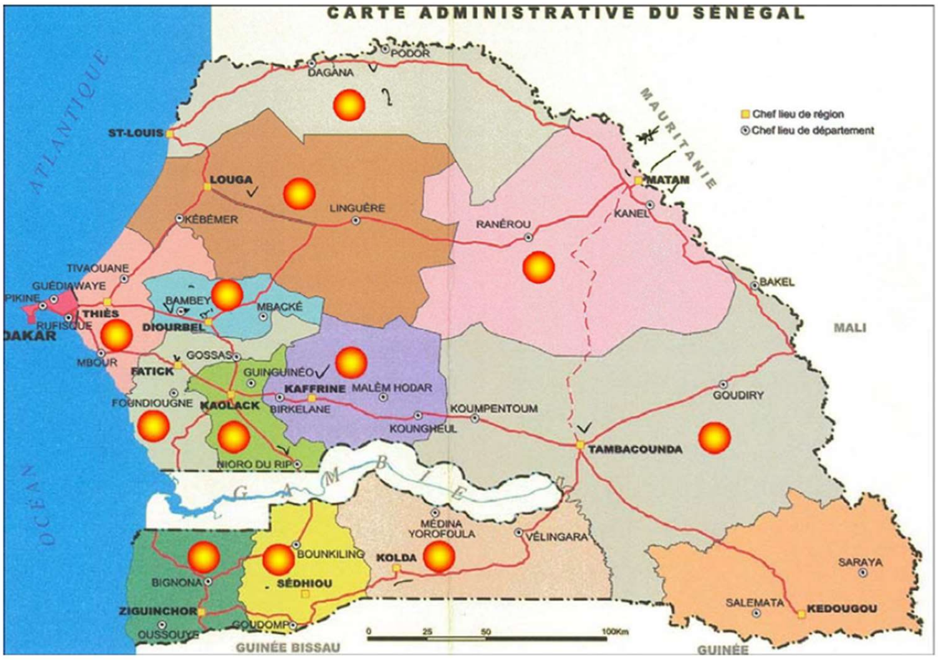
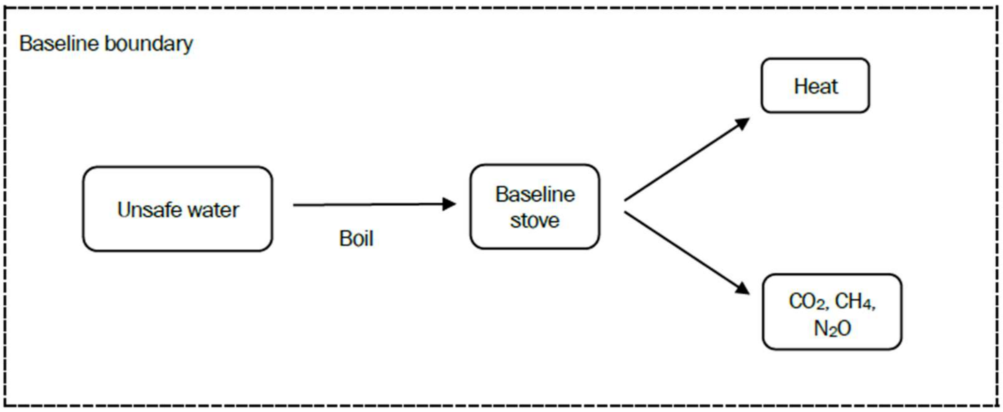
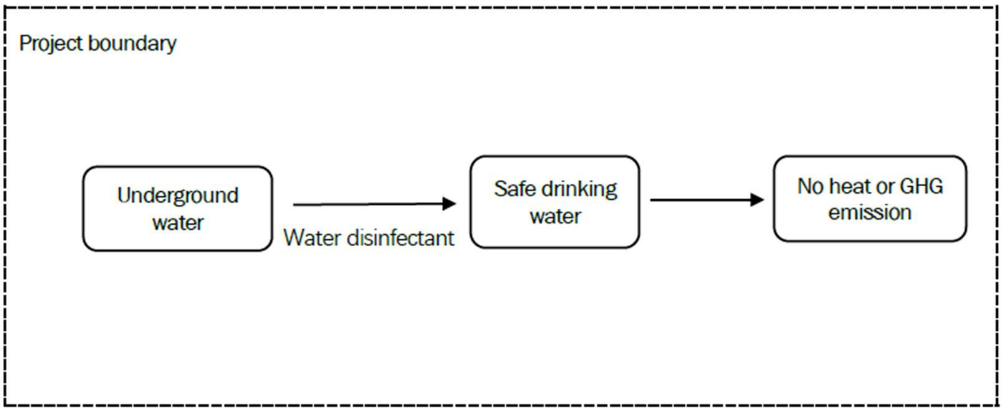


Figure 3: Project boundary of the project

A diagram of the energy flow in baseline boundary and project boundary is given below:


Baseline boundary
Unsafe water
Boil
Baseline stove
Heat
CO_2, CH_4, N_2O


Project boundary
Underground water
Water disinfectant
Safe drinking water
No heat or GHG emission

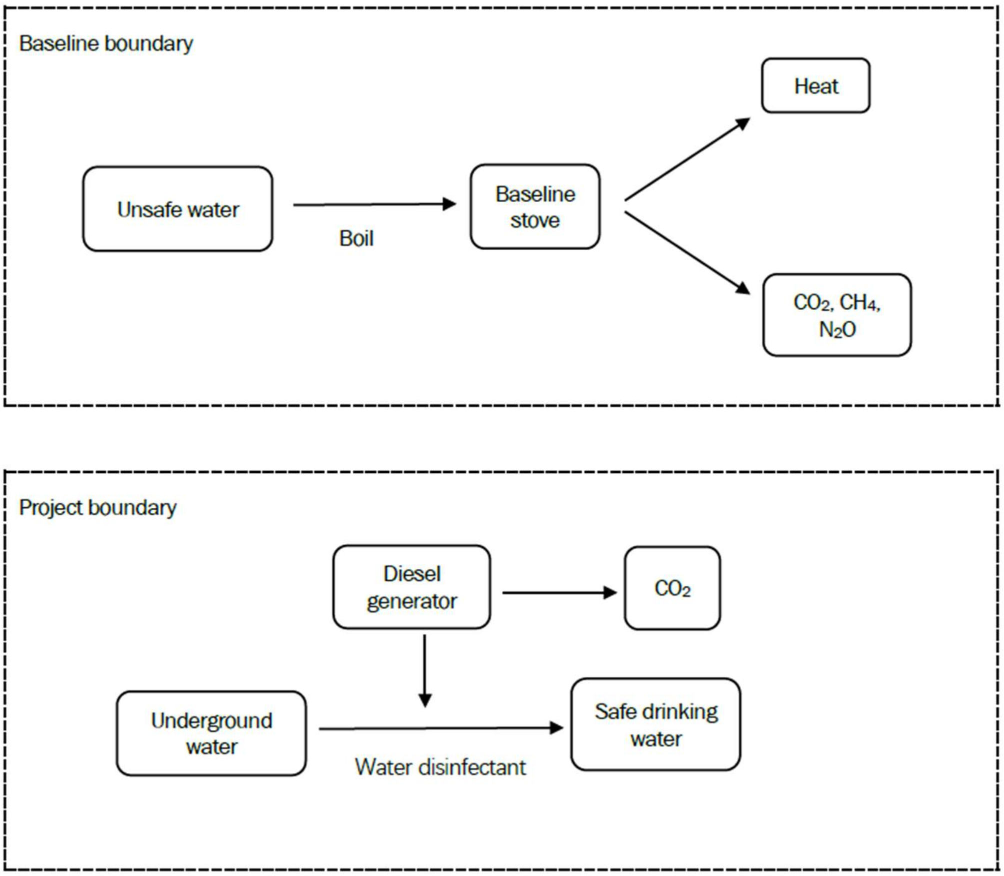


Figure 4: Energy flow of the project

3.4 Baseline Scenario

Before the implementation of the project, local people mostly would have used fossil fuels and non-renewable biomass (NRB) to boil water as a means of water purification. Due to low income, people will continue to use them to purify water without the project activity. According to the applied methodology, the baseline scenario is that fossil fuel and/or non-renewable biomass (NRB) would have been used to boil water as a means of water purification in the absence of the project activity.

3.5 Additionality

In the project, a water supply point is a basic unit for end users to collect water. According to Section 4 of this project design description, the emission reductions of each water supply point are fewer than 600 tCO_2e per year. So each water supply point is a microscale unit as per footnote 15(c) of “General guidelines for SSC CDM methodologies (Version 23.1)”. As per Paragraph 48 of “General guidelines for SSC CDM methodologies (Version 23.1)”, in the case of CPAs solely composed of microscale units, the CME is not required to demonstrate compliance with the small-scale CDM thresholds at the aggregate level of the CPA. As per Section 3.20.3 of

"VCS Standard (Version 4.3)", each component project activity (CPA) shall be registered with the VCS Program as a separate project accompanied by its associated program of activities design document. So a CDM CPA can be deemed as an independent VCS project in terminology. As a result, the project is a type III micro-scale project activity. According to Paragraph 13 and 14 of Tool 19 "Demonstration of additionality of microscale project activities (Version 09.0)", type III units[2] that aim to achieve emission reductions at a scale of no more than 20 ktCO_2e per year, are additional if the geographic location of the project activity is an LDC/SIDS or SUZ of the host country. Since the project is located in a least developed country-Senegal[3], all the units as well as the project are additional.

3.6 Methodology Deviations

The project did not apply any methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The baseline emissions shall be calculated as follows:

$$BE_y = QPW_y \times m \times X_{boil} \times SEC \times \sum_i (BL_{fuel,i} \times f_i \times EF_{projected\_fossil\ fuel,i} \times 10^{-9})$$

Where:

BE_y	=	Baseline emissions during the year y in (t CO_2e)
QPW_y	=	Total quantity of water purified by the project in year y (L)
m	=	Fraction of functional appliances that are providing the SDW (%). Only project appliances that (i) use technologies that meet the technology standards as per paragraph 4(b) and (ii) are operating or replaced by an equivalent in service appliance and (iii) deliver microbiologically safe drinking water, are counted for emission reductions. It is assumed to be 100% for ex ante calculation.

[2] Here "units" is used to replace "project activities" as per the requirement in Paragraph 14 of Tool 19 "Demonstration of additionality of microscale project activities (Version 09.0)"

[3] https://www.un.org/development/desa/dpad/least-developed-country-category/ldcs-at-a-glance.html

X_{boil}	=	Fraction of the population served by the project activity for which the common practice of water treatment is or would have been water boiling. It is determined ex ante through surveys. It is assumed to be 100% for ex ante calculation.
SEC	=	Specific energy consumption required to boil one litre of water (kJ/L), to be calculated according to paragraphs below
$BL_{fuel,i}$	=	Proportions of baseline fuel type i (NRB and/or fossil fuels) used in the absence of the project activity (fraction). It is assumed that NRB to be 100% for ex ante calculation.
f_i	=	Fraction of non-renewable fuel type i used in the absence of the project activity in year y. For biomass, it is the fraction of woody biomass that can be established as non-renewable biomass (f_{NRB}). If the baseline fuel is fossil fuel, the value to be applied is 1
$EF_{projected_{fossil}fuel,i}$	=	Emission factor of the fuel type i substituted (t CO_2/TJ). The fuel displaced is NRB, 73.2 is used for Sub-Saharan Africa sourced from approved methodology AMS-I.E.

The quantity of purified water in a year is:

(a) Option 1: Directly monitored; or

(b) Option 2: Indirectly monitored following the procedures described in paragraph below.

For Option 2, the quantity of purified water should be monitored and calculated based on the following options:

(a) Option 2.1: The capacity of the equipment based on the manufacturers' specifications, and the usage time of the equipment, as follows:

$QPW_y = \Sigma q, \times t$

Where:

q, i	=	Capacity of the water purification device (L/hour) provided by the manufacturer
t	=	Usage time (hours/year)

(b) Option 2.2: The population serviced by the project activity and an average volume of drinking water per person per day, as follows:

$QPW_y = \mathrm{P}_y \times \min (QPW_{pp} ; 5.5) \times 365$

Where:

P_y	=	Population who consumes the purified water serviced by the project activity in year y
QPW_{pp}	=	Average volume of drinking water per person per day (L/person/day) determined ex ante of the crediting period through a baseline survey

For ex-ante calculation of QPW_y, a default value of 3 litres per person per day is used.

The capacity of each water supply point can meet the water demand of 1,000 people. Therefore,

QPW_y=1,000×3×365=1,095,000L/year

Specific energy consumption required to boil one litre of water is to be calculated as follows:

$$SEC = \left[WH \times \left(T_f - T_i\right) + 0.01 \times WHE\right] / \eta_{wb}$$

Where:

WH	=	Specific heat of water (kJ/L °C). Use a default value of 4.186 kJ/L °C
T_f	=	Final temperature (°C). Use a default value of 100°C
T_i	=	Initial temperature of water (°C). Use annual average ambient temperature; or use a default value of 20 °C
WHE	=	Latent heat of water evaporation (kJ/L). Use a default value of 2260 kJ/L. The latent heat required to boil one litre of water for five minutes is assumed to be equivalent to latent heat for the evaporation of 1% of the water volume (WHO recommends a minimum duration of five minutes of water boiling)
η_{wb}	=	Efficiency of the water boiling systems being replaced, estimated ex ante. Default values in Data / Parameter table 3 may be used

Default value 0.11 is used of η_{wb} for ex-ante calculation. Alternatively, if default values of the parameters are applicable to Equation above, SEC can be calculated as follows:

SEC=[357.48kJ/L]/0.11=3249.82kJ/L

We use "TOOL30: Calculation of the fraction of non-renewable biomass" to calculate f_{NRB} for host country Senegal. The calculation sheet will be submitted too. Please refer to it about the calculation.

A value of 93.53% is calculated.

It is assumed that each water point provides 1,000 people with SDW for ex ante calculation.

BE_y=1,095,000×100%×100%×3249.82×100%×93.53%×73.2×10^{-9}=243 t CO_2e

4.2 Project Emissions

If the operation of the project water purification system involves consumption of fossil fuels and/or electricity, CO_2 emissions from on-site consumption of fossil fuels and electricity due to the project activity shall be accounted for as project emissions.

$$PE_y = PE_{FF,y} + PE_{EC,y}$$

Considering the actual situation of unstable power supply in Senegal, all systems are equipped with diesel generators.

Emissions from fossil fuel combustion ($PE_{FF,y}$) is calculated by the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process j during the year y

The CO_2 emission coefficient $COEF_{i,y}$ can be calculated using one of the following two Options, depending on the availability of data on the fossil fuel type i, as follows:

(a) Option A: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i.

(b) Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type i.

We choose Option B to calculate $COEF_{i,y}$, therefore,

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:

$NCV_{i,y}$	=	Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	Is the weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

It is assumed that each diesel generator consumes 2500L diesel every year for ex-ante calculation.

According to 2006 IPCC Guidelines on National GHG Inventories, $NCV_{i,y}$ uses default value of 43.0TJ/Gg, $EF_{co2,i,y}$ uses default value of 74.1 tCO_2/TJ, density of diesel is 0.85kg/L[4].

Therefore,

$PE_{FF,y}$=2500×0.85×43×74.1×10^{-6}=7 tCO_2/yr

4.3 Leakage

According to the applied methodology, where relevant leakage relating to the non-renewable woody biomass shall be assessed as per the relevant procedures of AMS-I.E.

B_y (Quantity of woody biomass that is substituted or displaced in year y) is multiplied by a net to gross adjustment factor of 0.95 to account for leakages.

4.4 Net GHG Emission Reductions and Removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e/yr)
BE_y	=	Baseline emissions in year y (t CO_2e/yr)
PE_y	=	Project emissions in year y (t CO_2e/yr)
LE_y	=	Leakage emissions in year y (t CO_2e/yr)

LE_y=243×0.05=13 t CO_2e/yr

ER_y=243-7-13=223 t CO_2e/yr

[4] https://www.sciencedirect.com/topics/engineering/diesel-fuel

The ex-ante calculation of each water supply point is in the table below.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 1	243	7	13	223
Year 2	243	7	13	223
Year 3	243	7	13	223
Year 4	243	7	13	223
Year 5	243	7	13	223
Year 6	243	7	13	223
Year 7	243	7	13	223
Total	1,701	49	91	1,561

There are 1,340 water supply points of the project, ex-ante calculation of emission reductions as follows:

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 1	325,620	9,380	17,420	298,820
Year 2	325,620	9,380	17,420	298,820
Year 3	325,620	9,380	17,420	298,820
Year 4	325,620	9,380	17,420	298,820
Year 5	325,620	9,380	17,420	298,820
Year 6	325,620	9,380	17,420	298,820
Year 7	325,620	9,380	17,420	298,820
Total	2,279,340	65,660	121,940	2,091,740

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	$QPWpp$
Data unit	Litres
Description	Average volume of drinking water per person per day
Source of data	Estimated through ex ante survey or official data, or peer reviewed literature or local expert opinion. Alternatively, a default value of 3 litres per person per day can be used. The maximum value of 5.5 litres per person per day shall not be exceeded
Value applied	3L is used for ex-ante calculation.
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

<table>
<tr><td>Data / Parameter</td><td>LS</td></tr>
<tr><td>Data unit</td><td>Years</td></tr>
<tr><td>Description</td><td>Life span of water treatment technologies</td></tr>
<tr><td>Source of data</td><td>Manufacturer’s specifications</td></tr>
<tr><td>Value applied</td><td>Life spans of main equipment:
<table>
<tr><td>No.</td><td>Main equipment</td><td>Life span(years)</td></tr>
<tr><td>1</td><td>Well</td><td>20-50</td></tr>
<tr><td>2</td><td>water pump</td><td>10-20</td></tr>
<tr><td>3</td><td>diesel generator</td><td>20-25</td></tr>
<tr><td>4</td><td>water supply pipe</td><td>50</td></tr>
</table></td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>-</td></tr>
<tr><td>Purpose of Data</td><td>-</td></tr>
</table>

Comments	-

Data / Parameter	η_{wb}
Data unit	%
Description	Efficiency of the water boiling systems being replaced
Source of data	Project activity site
Value applied	Use one of the options below: (a) The efficiency of the water boiling system shall be established using representative sampling methods or based on referenced literature values (fraction), use weighted average values if more than one type of system is encountered; (b) 0.10 default value may be optionally used if the replaced system or the system that would have been used is a three-stone fire or a conventional system for woody biomass lacking improved combustion air supply mechanism and flue gas ventilation system that is without a grate as well as a chimney; for the rest of the systems using woody biomass 0.2 default value may be optionally used; (c) 0.5 default value may be used if the replaced system or the system that would have been used is a fossil fuel combusting system
Justification of choice of data or description of measurement methods and procedures applied	0.11 is used for ex-ante calculation.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$BL_{fuel,i}$
Data unit	Fraction
Description	Proportions of baseline fuel type i (NRB and fossil fuel)
Source of data	Estimated ex ante through a survey or official data or peer reviewed literature or local expert opinion
Value applied	100%

Justification of choice of data or description of measurement methods and procedures applied	It is assumed that people use NRB only for ex-ante calculation.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	f_i
Data unit	Fraction
Description	Factor to determine amount of non-renewable fuels
Source of data	Project activity site
Value applied	Fraction of fuel type i used in the absence of the project activity in year y. For biomass, it is the fraction of woody biomass that can be established as non-renewable biomass (fNRB) as per "TOOL30: Calculation of the fraction of non-renewable biomass". If the baseline fuel is fossil fuel use a default value of 1.0
Justification of choice of data or description of measurement methods and procedures applied	TOOL30 is used to calculate. The value is 93.53% as calculated.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{projected_{fossil}fuel,i}$
Data unit	t CO_2/TJ
Description	Emission factor of the fuel(s) type i substituted
Source of data	Project activity site
Value applied	If the fuel displaced is NRB, this parameter can be sourced from approved methodology AMS-I.E. (i.e. Table 2 in version 10.0 of AMS-I.E., if there are updates use the information from the latest version of AMS-I.E.); - If the fuel displaced is fossil fuel, apply the emission factor of the fossil fuel

Justification of choice of data or description of measurement methods and procedures applied	The value is 73.2 sourced from approved methodology AMS-I.E.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	X_{boil}
Data unit	%
Description	Fraction of the population serviced by the project activity for which the common practice of water purification is or would have been water boiling
Source of data	Established ex ante through survey
Value applied	It is assumed that the value is 100% for ex-ante calculation.
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$NCV_{i,y}$
Data unit	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description	Weighted average net calorific value of fuel type i in year y
Source of data	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
(a) Values provided by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A)
(b) Measurements by the project participants	If (a) is not available

	(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)
	(d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available
Value applied	Option (d) is used. According to 2006 IPCC Guidelines on National GHG Inventories, NCVi,y uses default value of 43.0TJ/Gg..	
Justification of choice of data or description of measurement methods and procedures applied	-	
Purpose of Data	Calculation of project emissions	
Comments	-	

Data / Parameter	$EF_{CO2,i,y}$	
Data unit	tCO_2/GJ	
Description	Weighted average CO_2 emission factor of fuel type i in year y	
Source of data	The following data sources may be used if the relevant conditions apply:	
	Data source	Conditions for using the data source
	(a) Values provided by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A)
	(b) Measurements by the project participants	If (a) is not available

	(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)
	(d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available
Value applied	Option (d) is used. According to 2006 IPCC Guidelines on National GHG Inventories, EFco2,i,y uses default value of 74.1 tCO_2/TJ..	
Justification of choice of data or description of measurement methods and procedures applied	-	
Purpose of Data	Calculation of project emissions	
Comments	-	

5.2 Data and Parameters Monitored

Data / Parameter	$P_{y,i,j}$
Data unit	Number
Description	Population who consumes the purified water serviced by the project activity in year y
Source of data	Survey records
Description of measurement methods and procedures to be applied	A survey shall be conducted annually to check the number of persons who consume the purified water supplied by functional project appliances

Frequency of monitoring/recording	Annual
Value applied	For ex-ante emission reduction calculation, it is assumed that each water supply point provides SDW to 1,000 persons.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	QPW_y
Data unit	Litres
Description	Quantity of purified water in year y
Source of data	Records
Description of measurement methods and procedures to be applied	The quantity of purified water in year y shall be determined: (a) For distributed appliances, as per the following options: • Monitoring on continuous basis using flow meter(s) for a statistically valid sample of the distributed appliances, or • Monitoring of a statistically valid sample of the distributed appliances during a period that is representative of the monitoring period. (b) For water kiosks, as per the following options: • Monitoring on continuous basis using flow meter(s), or • Monitoring on continuous basis using a standard vessel. Alternatively, this parameter can be calculated, based on either Equation (2) or Equation (3) above
Frequency of monitoring/recording	Annual
Value applied	For monitoring using a standard vessel, the volume of water shall be cross-checked against water sales receipts. 1,095,000L/year is used for ex-ante calculation.

Monitoring equipment	-
QA/QC procedures to be applied	For monitoring using a standard vessel, the volume of water shall be cross-checked against water sales receipts.
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	m
Data unit	fraction
Description	Fraction of functional appliances that are providing the SDW
Source of data	Surveys and microbiological testing
Description of measurement methods and procedures to be applied	This parameter shall be determined through checking all appliances or a statistically representative sample of the appliances to ensure the following conditions that: (a) they only use technologies that are meeting the SDW technology standards as per paragraph 4(b); (b) they are still operating or are replaced by an equivalent in-service appliance. The use of appliances shall be monitored through self-report measures (survey data from respondents) as well as physical signs that are observable (e.g. wetness of the unit, water in storage receptacle, functionality of parts) as per “Objective measures of functionality and use of project appliances” described in the Appendix. (c) they are delivering microbiologically safe drinking water. Appliances shall deliver treated water verified to be <1 cfu / 100 ml E. coli, using methods for measurement with a lower detection limit (LDL) of 1 cfu E. coli per 100 ml sample (See Box 3 below). Emission reductions cannot be claimed if over 10% of appliances in the project activity fail to meet the final water quality requirements mentioned above
Frequency of monitoring/recording	Annually
Value applied	100% for ex-ante calculation.
Monitoring equipment	-

QA/QC procedures to be applied	The sampling plan shall also include provisions to collect information for records of replacement of appliances, filters and maintenance
Purpose of data	Calculation of baseline emissions
Calculation method	
Comments	

Data / Parameter	Check for SDW public distribution network
Data unit	-
Description	Annual check if there is any other public distribution network supplying SDW is installed
Source of data	Surveys
Description of measurement methods and procedures to be applied	Monitoring shall include annual check if there is public distribution network supplying SDW
Frequency of monitoring/recording	Annually
Value applied	-
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	-
Calculation method	-
Comments	-

Data / Parameter	Quality of safe drinking water
Data unit	-
Description	The quality of the safe drinking water
Source of data	Project activity site

Description of measurement methods and procedures to be applied	The safe drinking water quality is monitored on sample basis at least once every two years (biennial)
Frequency of monitoring/recording	At least once every two years
Value applied	-
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	-
Calculation method	-
Comments	-

Data / Parameter	$FC_{i,j,y}$
Data unit	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Description of measurement methods and procedures to be applied	• Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions
Frequency of monitoring/recording	Continuously
Value applied	-

Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	-
Calculation method	-
Comments	-

5.3 Monitoring Plan

The local partners of Iceberg are in charge of the implementation of the monitoring plan and reporting to the project proponent. The project proponent is in charge of designing the monitoring plan and completing the monitoring report. Sampling survey will be applied for monitoring.

(a) Sampling Plan

According to Section 6 of the applied methodology, the monitoring provisions in the tools referred to in this methodology apply. The "Standard for Sampling and Surveys for CDM Project Activities and Programmes of Activities (Version 09.0)" is used for sampling.

Sampling design

(1) Objectives and reliability requirements

The following parameters may be determined by sampling:

Parameter	Description	Frequency
m	Fraction of functional appliances that are providing the SDW	Annually
Quality of safe drinking water	The quality of the safe drinking water	At least once every two years
$FC_{i,j,y}$	Quantity of fuel type i combusted in process j during the year y	Continuously

The objective is determining the value of parameter m , Quality of safe drinking water and $FC_{i,j,y}$, during the crediting period. Since the emission reductions of each water supply point are fewer than 600 tCO_2e per year, the device is a microscale CDM unit as per footnote 15(c) of "General guidelines for SSC CDM methodologies (Version 23.1)". According to paragraph 48(b) of

"General guidelines for SSC CDM methodologies (Version 23.1)", a 95/10 precision shall be applied for sampling surveys.

(2) Target population

The target population are 1,340 water supply points.

(3) Sampling method and size

According to CDM guidelines "Sampling and surveys for CDM project activities and programmes of activities" (Version 04.0), simple random sampling method is used for sampling.

For the parameters of m and quality of safe drinking water, the sample size equation for a required 95/10 confidence/precision is:

$$n \geq \frac{1.96^2 N \times p(1-p)}{(N-1) \times 0.1^2 \times p^2 + 1.96^2 p(1-p)}$$

Where:

n = Sample size

N = Population size

P = Expected proportion

1.96 = Represents the 95% confidence interval

0.1 = Represents the 10% relative precision

For the parameter of $FC_{i,j,y,}$ the sample size equation for a required 95/10 confidence/precision is:

$$\boldsymbol{n} \geq \frac{\mathbf{1.96^2 NV}}{(\boldsymbol{N}-\mathbf{1}) \times \mathbf{0.1^2} + \mathbf{1.96^2 V}}$$

Where:

V = $\left(\frac{SD}{mean}\right)^2$

n = Sample size

N = Total number of water supply points

Mean = Our expected mean

SD = Our expected standard deviation

1.96 = Represents the 95% confidence interval

0.1 = Represents the 10% relative precision

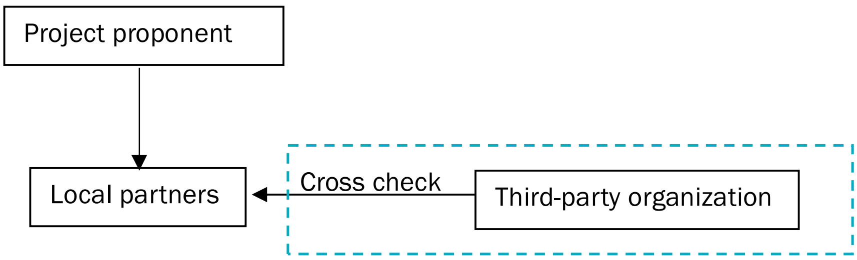
(b) Data to be collected

All data collected as part of monitoring will be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent of the data will be monitored if not indicated otherwise in the tables below. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

Quality assurance/Quality control

Training about monitoring plan will be provided to local partners, including survey method, data record and analysis. The monitoring plan will be carried out by qualified personnel trained for quality assurance and quality control. The project proponent will inspect local partners to confirm that the personnel are qualified and the monitoring plan has been properly implemented. The data collected may be cross checked by the project proponent or a third-party organization.

The organizational structure for monitoring is shown as the bellow:



(c) Implementation plan

The main survey methods applied in the sampling plan include hardcopy questionnaires, online questionnaires, face to face interview and telephone interview. The potential of refusals and other means of non-responses will be taken into account for calculation of sample size. Meanwhile, in order to minimize the rates of non-response and answer bias, the questionnaires will be designed by professional team and widely tested before use.

Any non-conformances with the validated monitoring plan will be recorded and analysed. If they are in accordance with the applied methodology and other related rules, a change may be conducted in the validated monitoring plan. Otherwise, revision and improvement will be conducted in the monitoring. The related ERs will not be claimed in the monitoring report until the non-conformance has been corrected in the latter case.