MONITORING REPORT FORM (F-CDM-MR)
Version 02.0

MONITORING REPORT

Title of the project activity	SASSA Low Pressure Solar Water Heater Programme
Reference number of the project activity	PoA 4302
Version number of the monitoring report	06
Completion date of the monitoring report	13/01/2014
Registration date of the project activity	12/03/2011
Monitoring period number and duration of this monitoring period	12/03/2011 -31/12/2011
Project participant(s)	CME: Solar Academy of Sub Saharan Africa (Pty) Ltd PPs: International Carbon Ltd, Eneco Energy Trade B.V., Standard Bank Plc
Host Party(ies)	Republic of South Africa
Sectoral scope(s) and applied methodology(ies)	Type I – Renewable energy projects AMS-I.C. -Thermal Energy Production with or without electricity, Version 17
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	63,580
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	14,227

SECTION A. Description of project activity
A.1. Purpose and general description of project activity

The purpose of the PoA and CPA001 is to install South African Bureau of Standards (SABS) approved non-pressure (also called low-pressure) storage tank and vacuum tube solar collectors to low income households free of charge.

Traditionally electric geysers have been used in South-Africa to heat water for domestic hot water purposes. Due to the historically low cost of electricity, alternatives have not been considered. Additional reasons for low market penetration are relatively high upfront costs and a lack of consumer awareness. Solar Water Heaters (SWHs) will help to reduce the electric water heating load. SWH offers also a great opportunity for households outside the national grid system. Suppressed demand for energy services refers to a state where current levels of access to energy services are inadequate because of income or infrastructure constraints. This state does not accurately reflect the real demand for energy services by energy poor households. The SWH rollout will eliminate part of the suppressed demand by decreasing the cost of energy services, thus increasing access to energy services whilst allowing energy poverty to decline.

The CPA-001 consists of 59 000, 110 litre vacuum tube storage tank low pressure SWHs with each having aperture i.e. absorber area of 1.08 m^2 totalling to 63,720 m^2.

The SWHs comply with the SABS Standard Specification for SWH systems SANS 6211-1:2003, SANS 151-2009 and SANS 1307:2003[1] to ensure that the SWHs installed are able to withstand local climatic and water quality conditions, and convert solar radiation into thermal energy for the heating of water.

The main components of a SWH are:

1. solar collectors/absorbers (evacuated tube collectors);
2. insulated hot water storage tanks;
3. pipe work;
4. support structures.

The solar collector and storage water tank is connected and relies on the natural circulation of waters between the collector and the water tank. As water in the vacuum tubes is heated, it rises naturally into the tank, while cool water in the tank flows down to the bottom of the vacuum tubes, causing circulation throughout the system. It is a simple and safe solution to heat water with energy from the sun.

The installation of the SWHs under the CPA001 started on 01/07/2010 with installations in Port Elizabeth in Nelson Mandela Bay Metropolitan Municipality, Eastern Cape. Other sites where commissioned as follows:

Ekurhuleni Metropolitan Municipality: 2011/01/07
Free State Province: 2011/01/02
eThekwini Metropolitan Municipality: 2011/02/03
Western Cape Province: 2011/02/05
North West Province: 2011/01/01

The CPA001 became full on 28/02/2012, which is the date of the last installation done under CPA001.

Dates for commissioning the monitoring sites/ equipment:

[1] Please note that the SANS test numbers are subject to changes if revised.

City / Municipality	*Province*	*Address*	*Latitude*	*Longitude*	*Commissioning date*
Durban / eThekwini Metropolitan Municipality	KwaZulu Natal	3324 Welbedacht West Chatsworth	S29 55.341	E30 51.796	19/04/2011
Botshabelo / Manganung Municipality	Free State	1230 U Section Botshabelo	S29 15.716	E26 41.195	2/08/2011
Calitzdorp/Kannaland Municipality/ Eden District	Western Cape	6th Road Calitzdorp	S33 31.368	E21 40.269	23/08/2011
Ekhurleni Metropolitan Minacity	Gauteng	7226 Cisticola Street	S26 06.574	E28 28.824	01/09/2011
Port Elizabeth/ Nelson Mandela Bay Metropolitan Municipality	Eastern Cape	224 K.D Matanzima Crescent Erf 3621 Motherwell	S33 48.207	E25 36.925	12/03/2011
Kroonstad / Moqhak Municipality	Free State	11858 Relebohile, Dingalo Street Kroonstad	S27 39.247	E27 11.360	1/09/2011
Potchefstoom / Tlokwe Local Municipality	North West	8186 Thladi Street, Potch	S29 10.256	E26 14.996	1/09/2011
Vredenburg / Saldhana Bay Local Municiplaity	Western Cape	13 Yster Street, Vredenburg	S32 54.933	E18 01.242	29/09/2011

As per the registered PoA-DD to confirm the number of operating systems 1 % of the installations in each CPA are sampled for functionality. The database will annually allocate the 1 in 100 sites for inspection by an automated random number generator, which will be set to never select the same site for inspection over the 10 years period. Therefore 10 percent of all the installations will be inspected over the 10 years monitoring period. The results are used to adjust the ex-post emission reduction calculation (i.e. % of SWHs operational). The operatinality checks took place in February 2012.

Total GHG emission reductions achieved in this monitoring period: 14,227 tons CO_2

The CPA001 contains a total of 59,000 houses. However, in 2011 only 38,974 installations where allocated to measured sites due to delays in data upload process and installation of monitoring equipment. Hence 2011 emission reductions base only on only 38,974 installations.

A.2. Location of project activity

Host Party: Republic of South Africa

Region/ State/ Province / City/ Town/ Community:

Installations took place in the following areas:

Nelson Mandela Bay Metropolitan Municipality in the Eastern Cape Province

eThekwini Metropolitan Municipality in the KwaZulu Natal Province
Botshabelo Metropolitan Municipality in the Free State Province
Moqhaka Muncipality[2] in the Free State Province
Ekurhuleni Metropolitan Municipality, in Gauteng Province
Tlokwe Local Municipality[3] in the North West Province
Saldhana Bay Local Municipality[4] in the Western Cape Province
Mosel Bay Municipality in the Western Cape Province
Theewaterskloof Local Municipality in the Western Cape Province

Physical/ Geographical location:

As defined in AMS.I.C, the project boundary is the physical, geographical site of the renewable energy generation including the residential facility consuming the thermal energy produced. Hence the boundary for the CPA- 001 comprises the physical site of each SWH within the CPA001 as well as the South African grid system, as the SWH will replace grid electricity. The GHG reduced through the CPAs is CO_2. The reduction takes place through the avoidance of fossil fuels (predominantly coal) used in the production of electricity to heat water, in the absence of the CPAs.

The exact geographical locations of each installation under CPA001 are presented in appendix II with GPS-coordinates.

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa (host)	Solar Academy of Sub Saharan Africa (Pty) Ltd	No
United Kingdom	Standard Bank Plc	No
United Kingdom	International Carbon Pty	No
United Kingdom	Eneco Energy Trade B.V	No

A.4. Reference of applied methodology

From Appendix B of the “Simplified modalities and procedures for small scale CDM projects”, the following methodology applies to the project activity:

[2] Also known as Kroonstad
[3] Also known as Potchefstroom
[4] Also known as Saldhana and Verenburg

Project Type: Type I – Renewable energy projects
Project Category: AMS-I.C. -Thermal Energy Production with or without electricity, Version 17

A.5. Crediting period of project activity

12/03/2011 – 11/03/2021 (Fixed crediting period of ten years)

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

Under the CPA001 SABS approved Cistern Type Tasol SWH systems have been installed. These systems consisted of an insulated 110 litre tank that is integrated with twelve vacuum-insulated absorbing glass tubes. The solar radiation that is absorbed by the hollow glass tubes heat the water contained in the insulated tank directly through the process of thermo-siphoning. The systems are installed on the outside roof of a low income domestic building.

<u>System specifications:</u>
Tank volume under test: 111 litres
Number of tubes: 12
Diameter of tubes: 58 mm
Exposed length of tubes: 1 800 mm
Absorbing area of the tubes: 50 mm
Total absorber/ aperture area of the tubes: 1.8 m * 0.05 m *12 = 1.08m^2
Total absorber/ aperture area of CPA001: 1.08 m^2 * 59 000 = 63 720 m^2
Total absorber/ aperture area of CPA001 in 2011: 1.08 m^2 * 38 974 = 42 092 m^2

The installation of the SWHs under the CPA001 started on 01/07/2010 with installations in Port Elizabeth in Nelson Mandela Bay Metropolitan Municipality, Eastern Cape. Other sites where commissioned as follows:

- Ekurhuleni Metropolitan Municipality: 2011/01/07
- Free State Province: 2011/01/02
- eThekwini Metropolitan Municipality: 2011/02/03
- Western Cape Province: 2011/02/05
- North West Province: 2011/01/01

The CPA001 became full on 28/02/2012, which is the date of the last installation done under CPA001. In 2011 a total of 58,984 installations where done under CPA001. However, only 38,974 installations where allocated to measured sites due to delays in data upload process and installation of monitoring equipment in Port Elizabeth. Hence 2011 emission reductions base only on 38,974 installations.

As per the monitoring plan of the registered PoA-DD one (1) in ten thousand (10,000) installations is monitored in real time so as to perform comprehensive measurement and verification. Furthermore the site selection bases on the geographical location, namely there must be at least 1 metered site within 50 km[5]

[5] The rationale for the selection of the 50km radius is based on measurements from three (3) weather stations near Nelson Mandela Bay, namely Addo [33° 34'E; 25° 42' S; Altitude 85m], Jansenville [32° 59'E; 25° 36' S; Altitude 60m] and

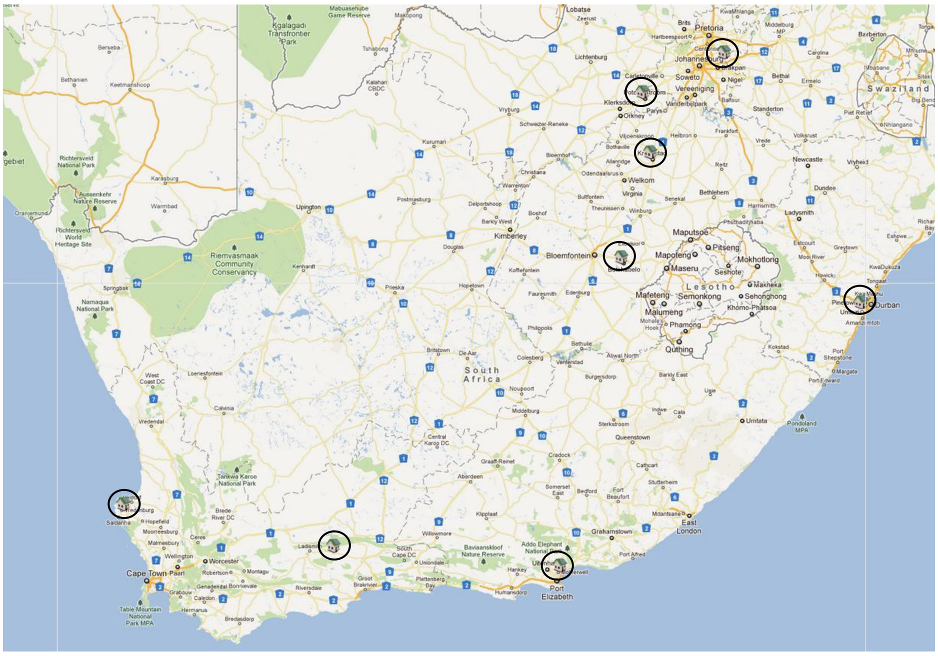
from any simulated site. The measured ambient temperature, cold water temperature and solar irradiation are loaded onto the independent central project database. The data at each of the metered sites is recorded every 5 minutes and integrated daily. At midnight every day, the simulation is executed on each home based on the daily measured values. The available solar irradiation at each site, together with daily average ambient and cold water temperatures is used in accordance with the SABS performance test to determine the delivered energy to that site.

Table 1. Dates for commissioning the monitoring sites/ equipment:

Location	***Commissioning date***
3324 Welbedacht West Chatsworth, eThekwini Metropolitan Municipality, Kwazulu- Natal	19/04/2011
1230 U Section Botshabelo, Manganung Municipality, Free State	2/08/2011
6th Road Calitzdorp, Kannaland Municipality, Eden District, Western Cape Province	23/08/2011
7226 Cisticola Street, Ekhurleni Metropolitan Muncipality, Gauteng	01/09/2011
224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	12/03/2011
11858 Relebohile, Dingalo Street Kroonstad, Moqhak Municipality, Free State	1/09/2011
8186 Thladi Street, Potchefstoom, Tlokwe Local Municipality, North West Province	1/09/2011
13 Yster Street, Vredenburg, Saldhana Bay Local Municiplaity, Western Cape	29/09/2011

The picture 1 below shows the location of the installed sites.

East London [33° 01’E; 27° 49’ S; Altitude 155m]. Addo is 115km from Jansenville and the annual average global radiation variance is 2%. Addo is 252km from East Loandon and the annual average global radiation variance is 0.4%. Jansenville is 303km from East London and the annual average global radiation variance is 1.7%. A monthly statistical analysis shows that the lowest confidence level is 94.16%. It is therefore assumed that at a 50km radius the average annual error per home will be less than 5.84%. (Ref 4:)



Picture 1. Location of measured sites.

As per the registered PoA-DD to confirm the number of operating systems 1 % of the installations in each CPA are sampled for functionality. The database will annually allocate the 1 in 100 sites for inspection by an automated random number generator, which will be set to never select the same site for inspection over the 10 years period. Therefore 10 percent of all the installations will be inspected over the 10 years monitoring period. The results are used to adjust the ex-post emission reduction calculation (i.e. % of SWHs operational). The operationality checks took place in February 2012.

As mentioned above the installation of the equipment was delayed due to correction of errors from the onsite manual capturers (i.e. inputting installation and home owner information from installation forms into the database).This was in specific relation to the GPS co-ordinates as there are several official formats in which GPS co-ordinates can be captured. The GPS originally captured did not synchronise with the RTE database formats, hence all the co-ordinates had to be edited and corrected manually, one by one and verified by the onsite installation teams and the data-capturing teams at head office. Any errors detected were immediately referred back to the installation teams for the correction and verification of the data. As this project involves a mass-roll out of thousands of solar water heaters the process to ensure data integrity was lengthy and took meticulous attention to detail. The longer it took to capture the installations with GPS coordinates into the RTE database, the longer it took to determine where to install monitoring equipment in order to determine correct monitoring site and fulfil 50 km radius and 1/10 000 units monitoring requirements. This affected Nelson Mandela Bay Municipality (NMBM) project site more than any other site, and hence only one monitoring site was installed in NMBM in 2011. In 2011 a total of 30,010 installations where done in NMBM under the CPA001. However, only 10 000 of the installations contribute towards to the emission reductions to follow the determined method.

The reasons for the above are described below:

1. The information from the installations is captured manually on site by the installers. This includes among others carbon ceding document, installation sign off, details of home owners, GPS co-ordinates and serial number of the units.

2. The actual forms with the captured information are then sent to SASSA head office in batches.

3. The data is double checked and captured on to an excel spread sheet by allocated resources dedicated to this process at SASSA head office.

4. Errors (e.g. GPS coordinates captured wrongly by installer i.e. different types of GPS formatting and certain database field formats.) are checked and referred back to the data capturers on the installation site for correction, if any. Once the errors are corrected manually on the forms they are edited on the SASSA excel database, and then uploaded the RTE database.

5. Once the data has been captured into the RTE database the units, which fall into the scope of the measurement sites are allocated to that particular site and indicated on the RTE database and presents the information on monitoring and measurement of carbon savings.

6. Monitoring Equipment is reliant to GPS co-ordinates and geographic areas i.e. the monitoring methodology states that 1/10,000 units need to be monitored and furthermore a monitoring site shall be within 50 km radius from each site. The installation of the equipment (i.e. determination of ideal location for the monitoring equipment in order to capture as many installations within 50 km radius as possible (i.e. central point within installations) was delayed due to correction of errors from onsite capturers which was then rectified at head office. This affected Port Elizabeth project site more than any other site.

7. Total of 8 measurement sites where installed in 2011 (and 3 additional sites has been installed so far in 2012).

8. The reason for installing only one measurement site in Port Elizabeth in 2011 is that RTE did not know where to locate the second measurement site, before all installation where uploaded into database.

It should be noted that installations start to generate reductions only when monitoring equipment is installed. In 2011 only 38,974 installations where allocated to measured sites and hence the emission reductions presented base in 2011 on 38,974 SWHs.

B.2. Post registration changes
B.2.1. Temporary deviations from registered monitoring plan or applied methodology
n/a

B.2.2. Corrections

It was initially intended that the SWHs would be uniquely identified with ERF number and serial number of the SWH. The ERF numbers available were not complete i.e. 21 digits and hence not unique. The ERF is an alphanumeric key (21 digits) of the Cadastral1 Land Parcel. The 21 digits are made up a number of different components, which are surveyor’s General office (e.g. Pretoria), registration division used for

registration in a deeds office, administrative districts, parcel number. However, the SWHs installed can be uniquely identified based on the unique number allocated by the database and linked to the owners GPS coordinates and the SWH serial number.

Furthermore, the registered PoA-DD stated that confirmation that the dwelling has electricity and water connection and the Residence Agreement to cede subsidy and carbon rights to SASSA would be captured in the database. The copy of persons ID, installation sheet / Eskom subsidy application, which include home owner and installation details and Carbon Ceding Form, are filed electronically but not uploaded into the webpage database. Also hardcopies for each individual installation are filed and stored by SASSA. The electricity and water connection is a requirement for Eskom subsidy application and is confirmed by the SASSA installation team. However, there is no additional recording of this to the database.

In addition in the CPA-DD, EF grid was moved to the monitoring plan. In the CPA-DD template version available at the time of inclusion this parameter was listed among the data and parameters available at validation, but the registered monitoring plan clearly indicated the parameter has to be updated at the time of each issuance. The correction therefore makes it clearer that the parameter is monitored.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

Two new parameters have been included under the section “Data and parameters monitored” B.7.1 of the PoA-DD. These are: Incoming cold water temperature (Tc) and Volume of daily cold water flow (V). These parameters have been monitored and are relevant for the emission reduction calculation as presented in section D of this document. The parameters where also mentioned in section E.7.2 of the registered PoA-DD. However, where not listed under “Data and parameters monitored”.

In February 2012 a random sample of 590 sites was issued and altogether 590 houses where inspected. Team managers inspected the units at the respective homes. However, not all residents where home and therefore, two criteria were developed to mitigate time delays and to accommodate this social phenomenon, which is beyond the control of the project developer. These criteria included:

1. If access can be gained to the SWH unit, without breeching Health and Safety regulations or causing damage to property and the unit can be inspected without the homeowner being present, then the unit would be inspected according to the operationality checklist.

2. If the homeowner is not home and there is no access to the unit and it cannot be inspected, the house in closest proximity (next door), to the random sample house where the homeowner was present would be inspected according to the operationality checklist. This incident would be indicated and declared on the operationality checklist to manage quality control.

However, it should be noted out of the 590 original sample only one house could not be inspected and an alternative house was inspected. To allow for this possibility in future and to meet the confidentiality and precision levels set in the monitoring plan and the CDM guidelines the section B.7.2 of the PoA-DD is amended to allow inspection in the next door house. Please see section D.3. which explains the results of the operationality check analysis in detail.

B.2.4. Changes to project design of registered project activity

None.

B.2.5. Changes to start date of crediting period

None.

B.2.6. Types of changes specific to afforestation or reforestation project activity
N/a

SECTION C. Description of monitoring system

The diagram 1 below presents the organizational structure of the SASSA PoA:

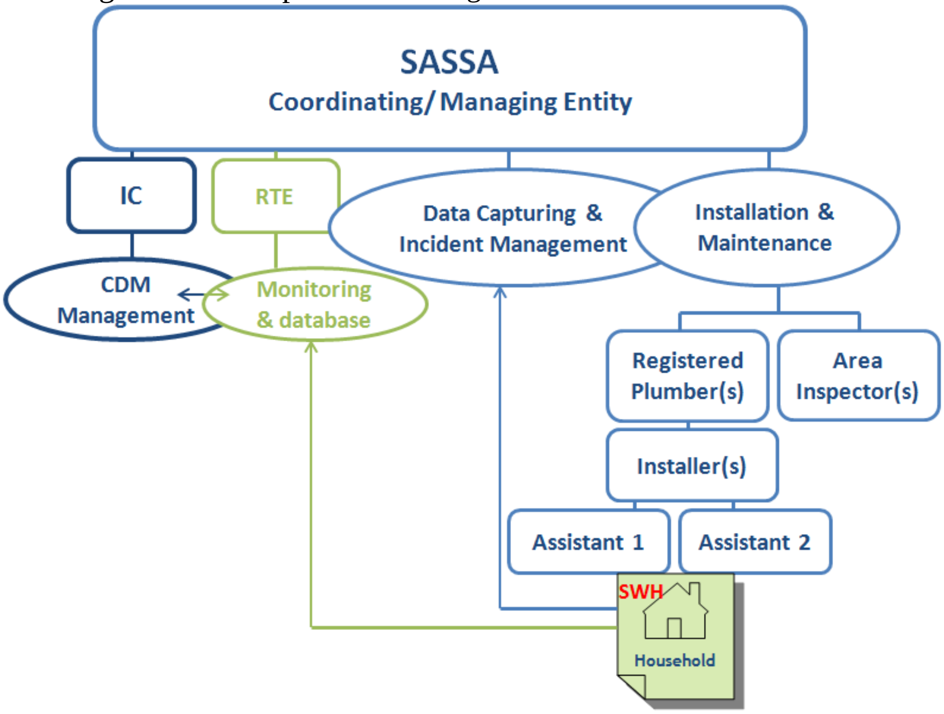


Diagram 1. Organizational structure of the SASSA PoA.

SASSA is the CME and responsible for installation and maintenance of the SWHs as well as data collection and incident management. SASSA has 27 employees, which are dedicated to data capturing, incident management and maintenance.

International Carbon Ltd ("IC"), a carbon development company, is responsible for the CDM Cycle Management including establishment Monitoring Reports.

Real Time Energy (Pty) Ltd ("RTE") is responsible for the monitoring and database hosting of the SASSA Low Pressure Solar Water Heater Programme. Real Time Energy (Pty) ltd has three (3) integral staff members that manage the SASSA contract they are:

- Shaun Worthmann, a registered professional engineer, measurement and verification professional and carbon reduction manager. He is responsible for the measurement and verification methodology and is also the client relationship manager for the SASSA contract.
- Mike Dickerson is the hardware and database engineer that integrates the GSM based field measurement devices with the house installation data and couples this with the measurement and verification methodology in a Real Time On-Line SQL database.
- Derek Pheonix is the primary frontend and SQL database programmer.

Remote monitoring is used to gather data from distant locations, when data collection would be difficult for a variety of reasons (e.g. high number of small installations spread throughout the country). In remote monitoring, inputs, outputs, analogue signals and specialized instruments perform measurement of physical quantities that can be transmitted to a via a GSM network server. The database used is a SQL database that is hosted in a secure hosted environment. All information is inputted from the residential agreement/installation form into the database directly via the web. The Global Positioning System (GPS) coordinates are used to locate each SWH in a Google map to enable spatial integration.

The information can be accessed via a web interface, where information can be managed and reports can be established. The data in a database is organized into the logical components visible to users who may both view reports and manage the data. The data will be archived for two years once the 10 year crediting period has lapsed.

As per the registered PoA-DD following data was collected for installation:

1. Location of the SWH systems registered (address, GPS coordinates and ERF number);
2. Name and ID of the SWH system /property owner;
3. Installation date of the SWH system;
4. Details of the SWH installer
5. Technical specifications of the SWH system (inc. type, size/volume, collector area);
6. Unique identification number of the SWH (serial number);

It was initially intended that the SWHs would be uniquely indentified with ERF number and serial number of the SWH. The ERF numbers available where not complete, i.e. 21 digits, and hence not unique[6]. However, the SWHs installed can be uniquely identified based the unique number allocated by the database and linked to the owners Identification Number, GPS coordinates and the SWH serial number.

As per the monitoring plan of the registered PoA-DD one (1) in ten thousand (10,000) installations is monitored in real time to perform comprehensive measurement and verification. Furthermore the site selection bases on the geographical location, namely there must be at least 1 metered site within 50 km[7] from any simulated site. The measured ambient temperature, cold water temperature and solar irradiation are loaded onto the independent central project database. The data at each of the metered sites is recorded every 5 minutes and integrated daily. At midnight every day, the simulation is executed on each home based on the daily measured values. The available solar irradiation at each site, together with daily average ambient and cold water temperatures is used in accordance with the SABS performance test to determine the delivered energy to that site. The data recorders will have an error margin of ±0.5 %.

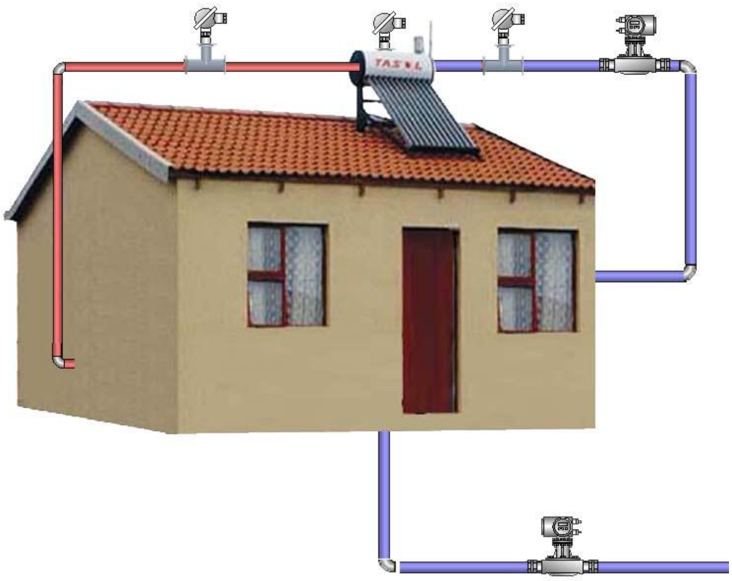
The following parameters are at every measured house:
1. Cold water feed temperature to the geyser,
2. Ambient air temperature.

[6] The ERF is an alphanumeric key (21 digits) of the Cadastral6 Land Parcel. The 21 digits are made up a number of different components, which are surveyor’s General office (e.g. Pretoria), registration division used for registration in a deeds office, administrative districts, parcel number.

[7] The rationale for the selection of the 50km radius is based on measurements from three (3) weather stations near Nelson Mandela Bay, namely Addo [33° 34’E; 25° 42’ S; Altitude 85m], Jansenville [32° 59’E; 25° 36’ S; Altitude 60m] and East London [33° 01’E; 27° 49’ S; Altitude 155m]. Addo is 115km from Jansenville and the annual average global radiation variance is 2%. Addo is 252km from East Loandon and the annual average global radiation variance is 0.4%. Jansenville is 303km from East London and the annual average global radiation variance is 1.7%. A monthly statistical analysis shows that the lowest confidence level is 94.16%. It is therefore assumed that at a 50km radius the average annual error per home will be less than 5.84%. (Ref 4:)

3. Water flow/quantity of water used in SWH
4. Pyranometer readings (a pyranometer measures solar irradiation).
5. Hot Water temperature to the home.

The picture 2 below shows the placement of the monitoring equipment.



Picture 2. Placement of the monitoring equipment.

The metering equipment was supplied by RTE and installed by SASSA and/or their agents. The remote metering period began after the installation of the metering equipment and the remote metering equipment will remain in operation until the end of the crediting period.

The equipment is installed in the housing is fitted with a tamper alert switch that warns RTE in the event of someone opening the panel. The equipment is powered via a photovoltaic panel with battery back-up.

To confirm the number of operating systems 1 % of the installations in each CPA are sampled for functionality, as well as to check the data capture accuracy. The database annually allocates the 1 in 100 sites for inspection by an automated random number generator, which will be set to never select the same site for inspection over the 10 years period. Therefore 10 percent of all the installations will be inspected over the 10 years monitoring period.

In February 2012 a random sample of 590 sites was issued and sites where inspected. The operationality check procedure is managed by SASSA and follows the above-mentioned criteria (1/100). The operationality check procedure and related results are presented in section E.3 below.

Additional to the operationality checks SASSA record all incidents reported into an incident management log book. (The beneficiaries/ households receive a manual which included the call centres phone number of SASSA. In case of a failure of a SWH the household will contact SASSA via given phone number.) The purpose of the incident management log record is twofold:

1) To manage and respond to incidents reported by residents such as leaks closed valves etc.;

2) To identify and inspect any systems, which were completely non-operational i.e. the system is not working and not producing hot water and has failed indefinitely. Such systems would be fixed or replaced under warranty by the community maintenance manager of the specific community.

The incident management procedure includes the following:

1. Upon installation, the household resident beneficiaries (here after termed as the "client") are provided with material on their system. A dedicated call centre number has been established to manage client complaints, queries and incidents;

2. Should an incident occur (minor incidents such as leaks or total system failure) the client phones the SASSA call centre;

3. The incident is logged by the call centre agent in the incident management spread sheet;

4. The maintenance manager in the community is then contacted with the respective details via telephonic call and SMS to tend to the matter;

5. The maintenance manager is to respond and inspect the unit within 24 hours of the call incident being logged;

6. Once the unit has been inspected the maintenance manager commences to fix the respective unit accordingly and reports back to the call centre with feedback on the status of the system and the resolution;

7. Through this mechanism it is possible to monitor the performance of the technology in terms of operationality and to detect faults that lead to system failure.

The incidents are typically reported immediately and managed within a 24 hour call out period. This means that the affected SWH unit needs to have been inspected and fixed within 24 hours of the client reporting the incident to the SASSA call centre. Many incidents reported are however maintenance orientated and comprise of leaks, or residents whom have accidently closed valves. These are minor fixable and easy incidents that do not necessarily mean that the SWH is out of operation. In 2011 a total of 262 incidents were reported of which 56 where incidents where the unit was not operational and/or not providing hot water.

The SASSA maintenance teams that are placed within the communities where interviewed to find out maximum reporting time from a beneficiary to SASS maintenance team/ ward counsellor. In most instances beneficiaries report the malfunction of a SWH immediately. However, in some cases this can take up to 4 days. As SASSA response time is 24 hours the, 56 units that were reported to be non operational are accounted for not operational for six days (144 hours). This is a conservative approach, as most incidents are reported and fixed immediately i.e. within 24-48 hours.

SECTION D. Data and parameters

Parameters recorded:

- Cold water feed temperature to the geyser,
- Ambient air temperature.
- Water flow/quantity of water used in SWH
- Pyranometer readings (a pyranometer measures solar irradiation).
- Hot Water temperature to the home

The equipment used to monitor each parameter is:

Pyranometer to measure irradiation. One paranometer will be required on each site. The pyranometers supplied are to be in accordance with the World Meteorological Organisation (WMO). The detector of the pyranometer is a high stability silicon photovoltaic detector (blue enhanced), and the sensor housing is weatherproof anodized aluminum case with acrylic diffuser and stainless steel hardware. The accuracy of the meters is presented in the table 2 below.[8]

Specifications	**Value**
Accuracy	Absolute error in natural daylight is ±5% maximum; ±3% typical
Stability	< ±2% change over a 1 year period
Operating Temperature	-40 to +65 °C
Response Time	10 µs
Linearity:	Maximum deviation of 1% up to 3000 W m-2

Table 2. Accuracy of the pyranometers.

Temperature transducers to measure cold water temperature, hot water temperature and ambient air temperature. The measurement site will require two water temperature transducers and one ambient temperature probe per metered site. The water temperature transducers must have an error margin of no greater than ±0.35 °C and a precision of ±0.358°C . The ambient air temperature probe has an accuracy error margin of no greater than ±0.35°C and a precision of ±0.35°C. The Temperature transducers have been tested according DIN EN 60751:2009 and DIN IEC 751. The accuracy of the Temperature transducers is presented in table 3 below[9]:

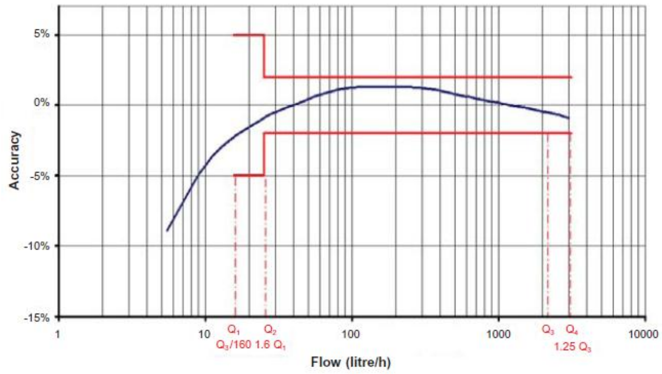
Table 3.Accuracy of the Temperature transducers

Temperature rage	Accuracy	
- 30 … + 300 °C	At 0 °C	± 0.15 °C
	At 100 °C	± 0.35 °C

[8] LI200X Pyranometer, instruction manual.

[9] Wika data sheet: Usage limitations and accuracies of platinum resistance thermometers in industrial applications, page 4; and Wika Temperature, Basic Values and Tolerances for Resistance elements, page 1.

Flow meters to measure water flow on cold water supply to the solar water heater (equal to the hot water consumed). The accuracy is a function of the flow rate and can be seen in the accuracy curve below (picture 3). The accuracy of the flow meter is 100% when the flow is 40 litres per hour or 0.67 per minute. Typical flow rates for the measured sites based on 2011 data are from 20 litres per hour to 250 litres per hour, when water is drawn. This is well within the specified maximum flow rate. At these flows the error is ± 2 % (shown in read in the below curve).[10]



Picture 3. Accuracy of the flow meters.

The pyranometer, the ambient temperature probe, the cold and hot water temperature probe and cold water flow meter have valid calibration certificates. The calibration certificate dates are presented in the below tables (4-6):

Table 4. Pyranometer serial number and validity date.

Monitoring site	Pyranometer Serial No	Certificate Date	Valid until
11858 Relebohile, Dingalo Street Kroonstad, Moqhak Municipality	PY71638	08/09/2010	1/09/2015
8186 Thladi Street, Potchefstoom, Tlokwe Local Municipality	PY71639	08/09/2010	1/09/2015
1230 U Section Botshabelo, Manganung Municipality	PY 71636	08/09/2010	2/08/2015
13 Yster Street, Vredenburg, Saldhana Bay Local Municipality	PY 71645	08/09/2010	29/09/2015
224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth	PY 67126	25/09/2009	12/03/2015
3324 Welbedacht West Chatsworth, eThekwini Metropolitan Municipality	PY 69976	15/07/2010	19/04/2015
7226 Cisticola Street, Ekhurleni Metropolitan Municipality	PY71637	08/09/2010	01/09/2015
6th Road Calitzdorp, Kannaland Municipality, Eden District	PY71635	08/09/2010	23/08/2015

Table 5. Flow meter serial number and validity date.

Monitoring site	Flow meter Serial No	Certificate Date	Valid until
11858 Relebohile, Dingalo Street Kroonstad, Moqhak Municipality	100016988	26/06/2008	01/09/2016
8186 Thladi Street, Potchefstoom, Tlokwe Local Municipality	100016985	27/06/2008	01/09/2016
1230 U Section Botshabelo, Manganung Municipality	100016986	28/06/2008	02/08/2016

[10] Sensus Metering System, LD 1660 INT, Volumetric Meter Composite Body Protected Dial, page 2.

13 Yster Street, Vredenburg, Saldhana Bay Local Municipality	100016987	29/06/2008	29/09/2016
224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth	100016981	30/06/2008	12/03/2016
3324 Welbedacht West Chatsworth, eThekwini Metropolitan Municipality	100016982	01/07/2008	19/04/2016
7226 Cisticola Street, Ekhurleni Metropolitan Municipality	100016984	02/07/2008	01/09/2016
6th Road Calitzdorp, Kannaland Municipality, Eden District	100016983	03/07/2008	23/08/2016

Table 6. Temperature transducers serial number and validity date.

Monitoring site	Certificate No	Ambient Temp (serial no.)	Water Temp In (serial no.)	Certificate Date	Validity Date
11858 Relebohile, Dingalo Street Kroonstad, Moqhak Municipality	WCT-CF-DBN-T1118/1	139982015	139982012	04/08/2011	04/08/2015
8186 Thladi Street, Potchefstoom, Tlokwe Local Municipality	WCT-CF-DBN-T1118/1	139952015	139952012	04/08/2011	04/08/2015
1230 U Section Botshabelo, Manganung Municipality	WCT-CF-DBN-T1118/1	139962015	139962012	04/08/2011	04/08/2015
13 Yster Street, Vredenburg, Saldhana Bay Local Municipality	WCT-CF-DBN-T1118/1	139972015	139972012	04/08/2011	04/08/2015
224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth	WCT-CF-DBN-T1001	117392015	117392012	15/03/2010	15/03/2014
3324 Welbedacht West Chatsworth, eThekwini Metropolitan Municipality	WCT-CF-DBN-T1001	135792015	135792012	15/03/2010	15/03/2014
7226 Cisticola Street, Ekhurleni Metropolitan Municipality	WCT-CF-DBN-T1118/1	139942015	139942012	04/08/2011	04/08/2014
6th Road Calitzdorp, Kannaland Municipality, Eden District	WCT-CF-DBN-T1118/1	139932015	139932012	04/08/2011	04/08/2015

As mentioned in section C above the data at each of the metered sites is recorded every 5 minutes and integrated daily. The measurement data/ records are then transmitted to a via a GSM network server into RTE's SQL database that is hosted in a secure hosted environment. At midnight every day, the simulation is executed on each home/ SWH installation based on the daily measured values.

The measurement process, data transfer and calculation of saving and emission reductions are completely automated. In case of any failures in communication with the measurement equipment the RTE database alerts the responsible RTE staff.

Determination of calculation methods for relevant parameters:

Three relevant parameters are calculated, of which the energy delivered and operational hours are calculated based on monitoring data, and grid emission factor is calculated based on Eskom data. The available solar irradiation at each site, together with the daily average ambient and cold water temperatures, are used in accordance with the SABS performance test to determine the delivered energy to that site.

This is done using the Formula provided by the SABS ***Q***-Factor test conducted as per SABS 6211-1: 2003.

$$Q = \alpha_1 H + \alpha_2 (T_a - T_c) + \alpha_3$$

Where,

$\boldsymbol{Q}$ = Energy output in MJ

H	=	The energy input i.e. irradiation in MJ per m^2
T_a	=	The ambient air temperature and
T_c	=	Incoming cold water temperature
α_1,	=	H coefficient determined in the SABS test,
α_2,	=	Delta T coefficients determined in the SABS test,
α_3	=	Intercept coefficients determined in the SABS test.

The determination of ***Q*** complies with SABS 6211-1 (SABS, 2003) test for the solar absorption efficiency of a domestic solar water heating system. ***Q*** is measured in MJ and is limited to a maximum of 16 MJ per day[11]. This sets a maximum ***Q***-Factor of 13.692MJ. When the measured H value is greater than 16 MJ, H is set at 16 MJ i.e. limited to ***Q*** of 13.692MJ.

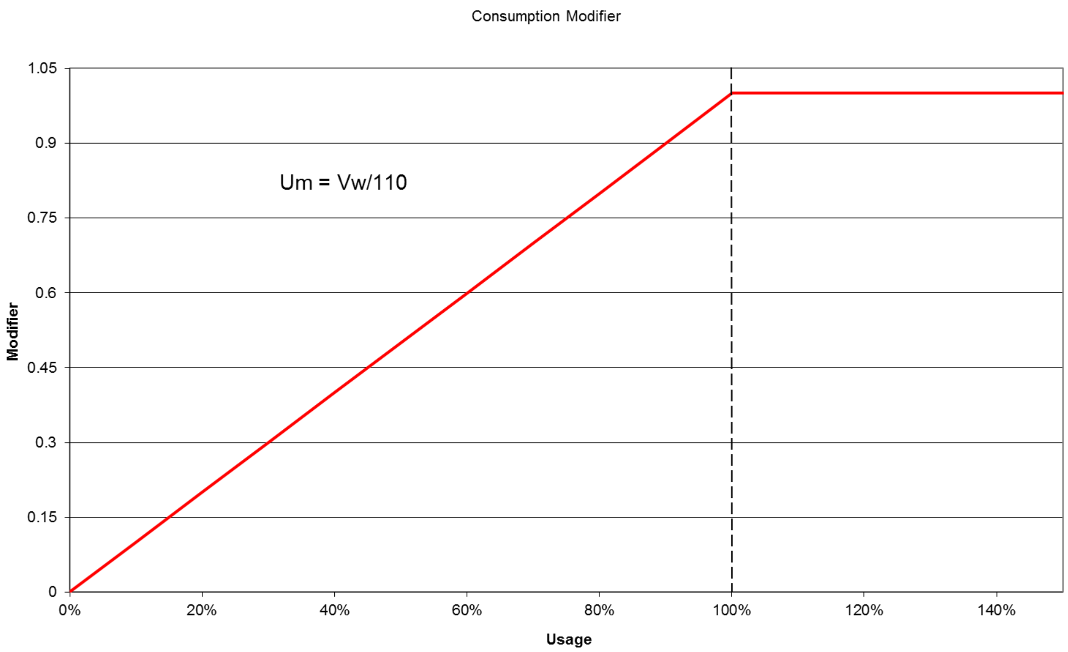
The water meter, measures the volume of water that is drawn through the solar geyser. The usage pattern is plotted for each day and integrated to determine the total consumption for each day. If the consumer uses the full 110 liters of hot water the full ***Q***-factor energy is used as the energy reduction for that day. However, a linear regression is used to discount the energy reduction as the water consumption decreases. Please see graph 1 below.

V_w = Daily Hot Water Usage in Liters

U_m = Usage Modifier

If V_w is less than 110 liters then the following applies:

$U_m = V_w/110$



Graph 1. Usage Modifier

[11] *See Reference 1 page 57*

The calculation is done daily based on the 5 minute interval measurement results in each of the eight sites and the Q_y is a sum of these measurements multiplied by the total number of units in each measurement area, which increased daily in 2011. The appendix I present the calculation of Q daily. Furthermore the table 8-12 shows the monitored parameters at each site.

The average annual hours of operation are calculated with the help of the energy baseline $EG_{BL,y}$ and the rated capacity of the SWH as per SABS test, as follows:

$h = EG_{BL,y}\ [kWh] / Q\ [kW]$

As per registered PoA-DD the weighted average emissions (in tCO2/MWh) of the current generation mix are used to determine the grid emission factor, and are calculated as follows:

$$EF_{EL} = \frac{\sum FC_{i,m,y} * NCV_{i,y} * EF_{CO2,i,y}}{EG_{m,y}}$$

Where;

EF_{EL}	= EnergCO2 emission factor for power unit , in year y (tCO2/MWh)
$FC_{i,m,y}$	= Amount of fossil fuel type i consumed by power unit m in year y (t)
$NCV_{i,y}$	= Net caloric value of fossil fuel type i in year y (MJ/t)
$EF_{CO2,i,y}$	= CO2 emission factor for fossil fuel type i in year y (tCO2/MJ)
$EG_{m,y}$	= Net quantity of electricity generated and derived to the grid by power unit m in year y (MWh)
M	All power units serving the grid in a year y
I	All fossil fuel types combusted in power unit m in year y
Y	The relevant year

The latest data available from Eskom has been used to calculate the grid emission factor. The detailed data and calculation is presented in appendix I. The table 7 presents the data and sources applied:

Table 7: Data and Sources applied for determination of GEF.

Data	**Source**
Fuel consumption per plant 2011	http://www.eskom.co.za/c/article/236/cdm-calculations/
Electricity generation per plant 2011	http://www.eskom.co.za/c/article/236/cdm-calculations/
NCVs: Coal: 19 450 MJ/t	Eskom annual report 2011,p.324 , http://financialresults.co.za/2011/eskom_ar2011/downloads/eskom-ar2011.pdf

Kerosene: 42 000 MJ/t Diesel: 41 400 Mj/t	2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 2, table 1.2
Emission Factors: Coal: 89.5 t CO_2/TJ Kerosene: 70.8 t CO_2/TJ Diesel: 72.6 t CO_2/TJ	2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 2, table 1.4.

Parameters Monitored:

The below tables 8-12 shows the monitoring results for each monitored sites:

Table 8. Average daily cold water temperature

Average Daily Cold Water Temp (°C)									
Month	**Botsh.**	**Calitzd.**	**Durban**	**Ekhur.**	**Kroons.**	**Port Elizab.**	**Potchest.**	**Saldhana**	**Total**
March						19.61			**19.61**
April			21.61			17.42			**18.61**
May			20.24			16.02			**18.13**
June			17.13			13.94			**15.54**
July			15.80			13.65			**14.72**
August	15.79		17.43			14.31			**15.86**
September	17.90	14.34	20.35	19.13	18.12	17.09	21.57	19.41	**18.37**
October	20.91	16.31	21.93	20.79	21.05	19.34	23.57	21.30	**20.65**
November	23.53	17.10	22.14	22.06	23.33	19.73	25.33	22.45	**21.96**
December	23.96	19.35	25.13	22.51	23.53	21.96	25.76	24.11	**23.31**
Total	**21.19**	**16.79**	**20.09**	**21.13**	**21.52**	**17.17**	**24.07**	**22.55**	**20.02**

Table 9. Average daily ambient temperature

Average Ambient Temp (°C)									
Month	**Botsh.**	**Calitzd.**	**Durban**	**Ekhur.**	**Kroons.**	**Port Elizab.**	**Potchest.**	**Saldhana**	**Total**
March						21.94			**21.94**
April			20.05			19.49			**19.65**
May			19.05			15.91			**17.48**
June			16.61			13.66			**15.14**
July			15.15			13.26			**14.20**
August	14.95		17.14			13.77			**15.39**
September	16.32	16.43	19.08	17.41	17.51	15.81	18.66	14.61	**17.29**
October	18.78	18.56	19.85	18.98	19.71	17.94	20.33	16.83	**18.87**
November	20.61	20.03	20.19	20.29	21.48	17.84	21.60	17.78	**19.98**
December	21.45	22.62	22.55	20.66	21.66	19.87	21.81	19.15	**21.24**
Total	**19.00**	**19.43**	**18.77**	**19.34**	**20.10**	**16.74**	**20.61**	**17.85**	**18.68**

Table 10. Average daily Pyronometer

Average of Avg Pyro (W/m^2)									
Month	**Botsh.**	**Calitzd.**	**Durban**	**Ekhur.**	**Kroons.**	**Port Elizab.**	**Potchest.**	**Saldhana**	**Total**

March						310.79			**310.79**
April			344.80			395.25			**380.83**
May			250.99			242.54			**246.76**
June			243.40			193.02			**218.21**
July			221.27			230.70			**225.99**
August	211.88		198.51			250.77			**223.03**
September	253.49	186.26	167.80	227.04	252.77	204.35	254.52	212.82	**220.81**
October	280.77	227.64	179.35	264.17	260.34	236.76	259.43	241.01	**243.68**
November	323.82	270.04	169.10	277.43	283.29	245.36	269.31	320.83	**269.90**
December	284.56	287.32	207.86	241.45	271.85	274.73	244.73	327.24	**267.38**
Total	**280.54**	**243.05**	**211.46**	**252.53**	**267.05**	**256.27**	**256.92**	**294.32**	**251.96**

Table 11. Average Daily Solar Irradiation

Average of Solar Irradiation (MJ/m^2)									
Month	**Botsh.**	**Calitzd.**	**Durban**	**Ekhur.**	**Kroons.**	**Port Elizab.**	**Potchest.**	**Saldhana**	**Total**
March						27.01			**27.01**
April			29.74			33.07			**32.12**
May			21.70			21.93			**21.81**
June			21.03			16.68			**18.85**
July			19.12			19.93			**19.52**
August	18.31		17.14			21.66			**19.27**
September	21.90	16.10	14.50	19.62	21.83	17.66	21.99	18.39	**19.08**
October	24.26	19.67	15.50	22.82	22.49	20.46	22.41	20.82	**21.05**
November	27.98	23.26	14.60	23.91	24.48	21.20	23.27	27.71	**23.30**
December	24.59	24.81	17.96	20.86	23.49	23.74	21.15	28.27	**23.10**
Total	**24.24**	**20.98**	**18.27**	**21.81**	**23.07**	**22.15**	**22.20**	**25.43**	**21.77**

Table 12. Average daily water flow.

Average Water Flow (litres)									
Month	**Botsh.**	**Calitzd.**	**Durban**	**Ekhur.**	**Kroons.**	**Port Elizab.**	**Potchest.**	**Saldhana**	**Total**
March						38.40			**38.40**
April			72.00			124.33			**109.38**
May			119.90			113.10			**116.50**
June			160.17			155.03			**157.60**
July			135.77			69.90			**102.84**
August	66.50		144.31			114.68			**121.51**
September	59.88	26.00	109.10	47.03	37.52	113.50	26.20	45.25	**59.75**
October	67.65	22.61	71.11	41.27	38.10	86.45	26.44	42.32	**49.49**
November	62.23	15.65	78.32	55.52	40.68	79.40	20.77	37.67	**48.78**
December	52.24	19.47	44.79	66.02	35.77	137.57	15.15	49.60	**51.53**
Total	**60.90**	**20.93**	**106.16**	**52.48**	**38.00**	**105.12**	**22.11**	**43.30**	**68.40**

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/Parameter	Q
Unit	TJ
Description	Daily solar energy output by the SWH i in the day
Source of data	SABS test results
Value(s) applied	13.692 MJ
Purpose of data	Calculation of baseline emissions (ex ante)
Additional comment	The solar water heater system analysis is based on SANS 6211-1:2003. The SABS test determines the energy output of the SWH. The SABS test result is used for ex-ante calculation. For ex-post calculation the SABS test is adjusted based on the real-time measurements.

Data/Parameter	$\mathbf{N_{estimate}}$
Unit	Units
Description	Estimated number of units installed under the CPA
Source of data	Estimated based on size of absorber area
Value(s) applied	59 000
Purpose of data	Calculation of baseline emissions (ex ante)
Additional comment	It is estimated that the no of SWH installed with this CPA include 59 000 installations, based on the collector area of 1.08 m^2. The maximum total collector area of each CPA shall be 64 000 m^2.

D.2. Data and parameters monitored

Data/Parameter	N
Unit	-
Description	Number of SWH operating in the year
Measured/Calculated /Default	Calculated based on a sample (1%)
Source of data	Operationality sample
Value(s) of monitored parameter	38 974
Monitoring equipment	Site visits: visual and technical checks, as well as failure reporting
Measuring/Reading/ Recording frequency	Annual sample
Calculation method (if applicable)	1 in 100 randomly selected sites will be inspected, the installation will be checked for data capture accuracy and if system functionality. The database will annually allocate the 1 in 100 sites for inspection by an automated random number generator, which will be set to never select the same site for inspection over the 10 year period. Therefore 10 percent of all the installations will be inspected over the 10 year monitoring period. Furthermore all reported failures will be recoded into the data management system. The results of the sample and failure reporting are applied to the CPA to determine the number of SWHs operational as per the "General guidelines for sampling and surveys for SSC project activities".
QA/QC procedures	SASSA record all incidents reported and react within 24 hours to correct any possible failure of the SWH.
Purpose of data	Calculation of baseline emissions
Additional comment	Please note that a total of 58,984 units were installed between July 2010 and December 2011. However, as explained under section B.1. above only 38 974 units could be monitored and hence forms the total population of the CPA001 in 2011.

Data/Parameter	$Q_{,y}$
Unit	MWh
Description	Solar energy output by the SWHs in the year *y*, kWh
Measured/Calculated /Default	Calculated
Source of data	Measurement results
Value(s) of monitored parameter	14 427.48
Monitoring equipment	n/a
Measuring/Reading/ Recording frequency	Daily
Calculation method (if applicable)	The calculation bases on the SABS test results, which is adjusted with the real-time measurement results. Please see section D above for more details.
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	Please see section D above and the appendix I.

Data/Parameter	H_{year}
Unit	MJ/m^2
Description	Annual average irradiation
Measured/Calculated /Default	Measured
Source of data	Onsite measurements
Value(s) of monitored parameter	Annual average daily irradiation: (see table below)
Monitoring equipment	Pyranometer
Measuring/Reading/ Recording frequency	The data at each of the metered sites is recorded every 5 minutes and integrated daily.
Calculation method (if applicable)	n/a
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Solar radiation is measured using a pyranometer and is measured in W/m^2. These readings are integrated into daily values and reported in kWh per installation. Please see section D above.

Month	Total (W/m^2)	Total (MJ/m^2)
March	310.79	27.01
April	380.83	32.12
May	246.76	21.81
June	218.21	18.85
July	225.99	19.52
August	223.03	19.27
September	220.81	19.08
October	243.68	21.05
November	269.90	23.30
December	267.38	23.10
Total av.	**251.96**	**21.77**

<table>
<tr><td>Data/Parameter</td><td>$Ta_{,\ year}$</td></tr>
<tr><td>Unit</td><td>Celsius</td></tr>
<tr><td>Description</td><td>The average annual ambient air temperature</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Onsite measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Annual average daily ambient air temperature:
<table>
<tr><td>Month</td><td>Total</td></tr>
<tr><td>March</td><td>19.61</td></tr>
<tr><td>April</td><td>18.61</td></tr>
<tr><td>May</td><td>18.13</td></tr>
<tr><td>June</td><td>15.54</td></tr>
<tr><td>July</td><td>14.72</td></tr>
<tr><td>August</td><td>15.86</td></tr>
<tr><td>September</td><td>18.37</td></tr>
<tr><td>October</td><td>20.65</td></tr>
<tr><td>November</td><td>21.96</td></tr>
<tr><td>December</td><td>23.31</td></tr>
<tr><td>Total av.</td><td>20.02</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td>Temperature probe</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>The data at each of the metered sites is recorded every 5 minutes and integrated daily.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>n/a</td></tr>
<tr><td>QA/QC procedures</td><td></td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>Used to adjust the energy output determined in the SABS test. Please see section D above.</td></tr>
</table>

Data/Parameter	**Tc, $_{year}$**
Unit	Celsius
Description	The average annual Cold Water Temperature
Measured/Calculated /Default	Measured
Source of data	Onsite measurements
Value(s) of monitored parameter	Annual average Cold Water Temperature:
Monitoring equipment	Temperature probe
Measuring/Reading/ Recording frequency	The data at each of the metered sites is recorded every 5 minutes and integrated daily.
Calculation method (if applicable)	n/a
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Used to adjust the energy output determined in the SABS test. Please see section D above.

Month	Total
March	19.61
April	18.61
May	18.13
June	15.54
July	14.72
August	15.86
September	18.37
October	20.65
November	21.96
December	23.31
Total av.	**20.02**

Data / Parameter	V
Unit	Litres
Description	Volume of daily cold water flow
Measured/Calculated /Default	Measured
Source of data	Onsite measurements
Value(s) of monitored parameter	Annual average daily water flow: (see table below)
Monitoring equipment	Volumetric flow meter
Measuring/Reading/ Recording frequency	Continuous measurement i.e. when water withdrawn by household.
Calculation method (if applicable)	n/a
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	The volume is used to calculate mass (m) of water. Please see section D.

Month	Total
March	38.40
April	109.38
May	116.50
June	157.60
July	102.84
August	121.51
September	59.75
October	49.49
November	48.78
December	51.53
Total	**68.40**

Data/Parameter	**$Q_{on\text{-}site}$**
Unit	MWh
Description	Solar energy output by the SWH in the year *y*, MWh
Measured/Calculated /Default	Calculated
Source of data	Onsite measurements
Value(s) of monitored parameter	28 004.61
Monitoring equipment	n/a
Measuring/Reading/ Recording frequency	Daily
Calculation method (if applicable)	The SWHs are measured for irradiation, ambient air temperature, for water inlet temperature and water flow to determine daily solar energy output. Please see section D above for more details.
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	The measured SWHs are used to adjust the energy output determined in the SABS test. However, the total reduction is capped in a maximum daily reduction as per SABS (see parameter $\mathbf{Q_{,y}}$) to be conservative.

Data/Parameter	**EF_{grid}**
Unit	tCO_{2e}/MWh
Description	The emission factor for the electricity system.
Measured/Calculated /Default	Calculated
Source of data	http://www.eskom.co.za/c/article/236/cdm-calculations/; Eskom annual report 2010,p.296, http://www.eskom.co.za/annreport10; Emission Factors IPCC 2006.
Value(s) of monitored parameter	0.9861
Monitoring equipment	n/a
Measuring/Reading/ Recording frequency	Annual
Calculation method (if applicable)	The calculation follows the guidance of AMS.I.D option b as per the registered PoA-DD.
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Please see appendix I for the detailed calculation.

D.3. Implementation of sampling plan

As per the registered PoA-DD, to confirm the number of operating systems 1 % of the installations in each CPA are sampled for functionality, as well as to check the data capture accuracy. The database will annually allocate the 1 in 100 sites for inspection by an automated random number generator, which will be set to never select the same site for inspection over the 10 years period. Therefore 10 percent of all the installations will be inspected over the 10 years monitoring period. The results are used to adjust the emission reduction calculation (i.e. % of SWHs operational).

Under the CPA001 590 installations per year are checked for operationality. As demonstrated in the registered PoA-DD the sample size meets well the requirements of "General guidelines for sampling and surveys for SSC project activities" i.e. the sample size shall be determined with minimum 90% confidence interval and 10% maximum error margin.

The random sample was issued by RTE and sample houses where inspected by SASSA's maintenance teams, who did check, if the SWHs provide hot water to the households. Furthermore the SWHs where inspected for optimal functionality and checked for lakes, over flow, or breaks. It should be noted that SASSA does continuous maintenance, in case household's reports for any faults. The results of the inspection where captured manually in a form, which then was scanned and the data result of the inspection operational or not operational was captured by SASSA data capturers into the RTE database.

In February 2012 a random sample of 590 sites was issued and altogether 590 houses where inspected. The operationality check procedure is managed by SASSA, and entails the following:

1. A random sample of houses with the installed solar water heating units to inspect was issued by the Real Time Energy database system;
2. The sample size was based on the above mentioned criteria (1/100) of the total CPA size.
3. Solar water heating unit "operationality check list" was developed by the SASSA technical team to define operationality;
4. The SASSA teams, on the ground in the respective areas were briefed according to the operationality check list to audit the homes allocated by the issued sample;
5. Team managers inspected the units at the respective homes.

   During the inspections it was noted that not all households visited where home during the inspection time. Therefore, two criterions were developed to mitigate time delays and to accommodate this social phenomenon, which is beyond the control of the project developer. These criteria included:

   i. If access can be gained to the SWH unit, without breeching Health and Safety regulations or causing damage to property and the unit can be inspected without the home owner being present, then the unit would be inspected according to the operationality checklist.

   ii. If the home owner is not home and there is no access to the unit and it cannot be inspected, the sample size is reduced accordingly.

6. Once all the units were inspected, the operationality checklist documents were sent back to SASSA's head office. Where the data was captured via web interface and documents uploaded to the database accordingly.

All together 590 households where inspected, of which 589 households where original issued sample houses i.e. one home could not be inspected and a next door house was inspected instead. Following analysis can be driven from the operationality sample:

Table 12: Confidentiality

Item	No	%		
Population (total CPA size)	**59 000**	Of		
Population in 2011 (units installed)	**58 984**	total CPA size	units installed 2011	units monitored 2011
Population monitored in 2011	**38 974**			
Initial sample size	590	1.000%	1.000%	1.514%
Initial houses	589			
House nest door	1			
Total sample size inspected	**590**	**1.000%**	**1.000%**	**1.514%**
SWHs operational	589	100 %		
SWHs not operational	0	0.00 %		
SQRT	0.00			
Standard error	0.00	0.00 %		
Precision (@ 90% confidence level)	0.00	0.00 %		
Precision (@ 95% confidence level)	0.00	0.00 %		
Maximum amount of houses not operational	0	0.00 %		
Minimum no houses operational: total CPA size	**59 000**	**100 %**		
Minimum no houses operational in 2011	**58 984**	**100 %**		
Minimum no houses operational of the monitored units	**38 974**	**100 %**		
As per indecent management records additional 56 units were reported to be out of operation during 2011. These units have been counted to be unoperational for 48 hours, as SASSAs reaction time is 24 hours after a incident call, and hence 0.195 t CO2 where "lost" due maintenance downtime.				

The detailed calculation is presented in appendix I.

SECTION E. Calculation of emission reductions or GHG removals by sinks
E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

$BE_y = EG_{BL,y} * EF_{grid}$

Where,

Symbol	*Description*	*Value Applied*
BE_y	= Baseline Emissions in year *y*, tCO_2	14 227
$EG_{BL,y}$	= Energy baseline in year *y*, MWh	14 426.88
EF_{grid}	= CO_2 Emission factor, tCO_2/MWh.	0.9861

The Energy Baseline ($EG_{BL,y}$) is the solar energy output ($Q_{,y}$) of SWHs, which is multiplied by the operationality ratio (i.e. number of SWHs operational, N) and further adjusted with maintenance downtime as follows:

$EG_{BL,y}$ = 14 427.48 MWh * 100 % - 0.59975 MWh = 14 426.88 MWh

Where,

Symbol	***Description***	***Value Applied***
$EG_{BL,y}$	= Energy baseline in year *y*, MWh	14 426.88
$Q_{,y}$	= Solar energy output, MWh	14 427.48
N	= SWHs operationality ratio	100 %
MD	Maintenance Downtime, MWh	0.59975

The average annual hours of operation are calculated with the help of the energy baseline $EG_{BL,y}$ and the rated capacity of the SWH as per SABS test, as follows:

h = 14 426.88 MWh / 13.692 MJ = 14 426.884 MWh /0.0038 MWh = 3 793 219

E.2. Calculation of project emissions or actual net GHG removals by sinks

As per the registered PoA-DD and the methodology AMS.I.C, version 17 the project emissions consist of CO_2 emissions from onsite fossil fuel consumption. As this PoA does not include an electric backup system, there are no emissions related to the project activity. Hence the project emissions in year y is zero (PEy = 0) under this programme and the CPA-001.

E.3. Calculation of leakage

As per the registered PoA-DD and the methodology AMS.I.C, version leakage shall be considered if the SWH is transferred from another activity, or the PoA includes replacement of existing equipment. The PoA takes place in poor income households that currently lack proper water heating equipment, and hence heat up water with electric kettles and electric and kerosene stoves. Hence the SWH is rather seen as a new installation opposite to the replacement of existing equipment (see section E.4 for suppressed demand argumentation in the PoA-DD). The baseline water heating systems will be further used for cooking and do not create a leakage. Hence, leakage (LE,y) is considered to be zero under this programme and CPA-001.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO_2e)	Project emissions or actual net GHG removals by sinks (tCO_{2e})	Leakage (tCO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO_2e)
Total	14 227	0	0	14 227

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e)	63 580	14 227

E.6. Remarks on difference from estimated value in registered PDD

The emission reductions received are less than initially estimated in the CPA-001 DD. Following cause of decrease has been indentified:

1. In 2011 only one measurement site was installed in Port Elizabeth due to constrain to identify measurement site within 50 km radius from installations (see section B.1 above). The monitoring plan however requires 1 measurement site per 10,000 installations and hence Port Elizabeth that has 34,450 in CPA001 can generate reductions only for 10,000 installations in 2011. A further 3 monitoring sites have been installed in Port Elizabeth in 2012.

2. Monitoring results lower than initially estimated in the PoA-DD and CPA001-DD. The ex ante estimation did base on the daily thermal capacity of the SWH as per SABS test results. These results gave an estimated 1.3 t CO2 per SWH per year (this results to a monthly average of 0.1 tCO2). The daily capacity of a 110 litre SWH bases on the idea that a household would uses 110 litre of water daily. Based on literature values on typical daily water consumption, minimum required water consumption, average household size and free allocation of water in low income areas in South Africa, it was estimated that each household would use a minimum of 110 litre of water. However, the measurement results show that daily water consumption seems to vary significantly more i.e. someday households use significantly less than 110 litres others more than 110 litres. To be conservative as required per CDM rules the daily SABS thermal capacity was set as basis for maximum daily consumption i.e. CO2 reduction and hence days that household actually use more water and thermal energy can be accounted only up to SABS capacity.

3. Furthermore due to sudden Eskom subsidy restrictions the installation figures are less that initially predicted. SASSA is currently restricted to 1,100 installations per month which is 5,000 units less than its installation capacity.

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History of the document

Version	Date	Nature of revision
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	EB 54, Annex 34 28 May 2010	Initial adoption.
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