



Monitoring report form (Version 03.1)

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	05
Completion date of the monitoring report	16/01/2014
Registration date of the project activity	12/03/2011
Monitoring period number and duration of this monitoring period	# 2 01/01/2012 - 31/12 /2012
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	105 427
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	34 749

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The purpose of the PoA and CPAs 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 CPAs consists 110 litre vacuum tube storage tank low pressure SWHs with each having 1.08 m² aperture i.e. absorber area. The below table 1 shows total installation and absorber area numbers for 2012.

Table 1. Installation number and absorber area.

CPA	Number of Installations	Total absorber area
001	59 000	63 720 m ²
002	25 632	27 683 m ²

The SWHs comply with the SABS Standard Specification for SWH systems SANS 6211-1:2003, SANS 151-2009 and SANS 1307:2003¹ 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 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
- eThekweni Metropolitan Municipality: 2011/02/03
- Western Cape Province: 2011/02/05
- North West Province: 2011/01/01
- KwaZulu Natal: 08/12/2010
- Gauteng: 01/10/2010
- Mpumalanga: 19/04/2011

The dates for the CPAs are as follows:

- Start date of CPA001: 01/07/2010;
- Start date of CPA002: 09/10/2010;
- CPA001 became full: 28/02/2012;

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

- CPA002: Installations still continuing.

Dates for commissioning the monitoring sites/ equipment are given in below table 2.

Table 2. Commissioning dates of the monitoring sites.

No.	City / Municipality	Province	Address	Latitude	Longitude	Commissioning date
1	Port Elizabeth/ Nelson Mandela Bay Metropolitan Municipality	Eastern Cape	224 K.D Matanzima Crescent Erf 3621 Motherwell	-33.80345	25.615417	12/03/2011
2	Durban / eThekweni Metropolitan Municipality	KwaZulu Natal	3324 Welbedacht West Chatsworth	-29.921317	30.831017	19/04/2011
3	Botshabelo / Manganung Municipality	Free State	1230 U Section Botshabelo	-29.261933	21.67115	2/08/2011
4	Calitzdorp/Kannal and Municipality/ Eden District	Western Cape	6 th Road Calitzdorp	-33.5228	21.67115	23/08/2011
5	Ekhurleni Metropolitan Municipality	Gauteng	7226 Cisticola Street	-26.1101	27.189333	01/09/2011
6	Kroonstad / Moqhak Municipality	Free State	11858 Relebohile, Dingalo Street Kroonstad	-27.654117	27.189333	1/09/2011
7	Potchefstroom / Tlokwe Local Municipality	North West	8186 Thladi Street, Potch	-26.730184	27.053916	1/09/2011
8	Vredenburg / Saldhana Bay Local Municipality	Western Cape	13 Yster Street, Vredenburg	-32.91555	18.0207	29/09/2011
9	Uitenhage, Rocklands / Nelson Mandela Bay Municipality	Eastern Cape	301 Rocklands Street	-33.856783	25.289017	16/02/2012
10	Uitenhage, Nelson Mandela Bay Municipality	Eastern Cape	22 Heron Street	-33.731783	25.377383	16/02/2012
11	Uitenhage, Rocklands / Nelson Mandela Bay Municipality	Eastern Cape	334 Rocklands Street	-33.858217	25.28795	01/03/2012
12	City of Johannesburg	Gauteng	32 Field Street, Alexandra	-26.087583	28.112809	26/09/2012
13	Caledon / Theewaterskloof Municipality	Western Cape	2532 School Street Genadendal 7234	-34.245499	19.420878	26/09/2012
14	Klipplaat / Ikwezi Municipality	Eastern Cape	1317, Klipplaat	-33.01851667	24.34828333	30/09/2012
15	Machadodorp / Emakhazeni Municipality	Mpumalanga	795 Shabalala Ave eNtokozeni	-25.69405	30.24405	01/09/2012
16	Willowmore / Baviaans Municipality	Eastern Cape	7th Avenue Willowmore	-33.28205	23.49858333	30/09/2012
17	Barrydale/ Swellendam Municipality	Western Cape	6750 Protea Ave, Barrydale	-33.913683	20.737983	10/10/2012
18	Pellrus, Jeffreys Bay / Kouga Municipality	Eastern Cape	11 Galjoen Street, Pellrus Jeffreys Bay	-34.06516667	24.9195	30/09/2012
19	Buitesig /	Free State	54592 Monyatsi St,	-29.130817	26.231533	30/09/2012

	Mangaung		Buitesig			
20	Darnall / Ilembe District Municipality	Kwa Zulu Natal	2320 Zamani; Darnall; Stanger	-29.28175	31.356117	09/10/2012
21	Caledon/ Theewaterskloof Municipality	Western Cape	2210 Edsin Ave; Theewaterskloof; Caledon	-34.079083	19.9013	11/10/2012

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 November 2012.

Total GHG emission reductions achieved in this monitoring period: 34 749 tons CO₂

The CPA001 contains a total of 59,000 houses and CPA002 a total of 25,632 houses i.e. a total of 84,632 installations under this PoA in 2012. However, in 2012 only 79 498 installations were allocated to measured sites due to delays in data upload process and installation of monitoring equipment. Hence 2012 emission reductions base only on 79 498 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
- Ikwezi Municipality in the Eastern Cape Province
- Baviaans Municipality in the Eastern Cape Province
- Kouga Municipality in the Eastern Cape Province
- eThekweni Metropolitan Municipality in the KwaZulu Natal Province
- Botshabelo Metropolitan Municipality in the Free State Province
- Moghaka Municipality² in the Free State Province
- Ekurhuleni Metropolitan Municipality in Gauteng Province
- City of Johannesburg Metropolitan Municipality in Gauteng Province
- Tlokwe Local Municipality³ in the North West Province
- Saldhana Bay Local Municipality⁴ in the Western Cape Province
- Mossel Bay Municipality in the Western Cape Province
- Theewaterskloof Local Municipality in the Western Cape Province
- Kannaland Municipality and Eden District 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 PoA and the relevant CPAs comprises the physical site of each SWH within the CPA as well as the South African grid system, as the SWH will replace grid electricity. The GHG reduced through the CPAs is CO₂. 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 each CPA are presented in the detailed House List with GPS-coordinates, as provided to the verifying DoE.

² Also known as Kroonstad

³ Also known as Potchefstroom

⁴ Also known as Saldhana and Verenburg

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 Ltd	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:

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

CPA001: 12/03/2011 – 11/03/2021 (Fixed crediting period of ten years)

CPA002: 01/04/2012 – 31/03/2022 (Fixed crediting period of ten years)

SECTION B. Implementation of project activity**B.1. Description of implemented registered project activity**

Under the PoA 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.

System specifications:

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: $1.8 \text{ m} \times 0.05 \text{ m} \times 12 = 1.08 \text{ m}^2$

Total absorber/ aperture area of CPA001: $1.08 \text{ m}^2 \times 59\,000 = 63\,720 \text{ m}^2$

Total absorber/ aperture area of CPA002: $1.08 \text{ m}^2 \times 25\,632 = 27\,683 \text{ m}^2$

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. The CPA001 became full on 28/02/2012,

which is the date of the last installation done under CPA001. The CPA002 started on 09/10/2010 also with installations in Port Elizabeth in Nelson Mandela Bay Metropolitan Municipality, Eastern Cape. The CPA002 did not reach its full volume in 2012 i.e. installations continued in 2013. In 2012 a total of 84,632 installations were done. However, only 79 498 installations were allocated to measured sites. This was due to delays in data upload process and installation of monitoring equipment, as well as problematic monitored sites where equipment was damaged or tampered with, and the lack of recording or capturing residents' IDs (an eligibility criterion required for inclusion under the PoA). Furthermore 792 households did not provide ID documentation in this regard, and hence they have been disqualified from generating CERs, which is a conservative approach. Hence 2012 emission reductions are based only on 79 498 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 km⁵ 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 3. Dates for commissioning the monitoring sites/ equipment.

No.	Address	Commissioning date
1	224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth	12/03/2011
2	3324 Welbedacht West Chatsworth, Durban	19/04/2011
3	1230 U Section, Botshabelo, Manganung Municipality	2/08/2011
4	6 th Road Calitzdorp, Eden District	23/08/2011
5	7226 Cisticola Street, Ekurhuleni	01/09/2011
6	11858 Relebohile, Dingalo Street Kroonstad	1/09/2011
7	8186 Thladi Street, Potchefstroom	1/09/2011
8	13 Yster Street, Vredenburg	29/09/2011
9	301 Rocklands Street, Uitenhage	16/02/2012
10	22 Heron Street, Uitenhage	16/02/2012
11	334 Rocklands Street, Uitenhage,	01/03/2012
12	32 Field Street, Alexandra, Johannesburg	26/09/2012
13	2532 School Street Genadendal 7234, Caledon / Theewaterskloof	26/09/2012
14	1317, Klipplaat	30/09/2012
15	795 Shabalala Ave eNtokozen, Machadodorp	01/09/2012
16	7th Avenue Willowmore	30/09/2012
17	6750 Protea Ave, Barrydale, Swellendam	10/10/2012
18	11 Galjoen Street, Pellsrus Jeffreys Bay	30/09/2012
19	54592 Monyatsi St, Buitesig, Mangaung	30/09/2012
20	2320 Zamani; Darnall; Stanger	09/10/2012
21	2210 Edsin Ave; Theewaterskloof; Caledon	11/10/2012

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 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 London 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:)

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 November 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. Hence only 79 498 installations of 84,632 total installations were monitored in 2012 and 10 monitored sites were installed only in the second quarter of 2012.

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 crediting 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 incorrectly 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 on 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 were installed in 2011 and 12 additional sites were installed in 2012 of which 9 were installed only in the second half of 2012.

It should be noted that installations start to generate reductions only when monitoring equipment is installed.

A total of 792 households did not provide ID documentation in this regard, and hence they have been

disqualified from generating CERs, which is a conservative approach.

Therefore, in 2012 only 79 498 installations (out of the total 84,632 installations) were allocated to measured sites and hence the emission reductions base on 79 498 SWHs.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

n/a

B.2.2. Corrections

No corrections to the PoA.

Corrections to CPA-002-DD due to corrections made during first verification in the PoA-DD, as follows⁶:

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 Cadastral 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 CPA-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

Parameter Tc – Incoming cold water temperature – and V - Volume of daily cold water flow have been added to the list of parameters to be monitored by CPAs in section B.7.1 of the revised PoA-DD. This is because both parameters were included in the description of the monitoring plan of the registered PoA-DD, but were absent from the list of parameters to be monitored. Section B.7.1 of the revised PoA-DD is now in line with the registered monitoring plan.

Moreover, in order to address instances where residents were not at home at the time the household was visited as part of the operability survey, the project participant intends to apply the following criteria:

1. If access can be gained to the SWH unit, without breaching Health and Safety regulations or causing damage to property and the unit can be inspected without the home owner being present, then the unit is inspected according to the operability checklist;
2. If the home owner 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 sampled house where the home owner was present would be inspected according to the operability checklist. This incident would be indicated and declared on the operability checklist to manage quality control.

⁶ The Post Registration Changes were approved by EB on 15 November 2013 (PRC-4302001)

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

n/a

B.2.5. Changes to start date of crediting period

n/a

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:

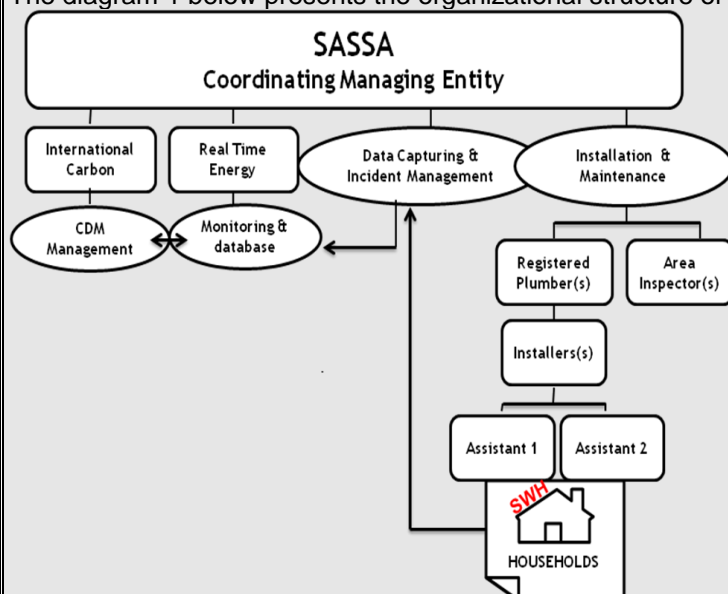


Diagram 1. Organizational structure of the SASSA PoA.

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 managed the SASSA contract in 2012 where:

- 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 and GPS coordinates);
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 identified with ERF number and serial number of the SWH. The ERF numbers available were not complete, i.e. 21, digits and hence not unique⁷. 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 km⁸ 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 %.

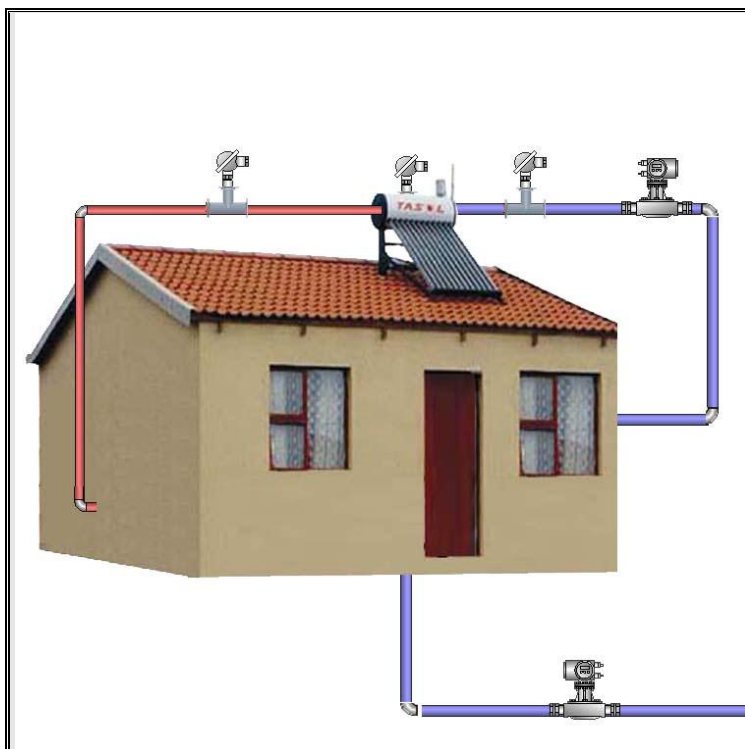
The following parameters are at every measured house:

1. Cold water feed temperature to the geyser,
2. Ambient air temperature.
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 1 below shows the placement of the monitoring equipment.

⁷ The ERF is an alphanumeric key (21 digits) of the Cadastral 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.

⁸ 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:)



Picture 1. 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 November 2012 a random sample of 793sites 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 accidentally closed valves. These are minor fixable and easy incidents that do not necessarily mean that the SWH is out of operation. In 2012 a total of 502 incidents were reported of which 112 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 SASSA 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 112 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 pyranometer 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 4 below.⁹

Table 4. Accuracy of the pyranometers.

Specifications	Value
Model	LI200X
Accuracy	Absolute error in natural daylight is $\pm 5\%$ maximum; $\pm 3\%$ typical
Stability	$< \pm 2\%$ change over a 1 year period
Operating Temperature	-40 to +65 °C
Response Time	10 μ s
Linearity:	Maximum deviation of 1% up to 3000 W m ⁻²

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 5 below¹⁰:

Table 5. Accuracy of the Temperature transducers

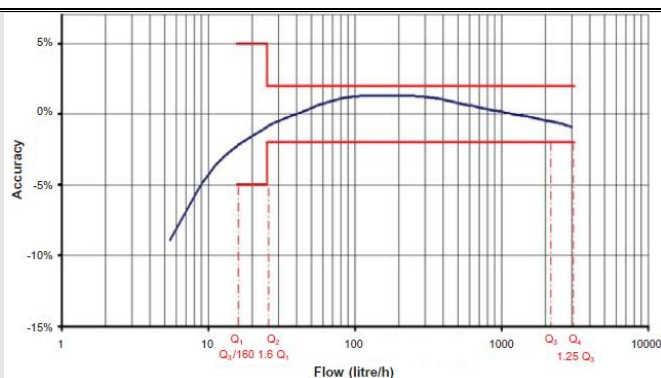
Temperature range	Accuracy	
Model	Pt100	
- 30 ... + 300 °C	At 0 °C	± 0.15 °C
	At 100 °C	± 0.35 °C

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 2). The accuracy of the 220 C model 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 $\pm 2\%$ (shown in read in the below curve).¹¹

⁹ LI200X Pyranometer, instruction manual.

¹⁰ Wika technical information 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.

¹¹ Sensus Metering System, LD 1660 INT, Volumetric Meter Composite Body Protected Dial, page 2.



Picture 2. 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 (6-8):

Table 6. Pyranometer serial number and validity date.

No.	Monitoring site	Pyranometer Serial No	Certificate Date	Valid until
1	224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	PY 67126	25-Sep-10	12-Mar-15
2	3324 Welbedacht West Chatsworth, eThekweni Metropolitan Municipality, Kwazulu- Natal	PY 69976	15-Jul-10	19-Apr-15
3	1230 U Section Botshabelo, Manganung Municipality, Free State	PY 71636	08-Sep-10	02 Aug 15
4	6th Road Calitzdorp, Kannaland Municipality, Eden District, Western Cape Province	PY71635	08-Sep-10	23-Aug-15
5	7226 Cisticola Street, Ekurhuleni Metropolitan Municipality, Gauteng	PY 71637	08-Sep-10	01-Sep-15
6	11858 Relebohile, Dingalo Street Kroonstad, Moghak Municipality, Free State	PY 71638	08-Sep-10	01-Sep-15
7	8186 Thladi Street, Potchefstroom, Tlokwe Local Municipality, North West Province	PY 71639	08-Sep-10	01-Sep-15
8	13 Yster Street, Vredenburg, Saldhana Bay Local Municipality, Western Cape	PY 71645	08-Sep-10	29-Sep-15
9	301 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	PY 71640	08-Sep-10	16-Feb-16
10	22 Heron Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	PY 71632	08-Sep-10	16-Feb-16
11	334 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	PY 71633	08-Sep-10	12-Mar-16
12	32 Field Street, Alexandra, Gauteng	PY 79120	06-Mar-12	26-Sep-16
13	2532 School Street Genadendal 7234, Caledon / Theewaterskloof Municipality, Western Cape	PY 67482	25- Aug-09	26-Sep-16
14	1317, Klipplaat, Ikwezi Municipality, Eastern Cape	PY 79118	06-Mar-12	30-Sep-16
15	795 Shabalala Ave; eNtokozweni, Machadodorp, Emakhazeni Municipality, Mpumalanga	PY 79121	06-Mar-12	01-Sep-16
16	7th Avenue Willowmore, Baviaans Municipality, Eastern Cape	PY 79119	06-Mar-12	30-Sep-16
17	6750 Protea Ave, Barrydale, Swellendam Municipality, Western Cape	PY 79124	06-Mar-12	10-Oct-16
18	11 Galjoen Street, Pellsrus Jeffreys Bay, Kouga Municipality, Eastern Cape	PY 79123	06-Mar-12	30-Sep-16
19	54592 Monyatsi St, Buitesig, Mangaung, Free State	PY 79122	06-Mar-12	30-Sep-16
20	2210 Edsin Ave; Theewaterskloof; Caledon, Western Cape	PY 79125	06-Mar-12	11-Oct-16

21	2320 Zamani; Darnall; Stanger, Ilembe District Municipality, Kwa Zulu Natal	PY 79132	06-Mar-12	09-Oct-16
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Table 7. Flow meter serial number and validity date.

No.	Monitoring site	Flow meter Serial No	Certificate Date	Valid until
1	224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	100016981	13 Jun 11	12-Mar-16
2	3324 Welbedacht West Chatsworth, eThekweni Metropolitan Municipality, Kwazulu- Natal	100016982	13 Jun 11	19-Apr-16
3	1230 U Section Botshabelo, Manganung Municipality, Free State	100016986	13 Jun 11	2016/802
4	6th Road Calitzdorp, Kannaland Municipality, Eden District, Western Cape Province	100016983	13 Jun 11	23-Aug-16
5	7226 Cisticola Street, Ekurhuleni Metropolitan Municipality, Gauteng	100016984	13 Jun 11	01-Sep-16
6	11858 Relebohile, Dingalo Street Kroonstad, Mophak Municipality, Free State	100016988	13 Jun 11	01-Sep-16
7	8186 Thladi Street, Potchefstroom, Tlokwe Local Municipality, North West Province	100016985	13 Jun 11	01-Sep-16
8	13 Yster Street, Vredenburg, Saldhana Bay Local Municipality, Western Cape	100016987	13 Jun 11	29-Sep-16
9	301 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	120053141	12 Jun 12	16-Feb-17
10	22 Heron Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	120053142	12 Jun 12	16-Feb-17
11	334 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	120053143	12 Jun 12	01-Mar-17
12	32 Field Street, Alexandra, Gauteng	120026915	12 Jun 12	26-Sep-17
13	2532 School Street Genadendal 7234, Caledon / Theewaterskloof Municipality, Western Cape	120053146	12 Jun 12	26-Sep-17
14	1317, Klipplaat, Ikwezi Municipality, Eastern Cape	120026912	12 Jun 12	30-Sep-17
15	795 Shabalala Ave; eNtokozweni, Machadodorp, Emakhazeni Municipality, Mpumalanga	120026914	12 Jun 12	01-Sep-17
16	7th Avenue Willowmore, Baviaans Municipality, Eastern Cape	120026904	12 Jun 12	30-Sep-17
17	6750 Protea Ave, Barrydale, Swellendam Municipality, Western Cape	120026916	12 Jun 12	10-Oct-17
18	11 Galjoen Street, Pellsrus Jeffreys Bay, Kouga Municipality, Eastern Cape	120026909	12 Jun 12	30-Sep-17
19	54592 Monyatsi St, Buitesig, Mangaung, Free State	120026905	12 Jun 12	30-Sep-17
20	2210 Edsin Ave; Theewaterskloof; Caledon, Western Cape	120026917	12 Jun 12	11-Oct-17
21	2320 Zamani; Darnall; Stanger, Ilembe District Municipality, Kwa Zulu Natal	120027220	12 Jun 12	09-Oct-17

Table 8. Temperature transducers serial number and validity date.

No	Monitoring site	Certificate No	Ambient Temp (tag no.)	Water Temp In (tag no.)	Certificate Date	Validity Date
1	224 K.D Matanzima Crescent Erf 3621 Motherwell, Port Elizabeth, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	WCT-CF-DBN-T1001	T-01-1001	T-02-1001	2010/03/15	2014/03/15
2	3324 Welbedacht West Chatsworth, eThekweni Metropolitan Municipality, Kwazulu- Natal	WCT-CF-DBN-T1001	T-03-1001	T-04-1001	2010/03/15	2014/03/15

3	1230 U Section Botshabelo, Manganung Municipality, Free State	WCT-CF-DBN-T1001 WCT-CF-DBN-T1111	T-05-1001	TE-01-1101	2010/03/15 2011/03/08	2014/03/15 2015/08/04
4	6th Road Calitzdorp, Kannaland Municipality, Eden District, Western Cape Province	WCT-CF-DBN-T1111	TE-02-1101	TE-03-1101	2011/03/08	2015/03/08
5	7226 Cisticola Street, Ekurhuleni Metropolitan Municipality, Gauteng	WCT-CF-DBN-T1111	TE-04-1101	TE-05-1101	2011/03/08	2015/03/08
6	11858 Relebohile, Dingalo Street Kroonstad, Moqhak Municipality, Free State	WCT-CF-DBN-T1111	TE-06-1101	TE-07-1101	2011/03/08	2015/03/08
7	8186 Thladi Street, Potchefstroom, Tlokwe Local Municipality, North West Province	WCT-CF-DBN-T1111	TE-08-1101	TE-09-1101	2011/03/08	2015/03/08
8	13 Yster Street, Vredenburg, Saldhana Bay Local Municipality, Western Cape	WCT-CF-DBN-T1111 WCT-CF-DBN-T1111/1	TE-10-1101	TE-11-1101	2011/03/08	2015/03/08
9	301 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	WCT-CF-DBN-T1111/1	TE-12-1101	TE-13-1101	2011/03/08	2015/03/08
10	22 Heron Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	WCT-CF-DBN-T1111/1	TE-14-1101	TE-15-1101	2011/03/08	2015/03/08
11	334 Rocklands Street, Uitenhage, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape	WCT-CF-DBN-T1111/1 WCT-CF-DBN-T1118	TE-16-1101	TE-01-1102	2011/03/08	2015/03/08
12	32 Field Street, Alexandra, Gauteng	WCT-CF-DBN-T1118	TE-02-1102	TE-03-1102	2011/03/08	2015/03/08
13	2532 School Street Genadendal 7234, Caledon / Theewaterskloof Municipality, Western Cape	WCT-CF-DBN-T1118	TE-04-1102	TE-05-1102	2011/03/08	2015/03/08
14	1317, Klipplaat, Ikwezi Municipality, Eastern Cape	WCT-CF-DBN-T1118	TE-06-1102	TE-07-1102	2011/03/08	2015/03/08
15	795 Shabalala Ave; eNtokozweni, Machadodorp, Emakhazeni Municipality, Mpumalanga	WCT-CF-DBN-T1118	TE-08-1102	TE-09-1102	2011/03/08	2015/03/08
16	7th Avenue Willowmore, Baviaans Municipality, Eastern Cape	WCT-CF-DBN-T1118 WCT-CF-DBN-T1118/1	TE-10-1102	TE-11-1102	2011/03/08	2015/03/08
17	6750 Protea Ave, Barrydale, Swellendam Municipality, Western Cape	WCT-CF-DBN-T1118/1	TE-12-1102	TE-13-1102	2011/03/08	2015/03/08
18	11 Galjoen Street, Pellsrus Jeffreys Bay, Kouga Municipality, Eastern Cape	WCT-CF-DBN-T1118/1	TE-14-1102	TE-15-1102	2011/03/08	2015/03/08
19	54592 Monyatsi St, Buitesig, Mangaung, Free State	WCT-CF-DBN-T1118/1	TE-16-1102	TE-17-1102	2011/03/08	2015/03/08
20	2210 Edsin Ave; Theewaterskloof; Caledon, Western Cape	WCT-CF-DBN-T1118/1	TE-18-1102	TE-19-1102	2011/03/08	2015/03/08
21	2320 Zamani; Darnall; Stanger, Ilembe District Municipality, Kwa Zulu Natal	WCT-CF-DBN-T1118/1 WCT-CF-DBN-T1118/2	TE-20-1102	TE-21-1102	2011/03/08	2015/03/08

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,

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
α₁	= H coefficient determined in the SABS test,
α₂	= Delta T coefficients determined in the SABS test,
α₃	= 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 day¹². This sets a maximum **Q**-Factor of 13.692MJ.¹³ 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

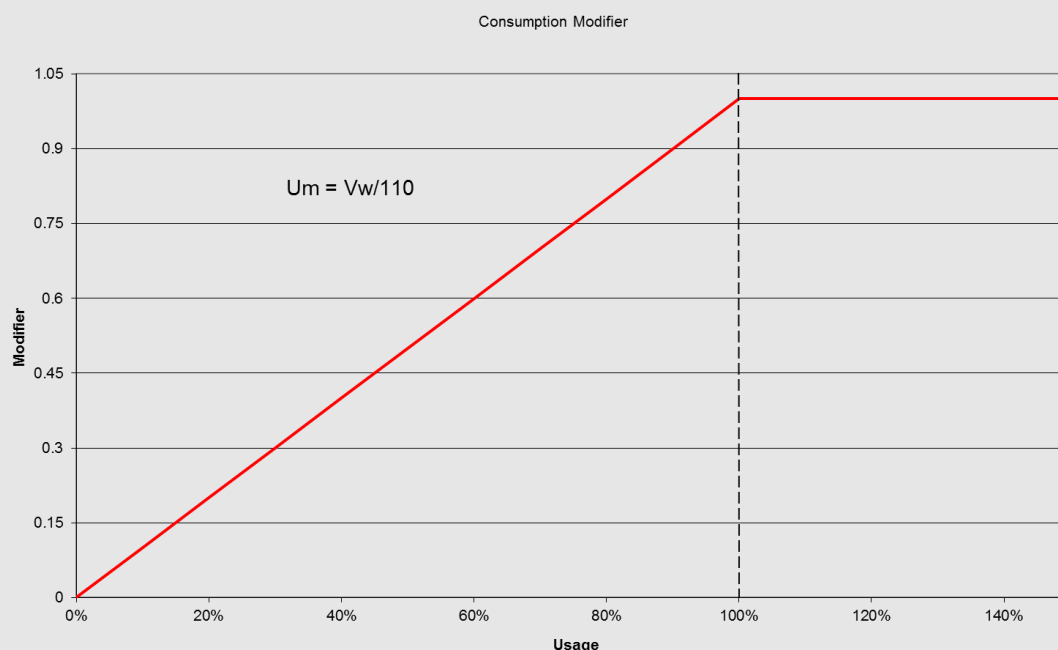
U_m = Usage Modifier

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

$$U_m = V_w / 110$$

¹² See Reference 1 page 57

¹³ Revised SABS 6211



Graph 1. Usage Modifier

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 2012. The appendix I present the calculation of Q daily and the tables 10-30 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}	= EnergCO ₂ emission factor for power unit , in year y (tCO ₂ /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)
$EF_{CO2,i,y}$	= CO ₂ emission factor for fossil fuel type i in year y (tCO ₂ /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 9 presents the data and sources applied:

Table 9: Data and Sources applied for determination of GEF.

Data	Source
Fuel consumption per plant 2012	http://www.eskom.co.za/c/article/236/cdm-calculations/
Electricity generation per plant 2012	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 10-30 shows the monitoring results for each monitored sites:

Table 10. Average Daily values measured at site no 12, 32 Field Street, Alexandra, City of Johannesburg.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Pyronometer
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
September	29.80	22.04	17.30	23.36	271.49
October	67.82	23.05	18.75	20.03	232.60
November	60.10	24.42	20.15	22.91	266.05
December	32.31	24.26	20.32	20.46	237.68
Total Average	52.12	23.81	19.61	21.23	246.57

Table 11. Average Daily values measured at site no 17, 6750 Protea Ave, Barrydale.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	52.70	18.15	14.69	21.80	253.14
November	31.92	22.14	17.89	29.09	337.85
December	33.82	25.31	21.88	28.20	327.51
Total Average	38.14	22.27	18.53	26.83	311.54

Table 12. Average Daily values measured at site no 3, 1230 U Section, Botchabello.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	46.34	26.94	24.00	26.71	308.61
February	52.12	25.27	22.22	22.16	256.40
March	52.84	23.31	20.70	21.20	246.25
April	67.35	17.93	15.50	17.81	206.78
May	60.71	15.76	14.32	14.73	171.05

June	56.27	11.02	9.36	11.25	130.60
July	61.85	10.55	9.00	14.06	163.26
August	58.52	13.90	12.85	15.19	176.41
September	61.98	16.79	14.71	20.56	238.82
October	62.39	21.61	19.05	24.32	282.35
November	57.65	24.49	21.77	25.84	300.15
December	58.44	23.57	20.76	23.26	270.13
Total Average	58.04	19.25	17.01	19.75	229.20

Table 13. Average Daily values measured at site no 13, 2532 School Street, Genadendal 7234, Caledon.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
September	94.60	14.53	12.76	14.80	171.99
October	124.69	15.97	14.21	17.76	206.17
November	216.97	20.24	17.52	24.15	280.50
December	299.40	23.79	21.62	23.04	267.63
Total Average	207.52	19.72	17.53	21.27	247.04

Table 14. Average Daily values measured at site no 4, 6th Road, Calitzdrop.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	0.00	22.19	25.53	22.24	257.57
February	0.03	20.07	23.29	20.71	240.54
March	0.00	20.51	22.92	17.26	200.45
April	0.00	17.22	18.72	12.87	149.51
May	0.00	15.00	16.41	10.46	121.43
June	0.02	13.34	14.21	8.04	93.34
July	0.00	12.43	13.15	9.00	104.58
August	31.32	12.97	13.13	15.33	157.57
September	26.10	17.66	16.24	18.86	219.06
October	27.77	19.49	17.51	20.07	233.05
November	24.43	24.01	21.54	26.07	302.83
December	28.21	27.59	25.35	24.40	283.41
Total Average	11.49	18.55	19.01	17.10	196.88

Table 15. Average Daily values measured at site no 21, 2320 Zamani, Darnall.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	68.02	22.49	19.99	14.27	165.76
November	68.08	24.05	21.04	16.50	191.64
December	45.05	27.37	23.79	21.65	251.39
Total Average	59.57	24.85	21.77	17.79	206.61

Table 16. Average Daily values measured at site no 2, 3324 Welbedacht, West Chatsworth, Durban.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	18.11	27.39	24.47	19.80	228.34
February	28.91	27.28	24.49	16.79	194.83
March	23.92	25.41	23.26	16.15	187.63
April	62.38	21.91	19.96	14.60	169.56
May	69.29	21.06	19.72	11.07	128.62

June	89.22	17.60	17.27	10.35	120.18
July	109.47	17.20	17.01	11.53	133.85
August	84.76	18.72	18.67	11.70	135.85
September	78.13	19.16	18.00	13.04	151.42
October	68.21	20.67	19.26	12.68	147.18
November	79.15	21.76	20.18	14.19	164.76
December	45.47	25.06	25.62	18.45	214.32
Total Average	63.12	21.93	20.66	14.19	164.69

Table 17. Average Daily values measured at site no 5, 7226 Cisticola Street, Ekurhuleni.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	70.69	22.64	20.89	22.65	262.52
February	69.86	23.99	21.59	20.35	236.64
March	86.06	21.68	19.57	18.87	219.14
April	81.37	18.14	15.81	16.32	189.53
May	97.55	17.29	14.80	13.28	154.25
June	53.67	12.15	10.01	10.60	123.15
July	78.11	12.74	11.06	11.91	138.33
August	70.94	14.80	13.66	13.81	160.43
September	55.80	16.61	15.24	17.93	208.26
October	48.92	19.78	18.25	19.56	227.13
November	84.48	21.49	19.73	23.14	268.77
December	93.98	21.43	19.95	21.12	245.29
Total Average	74.37	18.55	16.70	17.45	202.66

Table 18. Average Daily values measured at site no 18, 11 Galjoen Street, Pellsrus, Jefferies Bay.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	37.63	16.81	16.63	16.47	191.30
November	71.33	19.17	18.59	26.34	305.92
December	90.92	22.15	21.63	22.94	266.48
Total Average	66.58	19.38	18.95	21.87	254.01

Table 19. Average Daily values measured at site no 14, 1317, Kilppalaat.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	18.73	17.07	15.75	17.60	204.43
November	20.78	21.33	19.68	25.03	290.67
December	22.37	23.79	22.32	21.25	246.83
Total Average	20.63	20.72	19.25	21.25	246.84

Table 20. Average Daily values measured at site no 6, 11858 Relebohile, Dingalo Street, Kroonstad.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	38.79	25.79	23.58	27.01	310.40
February	44.07	24.40	22.54	20.93	243.10
March	36.89	22.81	21.14	20.96	243.45
April	35.23	17.78	16.57	18.12	210.44
May	46.00	15.66	14.93	14.83	172.29
June	39.75	10.11	9.56	11.87	137.86
July	43.23	10.17	9.95	14.50	168.36
August	42.44	14.12	13.88	15.97	185.43

September	43.05	16.07	15.30	19.94	231.60
October	34.63	21.61	20.33	23.21	269.55
November	37.52	23.65	21.83	24.66	286.41
December	36.98	23.39	21.45	23.53	273.33
Total Average	39.87	18.79	17.58	19.63	227.72

Table 21. Average Daily values measured at site no 19, 54592 Monyatsi St, Buitesig, Mangaung.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	7.61	19.35	26.88	24.21	281.16
November	22.00	22.22	29.60	24.71	286.95
December	21.19	20.91	27.80	21.45	249.15
Total Average	16.88	20.81	28.08	23.44	272.26

Table 22. Average Daily values measured at site no 15, 795 Shabalala, Machadodrop.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	40.40	19.30	16.86	18.41	213.83
November	39.32	21.25	17.87	20.77	241.19
December	30.31	22.07	18.61	19.03	221.02
Total Average	36.65	20.87	17.78	19.39	225.17

Table 23. Average Daily values measured at site no 1, 224 K.D Matanzima Crescent, NMBM.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	95.74	24.92	22.55	24.50	283.68
February	42.81	22.98	21.00	20.32	236.27
March	0.00	22.55	20.85	16.80	195.08
April	0.00	18.58	17.32	13.51	156.81
May	54.89	16.53	15.49	10.35	120.17
June	50.43	14.27	14.00	8.49	98.59
July	66.60	13.12	12.82	9.18	106.57
August	103.42	13.81	13.43	12.94	150.24
September	127.28	16.49	15.37	17.77	206.35
October	122.66	17.51	15.93	15.04	174.63
November	135.87	20.93	18.18	25.05	290.99
December	179.24	24.00	21.58	23.62	274.33
Total Average	81.83	18.80	17.37	16.44	190.93

Table 24. Average Daily values measured at site no 7, 8186 Thladi Street, Potchefstroom.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	12.11	27.01	22.91	21.41	247.26
February	19.81	25.91	22.17	19.61	226.97
March	18.55	24.45	20.79	20.05	232.88
April	25.87	19.88	16.64	17.97	208.75
May	17.61	18.47	15.89	14.94	173.50
June	17.85	13.36	11.08	12.38	143.75
July	24.13	14.26	11.86	14.08	163.58
August	16.64	13.86	10.76	15.08	181.64
September	0	0	0	0	0
October	15.15	23.17	20.12	22.19	266.36
November	17.53	25.05	22.49	24.36	282.95

December	8.19	23.96	21.54	21.69	251.87
Total Average	17.73	20.99	17.99	18.45	214.82

Table 25. Average Daily values measured at site no 9, 301 Rocklands, Uitenhage, NMBM.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
February	100.04	23.21	21.43	21.30	258.48
March	66.18	22.03	20.67	16.57	192.42
April	94.30	18.69	17.69	14.73	171.11
May	97.37	17.02	16.32	11.36	131.92
June	61.03	14.66	14.37	9.88	114.75
July	58.95	13.82	13.59	10.46	121.53
August	94.24	14.14	13.78	14.09	163.61
September	101.58	16.10	15.13	17.99	208.97
October	91.02	16.43	15.40	14.71	170.84
November	142.12	20.26	18.05	25.56	296.81
December	105.60	23.12	21.31	20.81	241.67
Total Average	91.52	17.87	16.84	15.85	184.53

Table 26. Average Daily values measured at site no 11, 334 Rockland, Uitenhagen, NMBM.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
March	19.34	22.86	20.44	15.85	184.06
April	31.45	19.29	17.52	13.70	159.10
May	37.63	17.26	16.22	10.06	116.85
June	25.18	14.93	14.27	8.56	99.41
July	38.48	14.06	13.53	9.19	106.72
August	27.63	14.76	13.66	12.75	148.04
September	0.00	17.16	14.93	16.83	195.48
October	0.00	16.97	15.16	14.02	162.83
November	0.07	21.39	17.74	24.71	287.09
December	0.11	24.34	21.02	20.38	236.66
Total Average	18.04	18.30	16.45	14.59	169.42

Table 27. Average Daily values measured at site no 8, 13 Yster Street, Vredenburg, Saldhana.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
January	26.02	26.87	21.97	28.06	324.75
February	39.14	25.59	21.02	24.89	289.20
March	47.39	24.45	20.33	19.48	226.21
April	118.63	21.74	17.99	13.46	156.38
May	62.52	18.93	14.97	11.04	128.26
June	87.42	18.36	13.67	8.38	97.38
July	75.50	17.63	13.01	9.92	115.25
August	77.06	17.35	12.24	12.16	141.27
September	88.88	19.53	14.58	15.79	183.39
October	68.00	21.36	16.65	22.78	264.53
November	80.45	23.40	18.45	26.83	311.62
December	57.42	26.60	21.62	27.15	315.36
Total Average	68.93	21.81	17.20	18.32	212.66

Table 28. Average Daily values measured at site no 20, 2210 Edsin Ave, Teerfswaterkloof, Caledon.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
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	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	50.05	16.85	14.94	16.53	191.99
November	34.73	21.33	17.83	25.35	294.41
December	162.45	24.57	21.71	23.13	268.58
Total Average	86.94	21.41	18.55	22.25	258.42

Table 29. Average Daily values measured at site no 10, 22 Heron Street, Uitehage, NMBM.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
February	28.57	25.73	22.25	18.96	225.52
March	23.87	23.88	21.21	14.74	171.25
April	79.17	19.73	17.75	12.98	150.77
May	47.31	16.80	15.64	10.26	119.93
June	22.20	14.71	14.15	8.47	98.39
July	32.68	13.71	13.07	9.14	106.15
August	41.52	15.13	13.65	12.34	143.28
September	51.68	18.42	15.64	15.91	184.83
October	45.71	18.12	15.99	12.64	146.82
November	38.50	23.05	18.82	23.30	270.63
December	33.47	25.98	22.18	21.26	246.88
Total Average	39.76	18.92	16.72	14.47	168.19

Table 30. Average Daily values measured at site no 16, 7th Avenue Willowmore.

	Water Flow (V)	Cold Water Temp (Tc)	Ambient Temp (Ta)	Solar Irradiation (H)	Solar Irradiation
	[l]	[°C]	[°C]	[MJ/m ²]	[W/m ²]
October	80.00	18.02	13.67	18.02	209.35
November	54.82	24.06	18.15	26.62	309.13
December	66.10	25.19	20.49	23.91	256.28
Total Average	67.10	22.41	17.43	22.81	257.70

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

Data / Parameter:	Q
Unit:	MJ
Description:	Daily solar energy output by the SWH 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:	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:	90,500
Purpose of data:	Calculation of baseline emissions (ex ante)
Additional comment:	CPA001: 59,000 It is estimated that the no. of SWH installed with this CPA includes 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 . CPA002: 31,500 Maximum number of units under the micro scale additionality limits.

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	78 787
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 84,632 units were installed in 2012. However, as explained under section B.1. above only 79 498 were monitored, of which 78 787 units are operational (see table 31, section D.3).

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	35 078.89
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: <table><tr><th>Month</th><th>Total (W/m²)</th><th>Total (MJ/m²)</th></tr><tr><td>January</td><td>277.89</td><td>24.05</td></tr><tr><td>February</td><td>240.66</td><td>20.66</td></tr><tr><td>March</td><td>208.98</td><td>17.99</td></tr><tr><td>April</td><td>175.34</td><td>15.10</td></tr><tr><td>May</td><td>139.84</td><td>12.03</td></tr><tr><td>June</td><td>112.98</td><td>9.73</td></tr><tr><td>July</td><td>127.86</td><td>11.01</td></tr><tr><td>August</td><td>156.37</td><td>13.58</td></tr><tr><td>September</td><td>202.80</td><td>17.46</td></tr><tr><td>October</td><td>211.82</td><td>18.23</td></tr><tr><td>November</td><td>279.41</td><td>24.06</td></tr><tr><td>December</td><td>258.63</td><td>22.39</td></tr><tr><td>Total av.</td><td>212.59</td><td>18.33</td></tr></table>			Month	Total (W/m ²)	Total (MJ/m ²)	January	277.89	24.05	February	240.66	20.66	March	208.98	17.99	April	175.34	15.10	May	139.84	12.03	June	112.98	9.73	July	127.86	11.01	August	156.37	13.58	September	202.80	17.46	October	211.82	18.23	November	279.41	24.06	December	258.63	22.39	Total av.	212.59	18.33
Month	Total (W/m ²)	Total (MJ/m ²)																																											
January	277.89	24.05																																											
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October	211.82	18.23																																											
November	279.41	24.06																																											
December	258.63	22.39																																											
Total av.	212.59	18.33																																											
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.
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Data / Parameter:	T_a, year																												
Unit:	Celsius																												
Description:	The average annual ambient air temperature																												
Measured/ Calculated / Default:	Measured																												
Source of data:	Onsite measurements																												
Value(s) of monitored parameter:	<p>Annual average daily ambient air temperature:</p> <table border="1"> <thead> <tr> <th>Month</th><th>Total</th></tr> </thead> <tbody> <tr><td>January</td><td>23.24</td></tr> <tr><td>February</td><td>22.24</td></tr> <tr><td>March</td><td>21.08</td></tr> <tr><td>April</td><td>17.40</td></tr> <tr><td>May</td><td>15.88</td></tr> <tr><td>June</td><td>13.01</td></tr> <tr><td>July</td><td>12.59</td></tr> <tr><td>August</td><td>13.72</td></tr> <tr><td>September</td><td>15.54</td></tr> <tr><td>October</td><td>17.44</td></tr> <tr><td>November</td><td>19.89</td></tr> <tr><td>December</td><td>22.04</td></tr> <tr><td>Total av.</td><td>18.26</td></tr> </tbody> </table>	Month	Total	January	23.24	February	22.24	March	21.08	April	17.40	May	15.88	June	13.01	July	12.59	August	13.72	September	15.54	October	17.44	November	19.89	December	22.04	Total av.	18.26
Month	Total																												
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June	13.01																												
July	12.59																												
August	13.72																												
September	15.54																												
October	17.44																												
November	19.89																												
December	22.04																												
Total av.	18.26																												
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.																												

Data / Parameter:	T_c, 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:																													
	<table border="1"> <thead> <tr> <th>Month</th> <th>Total</th> </tr> </thead> <tbody> <tr><td>January</td><td>25.47</td></tr> <tr><td>February</td><td>24.44</td></tr> <tr><td>March</td><td>23.09</td></tr> <tr><td>April</td><td>19.17</td></tr> <tr><td>May</td><td>17.25</td></tr> <tr><td>June</td><td>14.10</td></tr> <tr><td>July</td><td>13.62</td></tr> <tr><td>August</td><td>14.93</td></tr> <tr><td>September</td><td>17.58</td></tr> <tr><td>October</td><td>19.06</td></tr> <tr><td>November</td><td>22.35</td></tr> <tr><td>December</td><td>24.19</td></tr> <tr><td>Total av.</td><td>20.10</td></tr> </tbody> </table>	Month	Total	January	25.47	February	24.44	March	23.09	April	19.17	May	17.25	June	14.10	July	13.62	August	14.93	September	17.58	October	19.06	November	22.35	December	24.19	Total av.	20.10	
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August	14.93																													
September	17.58																													
October	19.06																													
November	22.35																													
December	24.19																													
Total av.	20.10																													
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.																													
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:																													
	<table border="1"> <thead> <tr> <th>Month</th> <th>Total</th> </tr> </thead> <tbody> <tr><td>January</td><td>38.48</td></tr> <tr><td>February</td><td>40.03</td></tr> <tr><td>March</td><td>34.09</td></tr> <tr><td>April</td><td>54.16</td></tr> <tr><td>May</td><td>53.72</td></tr> <tr><td>June</td><td>43.77</td></tr> <tr><td>July</td><td>51.81</td></tr> <tr><td>August</td><td>59.06</td></tr> <tr><td>September</td><td>61.90</td></tr> <tr><td>October</td><td>52.10</td></tr> <tr><td>November</td><td>56.75</td></tr> <tr><td>December</td><td>64.16</td></tr> <tr> <td>Total</td> <td>53.36</td> </tr> </tbody> </table>	Month	Total	January	38.48	February	40.03	March	34.09	April	54.16	May	53.72	June	43.77	July	51.81	August	59.06	September	61.90	October	52.10	November	56.75	December	64.16	Total	53.36	
Month	Total																													
January	38.48																													
February	40.03																													
March	34.09																													
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May	53.72																													
June	43.77																													
July	51.81																													
August	59.06																													
September	61.90																													
October	52.10																													
November	56.75																													
December	64.16																													
Total	53.36																													
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.																													

Data / Parameter:	Q_{on-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:	69 525.95
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 Q_{y}) to be conservative.

Data / Parameter:	EF_{grid}
Unit:	tCO ₂ e/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:	0.9996
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).

In 2012, 793 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 leaks, 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 November 2012 a random sample of 803 sites was issued.

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 or some houses where not accessible due to security issues. 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 breaching 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/or there is no access to the unit and it cannot be inspected safely, the house is excluded from the original operationality sample.
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 803 households where allocated for inspected, of which 15 where house next door and 10 units could not be inspected due to security issues, which makes the final sample size of 793. Following analysis can be driven from the operationality sample:

Table 31: Confidentiality

Population: total installed in 2012	84 632		
Population: installations assigned to measured sites	79 498	Installed	Measured
Initial sample size	803	0.949%	1.000%
Next Door	15		
Houses "pending" i.e. not inspected *	10		
Final sample size inspected	793	0.937%	0.988%
Sampling fraction, f	0.0094		
Operational/ success, r	780		
Not operational	13		
Sample proportion, p	0.9836		
Not operational, q	0.0164		
SQRT		0.0000	0.0000
Standard error		0.0045	0.0045
Standard error (%)		0.45%	0.45%
Absolute precision @90%		0.0074	0.0074
		0.7%	0.7%
Relative precision @90%		0.0075	0.0075
		0.75%	0.75%
Absolute precision@95%		0.01	0.01
		0.9%	0.9%
Relative precision @95%		0.0089	0.0089
		0.9%	0.9%
Maximum number of units not operational		Installed	Monitored
		757	711
Number of units operational		83 875	78 787

*Not inspected due to 1) no access to unit or next door unit, or 2) security issue i.e. civil unrest in the communities.

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

$$BE_y = E_{GBL, y} * EF_{grid}$$

Where,

Symbol	Description	Value Applied
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BE_y	= Baseline Emissions in year y , tCO_2	34 749
$EG_{BL,y}$	= Energy baseline in year y , MWh	34 763
EF_{grid}	= CO_2 Emission factor, tCO_2/MWh .	0.9996

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:

$$EG_{BL,y} = 35\,078.89 \text{ MWh} * 99 \% - 1.75 \text{ MWh} = 34\,763 \text{ MWh}$$

Where,

Symbol	Description	Value Applied
$EG_{BL,y}$	= Energy baseline in year y , MWh	34 763
Q_y	= Solar energy output, MWh	35 078.89
N	= SWHs operationality ratio	99 %
MD	Maintenance Downtime, MWh	1.75

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:

$$h = 34\,763 \text{ MWh} / 13.692 \text{ MJ} = 34\,763 \text{ MWh} / 0.0038 \text{ MWh} = 9\,148\,158 \text{ h}$$

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 ($PE_y = 0$) under this programme and the CPA-001 and CPA-002.

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 and CPA-002.

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e)
Total	34 749	0	0	34 749

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 (t CO ₂ e)	105,427	34 749

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

The emission reductions received are less than initially estimated in the Design Documents for 2012. Following cause of decrease has been identified:

1. In 2012 12 new monitored sites were commissioned to increase the number of units assigned to monitoring equipment and to fulfill the required monitoring rules of 50 km radius and 1 measurement site per 10,000 installations. However, 9 out of the 12 sites were commissioned only in the second half of 2012 and hence reductions in the areas could not be counted before installation of monitoring equipment.
2. Furthermore, at three of the monitoring sites (6th Road, Calitzdrop, 224 K.D Matanzima Crescent, NMBM and 8186 Thladi Street, Potchefstroom) problems were experienced due to vandalism. The flow meter cables had been cut off several times and hence no volume readings exist for some of the months and no CO₂ emission reductions could be counted for;
3. Monitoring results lower than initially estimated in the PoA-DD and CPA-DDs. 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 use 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.
4. Furthermore due to sudden Eskom subsidy restrictions the installation figures are less than initially predicted. SASSA is currently installing approximately 1,000 units per month which

is 5,000 units less than its installation capacity.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)	34 749	n/a

Document information

Version	Date	Description
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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