PROGRAMME DESIGN DOCUMENT FORM FOR SMALL-SCALE CDM PROGRAMMES OF ACTIVITIES (F-CDM-SSC-PoA-DD) Version 02.0

PROGRAMME OF ACTIVITIES DESIGN DOCUMENT (PoA-DD)

PART I. Programme of activities (PoA)

SECTION A. General description of PoA

A.1. Title of the PoA

Hot Water Heating Programme for South Africa
Version 7
26/09/2012

A.2. Purpose and general description of the PoA

The objective of this small scale programme of activities (hereafter referred to as the “PoA”) is to install heat pumps (hereafter referred to as “HP”) and solar water heaters (hereafter referred to as “SWH”) throughout South Africa. The solutions will be installed individually, and not as a combination of a heat pump and solar geyser solution. The installations can take place in domestic or commercial (small and medium size Enterprises, hereafter referred to as SMEs) buildings. The programme will replace exiting electric geysers.

In South Africa, electricity is used to heat water for domestic and industrial hot water purposes. Eskom, as the state-owned electricity supplier, dominates the generation capacity, which is driven mainly by coal (>90%). Since 2008, South Africa is subject to electricity shortfalls. Although new generation capacity is under construction (three new coal power stations being built by Eskom) electricity supplies are still predicted to be tight over the next three to five years. Due to the historically low cost of electricity, alternatives such as HPs and SWHs have not been considered. Additional reasons for low market penetration rates for these include comparatively high upfront costs and a lack of awareness of their environmental and economic benefits.

The main electrical-demand challenge for South Africa is therefore to reduce energy consumption from a sustainable demand side management perspective. This PoA will involve the implementation of HPs and SWHs and will therefore help reduce the electric water heating load. Furthermore it will contribute in achieving a sustainable energy mix for South Africa.

The PoA fulfils the national sustainable development criteria determined by the Department of Minerals and Energy of South Africa and contributes to sustainable development as follows[1]:

[1] Sustainable development criteria for approval of clean development mechanism projects by the designated national authority of the CDM, 2004, Department of mineral and energy, p. 3, available under: http://www.dme.gov.za/dna/pdfs/sustainable_criteria.pdf

Economic Dimension

Load shedding is one of the major problems in South Africa. Current electricity supply is not enough to meet projected future demand and it is hindering the fast growing economy of the country. The proposed PoA will reduce electric water heating loads and will help South Africa correct the energy mix, with a greater focus on renewable energy. Furthermore the project will create local job opportunities during the installation period as well as maintenance of the HPs and SWHs during the operational periods.

Environmental Dimension

The programme will contribute towards a sustainable, low-carbon economy by reducing electricity consumption and making use of renewable energy, and thereby reducing the amount of greenhouse gases (hereafter referred to as “GHGs”) produced by fossil fuel combustion at the national electricity grid level.

Social Dimension

Through the programme, job opportunities will be created in the HP and solar sector. Manpower is required for installation, maintenance and monitoring of the programme activity, with training provided for technicians to install and maintain the systems. Hence the project will lead to skills and knowledge development. Furthermore the PoA will lead to reduced electricity bills (cost savings) in the target households and SMEs.

Policy/Measure or Stated Goal of the PoA

This project is a voluntary initiative coordinated by Low E Co. Eskom supports the installation of HPs and SWHs for both domestic and SMEsl use by providing a subsidy. However, reduction of electricity use or installation of HPs/SWHs is not required by law. The stated goal of the PoA is to install HPs and SWHs in households and industry, thereby displacing carbon intensive electricity from the grid currently used to provide hot water.

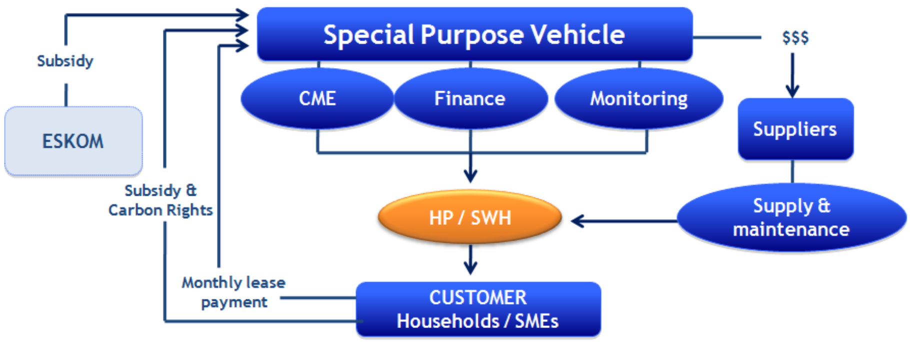
All HP and SWH installations under this PoA will comply with the relevant SABS Standard Specifications. These are for residential SWH systems SANS[2] 6211-1:2003, SANS 151-2002[3], SANS 6210:1992 and SANS 60335-2-21:2000 (including the Thermal Performance Testing, Fixed Electrical Storage Water Heaters, Mechanical Qualification Testing and Safety of Households and Similar Appliances) and for residential HP SANS 151-2002, SANS 181:2004 and SANS 514:2007 (Fixed Electric Storage Water Heaters, Thermostats for Electric Storage water Heaters and Immersion Heaters for Electric Storage Water Heaters).[4] There is currently no component testing and no scope to test custom built units for the commercial and industrial SWHs/HPs.

[2] SANS stands for South African National Standard
[3] Only applicable for systems with electric back up element.
[4] Please note that the SANS test numbers are subject to changes if reviews occur.

Low E Co is the coordinating entity and will ensure that all participating suppliers and HP/SWH systems meet the specified standards of the programme, thereby ensuring that the quality of both the systems and the installations is not compromised. A special purpose vehicle, Low E Co (hereafter referred to as "SPV") will be established to operate the programme.

The general implementing framework of the PoA is presented in the diagram below:

Diagram 1. Implementing framework of the Programme:



Voluntary Action

The PoA is a voluntary action taken by Low E Co together with its partners (project developers, suppliers and financiers) to supply, install, and finance HPs and SWHs to provide hot water services for domestic and SMEs purposes within South Africa. Currently there is no law or regulation in South Africa that would require replacement of electric geysers with HPs or SWHs, nor would require reduction of electricity use for water heating. Additional to the carbon funding, the PoA will make use of the Eskom Demand Side Management (hereafter referred to as "DSM") funds to finance the HPs and SWHs, as long as the subsidy is available.

A.3. CMEs and participants of PoA

The coordinating and managing entity of the PoA is the South African private entity Low E Solutions t/a Low E Co.

Project Participants of the PoA are International Carbon Ltd and I Carbon (Pty) Ltd t/a International Carbon.

A.4. Party(ies)

Name of 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 country)	I Carbon (Pty) Ltd[5]	No
Liechtenstein (Annex-a country)	International Carbon Ltd	No
Republic of South Africa (host country)	Low E Solutions (Pty) Ltd[6]	No

A.5. Physical/ Geographical boundary of the PoA

The PoA is located within the geographical boundaries of South Africa.

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[5] I Carbon (Pty) Ltd trading as International Carbon.

[6] Low E Solutions (Pty) Ltd trading as Low E Co

The boundary of the PoA is defined as the physical, geographical area within which all the implemented, small-scale, Clean Development Mechanism programme activities (hereafter referred to as "SSC-CPAs") included in the PoA will occur, including all power plants connected physically to the electricity system (grid) that the project equipment is connected to. All HPs and SWHs in the CPAs included in the PoA will be installed in residential or SMEbuildings within the borders of the Republic of South Africa. Therefore, the boundary of the PoA is defined as the residential or commercial/industrial buildings, the electricity system within the Republic of South Africa.

A.6. Technologies/measures

A typical CPA consists of a group of SWHs and/or HPs either in residential and/or SMEbuildings. The aggregate energy savings by a single CPA may not exceed the equivalent of 60,000 MWh per year for electrical end use energy efficiency technologies, and the total number of installed square meters of collectors of each individual CPA will remain below the small-scale threshold of 64,000 m^2 applicable to solar energy projects, as per Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism projects. Hence the maximum number of the installations in each CPA is determined by the total energy savings of the HPs and SWHs and the collector area of the SWHs installed.

Heat Pumps:

A heat pump is an electrically-powered device that extracts available heat from one area (the heat source i.e. air) and transfers it to another (the heat sink i.e. water) to heat water. The most common type of heat pump is the air-source heat pump (also applied under this programme), which transfers heat between the outside air and water used inside the building.

The working fluid, refrigerant, is pressurized and circulated through the system by a compressor. The low temperature and low pressure refrigerant evaporates when passing the expansion valve, and extracts energy (heat) from the ambient air into the refrigerant. Once it picks up heat it is sent to the compressor, where through high pressure it is compressed into liquid phase (ideal gas law) and circulated to the condenser (also known as heat exchanger). The compressed refrigerant ejects the heat into the environment (i.e. water), after which the liquid refrigerant returns to the expansion valve and the cycle is repeated. The heat pump heats water to temperatures in the region of 60°C.[7] Please see Figure 1.

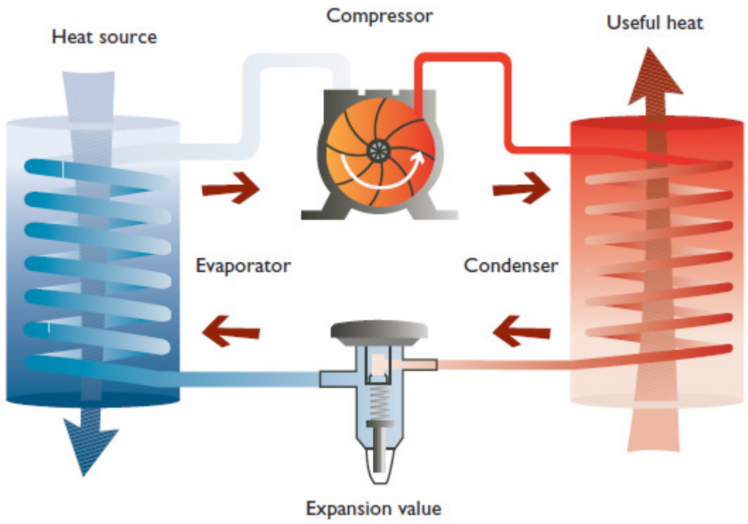

Figure 1. Functionality of a typical heat pump

[7] Eskom 2009, Effective Water Heating, page 1; Rankin and & van Eldik 2010, An Investigation into the Energy Savings and Economic viability of Heat Pump Water Heaters applied in the residential sector, page iii.

Two types of heat pumps can be found, namely integrated type and split type. In the first case the entire system is contained in one unit that consists of a storage tank and a heat pump. In the second configuration the tank is separated from the heat pump. Heat pumps are typically mounted on the outside walls of buildings under the eaves or at ground level depending on the configuration of the system.

Electrical energy is used to drive the compressor, a pump to circulate water through the refrigerant-to-water condenser, and a fan power to cycle air through the finned air-to-refrigerant evaporator. HPs typically consume 1 unit of electrical energy for every 2.5 – 3.5 units of heating produced i.e. only 30 – 40 kWh electrical energy is used to produce 100kWh thermal energy.[8] Hence, HPs realise an energy saving of 60 - 70% when compared to conventional electrical water heating systems.

The HPs installed under this PoA will typically be[9]:

Application	**Litres**	**Input power**	**Heating Capacity**
Domestic - 1-5 users	100-300	0.5-0.95 kW	1.5-3.8 kW
Commercial usage	301-500	1.06-1.9 kW	3.8-7.2 kW
Industrial usage	> 500	> 1 kW	> 3 kW

Solar Water Heaters:

SWH systems convert solar radiation into thermal energy for the heating of water. Both types of SWHs can be installed under this programme active (i.e. a pump to circulate water or heat transfer fluid [hereafter referred to as “HTF”] between the collector and the storage tank) high pressure systems, as well as passive systems. All types, vacuum tube collectors and flat plates as well as high and low pressure systems can be applied. The SWH system can be close-coupled, where the storage tank is horizontally mounted immediately above the solar collectors on the roof, or integrated collector storage, where the tank acts as both storage and solar collector. Both direct and indirect systems can be installed under this programme. The indirect system uses non-toxic antifreeze HTF in the collector, whereas in the direct system water from the main household water supply is circulate between the collector and the storage tank, and the water is heated directly without transfer fluids. The solar collector absorbs solar radiation, converts it into heat, and transfers it to the water or via HTF to water. Heated water is then held in the storage tank and is ready for use. Active SWHs rely on electric pumps, valves and controllers to circulate water, or other heat-transfer fluids through the collectors. The SWH technology typically comprises the following elements[10]:

1. solar collectors/absorbers (non-concentrating flat-plate and evacuated tube collectors);
2. insulated hot water storage tanks (mounted inside the house or externally);
3. insulated pipework;
4. circulating pumps;
5. control valves;
6. vacuum breakers;
7. electrical or gas backup heating;
8. electrical control systems to minimise the auxiliary heating required – including timers;
9. water mixing valve for over-temperature protection;
10. support structures.

[8] Rankin and & van Eldik 2010, An Investigation into the Energy Savings and Economic viability of Heat Pump Water Heaters applied in the residential sector, page iv.

[9] Eskom Supplier List (01.09.2011)

[10] The points 4,7and 8 are not relevant for low pressure systems.

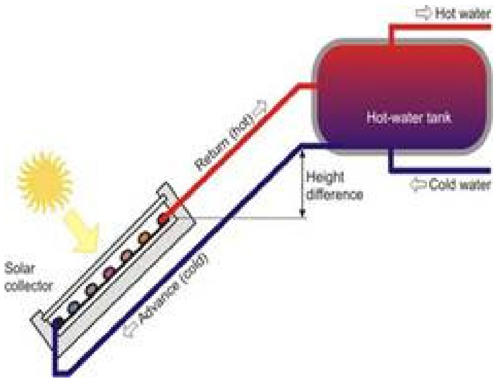

Figure 2. Principle design of a SWH

The SWHs installed under this PoA will be high pressure SWHs. The sizes vary, depending on suppliers and SWH type, typically from 85 litres up to 500 litres. A typical 4 person household is likely to select a 250 litre SWH, whereas commercial/industrial facilities will use 300-500 litre solutions or bigger ones. Both vacuum tube collectors and flat plate systems can be installed under this programme.

The SWHs installed under this PoA will typically be[11]:

No. of Users	Tank Size	Collector Are	Heating Capacity	Back up element[12]
1-2	100-150 l	1.5-2 m^2	10-20 MJ	2-3 kW
2-3	200 l	2-2.5 m^2	15-25 MJ	2-3 kW
3-4	250 l	2.5-3 m^2	20-30MJ	2-3 kW
> 4	300 l	3-3.5 m^2	25-35MJ	2-3 kW
Commercial usage	300 – 500 l	3-5.5 m^2	> 30 MJ	> 3 kW
Industrial usage	> 500 l	> 5 m^2	> 30 MJ	> 3 kW

Worldwide both technologies have been well-established in terms of technological development. In countries where SWH and HPs systems have been installed, they have been shown to have effective operating lifetimes in excess of ten years. The Eskom subsidy programme for SWHs was initiated in 2008 and has matured in the last 12 months. The SWH industry is growing and sales volumes are showing steady growth. By March 2010, less than 5,000 SWH had been installed under the Eskom programme[13] and by August 2011 this number had increased to almost 150,000[14], most installation being low pressure units[15]. The HP market in South Africa is still very small. Since the launch of the Eskom subsidy programme in February 2011, approximately 200 units have been installed under the Eskom programme[16]. This capacity can be scaled up significantly to supply a bigger market.

[11] Eskom Supplier List (07.01.20011)
[12] Please note that electric back up element is not necessary i.e. the customer will decide whether or not to have an electric back up element.
[13] Eskom Distribution 2010, Solar Water Heating Programme, Monthly Status Report March 2010
[14] Eskom August 2011, Solar Water Heating Programme, Weekly Administrative Dash Board
[15] It should be noted that since 2011 one SWH PoA from South Africa has been registered under the CDM, and several other SWH PoAs are under validation.
[16] Eskom August 2011, Residential Heat Pump Rebate Programme, page 14-15; Eskom 2011, Heat Pump Claim Form.

A.7. Public funding of PoA

No public funding from parties included in Annex I is involved in this programme.

SECTION B. Demonstration of additionality and development of eligibility criteria
B.1. Demonstration of additionality for PoA

In 2007 the South African government launched, through Eskom (national power utility), a once-off subsidy to homeowners to support the installation of SWHs. A subsidy for HPs was launched on 18th of February 2011. The funding is a subsidy, paid by Eskom, based on the technical performance of the equipment. The subsidies are part of Eskom's DSM initiative, which was established after South Africa suffered from major electricity supply interruptions due to insufficient power station capacity in 2007. DSM provides rebates to consumers upon the purchase and installation of SWH and HP systems to reduce demand on the electricity network. However, the Eskom subsidy is not sufficient to cover all cost associated with the installation, maintenance and monitoring of HPs and SWHs over a 10 year period and high upfront costs create a significant barrier for HPs and SWHs.[17,18] According to Eskom the average cost of a household HP is between ZAR 12 000 and ZAR 16 000, and the average cost for installed household SWHs is between ZAR 12 000 and ZAR 35 000[19]. This is two to three times more than typical electric geysers cost.[20] The Eskom subsidy for Heat Pumps is between ZAR 3 668 and ZAR 4 320 (depending on the size) and for SWHs between ZAR 3 280 and ZAR 8 969 (depending on the SWH type and size)[21]. For commercial and industrial installations Eskom has three different programmes: Standard Offer, Standard Product and ESCo Model. Under these programmes the following subsidies are paid:

- 0.7 ZAR per kWh saved for SWH;
- 0.42 ZAR per kWh saved for HPs.

The total subsidy is 70 % of the estimated saving over a 3 years.

The Eskom subsidy programme is a voluntary programme and currently there is no law or regulation in South Africa that would require replacement of electric geysers with HPs or SWHs, nor would require reduction of electricity use for water heating. Additional to the carbon funding, the PoA will make use of the Eskom Demand Side Management (hereafter referred to as "DSM") funds to finance the HPs and SWHs, as long as the subsidy is available.

In accordance with the "Guidelines on the Demonstration of Additionality of Small-Scale Project Avtivities" the small-scale project activity must either demonstrate at least one of the barriers listed in paragraph one or is defined as automatically additional, if included in the positive list of technologies and project activity types under paragraph 2. . In this respect, the positive list under paragraph 2 is applied for each CPA under this PoA as follows:

The SWH and HPs installed are isolated units and the installations will take place in households or SMEs. The size of each unit is no larger than 5% of the small-scale CDM thresholds:

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19 http://www.holleysplumbing.co.za/index.php?option=com_content&view=article&id=112&Itemid=131; http://www.draincorp.net/pricelist.html; http://www.pricecheck.co.za/offers/10923637/Duratherm+D200L+400kpa+Electric+Geyser/description/

According to AMS.II.C. "Demand-side energy efficiency activities for specific technologies" the small scale threshold for energy saving projects is maximum 60 GWh electrical saving, of which 5 % equals to 3 000 MWh saving per year. A typical household electric geyser has an electric element with a capacity of 3 to 4 kW[22]. Even if water would be heated 24 hours a day, which is a very unlikely scenario, and a maximum saving of 70 % would be used, the annual saving would be 24.6 MWh. In commercial facilities (SMEs), bigger saving per system can be achieved. However, only systems that fulfil the de-bundling rules will be included under this PoA.

According to "Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism project", the small-scale threshold for solar energy projects is 64,000 m^2. 5 % of this equals to 320 m^2. As described under the section A.6 the typical collector sizes vary between 1 and 5 m^2 which is clearly below the 5 % threshold (320m^2).

The above analysis shows that the technologies installed under this PoA are automatically additional.

The coordinating entity, together with the suppliers, will perform a number of crucial tasks which are currently not well performed by the existing SWH industry, to overcome the above mentioned barriers. These include:

1. Selection of reliable products;
2. Marketing, supply, installation and maintenance of the HP and SWH systems;
3. Organize and provide the funding for the installation of the HPs and SWHs on behalf of the households/ supplier;
4. The compilation of educational awareness campaigns in order to intensify the demand for HP and SWH products.

The PoA is a voluntary action, coordinated and implemented by the coordinating entity to supply, install, and finance HPs and SWHs to provide hot water services for residential, commercial and industrial buildings in South Africa and to reduce GHG emissions through the avoidance of electricity used for the purposes of heating water.

The project will contribute towards the 10 TWh renewable energy target set in the White Paper on Renewable Energy by the Department of Minerals and Energy, published in November 2003[23], as well as the Government's ambitious target announced in late 2009, to roll out one-million SWHs by 2014. However, both targets have been set out without any mandatory requirements and hence there is no regulation that requires replacement of electric geysers with HPs or SWHs in South Africa. The HPs and SWHs installed under the PoA are included in the PoA voluntarily by the coordinating entity and the customers.

B.2. Eligibility criteria for inclusion of a CPA in the PoA

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[22] Rankin and & van Eldik 2010, An Investigation into the Energy Savings and Economic viability of Heat Pump Water Heaters applied in the residential sector, page vi; Kwikot 2011, Electric Water Heating brochure page 2 and 3.
[23] Available at: http://www.dme.gov.za/pdfs/energy/renewable/white_paper_renewable_energy.pdf

The eligibility criteria for the inclusion of a SSC-CPA in a PoA are as follows:

No	Criteria
1	The SWHs to be included in the CPA shall meet the applicability requirements of the CDM methodology AMS.I.C. Thermal energy production with or without electricity, version 19 which are ▪ The CPAs included in this PoA comprise renewable energy technologies that supply users with thermal energy that displaces fossil fuel based gird energy; ▪ The methodology comprises technologies such as solar thermal water heaters; A SSC-CPA individually does not exceed the applicable SSC threshold which is 64 000 m^2 i.e. the CPAs are below the 64,000 m^2 threshold. The HPs to be included in the CPA shall meet the applicability requirements of the CDM methodology AMS.II.C. Demand-side en^{e}rgy efficiency activities for specific technologies, version 13, which are: ▪ The CPAs included in this PoA comprise energy-efficient equipment, which replaces existing equipment, or possibly are installed at new sites; ▪ The aggregate energy savings of the CPA will not exceed the equivalent of 60 GWh electric energy per year; ▪ The level of the output/service (e.g. water temperature) will not be significantly smaller (maximum - 10%) or significantly larger (maximum + 50%) than in the baseline situation. The CPAs shall apply both methodologies, if both technologies SWHs and HPs are installed within one CPA. However, a CPA may also consist of only SWHs or HPs, in which case only the relevant applicability requirements to the technology in questions shall apply.
2	The Sandard for Sampling and Surveys for CDM Project Activities and Programme of Activities shall be applied also for monitoring, and hence a 95/10 confidence/precision is requested as per section B.7.2 of this document.
3	The CPAs to be included in this PoA shall meet the criteria for automatic additionality as per the paragraph 2 C of the “Guidelines on the Demonstration of Additionality of Small-Scale Project Activities”. Hence each installation done under this PoA shall be below: ▪ HP < 3000 MWh; ▪ SWH < 320 m^2; As demonstrated in section B.1.
4	Each system included under the programme shall fulfill the relevant debundling rules i.e. annual savings for HPs ≤ 600 MWh and for SWHs absorber area ≤ 640 m2 as per Section C of this document.
5	Installation shall take place in residential and/or SMEs (as per the United Nations Industrial Development Organization definition)[24]within the geographical boundaries of South Africa.
6	The start date of the CPA is determined to be the first signed installation/carbon cession form agreement with the household and/or business under that CPA. The starting date of the CPA cannot be prior the date of 12/02/2012.
7	All the HPs and SWHs under the SSC-CPA shall comply with all relevant SABS/SANS Standard Specification for HP or SWH systems. Each supplier or CPA implementer, (if not Low E Co.) shall provide copies of relevant SABS/SANS Standard Specification to the CME before inclusion under this PoA.
8	In order to ensure that all CPAs under this PoA are neither registered as an individual CDM project activity nor included in another registered PoA: a. Each CPA shall be uniquely identified and defined by way of the unique identifying numbers (serial numbers) attached to each SWH and HP;

[24] USAID 2007, Booklet of Standardized SME Definition, page 6-7.

	b. Each supplier and household will sign an agreement with the CME which; 1) cedes the carbon to the CME, and 2) clarifies that the installations are not part of another CDM activity.
9	All participants joining the programme shall have electricity connection and an existing electric geyser. The electricity connection meter number as well as power (kW) and size (litre) of electric geyser shall be recorded for each installation as per section B.7.2 below.
10	All participants joining the programme shall have a proof of identity (ID), or corporate registration certificate. The ID/ registration number shall be recorded in the database as per section B.7.2 below and electronic copies of these documents will be stored.
11	No public funding from parties included in Annex I is involved in this programme. This shall be confirmed for each CPA by providing details of the funding to the validating/ including DOE.
12	Each SSC-CPA must be approved by the coordinating entity and Designated Operational Entity (hereafter referred to as "DOE") prior to its incorporation into the PoA.
13	When installing heat pumps the level of the output/service (e.g. water temperature) shall not be significantly smaller (maximum - 10%) or significantly larger (maximum + 50%) than in the baseline situation. Hence, the supplier is requested to set the thermostat in the same level than in the baseline scenario i.e. typically between 55-60 °C.

B.3. Application of methodologies

From Appendix B of the "Simplified modalities and procedures for small scale CDM projects", the following methodologies apply to the project activity:

Project Type: Type I – Renewable energy projects
Project Category: AMS-I.C. – Thermal Energy Production with or without electricity, Version 19

Project Type: Type II – Energy Efficiency
Project Category: AMS-II.C – Demand-side energy efficiency activities for specific technologies, Version 13

Furthermore the following tools are applied:
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption, Version 01"
"Tool to calculate the emission factor for an electricity system, Version 02.2.1"

As per the "General Guidelines to SSC CDM methodologies", PoAs can apply multiple methodologies without preapproval from the CDM Executive Board if these methodologies have been previously applied, in combination, in a registered project activity. The project with reference no 0079, has applied AMS.IC and AMS-II.C in combination.

The CPAs shall apply both methodologies, if both technologies SWHs and HPs are installed within one CPA. However, a CPA may also consist of only SWHs or HPs, in which case only the relevant applicability requirements to the technology in questions shall apply. The PoA or the CPAs will not result to interactive effects as per the CDM EB 68 annex 3 guidelines as no combination of technologies (i.e. SWH and HP) will be installed within a household/ SME.

The monitoring methodology and related sampling is explained in detail in section B.7.2 of this document.

SECTION C. Management system

A Special Purpose Vehicle, Low E Co, which includes financiers and project developers, has been created to take care of following functions: 1) the CDM coordinating entity, 2) the CDM Cycle management (subcontracted to International Carbon), 3) the supply and maintenance of the HPs and SWHs (via suppliers), 4) the financing facility, and 5) data capturing and monitoring. Figure 3 shows the implementation and management structure of the PoA.

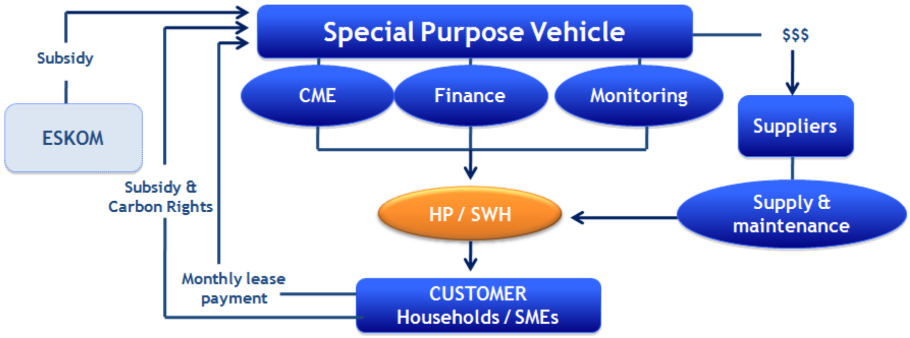

Figure 3. Implementation and management structure of the PoA

The main management tasks for the PoA are identified in the table below:

Step	Task	Description	Reference document (if relevant)
1	Technical development of the PoA/SPV concept and related documents	▪ Development of Implementation and Financing Structure ▪ Development of Management Structure ▪ Development of Maintenance and Monitoring Plan	▪ PoA-DD and CPA-DD template ▪ Grid Emission Factor ▪ CPA Inclusion Manual ▪ Monitoring Manual
2	Manage PoA CDM registration process	▪ Validation and registration of PoA	▪ Contract with DOE ▪ Host Country Approval ▪ Modalities of Communication ("MoC") with CDM Executive Board
3	Inclusion of new CPAs	▪ Consistency with CPA Inclusion Criteria	▪ CPA Inclusion Manual
4	Operation and Management of the PoA	▪ Consistency with maintenance and monitoring plans ▪ Continuous data capturing	▪ Monitoring Manual
5	Periodical Verification	▪ Review of CPA monitoring data and report ▪ Verification of each CPA shall be done by an appointed DOE	▪ CPA Monitoring Reports
6	Issuance of CERs	▪ Allocation of UNFCCC approved CERs	▪ MoC ▪ ERPA

A record keeping system for each CPA under the PoA

A database will be set up by the coordinating entity for the PoA. It will include the following information for each HP and SWH installed in a SSC-CPA:

1	Site Details	▪ Address

		▪ GPS coordinates
2	Residence / Company Details	▪ First name and surname / Company name ▪ ID number / Company registration number ▪ Contact details
3	Installer Details	▪ Installation date ▪ Installer name ▪ Company name ▪ Contact details
4	Installation Details	▪ Serial number ▪ HP/SWH type ▪ HP/SWH size ▪ HP input power ▪ HP / SWH heating capacity ▪ SWH absorber area ▪ SWH back up element size
5	Baseline Details	▪ Power of existing geyser ▪ Size of existing geyser
6	CPA identification number	▪ E.g. CPA-001
7	Confirmation that the building has electricity connection.	
8	Copy of the Carbon Ceding form signed by the resident/ company together with a copy of installation form.	

A database hosted by a specialised database company will be used to capture all above mentioned information including a scan of the carbon ceding rights form. This is done either directly via the web interface or by database synchronisation with a third party database (this may vary in each CPA). The GPS coordinates are used to locate each HP/SWH together with the serial number of the product. The information can be easily drawn from the database and utilized for reporting. Data will be archived for two years once the 10 year crediting period has lapsed. Relevant data capture, verification and storage procedures will be followed in maintaining the data to ensure its accuracy, validity and completeness.

Procedure to avoid double accounting

The database ensures that all installations in a CPA are uniquely defined and are included in one CPA only, thereby avoiding double counting of emissions reductions generated by the CPA. For each installation an installation sheet is compiled (including the information identified above in points 1-6) which is the proof that the HP/SWH has been installed. The installation sheet is attached to the ceding of the carbon rights form. Either the SPV or the installers/suppliers will input the information in an electronic form (data capturing software – described above) and submit copies of all installation sheets, and ceding of the carbon rights to the coordinating entity. Each HP/SWH will have a unique identifying number (serial number) which matches the unique identifier physically attached to the HP/SWH. With the help of the serial number and GPS coordinates, each HP/SWH can be linked to a specific building and can be viewed spatially in the database.

The SSC-CPA included in the PoA is not a de-bundled component of another CDM

In accordance with paragraph 9, Annex 32 "Guidelines on assessment of de-bundling for SSC project activities" of the EB 36, if each of the independent subsystems/measures (e.g. solar home system) included in the CPA of a PoA is no greater than 1% of the small scale thresholds defined by the methodology applied, then that CPA or PoA is exempted from performing a de-bundling check i.e. considered as not being a de-bundled component of a large scale activity.

According to AMS.II.C. "Demand-side energy efficiency activities for specific technologies" the small scale threshold for energy saving projects is maximum 60 GWh electrical saving, of which 1 % equals to 600 MWh saving per year. A typical household electric geyser has an electric element with a capacity of 3 to 4 kW[25]. Even if water would be heated 24 hours a day, which is a very unlikely scenario, and a maximum efficiency of 70 % is used, the annual saving would be 24.6 MWh. In industrial facilities, bigger saving per system can be achieved. However, only systems that fulfil the de-bundling rules will be included under this PoA.

According to "Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism project", the small-scale threshold for solar energy projects is 64,000 m^2. 1 % of this equals to 640 m^2. As described under the section A.4.2.1 the typical collector sizes vary between 1 and 5.5. m^2 which is clearly below the 1 % threshold (640m^2).

The conformity with the de-bundling rules shall be discussed in each CPA-DD under section A.4.6.

The provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the PoA

The coordinating entity will enter into a binding formal agreement with each supplier or project developer to develop and implement the identified CPA under the PoA. The agreement inter-alia contains the roles and responsibilities for each of the parties. Furthermore legally binding agreements will be signed by all residents and commercial/industrial customers for the installation of a HP and/or SWH under the PoA, making them aware that they are participating in the programme and that their HP/SWH will be included in a CPA and that the ownership of the carbon is ceded to the coordinating entity (possibly via suppliers), who is the legal owner of the Certified Emission Reductions (CERs) from the installed HP/SWH.

SECTION D. Duration of PoA
D.1. Start date of PoA

12/02/2012

This is the date for publishing the PoA for Global Stakeholder Consultation.

D.2. Length of the PoA

28 years.

SECTION E. Environmental impacts
E.1. Level at which environmental analysis is undertaken

[25] Rankin and & van Eldik 2010, An Investigation into the Energy Savings and Economic viability of Heat Pump Water Heaters applied in the residential sector, page vi; Kwikot 2011, Electric Water Heating brochure page 2 and 3.

Environmental analysis is undertaken at the PoA level, since the impacts of all CPAs will be similar.

E.2. Analysis of the environmental impacts

In August 2010 the new National Environmental Management Act ("NEMA") Environmental Impact Assessment ("EIA") regulations[26] came into effect, signalling the start of the official implementation process of a new regime aimed at improving the efficiency and effectiveness of EIAs in South Africa.

The NEMA EIA 2010 regulations and the listing notices thereto replace the NEMA EIA regulations of 2006 and its associated listing notices.

Three listing notices[27] have been published in conjunction with the new regulations, whereby depending on the type and scope of the activity, the activity must either be subjected to a Basic Assessment or to the more thorough Scoping and EIA process.

Listing notice one stipulates the activities requiring a basic assessment report. These are typically activities that have the potential to impact negatively on the environment but due to the nature and scale of such activities, these impacts are generally known. Listing notice two identifies the activities requiring both scoping and an Environmental Impact Report these are typically large scale or highly polluting activities and the full range of potential impacts need to be established through a scoping exercise prior to it being assessed. Listing notice three contains activities that will only require an environmental authorisation through a basic assessment process if the activity is undertaken in one of the specified geographical areas indicated in that listing notice.

These regulations govern EIAs, and do not require an EIA or any other assessment (i.e. basic assessment, scoping report) for this type of activities and hence an EIA is not required for the measures undertaken under this programme.[28]

There are no significant anticipated negative impacts on the environment and/or on people through this programme. The project reduces the consumption of non-renewable natural resources, such as fossil fuels and further reduces the GHG emission as well as airborne particulates (ash) and pollutant gases which cause air quality problems. The installations will take place in existing infrastructures i.e. residential and commercial buildings. The heat pumps installed under this programme will apply non ozone depleting refrigerants.

Hence, the environmental effects gained from the project implementation are of a positive nature.

SECTION F. Local stakeholder comments
F.1. Solicitation of comments from local stakeholders

[26 and 26] http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=11887&tid=13916

[28] More information on the national EIA law and process is available at: http://www.eiatoolkit.ewt.org.za/process/what.html

Local stakeholder consultation is done at PoA level, since the programme will be national.

Comments from local stakeholders where invited via a national news paper and through personal invites, which where send to the key stakeholders. The key stakeholders where identified to be the municipal managers, the Designated National Authority, the Department of Energy, Eskom, funders and some corporate, as well as HP/SWH suppliers. Altogether 74 personal invites where send out. The news paper advert was placed on October 9 in Sunday Times inviting people to a public participation meeting, and to submit comments and queries via phone, email and mail. The public participation meeting was held on October 24 in Sandton, Gauteng. Two meetings took place at 2 pm and 5 pm. In these meeting the implementation framework, the Clean Development Mechanism, technical details and corporate rollout was presented. Comments were invited until the May 24, 2010.

F.2. Summary of comments received

All together 4 calls and emails from 4 interested parties where received. The questions raised can be summarized as follows:

- Details of the public participation meeting;
- How to participate in the programme as supplier;
- When will the programme start in other parts (than Gauteng) of South Africa.

The questions raised in the public participation meeting, that was attended by 31 people were very similar. Additional to the above questions two main questions were raised:

- Implementing Structure;
- Financing Structure.

F.3. Report on consideration of comments received

Most of the comments and questions received where around how to join the programme as supplier and how the programme is structured. The implementation framework of the programme as well as participation possibilities and requirements where specified and the interested where asked to keep in contact with International Carbon in order to join the programme.

SECTION G. Approval and authorization

The Letters of Approval from the Republic of South Africa and United Kingdom where not available at the time of submitting the PoA-DD to the validating DOE.

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA
A.1. Purpose and general description of generic CPAs

In South Africa, electricity is used to heat water for domestic and industrial hot water purposes. Eskom, as the state-owned electricity supplier, dominates the generation capacity, which is driven mainly by coal (>90%). Since 2008, South Africa is subject to electricity shortfalls. Although new generation capacity is

under construction (three new coal power stations being built by Eskom) electricity supplies are still predicted to be tight over the next three to five years. Due to the historically low cost of electricity, alternatives such as HPs and SWHs have not been considered. Additional reasons for low market penetration rates for these include comparatively high upfront costs and a lack of awareness of their environmental and economic benefits.

As described in section A.6. above a typical CPA consists of a group of SWHs and/or HPs either in residential and/or SME buildings. The aggregate energy savings by a single CPA may not exceed the equivalent of 60,000 MWh per year for electrical end use energy efficiency technologies, and the total number of installed square meters of collectors of each individual CPA will remain below the small-scale threshold of 64,000 m^2 applicable to solar energy projects, as per Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism projects. Hence the maximum number of the installations in each CPA is determined by the total energy savings of the HPs and SWHs and the collector area of the SWHs installed.

The CPA-XXX will consist of... [confirm installation type, size and number of units, if available]

This project is a voluntary initiative coordinated by Low E Co, which is a special purpose vehicle (hereafter referred to as "SPV") established to operate the programme. The households, SMEfacilities as well as suppliers joining the programme will enter to an agreement with the CME and hence will know that they are part of the programme.

Eskom supports the installation of HPs and SWHs for both domestic and industrial use by providing a subsidy. However, reduction of electricity use or installation of HPs/SWHs is not required by law. The stated goal of the PoA is to install HPs and SWHs in households and industry, thereby displacing carbon intensive electricity from the grid currently used to provide hot water. Therefore, CPA-XXX is a voluntary action of the CPA implementer, XXX [name(s)].

The proposed SSC CPA is expected to reduce X XXX XXX tCO_2 over the selected ten years crediting period.

SECTION B. Application of a baseline and monitoring methodology
B.1. Reference of the approved baseline and monitoring methodology(ies) selected

From Appendix B of the "Simplified modalities and procedures for small scale CDM projects", the following methodologies apply to the project activity:

Project Type: Type I – Renewable energy projects
Project Category: AMS-I.C. – Thermal Energy Production with or without electricity, Version 19
Available at:
http://cdm.unfccc.int/filestorage/G/U/9/GU9MEH14PBSNCKJIOV3L7W82RTZY06/EB61_repan16_Revision_AMS-I%20C_ver19.pdf?t=SUF8bTJ4bGoyfDDSO33VpIJ_fXK7-SjW_QxB

Project Type: Type II – Energy Efficiency

Project Category: AMS-II.C – Demand-side energy efficiency activities for specific technologies, Version 13
Available at:
http://cdm.unfccc.int/filestorage/S/6/K/S6KJMZ0A7UON324I5QHER8BTPLDFCX/EB48_repan16_AMS_II.C_ver13.pdf?t=WVR8bTJ4bG1xfDDSiqypzDnoxNVxMBuBObfY

Furthermore the following tools are applied:
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption, Version 01"
Available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf
"Tool to calculate the emission factor for an electricity system, Version 02.2.1"
Available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf

As per the "General Guidelines to SSC CDM methodologies", PoAs can apply multiple methodologies without preapproval from the CDM Executive Board if these methodologies have been previously applied, in combination, in a registered project activity. The project with reference no 0079, has applied AMS.IC and AMS-II.C in combination.

B.2. Application of methodology(ies)

AMS.I.C version 19 is applicable to a SSC-CPA since a SSC-CPA meets all the requirements set out in the methodology:

- The CPAs included in this PoA comprise renewable energy technologies that supply users with thermal energy that displaces fossil fuel based gird energy (*paragraphs 1 and 25*)
- The methodology comprises technologies such as solar thermal water heaters (*paragraph 1*)
- A SSC-CPA individually does not exceed the applicable SSC threshold which is 64 000 m^2 i.e. the CPAs are below the 64,000 m^2 threshold (*paragraph 7 (d)*) [29]

AMS.II.C version 13 is applicable to a SSC-CPA since a SSC-CPA meets all the requirements set out in the methodology:

- The CPAs included in this PoA comprise energy-efficient equipment, which replaces existing equipment, or possibly are installed at new sites (*paragraph 1*)
- The aggregate energy savings of the CPA will not exceed the equivalent of 60 GWh electric energy per year (*paragraph 1*)
- The level of the output/service (e.g. water temperature) will not be significantly smaller (maximum - 10%) or significantly larger (maximum + 50%) than in the baseline situation (*paragraph 2*).

B.3. Sources and GHGs

As defined in AMS.I.C and AMS.II.C, the project boundary is the physical, geographical site of the energy efficiency/water heating measure including the building consuming the thermal energy produced.

[29] General Guidelines to SSC CDM methodologies, version 17, paragraph 4 d 'For thermal applications of solar energy projects, 'maximum output' shall be calculated using a conversion factor of 700 Wth/m2 of aperture area of glazed flat plate or evacuated tubular collector i.e. eligibility limit in terms of aperture area is 64000 m2 of the collector.'

Hence the boundary for a SSC-CPA comprises the physical site of each HP/SWH within the CPA as well as the South African grid system, as the HP/SWH replaces grid electricity. Each CPA (CPA number) and HP/SWH (serial number) can be indentified based on unique identification numbers.

The GHG reduced through the CPAs under this PoA 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.

B.4. Description of baseline scenario

In South Africa, hot water is predominantly heated by electric water heating systems. The domestic sector uses about 13 % from the total electricity consumption in the country and about 40 % of it is used for water heating. There are approximately 11 million households in the country of which the high and middle income households use electric geysers to heat water. More than 76 % of these income groups have an electric geyser. The annual geyser element sales in South Africa totals over 720 000 units.[30]

Electric hot water geysers/cylinders are pressurized electric hot water heaters. The geysers are normally connected to the main supply continuously, while the thermostat keeps the hot water at the set temperature (typically between 55-60 °C). Whenever it drops below the set point (typically 6°C below, in practice), the electric element switches on in order to reheat the water in the geyser to the set point.

The baseline emissions are determined by calculating the energy consumed by the water heating system in the baseline multiplied by an emission factor for the fossil fuel displaced. With respect to AMS-I.C (paragraph 21) and AMS.II.C (paragraph 6) the baseline for the displacement of electricity shall be calculated as per the procedures detailed in AMS-I.D. This further states that the baseline emissions are the product of electrical energy baseline expressed in kWh produced by the renewable generating unit multiplied by an emission factor and refers further to the “Tool to calculate the emission factor for an electricity system” (option a), or the weighted average emissions of the current generation mix (option b). Option b is selected and the equations used to calculate the baseline are shown in the section B.6.1.

South Africa has a temperate climate. Most areas in the country have more than 2 500 hours of sunshine per year, and the solar-radiation levels range between 4.5 and 6.5kWh/m^2 per day, and the average annual winter temperature is above 13°C and summer temperature above 21°C. Regardless of the favourable climate conditions and subsidy programme only a few HPs/SWHs are in the market. More than 76 % of middle and high income households use an electric geyser, which is the identified baseline scenario.[31,32]

Each CPA-DD shall present the key parameters for the baseline determination for that specific CPA under the section B.4. The key parameters to be considered are, is available:

Parameter	**Unit**	**Value**
Size	litre	[insert value]
Electric geysers:		
Heating Capacity	kW	[insert value]

[30] N. Magubabe 2009, Speaking Notes of the Acting Director-General of Department of Energy Ms Nelisiwe Magubabe, Johannesburg 5 November 2009; O.D Dintchev 2004, Evaluation of Domestic Solar Water Heaters – Domestic Use of Energy Conference 2004;A. Harris, M. Kilfoil and E-A. Uken, Options for Residential Water Heating, page 2.

[31] Wikipedia, Geography of South Africa, 5 October 201: http://en.wikipedia.org/wiki/Geography_of_South_Africa

[32] Department of Energy Website 15 August 2011: http://www.energy.gov.za/files/renewables_frame.html

For heat pumps:		
Heating Capacity	kW	[insert value]
Operation hours	h	[insert value]
For solar water heats:		
Energy Output per Day (Q)	kWh	[insert value]
SABS Test Period	h	[insert value]
Power Rating of a SWH	kW	[insert value]
Absorber Area	m^2	[insert value]

The CPAs under this PoA will apply the small scale methodology AMS-I.C. “Thermal energy production with or without electricity”, version 19 for SWHs, and AMS-II.C. “Demand-side energy efficiency activities for specific technologies”, Version 13 for HPs.
With respect to AMS-I.C paragraph 21, the baseline for the displacement of electricity shall be calculated as per the procedures detailed in AMS-I.D. AMS-I.D determines that the baseline emissions are the product of electrical energy baseline expressed in kWh produced by the renewable generating unit multiplied by an emission factor, and gives the option to use the weighted average emissions of the current generation mix as emission factor.

With respect to AMS.II.C paragraph 6, the baseline is the product of the baseline energy consumption of equipment/appliances and the emission factor for the electricity displaced determined as per AMS-I.D.

The equations used to determine the emission reduction are discussed in B.6.1.

B.5. Demonstration of eligibility for a generic CPA

The SSC CPA meets all the eligibility criteria for inclusion of a SSC CPA in the PoA as listed in Part I section B.2 above.

No	Criteria	Analysis
1	The SWHs to be included in the CPA shall meet the applicability requirements of the CDM methodology AMS.I.C. Thermal energy production with or without electricity, version 19 which are ▪ The CPAs included in this PoA comprise renewable energy technologies that supply users with thermal energy that displaces fossil fuel based gird energy; ▪ The methodology comprises technologies such as solar thermal water heaters; A SSC-CPA individually does not exceed the applicable SSC threshold which is 64 000 m^2 i.e. the CPAs are below the 64,000 m^2 threshold. The HPs to be included in the CPA shall meet the applicability requirements of the CDM methodology AMS.II.C. Demand-side en^{e}rgy efficiency activities for specific technologies, version 13, which are: ▪ The CPAs included in this PoA comprise energy-efficient equipment, which replaces existing equipment, or possibly are installed at new sites; ▪ The aggregate energy savings of the CPA will not exceed the equivalent of 60 GWh electric energy per year; ▪ The level of the output/service (e.g. water temperature) will not be significantly smaller (maximum - 10%) or significantly larger (maximum + 50%) than in the baseline situation. The CPAs shall apply both methodologies, if both technologies SWHs and HPs are installed within one CPA. However, a CPA may also consist of only SWHs or HPs, in which case only the relevant applicability requirements to the technology in questions shall apply.	[add]
2	The Sandard for Sampling and Surveys for CDM Project Activities and Programme of Activities shall be applied also for monitoring, and hence a 95/10 confidence/precision is requested as per section B.7.2 of this document.	[add]
3	The CPAs to be included in this PoA shall meet the criteria for automatic additionality as per the paragraph 2 C of the “Guidelines on the Demonstration of Additionality of Small-Scale Project Activities”. Hence each installation done under this PoA shall be below: ▪ HP < 3000 MWh; ▪ SWH < 320 m^2; As demonstrated in section B.1.	[add]
4	Each system included under the programme shall fulfill the relevant debundling rules i.e. annual savings for HPs ≤ 600 MWh and for SWHs absorber area ≤ 640 m2 as per Section C of this document.	[add]

5	Installation shall take place in residential and/or SMEs (as per the United Nations Industrial Development Organization definition)[33]within the geographical boundaries of South Africa.	[add]
6	The start date of the CPA is determined to be the first signed installation/carbon cession form agreement with the household and/or business under that CPA. The starting date of the CPA cannot be prior the date of 12/02/2012.	[add]
7	All the HPs and SWHs under the SSC-CPA shall comply with all relevant SABS/SANS Standard Specification for HP or SWH systems. Each supplier or CPA implementer, (if not Low E Co.) shall provide copies of relevant SABS/SANS Standard Specification to the CME before inclusion under this PoA.	[add]
8	In order to ensure that all CPAs under this PoA are neither registered as an individual CDM project activity nor included in another registered PoA: c. Each CPA shall be uniquely identified and defined by way of the unique identifying numbers (serial numbers) attached to each SWH and HP; a. Each supplier and household will sign an agreement with the CME which; 1) cedes the carbon to the CME, and 2) clarifies that the installations are not part of another CDM activity.	[add]
9	All participants joining the programme shall have electricity connection and an existing electric geyser. The electricity connection meter number as well as power (kW) and size (litre) of electric geyser shall be recorded for each installation as per section B.7.2 below.	[add]
10	All participants joining the programme shall have a proof of identity (ID), or corporate registration certificate. The ID/ registration number shall be recorded in the database as per section B.7.2 below and electronic copies of these documents will be stored.	[add]
11	No public funding from parties included in Annex I is involved in this programme .This shall be confirmed for each CPA by providing details of the funding to the validating/ including DOE.	[add]
12	Each SSC-CPA must be approved by the coordinating entity and Designated Operational Entity (hereafter referred to as "DOE") prior to its incorporation into the PoA.	[add]
13	When installing heat pumps solutions the level of the output/service (e.g. water temperature) shall not be significantly smaller (maximum - 10%) or significantly larger (maximum + 50%) than in the baseline situation. Hence, the supplier is requested to set the thermostat in the same level than in the baseline scenario i.e. typically between 55-60 °C	[add]

In accordance with the "Guidelines on the Demonstration of Additionality of Small-Scale Project Activities" the small-scale project activity must either demonstrate at least one of the barriers listed in paragraph one or is defined as automatically additional, if included in the positive list of technologies and project activity types under paragraph 2. In this respect, the positive list under paragraph 2 is applied for each CPA as follows:

The SWH and HPs installed are isolated units and the installations will take place in households or SMEs. The size of each unit is no larger than 5% of the small-scale CDM thresholds:

[33] USAID 2007, Booklet of Standardized SME Definition, page 6-7.

According to AMS.II.C. “Demand-side energy efficiency activities for specific technologies” the small scale threshold for energy saving projects is maximum 60 GWh electrical saving, of which 5 % equals to 3 000 MWh saving per year. A typical household electric geyser has an electric element with a capacity of 3 to 4 kW[34]. Even if water would be heated 24 hours a day, which is a very unlikely scenario, and a maximum saving of 70 % would be used, the annual saving would be 24.6 MWh. In commercial facilities (SMEs), bigger saving per system can be achieved. However, only systems that fulfil the de-bundling rules will be included under this PoA.

According to “Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism project”, the small-scale threshold for solar energy projects is 64,000 m^2. 5 % of this equals to 320 m^2. As described under the section A.6 the typical collector sizes vary between 1 and 5 m^2 which is clearly below the 5 % threshold (320m^2).

The above analysis shows that the HPs/ SWHs installed under this PoA are automatically additional. This shall be confirmed in each CPA-DD.

B.6. Estimation of emission reductions of a generic CPA
B.6.1. Explanation of methodological choices

Baseline Emissions

According AMS.II.C paragraph 6 option 1, baseline emissions are determined as follows:

$$BE_y = E_{BL,y}\ x\ EF_{CO2,ELEC,y} + Q_{ref,BL}\ x\ GWP_{ref,BL}$$

Where,

BE_y = Baseline Emissions in year *y*, tCO_2e;

$E_{BL,y}$ = Energy consumption in the baseline in year, kWh;

EF_{CO2} = CO_2 Emission factor, tCO_2/kWh.

$Q_{ref,BL}$ = Average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked, t/year;

$GWP_{ref,BL}$ = Global Warming Potential of the baseline refrigerant, tCO_2e/t refrigerant.

$$E_{BL,y} = \sum_i (n_i\ x\ \rho_i\ x\ o_i) / (1 - l_y)$$

Where,

n_i = Number of devices of the group of *“i”* replaced;

ρ_i = Power of the devices of the group of *“i”* baseline devices;

o_i = Average annual operating hours of the devices of the group of *“i”* baseline devices;

l_y = Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction.

[34] Rankin and & van Eldik 2010, An Investigation into the Energy Savings and Economic viability of Heat Pump Water Heaters applied in the residential sector, page vi; Kwikot 2011, Electric Water Heating brochure page 2 and 3.

The paragraph 21 of AMS-I.C applicable for displacement electricity from a grid refer to AMS-I.D (version 17), which determines that the baseline emissions are the product of electrical energy baseline expressed in kWh produced by the renewable generating unit multiplied by an emission factor:

$BE_y = EG_{BL,\ y} * EF_{CO2}$

Where,

BE_y	= Baseline Emissions in year *y*, tCO_2e;
$EG_{BL,y}$	= Net quantity of energy supplied as a result of the implementation of the project activity in year, y MWh;
EF_{CO2}	= CO_2 Emission factor, tCO_2/MWh.

The net energy supplied is the energy output determined by SABS test[35] (used for ex-ante calculation) adjusted by estimated solar geyser contribution, which has been calculated as follows:

$Q = (\alpha_1 H + \alpha_2 (T_a - T_c) + \alpha_3) / 3.6 / 1000 * n$

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
$\alpha_1, \alpha_2, \alpha_3$	= Specific coefficients determined in the SABS test

The determination of $Q_{i,y}$ complies with the SANS 6211-1: 2003 test[36] for the solar absorption efficiency of a domestic solar water heating system. For more detailed explanation of SABS test in appendix 4. Please note that Q-Factor is only applied for ex ante emission reduction estimates.

CO_2 Emission factor

According to the methodology AMS-I.D. version 17, in paragraph 12, the baseline is the MWh produced by the renewable generation unit multiplied by an emission factor (measured in tones CO_2/MWh) calculated in a transparent and conservative manner in either way (a) or (b) as follows:

(a) A combined margin ("CM"), consisting of the combination of operating margin ("OM") and build margin ("BM") according to the procedures prescribed in the 'Tool to calculate the Emission Factor for an electricity system'.

OR

(b) The weighted average emissions (in tCO2/MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

[35] The SABS test results determine also the level of Eskom subsidy.

[36] South African National Standard as published by the South African Bureau of Standards (www.sabs.co.za)

Option a is selected and the grid factor is calculated in accordance with the 'Tool to calculate the emission factor for an electricity system'.

In South Africa, Eskom dominates the electricity supply market and only a few municipal and private generators exist. Public information on the Eskom power plants exists until 2008, and the private generators' information is available only partly until 2005. It is considered acceptable that Eskom represents the electricity production industry in South Africa, as it produces over 96 % of electricity in South Africa. Only less than 4 % comes from private and municipal generators.[37]

In South Africa the grid system is a nationwide grid system, and the fuel consumption as well as net electricity generation data is available for all Eskom systems. The calculation has been provided in Grid Factor Calculation of the PoA-DD. The power plant data has been obtained from the Eskom website and the data for most recent years (2007/8, 2008/9, 2009/10) has been applied, available under:
http://www.eskom.co.za/c/article/236/cdm-calculations/

The grid system is part of the national grid system, and fuel consumption as well as net electricity generation data is available for all Eskom systems. However, as per the data provided by Eskom, only coal power plants are have been producing electricity in the last 5 years and hence it is assumed that coal forms part of low-cost/must-run resources, and hence average OM has been selected as suitable calculation method (step 4 d, option A, equation 1 and option 1A equation 2 of the tool are applied). The *ex-ante* option for calculation of operational margin has been selected, based on 3-year generation-weighted average on the most recent publicly available data.

The *ex-ante* option for calculation of build margin is selected, based on 20 % generation capacity including grid connected CDM projects as well as plants older than 10 years, as the generation capacity of plants built within the last 10 years is marginal (< 1 %). The option 1 and equation 12 are applied.

The combined margin is calculated based on weighted average (step 6, option a), which is determined to be used for all project types other than wind and solar projects.

The detailed calculation is presented in Grid Factor Calculation of the PoA-DD.

Project Emissions

According AMS.II.C and AMS.I.C project emissions, relevant to the project activity, consist of electricity consumption from onsite electricity consumption. The project emission shall be determined ex ante.

For AMS.II.C as follows:

[37] Electricity supply statistics of South Africa, 2005 (the latest one), page 6, 14. Available under: http://www.nersa.org.za/documents/ArchivedESSDocuments.aspx

$PE_y = E_{PJ,y}\ x\ EF_{CO2,ELEC,y} + Q_{ref,PJ}\ x\ GWP_{ref,PJ}$

Where,

PE_y = Project Emissions in year *y*, tCO_2e;

$EG_{PJ,y}$ = Energy consumption in the project in year, kWh;

EF_{CO2} = CO_2 Emission factor, tCO_2/kWh.

$Q_{ref,PJ}$ = Average annual quantity of refrigerant used in the project to replace the refrigerant that has leaked, t/year;

$GWP_{ref,PJ}$ = Global Warming Potential of the project refrigerant, tCO_2e/t refrigerant.

$E_{PJ,y} = \sum_i (n_i\ x\ \rho_i\ x\ o_i) / (1-l_y)$

Where,

n_i = Number of devices of the group of *"i"* replaced;

ρ_i = Power of the devices of the group of *"i"* project devices;

o_i = Average annual operating hours of the devices of the group of *"i"* project devices;

l_y = Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction. According Eskom these losses are 8.45 %.[38]

AMS.I.C paragraph 45 determines that project emissions are calculated according the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", as follows:

$PE_{EC,y} = \sum_j EC_{PJ,j,y}\ x\ EF_{EL,j,y}\ x(1+TDL_{j,y})$

Where,

$PE_{EC,y}$ = Project emissions from electricity consumption in year y, tCO2;

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y, MWh;

$EF_{EL,j,y}$ = Emission factor for electricity generation for source j in year y, tCO2/MWh;

$TDL_{j,y}$ = Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction. Same as l_y (above).

$EC_{PJ,j,y}$ the quantity of electricity consumed by the project electricity consumption source is estimated as a percentage of baseline for ex ante calculations, and following values shall be applied: 30% for 200 litre SWH

For $EF_{EL,j,y}$ the Scenario A and option A1 of the tool is applied to determine the grid factor. According the option 1 the combined margin shall be determined according the Tool to calculate the emission factor

[38] Eskom Annual Report, 2010, page 32.

for an electricity system. Hence, the combined margin is calculated according the same principle and equations presented above for baseline.

Leakage

According AMS.I.C., leakage shall be considered if the energy generating equipment currently being utilised is transferred from outside the boundary to the project activity.

According AMS.II.C., leakage shall be considered if the energy efficiency technology is equipment transferred from another activity.

Furthermore both methodologies state that in the case of PoAs, if the project activity involves the replacement of equipment, the leakage effect of the use of the replaced equipment in another activity can be neglected because the replaced equipment is scrapped.

Under this PoA only new SWH/HP technology will be installed. In case of new installation (i.e. no pre-feed or retrofit) the electric element is disconnected and the whole geyser is replaced with a new SWH/HP. By disconnecting the electric element they geyser is made unusable. Pre-feed or retrofit installation which accounts for approx. 5% of installations under the Eskom subsidy scheme, the existing element (typically 3 kW element) is replaced with a 2 kW element in order to apply for Eskom subsidy. In case of any pre-feed or retrofit installation the electricity usage of the element is monitored and will form part of project emissions, and hence is not a leakage occurs.[39]

Leakage (LE,y) is considered to be zero under this programme.

Emission Reductions

$ER_y = BE_y – PE_y - LE_y$

[39] Eskom. New Installation Guidelines for SWH requirement 9.3 on p 9;
Emailing 02 May 2012, with Eskom; Eskom basic requirements for participation on the heat pump rebate, p 3[39];
Eskom Programme Requirements.

B.6.2. Data and parameters that are to be reported ex-ante

Data / Parameter	**EF_{grid}**
Unit	tCO2e/MWh
Description	The emission factor for the electricity system.
Source of data	Calculated based on data provided by Eskom. Available at: http://www.eskom.co.za/c/article/236/cdm-calculations/
Value(s) applied	0.967 tCO_2e/MWh
Choice of data or Measurement methods and procedures	As per the Tool to calculate the emission factor for an electricity system. Calculated ex ante for each CPA and fixed for the 10 year crediting period.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Please see Grid Factor Calculation of the PoA-DD for detail calculation.

B.6.3. Ex-ante calculations of emission reductions

Baseline Emissions

For AMS.II.C as follows:

$$BE_y = E_{BL,y}\ x\ EF_{CO2,ELEC,y} + Q_{ref,BL}\ x\ GWP_{ref,BL}$$

Where,

BE_y	= Baseline Emissions in year y, tCO_2e;	[add value]
$E_{BL,y}$	= Energy consumption in the baseline in year, MWh;	[add value]
EF_{CO2}	= CO_2 Emission factor, tCO_2/MWh.	0.967
$Q_{ref,BL}$	= Average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked, t/year;	[add value]
$GWP_{ref,BL}$	= Global Warming Potential of the baseline refrigerant, tCO2e/t refrigerant.	[add value]

$$E_{BL,y} = \sum_i (n_i\ x\ \rho_i\ x\ o_i)/\ (1\text{-}l_y)$$

Where,

n_i	= Number of devices of the group of "i" replaced;	[add value]
ρ_i	= Power of the devices of the group of "i" baseline devices;	[add value]

o_i	= Average annual operating hours of the devices of the group of *"i"* baseline devices;	[add value]
l_y	= Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction.	[add value]

For SWHs AMS.I.C is applied as follows:

$$BE_y = EG_{BL,\ y} * EF_{CO2}$$

Where,

BE_y	= Baseline Emissions in year *y*, tCO_2e;	[add value]
$EG_{BL,y}$	= Net quantity of energy supplied as a result of the implementation of the project activity in year, y MWh;	[add value]
EF_{CO2}	= CO_2 Emission factor, tCO_2/MWh.	0.967

$EG_{BL,}$ *is* calculated as follows ex ante:

$$Q = (\alpha_1 H + \alpha_2 (T_a\text{-}T_c) + \alpha_3) /3.6 /1000 * n$$

Where,

Q	= Energy output in MJ	[add value]
H	= The energy input i.e. irradiation in MJ per m^2	[add value]
T_a	= The ambient air temperature and	[add value]
T_c	= Incoming cold water temperature	[add value]
$\alpha_1, \alpha_2, \alpha_3$	= Specific coefficients determined in the SABS test	[add value]
n	= Number of units	[add value]

The determination of $Q_{i,y}$ complies with the SANS 6211-1: 2003 test[40] for the solar absorption efficiency of a domestic solar water heating system. For more detailed explanation of SABS test please see appendix 4.

CO_2 Emission factor

EF_{grid}	= CO_2 Emission factor, tCO_2/MWh.	0.967

The detail calculation is provided in the Emission Reduction Calculations for CPA001

[40] South African National Standard as published by the South African Bureau of Standards (www.sabs.co.za)

Project Emissions

For AMS.II.C as follows:

$PE_y = E_{PJ,y} \times EF_{CO2,ELEC,y} + Q_{ref,PJ} \times GWP_{ref,PJ}$

Where,

PE_y	= Project Emissions in year *y*, tCO_2e;	[add value]
$E_{PJ,y}$	= Energy consumption in the project in year, kWh;	[add value]
EF_{CO2}	= CO_2 Emission factor, tCO_2/kWh.	[add value]
$Q_{ref,PJ}$	= Average annual quantity of refrigerant used in the project to replace the refrigerant that has leaked, t/year;	[add value]
$GWP_{ref,PJ}$	= Global Warming Potential of the project refrigerant, tCO_2e/t refrigerant.	[add value]

$E_{PJ,y} = \sum_i (n_i \times \rho_i \times o_i) / (1 - l_y)$

Where,

n_i	= Number of devices of the group of *"i"* replaced;	[add value]
ρ_i	= Power of the devices of the group of *"i"* project devices;	[add value]
o_i	= Average annual operating hours of the devices of the group of *"i"* project devices;	[add value]
l_y	= Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction.	8.45 %.[41]

For AMS.I.C as follows:

$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$

Where,

$PE_{EC,y}$	= Project emissions from electricity consumption in year y, tCO2;	[add value] (Not relevant for ex-ante calculations, as the efficiency of solar system is assessed when calculating baseline emissions.)
$EC_{PJ,j,y}$	= Quantity of electricity consumed by the project electricity consumption source j in year y, MWh;	[add value]
$EF_{EL,j,y}$	= Emission factor for electricity generation for source j	[add value]

[41] Eskom Annual Report, 2010, page 32.

in year y, tCO2/MWh;

$TDL_{j,y}$	= Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction. Same as l_y (above).	[add value]

Hence project emissions (PE_y) determined ex ante in year y are XX tCO_2 under the CPA-XXX [confirm].

Leakage

$LE_y = 0$ under this the CPA-XXX [confirm].

Emission Reductions

[add value for ER_y] = [add value for BE_y] – [add value for PE_y] - [add value for LE_y]

For more detailed information please see the Emission Reduction Calculations for CPAXXX

B.7. Application of the monitoring methodology and description of the monitoring plan
B.7.1. Data and parameters to be monitored by each generic CPA

Data / Parameter	N_{HP}
Unit	-
Description	Number of HPs operating in the year
Source of data	Site visits: visual and technical checks, as well as failure reporting
Value(s) applied	-
Measurement methods and procedures	Sample in accordance with the “Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities”.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comments	For ex-post, this will be reduced based on the results of the sample and reported failures. Please note that this parameter is relevant only for CPAs that include HPs.

Data / Parameter	E_y
Unit	kWh
Description	Annual energy consumption of the heat pump
Source of data	Electricity meter
Value(s) applied	-
Measurement methods and procedures	Sample based on the “Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities”.
Monitoring frequency	Continuous measurement of a sample of units
QA/QC procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comments	Please note that this parameter is relevant only for CPAs that include HPs, and will be used to determine the operating hours.

Data / Parameter	N_{SWH}
Unit	-
Description	Number of SWH operating in the year
Source of data	Site visits: visual and technical checks, as well as failure reporting
Value(s) applied	-
Measurement methods and procedures	Sample in accordance with the “Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities”.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comments	100 % applied for ex-ante. For ex-post, this will be reduced based on the results of the sample and reported failures. Please note that this parameter is relevant only for CPAs that include SWHs.

Data / Parameter	$Q_{,y}$
Unit	MWh
Description	Solar energy used by the household in the year *y*, MWh
Source of data	Calculation
Value(s) applied	-
Measurement methods and procedures	Calculation based on the monitoring results of inlet and outlet temperature and water flow.
Monitoring frequency	Calculation based on continuous measurement results
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	The ex ante 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 calculations and determined in the CPA-DD. Please note that this parameter is relevant only for CPAs that include SWHs.

Data / Parameter	Q_{rated}
Unit	MW
Description	Rated capacity of the SWH
Source of data	Calculation based on SABS heating value (MJ) and 86 400s (seconds in a day) giving the rated capacity.
Value(s) applied	-
Measurement methods and procedures	Calculation based on SABS heating value and 86 400s (seconds in a day) giving the rated capacity.
Monitoring frequency	Once (based on technical spec of the SWH)
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	Used to calculate annual hours of operation.

Data / Parameter	**V**
Unit	litres
Description	Volume of daily warm water usage (water flow)
Source of data	Measured on-site
Value(s) applied	-
Measurement methods and procedures	A volumetric flow meter will measure the water flow at the inlet of the SWH i.e. amount of water entering to the tank. Sample in accordance with the “Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities”.
Monitoring frequency	Continuous measurement i.e. when water withdrawn by household.
QA/QC procedures	Calibration of the flow meter as per manufacturer specifications, but at least once in three years, or replacement of temperature probe with a new one.
Purpose of data	Calculation of baseline emissions
Additional comments	The volume is used to calculate mass (m) of water.

Data / Parameter	$\mathbf{T_{inlet}}$
Unit	Celsius or Kelvin
Description	Temperature of water outlet point
Source of data	Measured on-site
Value(s) applied	-
Measurement methods and procedures	The temperature will be monitored with a temperature probe. The probe must be installed on the inlet of the SWH before any recirculation stream enters the solar panel. The meter should be installed as specified by the equipment supplier.
Monitoring frequency	Continuous measurement, when water withdrawn by household.
QA/QC procedures	Calibration of the temperature probe as per manufacturer specifications, but at least once in three years.
Purpose of data	Calculation of baseline emissions
Additional comments	Please note that this parameter is relevant only for CPAs that include SWHs.

Data / Parameter	T_{outlet}
Unit	Celsius or Kelvin
Description	Temperature of water outlet point
Source of data	Measured on-site
Value(s) applied	-
Measurement methods and procedures	The temperature will be monitored with a temperature probe. Probe must be installed on the outlet before distribution to the house. If the hot water is mixed with cold water (to prevent the hot water temperature rising above 55 °C degrees i.e. for safety reasons) the probe must be installed at the mixing point before distribution to the house. The meter should be installed as specified by the equipment supplier.
Monitoring frequency	Continuous measurement, when water withdrawn by household.
QA/QC procedures	Calibration of the temperature probe as per manufacturer specifications, but at least once in three years.
Purpose of data	Calculation of baseline emissions
Additional comments	The outlet water of the SWH is mixed with cold water before distribution to the house. The thermostatic mixing valve is typically set at 55 °C for safety reasons. Please note that this parameter is relevant only for CPAs that include SWHs.

Data / Parameter	ρ_i
Unit	kW
Description	Power of the devices of the group of “i” for project devices
Source of data	Project devices installed
Value(s) applied	-
Measurement methods and procedures	The power of the nameplate data of the project device will be recorded into the database. 100 % of the data shall be recorded.
Monitoring frequency	Once at installation
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	Please note that this parameter is relevant only for CPAs that include HPs.

Data / Parameter	ρ_i
Unit	kW
Description	Power of the devices of the group of "i" for baseline devices
Source of data	Baseline device replaced
Value(s) applied	-
Measurement methods and procedures	The power of the nameplate data of the baseline device will be recorded into the database. 100 % of the data shall be recorded.
	Once at installation
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	Please note that this parameter is relevant only for CPAs that include HPs.

Data / Parameter	o_i
Unit	H
Description	Average annual operating hours of the devices of the group of *"i"* project devices
Source of data	Calculated
Value(s) applied	-
Measurement methods and procedures	Calculation based on the monitoring results of energy consumption of the heat pump and power of the device.
Monitoring frequency	Calculation based on continuous measurement results
QA/QC procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	Literature or measurements data (if available) will be used for ex ante emission reduction calculation and will be determined in the CPA-DD. Please note that this parameter is relevant only for CPAs that include HPs

Data / Parameter	EC_{PJ}
Unit	kWh
Description	Annual energy usage by the back-up element
Source of data	Electricity meter
Value(s) applied	-
Measurement methods and procedures	Sample based on the "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities".
Monitoring frequency	Continuous measurement of a sample of units
QA/QC procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comments	Please note that this parameter is relevant only for CPAs that include SWHs, and will be used to determine the operating hours.

Data / Parameter	$TDL_{j,y}$ / l_y
Unit	%
Description	Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction.
Source of data	Literature
Value(s) applied	8.45 % based on Eskom's Annual Report from 2010
Measurement methods and procedures	Latest Eskom information available
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	-

Data / Parameter	$Q_{ref,PJ}$
Unit	T
Description	Average annual quantity of refrigerant used in the project to replace the refrigerant that has leaked, t/year
Source of data	Project equipment
Value(s) applied	-
Measurement methods and procedures	In case any of the HPs apply a refrigerant with a GHG potential, and this refrigerant is replaced due to leakage, the amount of refrigerant replaced shall be recorded. The extent of a leakage (amount of refrigerant discharge/recharge) is measured through pressure measurement.
Monitoring frequency	Measured in case of leakage
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	Please note that all heat pumps under this programme are CFC free. This parameter is only relevant for refrigerants with GHG potential. Leaks will take place only in case of equipment failure/ The suppliers will implement all necessary measures to minimise leaks and estimate leak.

Data / Parameter	$Q_{ref,BL}$
Unit	T
Description	Average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked, t/year
Source of data	Baseline equipment
Value(s) applied	-
Measurement methods and procedures	n/a
Monitoring frequency	n/a
QA/QC procedures	n/a
Purpose of data	Calculation of baseline emissions
Additional comments	Please note that the baseline equipment electric geyser does not apply any refrigerants.

Data / Parameter	$GWP_{ref, PJ}$
Unit	t CO_{2e}/t refrigerant
Description	Global Warming Potential of the refrigerant that is used in the project equipment
Source of data	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual
Value(s) applied	-
Measurement methods and procedures	The IPCC Guidelines and technical specs of the project.
Monitoring frequency	Once (based on technical spec of the HP)
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comment	Please note that all heat pumps under this programme are CFC free. Leaks will take place only in case of equipment failure/ The suppliers will implement all necessary measures to minimise leaks and estimate leak. The ex ante calculation does not foresee any leaks.

B.7.2. Description of the monitoring plan for a generic CPA

The coordinating entity will implement a system that will allow the DOE to verify the emission reductions for each individual CPA and to consolidate the CPAs to determine the emission reductions for the PoA as a whole. The coordinating entity will contract a specialised data management company, which will establish and maintain a database for the PoA that contains sufficient data, specific to each CPA and each installation, to allow the DOE to calculate the emission reductions for each individual CPA.

Heat Pumps - Methodology:

Methodology AMS.II.C. "Demand-side energy efficiency activities for specific technologies", Version 13, determines that if the devices have a variable current (ampere) characteristics, the monitoring can consist of:

- *Metering the "energy use" of an appropriate sample of the devices installed.*
- *Annual checks of a sample of non-metered systems to ensure that they are still operating.*

A sample of the HPs will be equipped with an electricity meter that meters the electricity consumption of the HPs.

Furthermore, if the devices installed replace existing devices, the number and "power" of a representative sample of the replaced devices shall be recorded in a way to allow for a physical verification by the DOE.

The name plate for each installation, including baseline data, is captured into a database, which can be viewed by the DOE. Each installation can be uniquely identified based on address, GPS coordinates and serial number of the equipment.

Furthermore, paragraph 9 of AMS.II.C states that project emissions from physical leakage of refrigerants shall be accounted for and hence the average annual quantity of leaked refrigerant used in the project to replace the refrigerant needs to be monitored.

Solar Water Heaters - Methodology:

The methodology AMS-I.C. "Thermal energy production with or without electricity", Version 19, determines that if the emission reduction per system is less than 5 tonnes CO_2 per year; or in the case of household or commercial applications/systems whose maximum output capacity is less than 45 kW thermal and where it can be demonstrated that the metering of thermal energy output is not plausible, monitoring shall consist of:

i) *the number of systems operating, and*
ii) *estimating the annual hours of operation of the average system.*

Furthermore the project electricity consumption needs to be taken into consideration. AMS.I.C paragraph 45 determines that project emissions are calculated according the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

According the paragraph 51 c the monitoring should also include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other.

Implementation of the Methodology in the Programme

<u>Heat Pumps - Monitoring of Energy Usage:</u>

The metering of energy usage [E_y] as such is not sufficient in order to determine savings, as the baseline has been established using the power (kW) of baseline equipment (i.e. electric geyser) and hence the metering of energy usage is converted to annual operational hours as follows:

$o_y [h] = E_y [kWh] / \rho[kW]$

Where,

o_y	= Average annual operating hours of the heat pumps;
E_y	= Energy consumption of the heat pump in year;
ρ_{HP}	= Power of the heat pump.

The database captures the power of each baseline equipment [ρ_{EG}] (i.e. electric geyser) as well as the power of each installed heat pump and hence will be able to provide the difference in the capacity.

Heat Pumps - Monitoring of refrigerants:

A refrigerant leak occurs only due to a technical failure of a heat pump. Under this programme the supplier is responsible for the functionality of the HP over the 10 year crediting period. In case of failure the HP is either fixed and the refrigerant is replaced or the HP is replaced with new equipment.

To date there has been no legislation pertaining to the disposal of refrigerants in South Africa; however the SABS 0147 Code of Practice (Refrigerant systems including plants associated with air conditioning systems) has been introduced as a guideline. In case of discharge/recharge of the refrigerant or disposal of the HP certified companies that follow the Code of Practice will be used.

The amount/extend of physical leakage of refrigerant from the project equipment is measured through pressure measurement. The results (amount of refrigerant discharge/recharge) are reported into the database, and applied for the ex post emission reduction calculations.

Solar Water Heaters - Estimation of the operational hours:

The estimation of the operational hours alone is not an appropriate measure for the energy saving calculations as the solar water heaters (SWHs) receive solar radiation constantly during the day, and the amount of energy replaced is subject to the households' hot water usage.

The amount of energy provided by a SWH [Q] and used by a household on a specific day and the related annual operational hours can be calculated from:

1. the difference between inlet and outlet water temperate [ΔT]; and
2. the water flow rate i.e. volume of water usage [V].

To calculate the amount of energy used, the following adjustments are undertaken:

3. the volume is adjusted with density to calculate mass [m] of water; and

4. the adjusted volume is further multiplied with the specific water heating value (amount of energy needed to heat up a kilogram of water to 1°C).

Hence:

$Q\ [kWh] = \Delta T\ [°C] * m\ [kg] * 4{,}187\ [kJ/(kg*°C)] * (1/3600)$

The average annual hours of operation can be determined with the help of the energy usage (i.e. energy replaced/saved) and the rated capacity of the SWH, as follows:

$h = Q\ [kWh] * 365 / Q_{rated}\ [kW]$

Where ,
Q_{rated} = Rated capacity of the SWH, in kW

Continuous measurements are done to meter the actual demand profiles. The following parameters are metered in a sample of units:

Parameter	Unit	Symbol
Inlet water temperature	° C	T_{inlet}
Outlet water temperature	° C	T_{outlet}
Volume of daily water flow (water usage)	litre	V

The mass of water [m] is calculated as follows:

$m = \rho / V$
ρ =density of water [kg/m^2]
V = of water as per flow meter measurement [m^2 or litres]

The below table gives the densities of water at different temperatures:

Temperature - T -	Density - ρ -	Specific mass - m -
[^{o}C]	[kg/m^3]	[kg/litres]
15	999.10	0.999
20	998.20	0.998
22	997.77	0.997
25	997.05	0.997
40	992.22	0.992
45	990.22	0.990
50	988.05	0.988
55	986.00	0.986

60	983.22	0.983

The differences in the mass are minimal and they deviate by less than 0.006 [kg/litres] from each other. Hence, it is suggested that the average value of 0.99 [kg/litres] is applied.

Finally the project electricity consumption needs to be taken into consideration. AMS.I.C paragraph 45 determines that project emissions are calculated according the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" i.e. the quantity of electricity consumed by the electric back-up element of the SWH [$EC_{PJ,y}$]. A sample of the SWHs will be equipped with an electricity meter that meters the electricity consumption of the SWHs.

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" requires the adjustment of $EC_{PJ,j,y}$ with average annual technical and distribution losses [TDL_y] as follows:

$$EC_{PJ,j,y}[kWh]\ x(1+TDL_{j,y}[\%])$$

SWHs – Scraping:

It is the installer's responsibility to disconnect the electric element. This is also an Eskom requirement in order to apply for subsidy. This information (disconnected or not) is recorded in the installation form and further into the database. During annual operatinality checks it is confirmed that the electric element is still disconnected. During verification a sample of household can be visited to check: 1) operationality of project equipment; 2) capacity of baseline equipment; and 3) baseline equipment still disconnected.

In case the household decides to get rid of the electric geyser, it shall make sure that it gets a scraping certificate when disposing the electric geyser. This certificate shall also state the capacity of the baseline equipment.

Sample Sizes

Operationality of SWHS and HPs:

To confirm the number of operating systems, 97 installations in each CPA are sampled for functionality every year, as well as to check the data capture accuracy (i.e. spot-checks). The database will annually allocate the 97 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. The results are used to adjust the ex-post emission reduction calculation (i.e. % of SWHs/ HPs that are operational).

The "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities", version 02.0 requires PoAs to use *95/10 confidence/precision as the criteria for reliability of sampling* efforts, if the sample is applied on the PoA level (i.e. not for individual CPAs). Furthermore *"this reliability specification shall be applied to determine the sampling requirements for each individual parameter value determined through a sampling effort*". This applies to the determination of the sample size with 95% probability of falling in the range of ± 10% of the true population value (often denoted as 95/10 confidence/precision) and can be calculated based on a normal / Gaussian distribution.

The number of SWHs / HPs operating shall be determined annually with a sample. To estimate the sample size (*n*) of the SWHs installed and operating under the programme in the households with a maximum 10% margin of error at the desired confidence level of 95%, the optimal sample size n of the SWHs / HPs is given by:

$$1.96\frac{\sigma}{\sqrt{n}} \le 0.1$$

And the sample size n is:

$$n \ge \frac{(1.96)^2}{(0.1)^2}\sigma^2 \approx 384.16$$

The value 1.96 denotes the abscissa of the normal curve that cuts off an area of 0.1 at the tails to give the desired confidence level of 0.95, and can be obtained from normal distribution tables.

Since the maximum value of σ^2 is ¼, the sample size n=96.04 should suffice, and hence the sample size for each CPA is determined to be a minimum of 97 SWHs/HPs.

The database will annually allocate the 97 sites for inspection by an automated random number generator. The installers/ suppliers of the SWH/HPs will inspect the determined SWH/HPs.

Parameters Monitored SWH and HP:

The same "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities", version 02.0 shall be applied also for monitoring, and hence a 95/10 confidence/precision is requested. The "Best Practice Exampled Focusing on Sample Size and Reliability Calculations", Version 01.0 is applied to determine the sample size ex-ante. However, the sample size determine below may be revised (i.e. increased or decreased) based on the confidence level reached,

According to paragraph 9, the parameters of interest (proportion, mean and standard deviation) are required for sample size calculations and the following different ways are listed to obtain the parameters:

a) We may refer to the result of previous studies and use these results;
b) In a situation where we do not have any information from previous studies, we could take a preliminary sample as a pilot and use that sample to provide our estimates;
c) We could use "best guesses" based on the researcher's own experiences.

Furthermore the paragraph 10 notes that "...if the standard deviation is unknown but the range (maximum – minimum) is known, then a rough "rule of thumb" indicates that the standard deviation can be estimated as the range divided by 4.

Due to a lack of comprehensive studies and pilots on the performance of SWHs the option C, "best guess", has been applied together with literature and some measurement results, as well as the guidance on standard deviation.

Based on the examples and guidance given it is suggested that a sample size should be determined based on the mean value being the parameter of interest. The example 5 and equation 19 suits well for determining electricity consumption (which is used to calculate operational hours) for heat pumps

(simple random sampling), whereas the examples 9 and equation 36 as well as example 10 and equation 40 suits the best for volume of the daily water flow, inlet and outlet water temperatures of SWHs (systematic random sampling).

Details of the sample size determination are provided in the monitoring plan and related annex I.

Electricity consumption of heat pumps (example 5, equation 19):

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

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

Where:

1.96	= Represents the 95% confidence required (see above equations)
N	= Total number of heat pumps
SD	= Expected standard deviation
Mean	= Expected mean

The determination of the sample size for heat pumps is based on the following assumptions:

- Following reference values for operational hours of an electric geyser have been found from literature: 2.5, 2.7 and 6.8 h[42] giving a range of 2.5 to 6.8h. Due to lack of previous studies and measurement results "best guess" is used, and it is estimated that a heat pump would have the same operational hours, however using less energy;
- The minimum capacity (input power) of a heat pump is expected be 0.5 kW and the maximum capacity a heat pump is expected be 1.4 kW;
- Giving a range (maximum – minimum) of 8.27 kWh;
- And a mean of 5.39 kWh;
- The standard deviation can then be calculated based on "rule of thumb" to be 2.07;
- And the V to be 0.15 kWh;
- The total number of installations under the PoA is estimated to be a maximum of 100 000
- Based on the above assumptions and equations, the sample size n can be determined to be 57. It should be noted that sample size of 57 is only an estimate and the real samples size to reach 95 % confidence level can change.
- The total number of installations has only a minimal affect on the sample size. Hence, it is suggested that monitoring equipment be installed in the first installation and thereafter to every 20th installation till a sample size reaching 95 % confidence level is reached.

[42] D. Breakspear 1998,Residential Water Heating Systems, table 3 (element on time: 412 min/60 min = 6.8 (hours)); A Harris , Options for Residential water heating, table 1 (water heating: 2 722 kWh/year / 365/ 3 kW = 2.5 hours; Average Weekly Load Profile – NMBM Port Elizabeth, page 1 (Average geyser load: 8.18 kWh/day/geyser / 3 kW = 2.7 hours)

Electricity consumption of SWH back up element:

The determination of the sample size for SWH follows the above method heat pumps is based on the following assumptions:

- Following reference values for operational hours of an electric geyser have been found from literature: 2.5, 2.7 and 6.8 h[43] giving a range of 2.5 to 6.8h. Due to lack of previous studies and measurement results "best guess" is used, and it is estimated that a back-up element of a SWH would have the same operational hours. The variance up to 6.8 h is a conservative assumption as a SWH mainly heats up the water with irradiation;
- A SWH typically has a 2 kW back-up element. However 1 kW back-up elements are possible. Hence, the minimum capacity of the back-up element is determined to be 1 kW and the maximum capacity of a back-up element is 2 kW;
- Giving a range (maximum – minimum) of 11.1 kWh;
- And a mean of 9.3 kWh;
- The standard deviation can then be calculated based on "rule of thumb" to be 2.78;
- And the V to be 0.09 kWh;
- The total number of installations under the PoA is estimated to be a maximum of 100 000
- Based on the above assumptions and equations, the sample size n can be determined to be 35. It's should be noted that sample size of 35 is only an estimate and the real samples size to reach 95 % confidence level can change.
- The total number of installations has only a minimal affect on the sample size. Hence, it is suggested that monitoring equipment be installed in the first installation and thereafter to every 20th installation till a sample size reaching 95 % confidence level is reached.

Daily water flow of heat pumps (examples 9, equation 36):

$$n \geq \frac{1.96^2 V}{0.1^2}$$

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

Where:

1.96 = Represents the 95% confidence required

SD = Expected standard deviation

Mean = Expected mean

The determination of the sample size for water flow is based on the following assumptions:

- The size of a SWH and the related daily water flow depend on the number of persons in a household. When sizing a SWH, the common rule is 50 litres of hot water per person plus and

[43] D. Breakspear 1998,Residential Water Heating Systems, table 3 (element on time: 412 min/60 min = 6.8 (hours)); A Harris , Options for Residential water heating, table 1 (water heating: 2 722 kWh/year / 365/ 3 kW = 2.5 hours; Average Weekly Load Profile – NMBM Port Elizabeth, page 1 (Average geyser load: 8.18 kWh/day/geyser / 3 kW = 2.7 hours)

extra 50 litres to cover general domestic hot water usage, per day, is applied. The SWHs installed under this programme will typically vary between 150 and 300 litres.

- The variation of the daily water consumption varies between 0 and the maximum size of SWH. However, it is assumed that on most days hot water is used (i.e. 0 only when no one is home) and hence a minimum of 75 litres is suggested for a 200 litre unit e.g. 57 and 200 litres, giving a range (maximum – minimum) of 125 litres;
- No literature values were found for mean water usage. However, based on the rules for sizing of a SWH, the mean is estimated to be a 25 litres below the maximum i.e. for a 200 litre system this will be 175 litres;
- The standard deviation can then be calculated (based on “rule of thumb”) to be 31.25;
- And the V to be 0.032 litres;
- Based on the above assumptions and equations the sample size n can be determined to be 13 for 200 litre units. As the volume of daily water consumption will vary between different household sizes i.e. different SWH sizes, each SWH type (i.e. size) should be metered separately. The sample size for a 150 litre unit is 16, for 250 litre unit it is 11 and for 300 litre unit it is 10. It should be noted that sample sizes presented here are only an estimates and the real sample sizes to reach 95 % confidence level can change.
- As the total number of installations does not influence the sample size, it is suggested that monitoring equipment is installed in the first installation and after that to SWH equipped with a electric metre within in each SWH type (i.e. size) and thereafter to every SWH equipped 50^{th} installation within in each SWH type (i.e. size) till a sample size reaching 95 confidence level is reached.

Inlet and outlet water temperatures:

Daily water flow of heat pumps (examples 9, equation 36):

$$n \geq \frac{1.96^2 V}{0.1^2}$$

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

Where:

1.96	= Represents the 95% confidence required
SD	= Expected standard deviation
mean	= Expected mean

The determination of the sample size for inlet temperature is based on the following assumptions:

- Measurement data was available from SASSA PoA and data from two sites inland (Ekurhuleni) and costal (eThekwini). Two months were compared, one in winter (May) and one in summer (January), giving a temperature variation from 11 °C up to 31 °C, resulting to a range (maximum – minimum) of 20 °C.
- Measurement data further gave a mean of 22 °C between the two sites and two months analysed;
- And a standard deviation of 4.3 °C ;
- This results to a V of 0.04 °C;

- Based on the above assumptions and equations given, the sample size n can be determined to be 15. It should be noted that sample size of 15 is only an estimate and the real samples size to reach 95 % confidence level can change.
- As the total number of installations does not influence the sample size, it is suggested that monitoring equipment is installed in the first installation and thereafter to every SWH that is equipped with flow meter till a sample size that reaches 95 % confidence level is reached.

The determination of the sample size for outlet temperature is based on the following assumptions:

- In case of SWHs, the hot water temperature is regulated by a thermostat (minimum temperature). The thermostat of the back-up element is generally set at 55-60°C as eligibility for the Eskom subsidy requires a minimum outlet temperature setting of 55°C. Higher temperatures can be reached with SWHs during summer time, up to 91 °C. The maximum value for the measurement data was available from the SASSA PoA (as above). Minimum value cannot be determined through the SASSA PoA as it uses a different type of SWHs, which do not have electric back up element;
- Giving a range (maximum – minimum) of 41 °C;
- Mean is estimated to be 70 °C based on the minimum and maximum value;
- The standard deviation can then be calculated based on “rule of thumb” to be 10°C;
- And the V to be 0.02 °C;
- Based on the above assumptions and equations given, the sample size n can be determined to be 8. It should be noted that sample size of 8 is only an estimate and the real samples size to reach 95 % confidence level can change.
- As the total number of installations does not influence the sample size, it is suggested that monitoring equipment be installed in the first installation and thereafter to every SWH that is equipped with flow meter till a sample size that reaches 95 % confidence level is reached.

Data Recording

The following data is recorded in the database for monitoring purposes for each CPA:

1	Location of the SWH(s)	▪ Street address ▪ GPS coordinates	▪ Once when joining the programme
2	Residence / Company Details	▪ First name and surname / Company name ▪ ID number / Company registration number ▪ Contact details	▪ Once when joining the programme
3	Installer Details	▪ Installation date ▪ Installer name ▪ Company name ▪ Contact details	▪ Once when joining the programme
4	Technical Specifications	▪ Serial number ▪ HP/SWH type ▪ HP/SWH size ▪ HP input power ▪ HP / SWH heating capacity ▪ SWH absorber area ▪ SWH back up element size	▪ Once when joining the programme
5	Baseline Details	▪ Power of existing geyser ▪ Size of existing geyser	▪ Once when joining the programme
6	Data from the sample group indicating the number of HPs/SWHs operating during the monitoring period		▪ Annually

7	Measurement data for a sample group	SWH: ▪ Inlet water temperature ▪ Outlet water temperature ▪ Water flow HP: ▪ Electricity consumption	▪ Continuous/ daily
8	Measured	Quantity of refrigerants replaced, in case of leakage	▪ In case of leakage
9	Monitoring period of the CPA		▪ Annually/ relevant period

An electronic database that is hosted by a specialised data company in a secure environment will capture all above information. Data will be archived for two years over the 10 year crediting period. Relevant data capture, verification and storage procedures will be followed in maintaining the data to ensure its accuracy, validity and completeness.

The sampling (operationality of SWH/HP units) and maintenance will be undertaken by the relevant suppliers. International Carbon will produce a monitoring report for each monitoring period in order to verify the information related to the emission reductions contained in the CPA.

A Monitoring Manual has been established to guide the CME and CPAs with the monitoring.

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Appendix 1: Contact information on entity/individual responsible for the PoA

Organization	Low E Co (registered as Low E Solutions (Pty) Ltd)
Street/P.O. Box	P.O. BOX 1903 Sunninghill
Building	
City	Johannesburg
State/Region	
Postcode	2157
Country	South Africa
Telephone	+ 27 795423553
Fax	
E-mail	info@loweco.com
Website	www.low-eco.com
Contact person	
Title	
Salutation	Ms
Last name	Lahti
Middle name	
First name	Laura
Department	
Mobile	+ 27 795423553
Direct fax	
Direct tel.	
Personal e-mail	laura@low-eco.com

Organization	International Carbon Ltd
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Building	
City	Johannesburg
State/Region	
Postcode	KT12 1HH
Country	United Kingdom
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Fax	
E-mail	info@intlcarbon.com
Website	www.intlcarbon.com
Contact person	
Title	
Salutation	Ms
Last name	Lahti
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Direct tel.	
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Country	South Africa
Telephone	+ 27 795423553
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E-mail	info@intlcarbon.com
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Contact person	
Title	
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Appendix 2: Affirmation regarding public funding

n/a

Appendix 3: Application of methodology(ies)

n/a

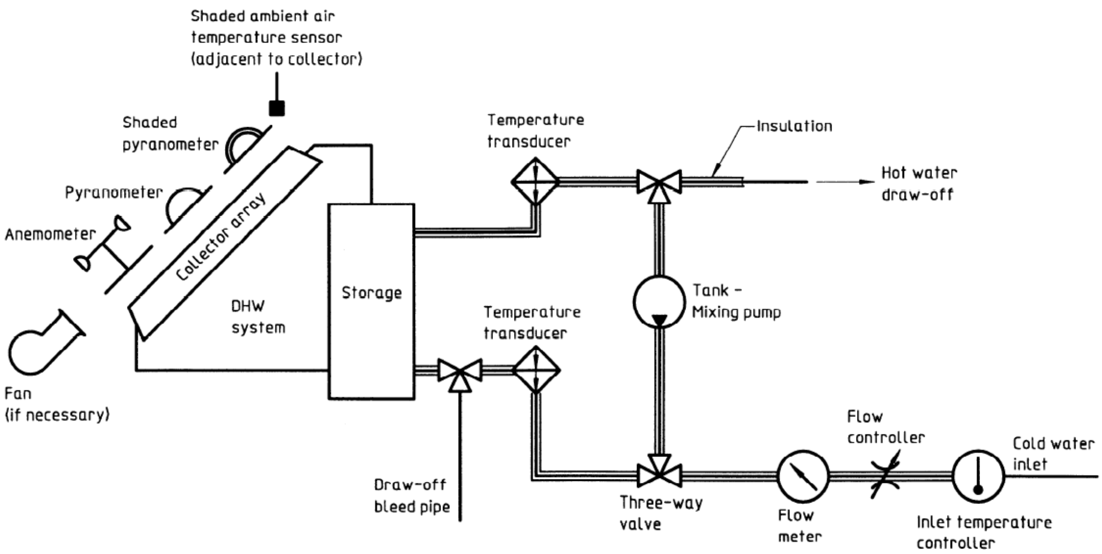
Appendix 4: Further background information on ex ante calculation of emission reductions

The South African Bureau of Standards Test for SWHs

The test results from the SANS[44]6211-1:2003, characterises a Solar Water Heating System in terms of its Energy Output (Q). A Code Of Practice has been established for the SWH installers and the SABS[45] defines the standards for SWH equipment. The SABS test complies with the SANS and has three main elements thermal performance, mechanical performance and safety. The thermal performance test SANS 6211, further bases on the ISO 9459-2 standard. ISO 9459-2 is a establishes test procedures for characterizing the performance of solar domestic water heating systems operated without auxiliary boosting, and for predicting annual performance in any given climatic and operating conditions. The SABS product certification approval is voluntary scheme, but it is a requirement for the Eskom subsidy, which bases on the system rating (Q factor) of each SWH.

The SABS test method correlates the Energy Output (Q), to the Solar Energy (H) incident on the system and the difference between the daily average ambient temperature (Ta) and the incoming cold water temperature (Tc). Each SABS test involves a solar heating period of not less than 6 hours, equally spaced about solar noon. On each day of the test, the SWH system is allowed to operate outdoors and a single draw-off is applied at the end of day. At the start of each day of the test, the system is preconditioned by flushing it with water at a known temperature. At the end of each day the accumulated hot water is drawn off. During the draw-off, temperatures, water flow and volume are measured. The values of temperature versus volume withdrawn are plotted on a draw-off profile graph, of which the energy output for each test day can be determined. A minimum of 6 tests will be carried out. The test procedure is described in detail in SANS 6211 and the equation applied is presented under section D.6.1. The picture 1 below gives a schematic representation of the apparatus applied for performance test.

Picture 1. The apparatus applied for performance test.



[44] South African National Standards (SANS)
[45] South African Bureau of Standards

Appendix 5: Further background information on the monitoring plan

n/a

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History of the document

Version	Date	Nature of revision(s)
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the programme design document form for small-scale CDM programmes of activities" (EB 66, Annex 13).
01	EB33, Annex43 27 July 2007	Initial adoption.
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