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

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Title: Residential Hot Water Efficiency Programme in South Africa
Version Number: 06
Date: 21/12/2012

A.2. Purpose and general description of the PoA

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Policy/measure or stated goal of the PoA

The small-scale Programme of Activities (henceforth referred to as PoA) is a programme for the installation of solar water heaters and heat pumps at residential facilities throughout South Africa. The objective of the PoA is to reduce greenhouse gas emissions through the roll out of energy efficient water heating technologies in South Africa which displace the consumption of electricity. The technologies included in this PoA are solar water heating systems and heat pumps. The technologies are described in more detail in Section A.6.

Solar water heating and heat pumps have not gained significant traction in South Africa.

South Africa has average daily solar radiation of between 4.5 and 6.5 kWh per square meter[1]. This resource is relatively predictable and well distributed throughout the country (with some regional variations)[1]. This makes South Africa a good place for the development of a robust solar water heating market. Despite the high daily solar radiation, the South African solar water heater market was dormant until 2007 when Eskom introduced a rebate program and load-shedding became a reality in South Africa[2]. Between 2007 and 2012 there were significant market volatility and quality issues[2]. During these years, there were numerous teething problems which caused stunted uptake of solar water heaters[2]. The lack of uptake can be attributed to consumer confusion, low rebate, accreditation issues, installation issues, operational problems and loss of interest by potential end-user[2]. To date, the growth in the solar water heating market is still relatively stunted[2]. By 31 December 2010, 30,974 solar water heaters had been installed under the Eskom programme since its advent in November 2008[3]. Since 2008, Eskom has

[1] Energy Research Centre. University of Cape Town. South Africa. October 2006. Renewable Energy Technologies for Poverty Alleviation. Available online from http://www.erc.uct.ac.za/Research/publications/06Visagie-Prasad%20RET.pdf. [Accessed 26 March 2012]

[2] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

[3] South African Department of Energy. Solar Water Heating. Available online from http://www.energy.gov.za/files/swh_frame.html. [Accessed 26 March 2012].

subsidised the purchase of registered solar water heaters; to date 156,000 claims have been received for systems installed as at end September 2011[4].

The market for heat pumps is also immature in South Africa. The Eskom 2012 Divisonal Report states a heat pump installation of only 1 MW up to March 2013[5]. The target of the residential rebate heat pump rollout under the Integrated Demand Management is 54 MW or a minimum of 65,585 units[6]. If these numbers are compared to the number of households in South Africa (12 million)[7], it is clear that there is still a long way to go before the solar water heating and heat pump markets in South Africa are mature.

The aim of the PoA is to promote the uptake of solar water heaters and heat pumps for domestic water heating.

General operating and implementing framework of PoA

The CME is the eThekwini Municipality. The CME will ensure that all participating CPA implementers meet the specified standards of the PoA, thereby ensuring that the quality of the systems, the installations and the maintenance is not compromised. The Energy Office of the eThekwini Municipality will operate the PoA.

The PoA involves the implementation of solar water heaters or heat pumps in residential units in South Africa. There are three main categories of households in which solar water heaters or heat pumps will be installed. The categories of households and the type of technologies that can be installed in each category under this PoA are described below. In addition, each household type has a different implementing framework which is described below. However, all implementing frameworks have the eThekwini Municipality as the CME and the Energy Office as the operator of the PoA. See the description of the households and implementing frameworks below:

1. Low Income Households

   According to the Department of Energy, low income households are households that earn less than R6,000 per month[7]. There are over 4.8 million of these households in South Africa[7].

   In terms of this PoA, low income households refer to households that earn less than R6,000 per month[7]. The houses must be grid-connected as a requirement for being part of this PoA. Typically, this would be houses built under the Reconstruction and Development Programme (RDP)[8]. These RDP houses are government subsidised houses that are built to replace shacks[8]. A picture of RDP houses is provided below:

[4] Eskom, COP17 Fact Sheet. Solar Water Heating Rebate Programme. Available online from http://www.eskom.co.za/content/The%20Solar%20Water%20Heating%20(SWH)%20Programme.pdf. [Accessed 10 October 2012]

[5] Eskom, Eskom 2012 Division Report, p33 Available online from: http://www.pads.eezeepage.co.za/i/69757 [Accessed 04 October 2012]

[6] Eskom, 'Residential Heat Pump Rebate Programme, Information Session, 18 February 2011' Slide 13. Available online from http://www.eskomidm.co.za/docs/heat_pump_presentation.pdf [Accessed 04 October 2012]

[7] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[8] Omeida Trading. Help us do Away with Shacks in South Africa. Available online from http://www.omeidatrading178.co.za/low_cost_housing.htm. [Accessed 26 March 2012].

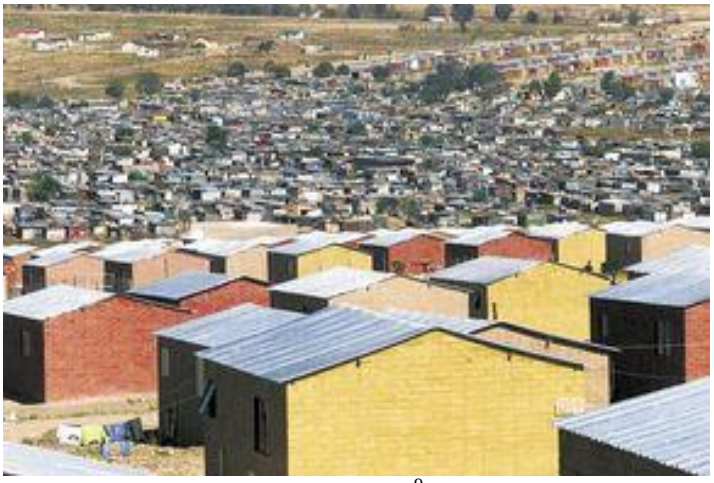

Figure 1: Low income households[9]

Low income households would use electric stoves or electric kettles to heat water[10]. Only 25.9% of these households have geysers according to a study done by the Department of Energy[10]. Electric geysers are not part of the standards in the National Housing Code and residents can choose to install them[11]. However, the houses will typically have an electrical connection and will use this electricity to heat water in kettles or stoves.

Under this PoA, low pressure solar water heaters would be installed in the low income households. More information on low pressure solar water heaters is presented in Section A.6.

The PoA allows for the installation of solar water heaters in existing low income households or in new builds.

The implementing framework of the PoA for low income households is as follows:

[9] Masombuka, S. Sowetan Live. 8 Spetember 2010. A Third of RDP Houses are 'Sub-Standard.' Available online from http://www.sowetanlive.co.za/news/2010/09/08/a-third-of-rdp-houses-are-sub-standard. [Accessed 26 March 2010]

[10] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[11] National Housing Code. Technical and General Guidelines. Available online from http://www.dhs.gov.za/Content/The%20Housing%20Code%202009/CD%20purposes%20=%20Code,%202009/2%20Technical%20&%20General%20Guidelines/1%20Vol%202%20Part%203%20Technical%20and%20General%20Guidelines.pdf. [Accessed 26 March 2012].

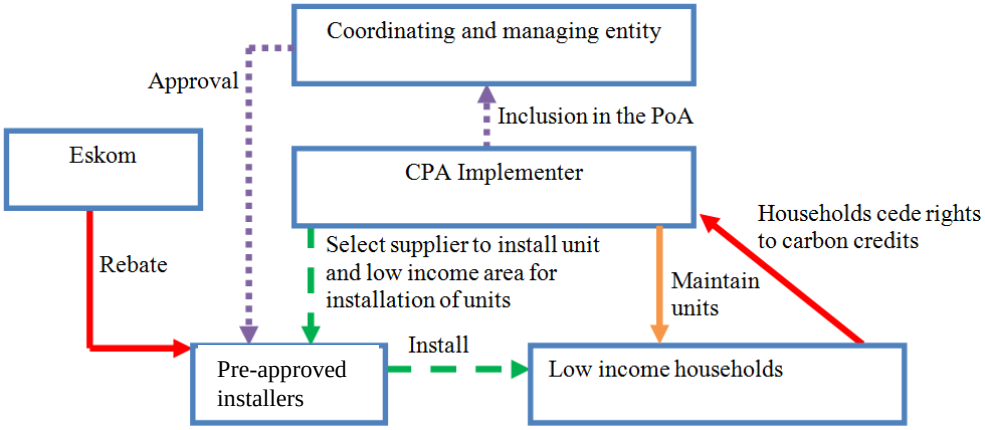

Figure 2: Implementing framework of the PoA for low-income households

The CME is responsible for pre-selecting/pre-approving installers. The CME has control over what installers are used in the CPA in order to ensure quality of installation. The CME pre-approves installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards. The CPA implementer selects an installer from the list of installers approved by the CME. The CPA implementer also selects the low income area where it will manage the installation of solar water heaters and ensure that the units are correctly installed. The CPA implementer is also responsible for maintaining the units for ten years after the installation. In order to do this maintenance, the CPA implementer needs to have a maintenance programme in place. The units are paid for by Eskom through the Eskom's Demand Side Management (DSM) initiative. The installer is responsible for claiming the rebate from Eskom and has an agreement with Eskom regarding the rebate. There is an agreement between the household and the CPA implementer regarding carbon credit ownership. The household cedes rights to the carbon credits to the CPA implementer. The CPA implementer uses the carbon credits to run the maintenance programme for the solar water heaters.

2. Community Residential Units

Community Residential Units (CRUs) are effectively hostels[12]. There are approximately 2,000 public hostels in South Africa[12]. The public hostels are owned by Provincial Housing Departments and Municipalities[12]. Each CRU consists of a number of residential units where people live[12]. There are 200,000 residential units in the ownership of the Provincial Housing Departments and Municipalities[12].

[12] National Department of Human Settlements. Community Residential Units. Available online from http://www.dhs.gov.za/Content/CRU/Home.htm. [Accessed 26 March 2011].

Figure 3: Example of community residential units[12]

The people living in the hostels are typically low income or poor and earn between R800 and R3,500 per month[13]. The people rent the units and are charged a standard per m^2 rate by the Provincial Housing Departments and Municipalities[12].

The CRUs are typically grid-connected and, like RDP housing, the people living in CRUs use electric stoves or electric kettles for heating water[13]. Some of the CRUs have a centralised electric geyser and storage tanks which provide hot water to each of the units.

The reason that the CRUs are separated out from low income households in the PoA is as a result of the fact that RDP houses are separate, individual buildings which will get their own solar water heater in the project. CRUs are a number of units within a single building. Each residential unit in the CRU will not get its own solar water heater or heat pump, but it will be a centralised system designed to feed all the units within the CRU. Each unit within the CRU will be allocated a specific hot water consumption per day from the central unit.

Low or high pressure solar water heaters or heat pumps can be installed under this PoA in CRUs. The technologies are further described in Section A.6.

The PoA applies only to existing CRUs and not to new builds.

The implementing framework of the PoA for CRUs is as follows:

[13] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

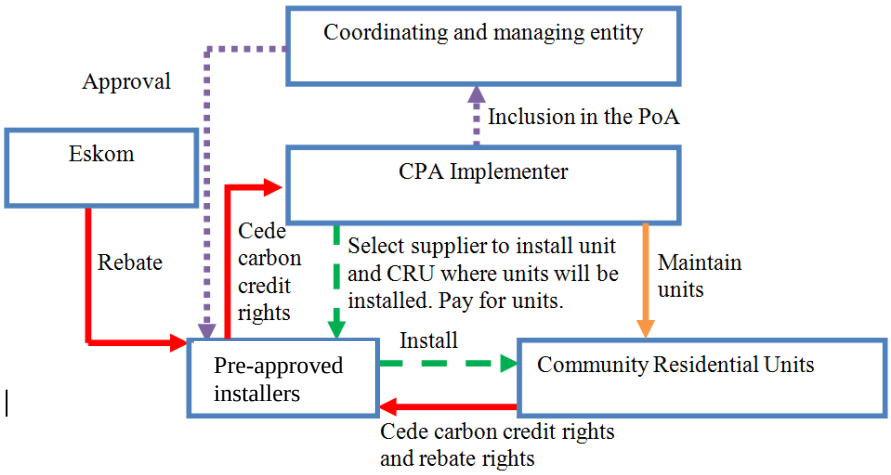

Figure 4: Implementing framework for community residential units

The CME is responsible for pre-selecting/approving installers. The CME has control over what installers are used in the CPA in order to ensure quality of installation. The CPA implementer selects the CRU where it will manage the installation of solar water heaters. The CME goes out to tender for installers for the selected CRU. The CME appoints installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards. The CPA implementer is also responsible for maintaining the units for ten years after the installation. In order to do this maintenance, the CPA implementer needs to have a maintenance programme in place. The units are partially paid for by Eskom through the Eskom's Demand Side Management (DSM) initiative. The remainder of the units will be paid for by the CPA implementer. The installer is responsible for claiming the rebate from Eskom and has an agreement with Eskom regarding the rebate. There is an agreement between the CRU residents and the CPA implementer regarding carbon credit ownership. The residents cede rights to the carbon credits to the CPA implementer. The CPA implementer uses the carbon credits to run the maintenance programme for the solar water heaters or heat pumps and to fund the units which are not fully funded by Eskom.

3. Middle and High Income Households

The final category is middle and high income households. According to the Department of Energy, middle and high (upper) income households earn more than R6,000 per month[14] . Most of these households use a conventional electric geyser for heating water[14]. The electric geyser penetration in middle income households is 75.9%[14]. In high income households, 98.4% of the households have electric geysers[14].

High pressure solar water heaters or heat pumps will be installed in middle and high income households as part of this PoA.

Only existing middle and high income houses qualify under the PoA.

The implementing framework of the PoA for middle and high income households is as follows:

[14] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

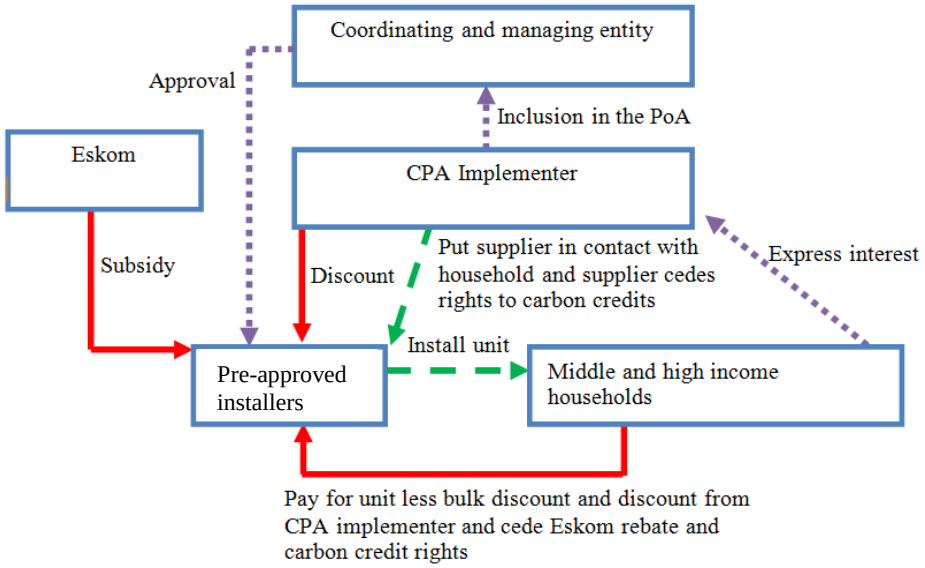

Figure 5: Implementing framework for middle and high income households

The middle and high income households express an interest in a solar water heater or heat pump to the CPA implementer. The CPA implementer will contact a number of credible installers which have reliable technology. The installers have all been pre-approved/selected by the CME. The CME is responsible for pre-approving installers for this programme in order to ensure quality of installation. The CME pre-approves installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards. The installers will provide the households with quotes for the installation of the unit. The households select the installer. The installer will install the unit and claim the Eskom rebate on behalf of the household. The Eskom rebate does not cover the full cost of the unit so the households need to pay for a portion of the unit. However, the household is provided with a further discount for the unit by the CPA implementer. In addition, if more than one household in the area is interested in having a unit installed then the installers offer a bulk discount. The households cede their rights to the carbon credits to the installer and the installer cedes their rights to the carbon credits to the CPA implementer. The CPA implementer uses the revenue from the carbon credits to manage (managing a database of interested households, matching them with installers and monitoring installation of the units) and promote the project and to get more middle and upper income households to express an interest in having a unit installed ensuring awareness creation.

Only existing community residential units and middle and high income households qualify under this PoA. The reason for this is that there is no legal requirement for existing houses to use solar water heaters or heat pumps. A requirement has recently been released for all new commercial and residential buildings to receive at least 50% of its hot water requirements from renewable energy sources[15]. This is governed by the amended National Building Regulations and Building Standards Act which came into effect from November 2011 and the standard is called SANS 10400[15 and 16].

[15] Selected Energy. September 2011. National Building Regulations and Building Standards Act. Available online from http://www.solahart.co.za/News/NationalBuildingRegulationsAct/tabid/16606/Default.aspx. [Accessed 26 March 2012].

[16] The Green Building Handbook. Chapter 10. Available online from http://energy4africa.net/klunne/publications/Green_Building_Hanbook_2012_Wim_Jonker_Klunne.pdf. [Accessed 26 March 2012].

Existing and new low income households qualify under this PoA as the Act mentioned above does not include low income households. Hence, there is no legal obligation for existing or new low income households to use renewable energy to meet their heating requirements[17]. This is demonstrated by the standards of government funded low income houses which are contained in the National Housing Code[18]. The Housing Code states that the standards that are funded by government are applicable to low income houses, but any standards above these government standards is not applicable[18]. The Housing Code does not make any reference to the need to use the SANS 10400 standard[18].

In 2007, the South African Government launched a rebate programme for the installation of solar water heaters[19]. Homeowners installing solar water heaters could access a rebate/subsidy for the installation of solar water heaters in their homes by applying for the rebate from Eskom. A similar subsidy has been launched for heat pumps in February 2011[20]. Under the rebate programme (also called the Eskom Demand Side Management (DSM) Programme), the household pays for the installation of the unit and claims the rebate back from Eskom.

The cost of a solar water heater is between R15,000 and R35,000[21] and it is possible to get a rebate of about R3,000 on the system (25% of the cost of the installation of a solar water heater)[22]. The cost of a heat pump is R15,000 and the value of the rebate from Eskom is between R3,668 and R4,320 depending on the size[23]. Even with the rebates, the capital cost outlay remains high. In addition, there are other costs not considered in the capital cost such as the cost of installation, maintenance and monitoring. The Eskom subsidies are not sufficient to cover all the costs associated with the installation, maintenance and monitoring of solar water heaters and heat pumps over a ten year period. Hence, the payback period for solar water heaters and heat pumps may be relatively short (around five years)[24], this does not include the installation, maintenance and monitoring of the installed units and the high capital outlay upfront is a barrier for the installation of these units. The subsidy for solar water heaters also only reduces the capital

[17] Hot Frog. 5 June 2011. Municipal Building Plans. Available online from http://www.hotfrog.co.za/Companies/Arch-Tekton-Consulting/Municipal-Building-Plans-44844. [Accessed 26 June 2011].

[18] National Housing Code. Technical and General Guidelines. Available online from http://www.dhs.gov.za/Content/The%20Housing%20Code%202009/CD%20purposes%20=%20Code,%202009/2%20Technical%20&%20General%20Guidelines/1%20Vol%202%20Part%203%20Technical%20and%20General%20Guidelines.pdf. [Accessed 26 March 2012].

[19] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

[20] Eskom Integrated Demand Management., Heat Pumps. Available online from http://www.eskomidm.co.za/heat-pumps. [Accessed 26 March 2012]. Go to heat pumps and then to heat pumps presentation to find the information.

[21] Energy Research Centre. University of Cape Town. South Africa. June 2010. Assessing the effectiveness of national solar and wind energy policies in South Africa. Available online from http://www.erc.uct.ac.za/Research/publications/10Edkinesetal-Solar_and_wind_policies.pdf. [Accessed 26 March 2012]

[22] Simply Green. 8 July 2009. Eskom's Solar Water Heating Rebate. Available online from http://www.simplygreen.co.za/local-stories/biz-and-community/eskoms-solar-water-geyser-rebate.html. [Accessed 26 March 2012].

[23] Eskom Integrated Demand Management. The Heat of the Moment. Available online from http://www.eskomidm.co.za/docs/2011_12_09_Residential_heat_pump_rebate_programme_brochure_FINAL.PDF . [Accessed 26 March 2012]

[24] Eskom Integrated Demand Management. Residential Technologies. Available online from http://www.eskomidm.co.za/residential. Go to technologies and then to how the rebate is calculated in order to find the information. [Accessed 26 March 2012].

cost and installation by 20 to 30% for middle and high income households. This leads to an even longer payback period (in excess of 6 years)[25].

For low income households, Eskom will install solar water heaters for free in collaboration with the local municipalities[26]. The solar water heaters are paid for by funds allocated by the Department of Energy[26]. A low income area is selected and notified that they will be receiving a free solar water heater for every household in the area[26]. Eskom partners with the municipality to assist in the operational and technical matters related to the roll outs[26]. The Low Pressure Solar Water Heater Roll-out does not cover the maintenance and monitoring of the solar water heaters once installed. The revenue from the carbon credits will be used to cover the maintenance and monitoring of the solar water heaters for ten years. A ten-year maintenance programme will be implemented using the revenue from the carbon credits to ensure that the solar water heaters continue to operate and save energy.

Despite the Eskom rebate, the number of solar water heaters and heat pumps installed is low in comparison to the target set by Government. South Africa is lagging behind other developing countries in terms of the installation of solar water heaters[27]. To date, the growth in the solar water heating market is still relatively stunted[28]. By 31 December 2010, 30,974 solar water heaters had been installed under the Eskom programme since its advent in November 2008[29]. According to the Department of Energy, despite the special solar water heating initiatives such as the Eskom rebate programme, the existing national solar water heating trade installs about 15,000 to 20,000 solar water heaters a year[27]. Compared to a national target of the installation of one million solar water heaters over the next five years (by 23 June 2014)[30], the progress made thus far is not sufficient. The number of heat pumps installed in South Africa is also relatively low. The Eskom 2012 Divisonal Report states a heat pump installation of only 1 MW up to March 2013[31]. The target of the residential rebate heat pump rollout under the Integrated Demand Management is 54 MW or a minimum of 65,585 units[32]. There are over 12 million households in South Africa so there is a need for significant scale-up in the roll out of solar water heaters and heat pumps[27].

Confirmation that the proposed PoA is a voluntary action by the CME

[25] North West University. October 2010. An Investigation into the Energy Savings and Economic Viability of Heat Pump Water Heaters Applied in the Residential Sector – A Comparison with Solar Water Heating Systems. Available online from http://www.geoplus.co.za/downloadfolder/Heat%20pumps%20vs%20solar%20for%20residential%20application%20-%20CASE%20STUDY.pdf. [Accessed 26 March 2012].

[26] Eskom. Low Pressure Solar Water Heater Roll-Out. Available online from http://www.eskomidm.co.za/docs/Eskom_dsm_website_content_lowpressure_solar_roll_outs_final.pdf. [Accessed 26 March 2012]

[27] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[28] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

[29] South African Department of Energy. Solar Water Heating. Available online from http://www.energy.gov.za/files/swh_frame.html. [Accessed 26 March 2012].

[30] South African Department of Energy. 23 June 2009. Solar Water Heating. Available online from http://www.energy.gov.za/files/swh_frame.html. [Accessed 26 March 2012].

[31] Eskom, Eskom 2012 Division Report, p33 Available online from: http://www.pads.eezeepage.co.za/i/69757 [Accessed 04 October 2012]

[32] Eskom, 'Residential Heat Pump Rebate Programme, Information Session, 18 February 2011' Slide 13. Available online from http://www.eskomidm.co.za/docs/heat_pump_presentation.pdf [Accessed 04 October 2012]

The PoA is a voluntary action undertaken by the eThekwini Municipality who is the CME for the PoA. There are no laws or regulations that mandate the installation of solar water heaters or heat pumps in existing residential facilities in South Africa.

There is currently a legal requirement that all new commercial and residential buildings must receive at least 50% of its hot water requirements from renewable energy sources[33].This is governed by the amended National Building Regulations and Building Standards Act which came into effect from November 2011[33]. This is only applicable to existing buildings and also excludes new build low income households.

The South African Designated National Authority (DNA) has defined sustainable development in terms of three core categories: economic, social and environmental. The project contributes to each of the three categories in the following manner:

Economic

- Solar water heaters make use of renewable energy to generate warm water. The use of renewable energy (solar radiation) to generate hot water results in a saving in electricity. Heat pumps use electricity more efficiently and hence also reduce the costs associated with heating water. Therefore this PoA will reduce household expenditure on electricity and will protect end users from the rising electricity prices.
- The PoA will result in a reduction in power demand which will help avoid power shortages in the future. Reliable power supply and access to power is an important requirement for economic development.
- Eskom foresees future power shortages which is a significant hindrance to the fast growing economy of the country. The proposed PoA will reduce electricity demand for water heating and correct the energy mix, with a greater focus on renewable energy. This will assist in the diversification of the sources of hot water supply, which is important for meeting growing energy demands and facilitating the move away from fossil fuels to generate electricity to renewable energy.
- The PoA will strengthen the solar water heating and heat pump industries in South Africa by providing state-of-the art technology, creating job opportunities in the supply, installation, operation and maintenance fields as well as stimulating the interest of new investors in the solar energy sector and energy efficiency.
- The Municipality is showing foresight in innovation by taking this route to supplying hot water to its residents and to allow other Municipalities or private companies to do the same for the residents in other Municipalities.

Social

- The PoA will provide households and community residential units with a clean, practical and convenient way to meet their daily hot water demand. It will increase energy security for warm water supply in households and community residential units.
- The PoA will contribute to social development by income and employment generation. The PoA will create job opportunities in solar water heating and heat pump manufacturing, supply, distribution, installation and maintenance.

Environmental

- The PoA will result in a reduction of greenhouse gas emissions by increasing the efficiency of domestic water heating. The installed solar water heaters will displace coal-fired grid electricity

[33] Selected Energy. September 2011. National Building Regulations and Building Standards Act. Available online from http://www.solahart.co.za/News/NationalBuildingRegulationsAct/tabid/16606/Default.aspx. [Accessed 26 March 2012].

with heat being generated using renewable resources. The heat pumps will heat water more efficiently than conventional electric geysers, reducing electricity consumption. The reduction in the consumption of electricity for water heating results in a reduction in greenhouse gas emissions. This reduction in greenhouse gas emissions will play a role in assisting South Africa to achieve its emission reduction target of 34% below business-as-usual by 2020.

- Apart from reducing greenhouse gas emissions, the PoA will displace the negative impacts of coal- mining and beneficiation as well as the adverse environmental impacts of combusting coal for electricity generation (particulate and sulphur emissions and water consumption and contamination). The success of this PoA will increase the uptake of solar water heaters and heat pumps in South Africa

A.3. CMEs and participants of PoA

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The CME of the proposed PoA is the eThekwini Municipality. The eThekwini Municipality is also the project participant to the PoA.

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)
South Africa (host)	eThekwini Municipality (public entity)	No

A.5. Physical/ Geographical boundary of the PoA

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The boundary of a PoA is defined as the geographical area within which all the small-scale CDM programme activities (SSC-CPAs) included under the PoA will be implemented. All the CPAs included under this PoA will be implemented within the geographical boundary of the Republic of South Africa. Therefore the boundary of the PoA is defined as the geographical boundaries of the Republic of South Africa.

The PoA is located within the geographical boundaries of the Republic of South Africa:

Figure 6: Provincial Map of South Africa from One World nations Online[34]

A.6. Technologies/measures

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The PoA involves the installation of solar water heaters and heat pumps. These technologies reduce the amount of grid electricity or fossil fuel required for water heating. The PoA applies only to existing residential facilities and new low income households (RDP houses) in South Africa.

A typical CPA consists of a group of SWHs and HPs in residential units. The aggregate savings by a single CPA may not exceed 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 heat pumps and solar water heaters and the collector area of the solar water heaters installed.

Currently, most middle and high income households make use of a conventional electric geyser[35]. This is confirmed by a study conducted by the Department of Energy[35]. Low income households typically heat water using a two-plate electric stove or an electric kettle[35]. See below:

[34] One World Nations Online. 2010. Map of South Africa Provinces. Available online from http://www.nationsonline.org/oneworld/map/za_provinces_map.htm. Accessed 11 August 2011.

[35] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

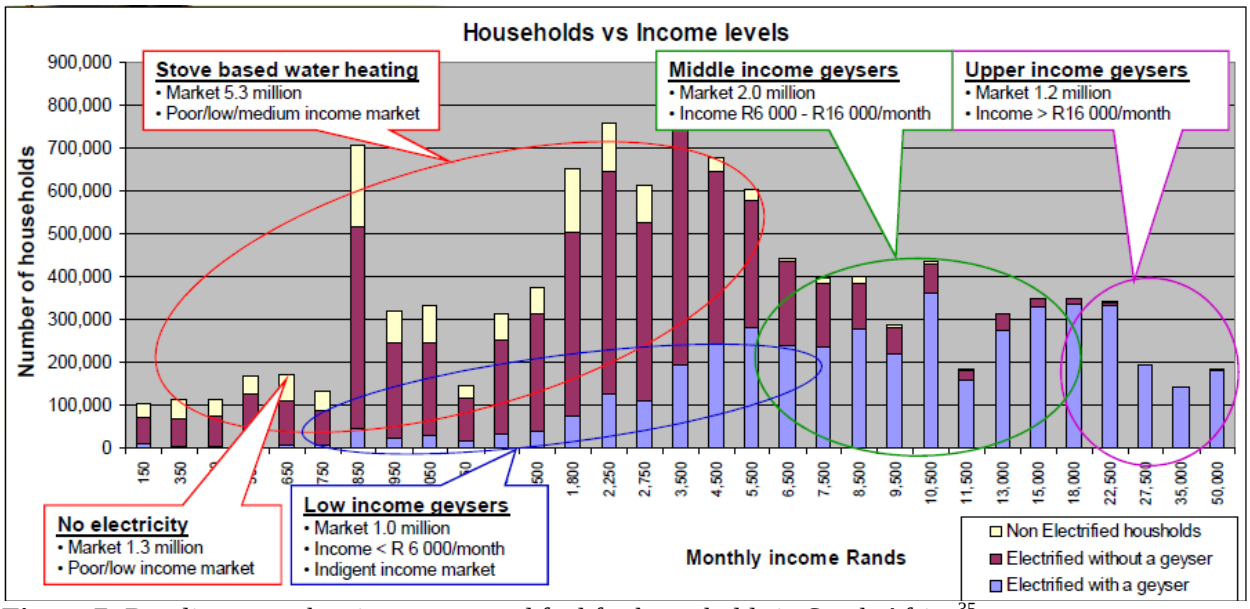

Figure 7: Baseline water heating system and fuel for households in South Africa[35]

A conventional electric geyser uses electricity to heat water. An electric geyser is normally a cylindrical container, either horizontal or vertical configuration which can be made from a variety of materials[36]. They can range in size from 80 to 300 litres for household use[36]. A geyser has a cold water supply inlet which supplies the water to be heated[36]. The geyser is fitted with an electric element in the side of the inner water container or cylinder[36]. The electric elements range in power consumption from 3 to 4 kW[37]. The electric element heats the water in the cylinder[36]. The cylinder comes equipped with a thermostat unit to control the temperature by switching the element off once the desired temperature has been reached[36]. This means that the temperature of the water in the cylinder will remain fairly constant under most circumstances[36]. An electric geyser is typically the appliance that consumes the most electrical power in a household[38]. A conventional electric geyser is depicted below:

[36] News24. Answerit. Available online from http://answerit.news24.com/Question/Question.aspx?QuestionID=34436. [Accessed 26 March 2012].

[37] North West University. October 2010. An Investigation into the Energy Savings and Economic Viability of Heat Pump Water Heaters Applied in the Residential Sector – A Comparison with Solar Water Heating Systems. Available online from http://www.geoplus.co.za/downloadfolder/Heat%20pumps%20vs%20solar%20for%20residential%20application%20-%20CASE%20STUDY.pdf. [Accessed 26 March 2012].

[38] Power Saving Services. Available online from http://www.powersavingservices.co.za/. [Accessed 26 March 2012].

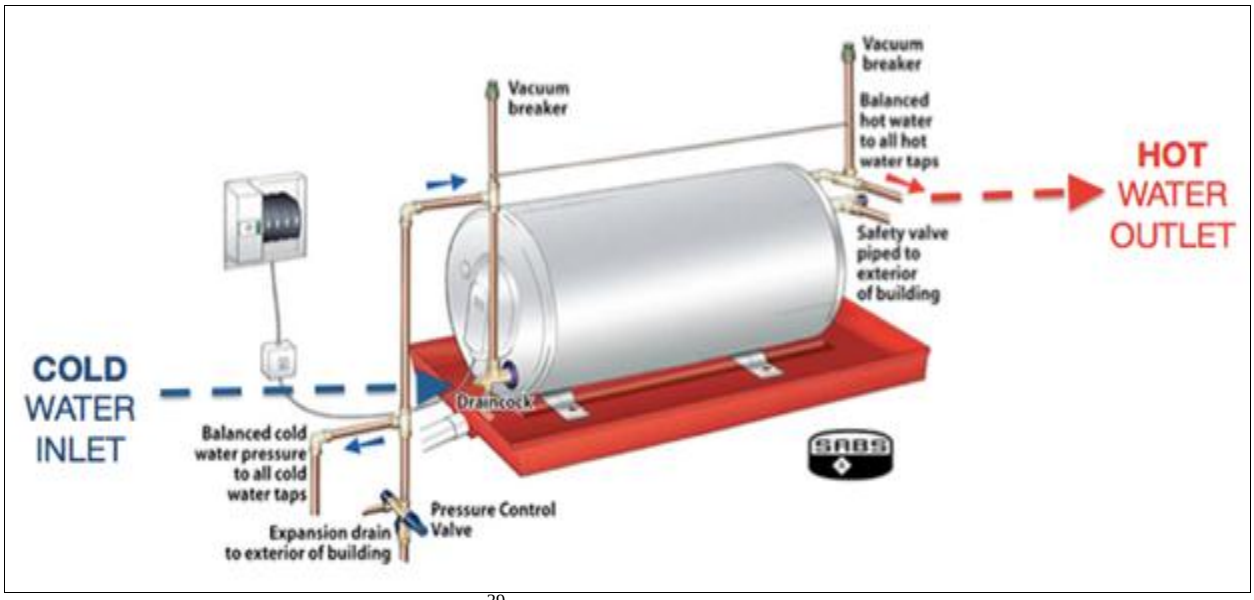

Figure 8: A conventional electric geyser[39]

A typical CPA will consist of the installation of solar water heaters and heat pumps. These technologies reduce the amount of electricity used for water heating. The technologies are described in more detail below:

Solar water heaters

Solar water heaters convert solar radiation into thermal energy for heating water[40]. Solar water heating systems consist of a solar collector and a storage tank connected by two pipes[40]. In the solar collector, the sun's energy is converted to heat in a liquid in the solar collector's channels[40]. This liquid transports the heat through pipes to the storage tank[40].

A number of different types of solar water heaters can be installed under this programme. The different types of solar water heaters are described below:

Active or high pressure solar water heating systems

There are two types of active solar water heating systems[41]. The direct circulation systems use pumps to circulate pressurised water directly through the collectors[41]. These systems are appropriate in areas that do not freeze for long periods and do not have hard or acidic water[41]. The indirect circulation systems, heat transfer fluids are pumped through collectors[41]. Heat exchangers transfer the heat from the fluid to the water[42]. These systems are suitable in areas that are prone to freezing temperatures[42]. A glycol fluid is used to protect the system from freezing[42].

Passive or low pressure solar water heating systems

[39] AGSSolar. How an existing geyser works. Available online from http://www.agssolar.co.za/solar-water-heating/why-solar/. [Accessed 26 March 2012]
[40] Clean Heat. Solar Water Heating Sytems. Available online from http://www.dolphinfinancecc.com/resources/Clean%20Heat%20infospec%20pack.pdf. [Accessed 26 March 2012].
[41] U.S Department of Energy. 31/05/2011. Solar Water Heaters. Available online from http://www.eere.energy.gov/basics/buildings/water_heaters_solar.html. [Accessed 26 July 2011].
[42] U.S Department of Energy. 31/05/2011. Solar Water Heaters. Available online from http://www.eere.energy.gov/basics/buildings/water_heaters_solar.html. [Accessed 26 July 2011].

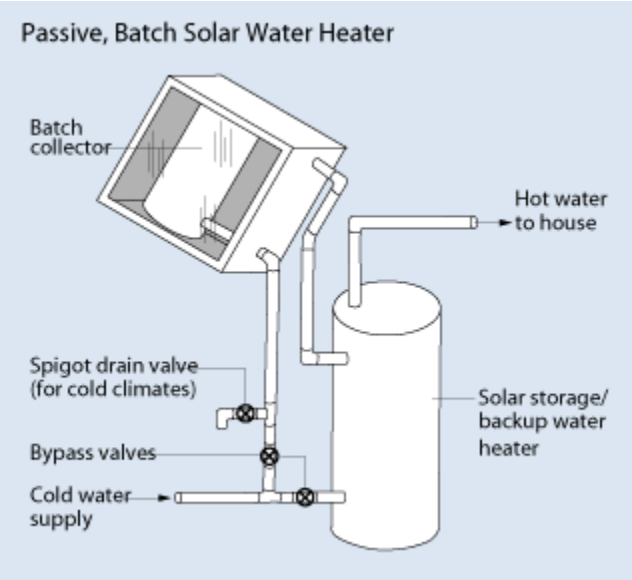

Figure 9: Passive solar water heating system[42]

Passive solar water heating systems rely on gravity[42]. There are two types of systems[42]. The integral collector-storage passive system consists of storage tanks placed in an insulated box with a glazed side facing the sun[42]. This system works best in areas where temperatures do not fall below freezing[42]. The thermosyphon systems rely on the natural convection of warm water rising to circulate water through the collectors to the tank[42]. The tank is located above the collector[42]. As water in the collector heats, it becomes lighter and rises into the tank[42]. The cooler water flows down the pipes to the bottom of the collector[43].

There are a number of different types of collectors[44]:

- Flat-plate collectors: A flat-plate collector is an insulated metal box with a glass or plastic cover (called glazing) and a dark-coloured absorber plate[44].
- Evacuated-tube solar collectors: Evacuated-tube solar collectors can achieve extremely high temperatures[44]. The collectors are made of a panel of rows of transparent glass tubes[44]. Each tube contains a glass outer tube and a metal absorber tube[44].

A typical CPA may consist of a number of different solar water heaters. The type of solar water heater installed in a household depends on a number of factors such as area, house type and number of residents. The solar water heaters installed under this PoA are typically between 100 and 300 litre geysers with a collector area of between 1.5 and 4 m^2. The heating capacity of these units is between 10 and 25 MJ. Some units may have a back-up electric element of between 2 and 3 kW. Please see technical specifications of the units shortlisted on the installer list by the CME.

Heat pumps

A heat pump works in the same manner as an air conditioner but in a reverse configuration, that is, instead of removing heat from your home and expelling hot air outside it absorbs heat from the air outside and uses this energy to heat water[45].

[43] U.S Department of Energy. 31/05/2011. Solar Water Heaters. Available online from http://www.eere.energy.gov/basics/buildings/water_heaters_solar.html. [Accessed 26 July 2011].
[44] United States of America Department of Energy. March 1996. Solar Water Heating. Available online from http://www.nrel.gov/docs/legosti/fy96/17459.pdf. [Accessed 26 March 2012]

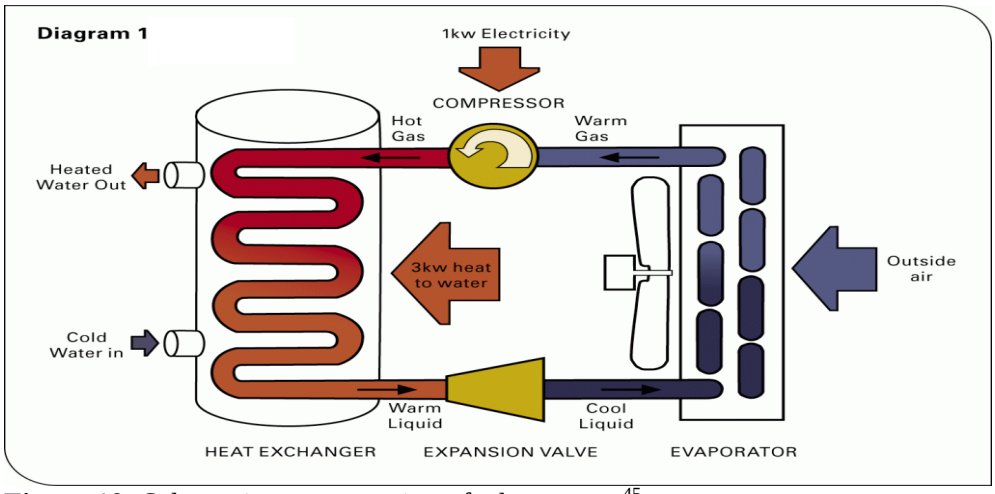

Figure 10: Schematic representation of a heat pump[45]

A heat pump is an electrically-driven device that extracts heat from one area (outside air) and transfers it to another (water) to heat water[45]. The working fluid or refrigerant is pressurized and circulated through the system by a compressor[45]. The low temperature and low pressure refrigerant evaporates when passing the expansion valve and extracts energy from the outside air into the refrigerant[45]. The refrigerant is sent to the compressor once it has extracted energy from the outside air[45]. The refrigerant is compressed into the liquid phase and circulated to the condenser (heat exchanger) [45]. The liquid refrigerant ejects the energy into the water[45]. The refrigerant then returns to the expansion values and the cycle continues[45]. The heat pump heats water to temperatures in the region of 60^{o}C[45].

The heat pump is not reliant on sunshine or direct radiation but can extract thermal energy from the surrounding air any time of the day or night[45].

There are two types of heat pumps manufactured for heating water:

- The integrated heat pump geyser, where the heat pump is integrated with the storage cylinder. [45]

- The separate heat pump geyser or split heat pump geyser, where the heat pump is separate from the storage cylinder and joined by a pipe taking the hot refrigerant to the heat exchanger in the storage tank and another pipe returning the cooled refrigerant through the expansion valve to the evaporator on the outside[45].

In its case the heat pump in its entirety is located on the outside of the building, either at the northern, sunny side of the building or on top of the roof (like in the case of mass volumes of hot water needed in big buildings) [45].

[45] Heat Pumps South Africa. Available online from http://www.heatpumpssouthafrica.co.za/. [Accessed 26 March 2012]

Figure 11: Heat pump[46]

A heat pump uses less electricity than a conventional electric geyser[47]. The electricity it uses goes into driving the fan at the evaporator and driving the compressor[47]. These components use only 1 kW, but the system produces 3 kW of energy[47]. A conventional electric geyser uses 3 kW to produce 3 kW of energy[47]. The electric element of the conventional electric geyser is replaced with the heat exchanger of the heat pump[47]. The typical heat pumps installed under this PoA range from 100 to 300 litres and have an input power of starting from 0.82 kW to produce a heating capacity of 3.6 upwards. Please see technical specifications of the units shortlisted on the installer list by the CME.

Under this PoA, heat pumps can be installed in middle and high income households and community residential units. The heat pumps replace the electric element used for water heating. Heat pumps will only be installed in grid-connected households.

All solar water heaters and heat pumps installed must comply with the applicable SABS (South African Bureau of Standards (SABS) standards. The relevant specifications for heat pumps are SANS 151-2002 (only applicable to systems with electric back-ups), SANS 181:2004 and SANS 514:2007. The relevant specifications for solar water heaters are SANS 6211-1:2003, SANS 151-2002, SANS 6210:1992 and SANS 60335-2-21:2000 (some are only applicable to active solar water heaters). The numbers allocated to these specifications may change if revised by SABS.

We have provided a preliminary list of pre-approved installers and technologies below. This list is subject to change.

Middle and high income households: Some of the installers that have been selected and are on the database for middle and high income households are KZN Solar, Renu Solar and Solar PriMeg. This is the current list of pre-approved installers, but it is subject to change. The technologies on offer from some of these installers are listed below:

[46] ITS Heat Pumps and Solar. Domestic heat pump – product manual. Available online from http://www.itssolar.co.za/downloads/heatpump_specifications/ITS%20-%20Domestic%20heat%20pump%20-%20product%20manual.pdf. [Accessed 26 March 2012].

[47] Heat Pumps South Africa. The Pros and Cons of Heat Pumps. Available online from http://www.heatpumpssouthafrica.co.za/the-pros-and-cons-of-heat-pumps/. [Accessed 26 March 2012].

KZN Solar offers the following products:

- Direct and indirect systems:

Table 1: Key parameter of the direct and indirect solar water heating systems supplied by KZN Solar

Capacity (Litres)	Absorbing area with vacuum tubes (m^2)	Aperture area for flat plate (m^2)
150	1.6	2
200	1.9	2.4
250	2.2	4

- Closed coupled direct systems:

Table 2: Key parameter of the closed couple direct solar water heating systems supplied by KZN Solar

Capacity (Litres)	Absorbing area with vacuum tubes (m^2)
150	1.6
200	1.9

Renu Solar offers the following products:

- High pressure split pumped systems:

Table 3: Key parameter of the high pressure split pumped solar water heating systems supplied by Renu Solar

Capacity (Litres)	Absorbing area with vacuum tubes (m^2)
150	2.641
200	3.31
250	3.31
300	3.979

- High pressure integrated systems:

Table 4: Key parameter of the high pressure integrated solar water heating systems supplied by Renu Solar

Capacity (Litres)	Absorbing area with vacuum tubes (m^2)
200	3.11
240	3.74

- Heat pumps:

Table 5: Key parameter of the heat pumps supplied by Renu Solar

Heating capacity (kW)	Water heater size (litres)	Rated power input (kW)
3.6	150, 200, 250	0.85

- Split thermosyphon systems:

Table 6: Key parameter of the spilt thermosyphon solar water heating systems supplied by Renu Solar

Capacity (Litres)	Absorbing area with vacuum tubes (m^2)
150	1.986
200	1.986
250	2.641
300	3.31

- Low income households: The installers that have been pre-selected for installations in low income households consist of the national database of installers that Eskom has approved for the installation of low pressure solar water heaters. Please see Eskom Integrated Demand Management website for more information (http://www.eskomidm.co.za/). Note that this is subject to change. Some of the pre-approved installers are KZN solar, Apollo Technology, Solar World and MGA Trading. These installers all offer low pressure solar water heating systems. For example, KZN Solar offers a low pressure solar water heater (110 litres, 1.2 m^2 aperture area).

- Community residential units: There are no pre-selected installers for community residential units. The CME will go out to tender for installers and select the installer for each community residential unit identified under each CPA.

More information can be found on the websites of the installers.

A.7. Public funding of PoA

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The proposed PoA will not receive any public funds in the operation resulting from official development assistance from Parties included in Annex I to the Convention.

SECTION B. Demonstration of additionality and development of eligibility criteria

B.1. Demonstration of additionality for PoA

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The proposed PoA is a voluntary coordinated action

The PoA is a voluntary programme implemented and coordinated by the eThekwini Municipality. The objective of the PoA is to reduce greenhouse gas emissions through the roll out of energy efficiency water heating technologies in South Africa which displace the consumption of grid electricity. The technologies included in this PoA are solar water heating systems and heat pumps.

If the PoA is implementing a voluntary coordinated action, it would not be implemented in the absence of the PoA

The '*Standard for the demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities (Version 01.0, EB 65, Annex 3)*' was used to determine additionality for the PoA.

The demonstration that the programme would not be implemented in the absence of the PoA follows paragraph 28 of the '*Simplified Modalities and Procedures for Small-Scale Clean Development Mechanism Project Activities*.' The Simplified Modalities and Procedures require project proponents to

demonstrate that the project activity would otherwise not be implemented due to the existence of one or more of the barriers listed in Attachment A to Appendix B of the Simplified Modalities and Procedures.

We have used non-binding best practice examples to demonstrate additionality for small scale project activities (EB35, Annex 34).

Access-to-Finance Barrier

According to the Energy Research Group of the University of Cape Town, one of the main barriers to alternative methods of heating water (other than using electricity) is the high upfront capital cost and the absence of affordable financing schemes[48].

High upfront capital costs create a significant barrier to the installation of solar water heaters and heat pumps. The cost of a solar water heater is between R12,000 and R35,000[49] and the cost of a heat pump is R15,000[49]. The capital cost outlay is high (significantly higher than the cost of a conventional electric geyser at between R3,000 and R6,000)[50].

In 2007, the South African Government launched a rebate programme for the installation of solar water heaters[51]. Homeowners installing solar water heaters could access a rebate/subsidy for the installation of solar water heaters in their homes by applying for the rebate from Eskom. A similar subsidy has been launched for heat pumps in February 2011[52]. Under the rebate programme (also called the Eskom Demand Side Management (DSM) Programme), the household pays for the installation of the unit and claims the rebate back from Eskom.

The cost of a solar water heater is between R15,000 and R35,000[50] and it is possible to get a rebate of about R3,000 on the system (25% of the cost of the installation of a solar water heater)[53]. The cost of a heat pump is R15,000 and the value of the rebate from Eskom is between R3,668 and R4,320 depending on the size[49]. Even with the rebates, the capital cost outlay remains high. In addition, there are other costs not considered in the capital cost such as the cost of installation, maintenance and monitoring. The Eskom subsidies are not sufficient to cover all the costs associated with the installation, maintenance and monitoring of solar water heaters and heat pumps over a ten year period. Hence, the payback period for solar water heaters and heat pumps may be relatively short (around five years)[54], this does not include the

[48] Energy Research Centre. University of Cape Town. South Africa. October 2006. Renewable Energy Technologies for Poverty Alleviation. Available online from http://www.erc.uct.ac.za/Research/publications/06Visagie-Prasad%20RET.pdf. [Accessed 26 March 2012]

[49] Eskom Integrated Demand Management. The Heat of the Moment. Available online from http://www.eskomidm.co.za/docs/2011_12_09_Residential_heat_pump_rebate_programme_brochure_FINAL.PDF . [Accessed 26 March 2012]

[50] Energy Research Centre. University of Cape Town. South Africa. June 2010. Assessing the effectiveness of national solar and wind energy policies in South Africa. Available online from http://www.erc.uct.ac.za/Research/publications/10Edkinesetal-Solar_and_wind_policies.pdf. [Accessed 26 March 2012]

[51] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

[52] Eskom Integrated Demand Management., Heat Pumps. Available online from http://www.eskomidm.co.za/heat-pumps. [Accessed 26 March 2012]. Go to heat pumps and then to heat pumps presentation to find the information.

[53] Simply Green. 8 July 2009. Eskom's Solar Water Heating Rebate. Available online from http://www.simplygreen.co.za/local-stories/biz-and-community/eskoms-solar-water-geyser-rebate.html. [Accessed 26 March 2012].

[54] Eskom Integrated Demand Management. Residential Technologies. Available online from http://www.eskomidm.co.za/residential. Go to technologies and then to how the rebate is calculated in order to find the information. [Accessed 26 March 2012].

installation, maintenance and monitoring of the installed units and the high capital outlay upfront is a barrier for the installation of these units. The subsidy for solar water heaters also only reduces the capital cost and installation by 20 to 30% for middle and high income households. This leads to an even longer payback period (in excess of 6 years)[55].

For low income households, Eskom will install solar water heaters for free in collaboration with the local municipalities[56]. The solar water heaters are paid for by funds allocated by the Department of Energy[56]. A low income area is selected and notified that they will be receiving a free solar water heater for every household in the area[56]. Eskom partners with the municipality to assist in the operational and technical matters related to the roll outs[56]. The Low Pressure Solar Water Heater Roll-out does not cover the maintenance and monitoring of the solar water heaters once installed. The revenue from the carbon credits will be used to cover the maintenance and monitoring of the solar water heaters for ten years. A ten-year maintenance programme will be implemented using the revenue from the carbon credits to ensure that the solar water heaters continue to operate and save energy.

Despite the Eskom rebate, the number of solar water heaters and heat pumps installed is low in comparison to the target set by Government. South Africa is lagging behind other developing countries in terms of the installation of solar water heaters[57]. To date, the growth in the solar water heating market is still relatively stunted[58]. By 31 December 2010, 30,974 solar water heaters had been installed under the Eskom programme since its advent in November 2008[59]. According to the Department of Energy, despite the special solar water heating initiatives such as the Eskom rebate programme, the existing national solar water heating trade installs about 15,000 to 20,000 solar water heaters a year[57]. Compared to a national target of the installation of one million solar water heaters over the next five years (by 23 June 2014)[59], the progress made thus far is not sufficient. The number of heat pumps installed in South Africa is also relatively low The Eskom 2012 Divisonal Report states a heat pump installation of only 1 MW up to March 2013[60]. The target of the residential rebate heat pump rollout under the Integrated Demand Management is 54 MW or a minimum of 65,585 units[61]. There are over 12 million households in South Africa so there is a need for significant scale-up in the roll out of solar water heaters and heat pumps[57].

The PoA will reduce the costs of the units by offering a discount (in addition to the Eskom rebate) for middle and high income households. The PoA will offer units for free to low income households (the capital cost of the unit is covered by the Eskom rebate). A ten year maintenance and monitoring programme will be set up for the units installed. The PoA will offer units for free to community

[55] North West University. October 2010. An Investigation into the Energy Savings and Economic Viability of Heat Pump Water Heaters Applied in the Residential Sector – A Comparison with Solar Water Heating Systems. Available online from http://solartech-sa.co.za/heatpump_vs_solar.pdf [Accessed 26 March 2012].

[56] Eskom. Low Pressure Solar Water Heater Roll-Out. Available online from http://www.eskomidm.co.za/docs/Eskom_dsm_website_content_lowpressure_solar_roll_outs_final.pdf. [Accessed 26 March 2012]

[57] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[58] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

[59] South African Department of Energy. Solar Water Heating. Available online from http://www.energy.gov.za/files/swh_frame.html. [Accessed 26 March 2012].

[60] Eskom, Eskom 2012 Division Report, p33 Available online from: http://www.pads.eezeepage.co.za/i/69757 [Accessed 04 October 2012]

[61] Eskom, 'Residential Heat Pump Rebate Programme, Information Session, 18 February 2011' Slide 13. Available online from http://www.eskomidm.co.za/docs/heat_pump_presentation.pdf [Accessed 04 October 2012]

residential units. The capital cost of the units installed in community residential units is not covered by Eskom and the CPA implementer will need to finance the capital cost and the cost of the maintenance programme using the revenue from the carbon credits.

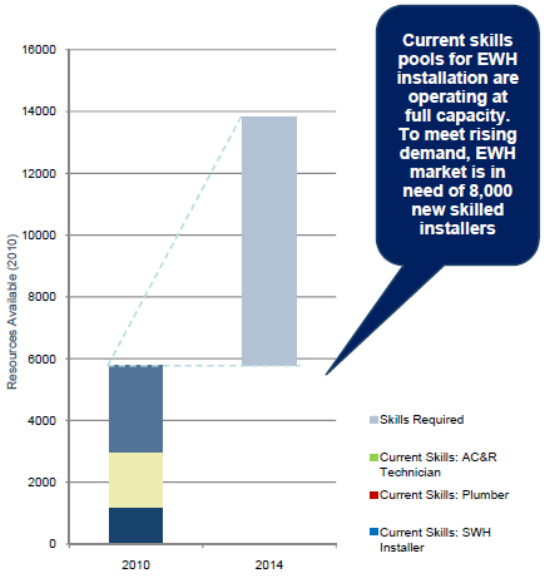
Technology Barrier

- *Non-availability of human capacity to operate and maintain the technology*

  There is a skills shortage in the installation, maintenance and monitoring of the technology. According to a report on the national solar water heating conference held in November 2009, the following barriers exist in the solar water heating market[62]:

  - A lack of researchers, trained installers and maintenance personnel[62];
  - A lack of skills and test equipment at the SABS. This has led to backlogs at the facility due mainly to difficulties in retaining skilled staff[62];
  - Isolated and limited local manufacturing[62];
  - The need for a well-structured, organized and effective solar water heating industry association[62]; and
  - The lack of a reliable and low-cost solar water heating unit for low income households[62].

  According to Frost & Sullivan, research indicates that there is a lack of installation skills need to handle the growth in the market required in order to reach the national target[63]. Solar water heaters can be four times as labour-intensive than conventional electric geysers[63]. Unique skills are needed for solar water heaters and more capacity must be developed to achieve the roll out of solar water heaters[63]. The graph below indicates the need for the development of more skills in the market to meet new demand[63]. The solar water heating market needs 8,000 new skilled workers[63].



[62] South African Department of Energy. November 2009. National Solar Water Heating Conference. Available online from http://www.dbsa.org/Confr/DBSA%20COP%2017%20Related%20Documents/Solar%20Water%20Heating%20Conference.pdf.[Accessed 26 March 2012]

[63] Frost and Sullivan. 28 July 2011. The South African Solar Water Heater Industry. Available online from http://www.reafrica.co.za/Images/Presentations%20Day%202/Dominic%20Goncalves.pdf. [Accessed 26 March 2012]

Figure 12: The lack of skills to handle growth in the market[63]

The PoA will lead to training of installation and maintenance teams to undertake these activities for the systems installed under this PoA.

Barrier due to Prevailing Practice

The use of electric geysers and electric appliances is common practice in South Africa[64]. This is demonstrated by the lack of penetration of solar water heaters and heat pumps in the South African market. There are over 12 million households in South Africa[65]. By 31 December 2010, 30,974 solar water heaters had been installed under the Eskom programme since its advent in November 2008[66]. Since the introduction of the rebate for heat pumps in February 2011, only 200 heat pumps have been installed.

The prevailing practice is to make use of electric geyser and electric appliances[65]. According to the Department of Energy, the total number of installed electric geysers in 2008 was 4.522 million[65]. The total number of households using electric geysers and electric stoves was 9,847 million (88% of the total number of households in South Africa)[65].

From these statistics, it can be concluded that the use of electricity for water heating is prevailing practice in South Africa. The lack of penetration of alternative water heating technologies in the market can be attributed to a lack of awareness of alternative water heating methods.

Demonstration of Additionality for Microscale CPAs

For CPAs with an installed capacity in solar water heaters of less than 5 MW and energy savings of less than 20 GWh per year from heat pumps, guidelines for demonstrating additionality are available. In the case of these microscale projects, additionality should be demonstrated using the '*Guidelines for demonstrating additionality of microscale project activities*' (Version 04, EB68, Annex 26).

The guidelines state that for project activities up to 5 MW that employ renewable energy as their primary technology are additional if one of the following conditions is satisfied:

- The geographic location of the project activity is in one of the Least Developed Countries or the Small Island Countries (LDCs/SIDs) or in a special underdeveloped zone of the host country. See '*Guidelines for demonstrating additionality of microscale project activities*' (Version 04, EB68, Annex 26) for more detail;

- The project activity is an off grid activity supplying energy to households/communities (less than 12 hours grid availability per 24 hours day is also considered as off grid for this assessment);

[64] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[65] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[66] South African Department of Energy. Solar Water Heating. Available online from http://www.energy.gov.za/files/swh_frame.html. [Accessed 26 March 2012].

- The project activity is designed for distributed energy generation (not connected to a national or regional grid) with both conditions below satisfied:
    - Each of the independent subsystems/measures in the project activity is smaller than or equal to 1500 kW electrical installed capacity;
    - End users of the subsystems or measures are households/communities/SMEs.

- The project activity employs specific renewable energy technologies/measures recommended by the host country DNA and approved by the Board to be additional in the host country (conditions apply: the total installed capacity of the technology/measure contributes less than or equal to 5% to the national annual electricity generation).

The above is applicable to solar water heaters.

Energy efficiency project activities that aim to achieve energy savings at a scale of no more than 20 GWh per year are additional if any one of the conditions below is satisfied:

- The geographic location of the project activity is in LDCs/SIDs or special underdeveloped zones of the host country as identified by the Government. See '*Guidelines for demonstrating additionality of microscale project activities*' (Version 04, EB68, Annex 26) for more detail;

- The project activity is an energy efficiency project with both the conditions below satisfied:
    - Each of the independent subsystems/measures in the project activity achieves an estimated annual energy savings of equal to or smaller than 600 MWh; and
    - End users of the subsystems or measures are households/communities/SMEs.

The above is applicable to heat pumps.

If the PoA is implementing a mandatory policy/regulation, this would/is not enforced;

The PoA is not a mandatory policy or regulation and, as such, this is not applicable.

If mandatory a policy/regulation are enforced, the PoA will lead to a greater level of enforcement of the existing mandatory policy/regulation.

The PoA is not a mandatory policy or regulation and, as such, this is not applicable.

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

>>

The '*Standard for the demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities (Version 01.0, EB 65, Annex 3)*' was used to define the eligibility criteria for this PoA.

All installations of solar water heating systems and heat pumps must comply with the following:

Table 7: The eligibility criteria of the PoA

No.	Requirement as per standard	Eligibility criteria
1	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA	All installations shall take place in residential buildings connected to the grid within the geographical boundaries of South Africa. The CME will check that this eligibility criterion is met by

		ensuring that all the installations have completed and submitted the Eskom rebate forms. The CME will check the rebate forms. The Eskom rebates are only available to grid-connected households. The rebate forms contain the address of the installed unit so that the CME can check that the unit is installed in South Africa. The CME will perform these checks on a monthly basis for all new installations to ensure that this eligibility criterion is met. The CME will also check that the units are installed in residential households. The installer will confirm this on installation. In addition, this will be checked during the inspection within three months of installation.
2	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo);	solar water heaters and heat pumps installed under the PoA must be uniquely identified by a serial or barcode number that is recorded on installation of the unit. The address and date of each solar water heating and heat pump installation must be recorded on installation of the unit. This information must be captured on the Eskom rebate form. All the relevant details from the form must be recorded in the CME's electronic database. The CME will check the serial or barcode number of the units and the addresses and dates of installation recorded on the Eskom rebate forms. These details will be compared with all the units installed thus far under this CPA and other CPAs in the PoA to ensure no double counting. This check will be conducted on a monthly basis by the CME for all new units installed.
3	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	All solar water heating systems and heat pumps installed under this PoA must adhere to applicable SABS standards. The CME will check that the installers are pre-approved. This will mean that they have received an SABS certificate for their technology. All units installed under this PoA must be done by an installer that has been pre-approved for the PoA by the CME. The CME will check that the installer is on the CME pre-approved installer database. All solar water heaters and heat pumps installed under the PoA must be new equipment. The installer must be able to provide purchase records from the supplier on request from the CME to indicate that the solar water heater and/or heat pump is new. All technical specifications of the unit must be available in manufacturer's specifications and the type of unit installed must be recorded upon installation of the unit. The CME will

		record the details of all units supplied by the pre-approved installers in their database. Manufacturer's specifications of all units provided under this PoA will be kept by the CME. The CME will check that the CPA implementer has used one of the pre-approved installers. The type of unit installed will be recorded on installation on the Eskom rebate form and in the CME's database. All relevant technical specifications of the existing water heating device must be recorded such as type of fuel used, type of unit used and size of geyser. This information (particularly the size of the geyser) will be used to inform the sizing calculations of the unit. These sizing calculations must be recorded by the supplier/installer and submitted to the CME to be recorded in the electronic database.
4	Conditions to check the start date of the CPA through documentary evidence	The start date of the CPA is the date on which the order for the first unit is placed under the CPA. This is captured by the supplier and recorded in the CME's electronic database. The CME will check the date of the first order placed and this will be the start date of the CPA. The CME will also check that this date is not prior to the date of publication of the PoA for global stakeholder consultation.
5	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs	Each CPA must meet the applicability criteria of the applicable methodologies. The applicable methodology for solar water heaters is Approved methodology small-scale (AMS) I.J '*Solar water heating systems (SWH)*' Version 01, EB 60. The applicable methodology for heat pumps is Approved methodology small-scale (AMS) II.C '*Demand-side energy efficiency activities for specific technologies*' Version 13, EB 48. Note that new CPAs must comply with the latest version of the methodologies as per EB 65, Annex 3. The eligibility criteria will be updated when new versions of the methodologies become available. The updated PoA-DD and generic CPA-DD will be submitted to the DOE who will submit it to the Board for approval. The new CPA will need to follow the PoA-DD and generic CPA-DD with the updated methodologies. The CME will check the CPA-DD drafted by the CPA implementer to ensure that the applicability criteria of the methodologies are complied with by the design of the CPA.
6	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality as specified in Section A above	Each CPA must demonstrate additionality in accordance with the procedure as set out under this PoA. The additionality demonstration is checked by the CME and the selected DOE.
7	The PoA-specific requirements	Local stakeholder consultation must be completed by the CPA

	stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	implementer in accordance with the procedures as set out under this PoA. Environmental impact analysis is done at PoA level. The CPA implementer is not required to do an environmental impact assessment. Please see Section E of the PoA for more details. The CME will check the environmental impact analysis and ensure it is in line with the legislation of the host country.
8	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance	The CPA implementer must provide the CME with a signed declaration that no official development assistance has been used or will be sourced for the project. . In the cases when the CPA implementer is the CME then a signed declaration is not required as the CME will know whether the CPA implementer has used or plans on using official development assistance.
9	Where applicable, target group (e.g. domestic/commercial/industrial, rural/urban, grid-connected/ off-grid) and distribution mechanisms (e.g. direct installation)	The target group is domestic water heating. This is confirmed by the supplier upon the installation. The CME will also check the CPA-DD to ensure that the CPA is designed to install solar water heaters and heat pumps in residential units.
10	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys	Each CPA implementer must apply the monitoring plan and the sampling requirements as set out in this PoA. The CPA implementer must produce monthly monitoring reports for the CME which will be checked by the CME.
11	Where applicable, the conditions that ensure that every CPA in aggregate meets the small-scale or microscale threshold criteria and remains within those thresholds throughout the crediting period of the CPA;	The aggregate savings by a single CPA may not exceed 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 heat pumps and solar water heaters and the collector area of the solar water heaters installed. The CPA implementer will be responsible for submitting a monthly report which includes a summary of the collector area installed in the month and the aggregate collector area installed since the start of the CPA. The report must also contain the saving in the month from the heat pumps installed and the aggregate savings for the heat pumps installed since the start of the CPA. The CME will check the monthly reports to ensure that the installations remain below the thresholds.

12	Where applicable, the requirements for the debundling check, in case CPAs belong to small-scale (SSC) or microscale project categories.	Each unit included in the CPA must not be larger than 1% of the small-scale thresholds defined by the methodology applied. This means that each solar water heater must not have a collector area of greater than 640 m^2 and each heat pump must not have an annual saving of more than 600 MWh per year. See Section C of the PoA for more detail. A check will be done for each technology offered by a new or existing installer included in the pre-selected installers by the CME. The installers cannot offer technologies that will exceed 1% of the threshold under the PoA.
13	Rights to the carbon credits	The owner of the solar water heater or heat pump must cede their rights to the carbon credits. This is done through ensuring that the agreement between the CPA implementer and the resident of the household is signed prior to installation of the unit. In some cases, an agreement can be signed between the installer and the household and the installer and the CPA implementer to cede rights to the carbon credits.
14	For solar water heating installations, the model-based approach is used. The model must be calibrated as per the requirements in the monitoring plan of the PoA.	The measurements and calibration results are recorded in the database maintained by the CME.
15	Operational lifetime of the CPA must not exceed 10 years	The CME will check the CPA-DD to ensure that the operational lifetime of the CPA-DD does not exceed 10 years. The CME will ensure that certified emission reductions are only claimed for 10 years for each CPA.
16	Starting date of the crediting period of the CPA is the date on which it is included in the registered PoA	The CME will check that the starting date of the crediting period of the CPA is the date on which it is included in the PoA as per eligibility criterion 21. The CME will ensure that the CPA does not generate any certified emission reductions prior to this date.
17	Each household or Community Residential Unit is only allowed one type of installation (either a solar water heater or a heat pump).	The CME will check the address of each installation and crosscheck the address of every new installation with existing installations to ensure that only one unit has been installed in the household. The installer will also check that only one unit is installed. This will be checked again within three months of installation at the inspection.
18	Each CPA must ensure that leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined.	The CME will check the CPA-DD to ensure that leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined and are in line with the PoA-DD and the requirements of the methodologies.

19	Heat pumps must replace existing equipment and cannot be installed at new sites	The heat pumps cannot be installed at new sites. The installer will check the baseline water heating method and this will be recorded in the CME's electronic database. Provided there is a baseline water heating method and the heat pump replaces the existing water heating method then it cannot be considered a new site.
20	Solar water heaters and heat pumps can only be installed in existing community residential units and middle and high income households. They cannot be installed in new builds.	The CME will ensure that the units are installed in existing community residential units and middle and high income households. The installer will check the baseline water heating method and this will be recorded in the CME's electronic database. Provided there is a baseline water heating method, the community residential unit and middle and high income households cannot be considered new build.
21	Each SSC-CPA must be approved by the CME and DOE prior to its incorporation into the PoA.	The CME and DOE must approve the inclusion of the CPA into the PoA prior to it being incorporated into the PoA and being allowed to generate certified emission reductions. The CME and the DOE will both provide approval for inclusion in written form.

In addition, in order to participate in this programme, it is not possible to install both a solar water heater and a heat pump at the same household. Each household or Community Residential Unit is only allowed one type of installation (either a solar water heater or a heat pump).

Each CPA must ensure that leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined.

Each SSC-CPA must be approved by the CME and DOE prior to its incorporation into the PoA.

B.3. Application of methodologies

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The following methodologies are used for this PoA:

- Solar water heating: Approved methodology small-scale (AMS) I.J '*Solar water heating systems (SWH)*' Version 01, EB 60

- Heat pumps: Approved methodology small-scale (AMS) II.C '*Demand-side energy efficiency activities for specific technologies*' Version 13 EB 48

The versions of the methodologies will be updated with the eligibility criteria of the PoA when new versions of the methodologies become available.

Since two methodologies are applied in the same PoA, the '*Standard for the demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities (Version 01.0, EB 65, Annex 3)*' was applied. The standard is applicable to CMEs seeking to apply multiple technologies or approved methodologies. A combination of methodologies can be applied if the following can be demonstrated:

1. There is no cross effect between technologies installed; and

2. The policy or goal of the PoA can only be reached through the use of multiple methodologies.

In terms of this PoA, each residential building or household can only have one of the technologies implemented. No household or community residential unit can have both a solar water heater and a heat pump installed. Only one technology may be installed per household or residential unit. This is an eligibility criterion for the inclusion of a CPA in the PoA. This eliminates any potential for cross effects or over-estimation of emission reductions.

The objective of this PoA is to improve energy efficiency in domestic water heating. This can only be achieved through the installation of heat pumps or solar water heaters in existing residential buildings and new low income households. To exclude one of the two technologies would mean that the PoA would not achieve this objective. The selection of technology for the household is dependent on the suitability of the technology for the household. The standard specifically mentions combinations of categories such as energy generation and energy efficiency. This PoA is focused on the category of water heating and each CPA will make use of both of the specified methodologies.

The sampling plan is described in detail in the monitoring section. Please see this section for a description of how sampling will be conducted. Sampling will be conducted for each CPA.

SECTION C. Management system

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The operational and management arrangements established by the CME for the implementation of the PoA include the following components:

A clear definition of roles and responsibilities of personnel involved in the process of inclusion of CPAs, including a review of their competencies

The process of inclusion will involve the responsible person from the CME, the CPA implementer and the DOE. The responsible person from the CME will be responsible for assessing the CPA against the eligibility criteria and providing feedback to the CPA implementer. The CPA implementer will be responsible for ensuring that the CPA complies with the eligibility criteria of the PoA. Once the responsible person from the CME is satisfied that the CPA meets the eligibility criteria then the CPA is assessed by the DOE to ensure that it meets the eligibility criteria prior to inclusion in the PoA.

The responsible person from the CME can either be someone employed by the CME or an independent contractor to the CME. This person should have at least two years' experience in the CDM and must understand the technical requirements of the CDM and this project. The responsible person must train the other personnel involved in the project in the requirements of the PoA and the CDM.

Personnel used in the monitoring process will need to be trained by the CME in the requirements of the PoA and the CDM. However, these personnel must have at least one years' experience in the operation and monitoring of solar water heaters.

The CPA implementer will be trained by the CME in the requirements of the PoA and will be given the forms that need to be completed.

Records of arrangements for training and capacity development for personnel

The responsible person of the CME is responsible for training and capacity development of all personnel involved in the PoA. The responsible person must keep a record of all training conducted.

All personnel involved in the project will need to be trained on the PoA by the responsible person of the CME. This training will take them through the monitoring requirements and the eligibility criteria.

Owing to the number of roles and responsibilities, training is important. The CME will be responsible for training the CPA implementer on the rules and requirements of the PoA. The CME will also be responsible for training the installers on what is required in terms of the PoA. The CPA implementer is responsible for ensuring that the installers are performing properly by checking the documentation submitted by the installer (Eskom rebate form, installation form and manufacturer's specifications) and checking the unit three months after installation.

In order to train the CPA implementer and the installer, the CME will provide the relevant parties with the PoA that sets out the rules and requirements and with all the required forms. The CME will also have a training workshop when new CPAs are added onto the programme in order to train the CPA implementer.

Procedures for technical review of inclusion of CPAs

The CPA implementer is responsible for preparing the CPA-DD and submitting it to the responsible person from the CDM. The CPA-DD must describe how the CPA meets the eligibility criteria of the PoA. The CPA implementer must provide the CME with the supporting documentation required in order to demonstrate adherence to the eligibility criteria of the PoA.

The responsible person of the CME must assess the CPA-DD and the CPA itself against the eligibility criteria of the PoA. If there are any gaps or issues then the responsible person must contact the CPA implementer and the CPA implementer must resolve any outstanding issues.

Once the CME has signed off on the CPA to say that it meets the criteria of the PoA then it is sent to the DOE along with all supporting documentation. The DOE checks that the CPA meets the eligibility criteria of the PoA before deciding that it can be included in the PoA.

Measures for continuous improvements of the PoA management system

The CME will develop a handbook for the management of the PoA. The handbook sets out the responsibilities of the CME and the CPA implementer. The handbook is a summary of the best practice for management of the PoA. The CME will use the guidelines in the handbook to manage the first CPA. Through the management of the first CPA, the CME may identify challenges in the management system or improved methods for managing CPAs. These improved methods will be incorporated into the handbook. The handbook will at least be updated annually to capture best practice and improvements in the management system.

Roles and Responsibilities

The CME and the CPA implementer have a number of roles and responsibilities under the PoA. The roles and responsibilities are described below. The CME has the following responsibilities:

- The CME is responsible for communication with the DOE and the CDM EB or UNFCCC.

- The CME is responsible for selecting and approving which CPAs are allowed to be included in the PoA. The CME checks the CPA against the eligibility criteria of the PoA.

- The CME is responsible for pre-selecting/pre-approving installers. The CME has control over what installers are used in the CPA in order to ensure quality of installation. The CME pre-

approves installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards.

- For community residential units, the CME has control over what installers are used in the CPA in order to ensure quality of installation. The CPA implementer selects the CRU where it will manage the installation of solar water heaters. The CME goes out to tender for installers for the selected CRU. The CME appoints installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards.

- The CME is responsible for managing and maintaining a central electronic database to record information for each installation. The CPA implementer provides the CME with the required information.

- The CME is responsible for updating the calculation of the grid emission factor.

- The CME is responsible for checking that the unit/household is not included in another CPA of the same PoA or a different PoA. The CME is also responsible for checking that the CPA is not included in another PoA.

- The CME can also conduct periodic checks (at least annually) of each CPA to ensure that monitoring is being conducted correctly and that the rules and requirements of the PoA are being adhered to in the CPA.

The CPA implementer has the following responsibilities:

- For low income households, the CPA implementer selects an installer from the list of installers approved by the CME. The CPA implementer also selects the low income area where it will manage the installation of solar water heaters and ensure that the units are correctly installed. The CPA implementer is also responsible for maintaining the units for ten years after the installation. In order to do this maintenance, the CPA implementer needs to have a maintenance programme in place.

- For community residential units, the CPA implementer selects the CRU where it will manage the installation of solar water heaters and/or heat pumps.

  For middle and high income households, the CPA implementer will contact a number of credible installers which have reliable technology. The CPA implementer also provides the household with a discount for the units installed. The CPA implementer uses the revenue from the carbon credits to manage (managing a database of interested households, matching them with installers and monitoring installation of the units) and promote the project and to get more middle and upper income households to express an interest in having a unit installed ensuring awareness creation.

- There is an agreement between the household and the CPA implementer regarding carbon credit ownership. The household cedes rights to the carbon credits to the CPA implementer.

- The CPA implementer provides the CME with the required information for each installation. Some of this information has been captured by the installers (Eskom rebate form, installation form and manufacturer's specifications). Some of this information is captured by the CPA implementer (installation inspection form and monitoring form). The CPA implementer compiles the documentation and gives them to the CME to be recorded in the electronic database. The

following documents are required for each installation: Eskom rebate form, manufacturer's specifications of the unit. Installation inspection form and monitoring form.

- The CPA implementer or a representative of the CPA implementer will physically inspect each installation within three months of installation to ensure quality of installation and will only include units that have been correctly installed under the CPA.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the solar water heater. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- The CPA implementer is responsible for monitoring the operation of a selected sample of solar water heaters and heat pumps to ensure operation.

- The CPA implementer is responsible for calibrating the model as per the requirement of the PoA.

- The CPA implementer is responsible for monitoring the amount of refrigerants used and the operating hours of the heat pumps as per the requirements of the PoA.

- The CPA implementer must produce a monthly monitoring report for the CME on the progress with the CPA and all relevant monitoring details as specified under this PoA.

The installers also have a number of functions to perform such as capturing all information correctly on installation.

A record keeping and document control system for each CPA under the PoA

A central electronic database has been set up by the CME which includes the following information for each solar water heater and each heat pump installed:

Table 7: The information that is captured in the electronic database

No.	**Parameter Description**	**Source of Data**		
		Heat pumps	**Solar water heaters**	
		Middle and high income households and community residential units	**Middle and high income households and community residential units**	**Low income households**
1	Name of owner (title, first name, surname)	Eskom rebate form	Eskom rebate form	Eskom rebate form
2	Contact details (email address, cell phone number, landline)	Eskom rebate form	Eskom rebate form	Eskom rebate form
3	Type of home	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form
4	Location of installation (street number, street name, suburb, complex, unit	Database – provided by the	Database – provided by the	Database – provided by the

	number or GPS co-ordinates)	selected installer on installation form	selected installer on installation form	selected installer on installation form
5	Date of installation	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form
6	Details on household if applicable (number of bathrooms, number of people per geyser etc.)	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form
7	Technical details about the existing water heating method	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form
8	Sizing calculation	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form	Database – provided by the selected installer on installation form
9	Technical details in the unit to be installed For solar water heaters: • Type of solar water heater (supplier and model) • Collector area • Tank size • Serial or barcode number • Demonstration of adherence to SABS applicable standards. • Confirmation that the unit is new and not transferred from another installation. • Tilt and orientation of the solar water heater upon installation. • Confirmation that there is no shading of the solar water heater upon installation. For heat pumps: • Type of heat pump (supplier and model) • The rated water temperature • Heating capacity • Coefficient of Performance	Eskom rebate form and manufacturer's specifications and installation inspection form	Eskom rebate form and manufacturer's specifications and installation inspection form	Eskom rebate form and manufacturer's specifications and installation inspection form

	of the heat pump • Refrigerant type • Refrigerant charge • Rated power input • Serial or barcode number • Demonstration of adherence to SABS applicable standards. • Geyser integral, split , retrofit • Confirmation that the unit is new and not transferred from another installation.			
10	Confirmation that the household has a water and electricity connection	Eskom rebate form	Eskom rebate form	Eskom rebate form
11	Name of installer and installer details	Eskom rebate form	Eskom rebate form	Eskom rebate form
12	Serial or barcode number of unit(s) installed and unique CPA number	Database – serial or barcode number is provided by the supplier and CPA number is allocated by the CME	Database – serial or barcode number is provided by the supplier and CPA number is allocated by the CME	Database – serial or barcode number is provided by the supplier and CPA number is allocated by the CME
13	Confirmation whether the solar water heater or heat pump is in a residential application	Eskom rebate form – address of household	Eskom rebate form – address of household	Eskom rebate form – address of household
14	Installation inspection form (indicating the results of the inspection that has taken place within three months of the installation)	Installation inspection form	Installation inspection form	Installation inspection form
15	Monitoring information recorded in the monitoring form	Monitoring information will be recorded in the monitoring form. Monitoring consists of checking that the selected sample of units is operational.	Monitoring information will be recorded in the monitoring form. Monitoring consists of checking that the selected sample of units is operational.	Monitoring information will be recorded in the monitoring form. Monitoring consists of checking that the selected sample of units is operational.
16	Measurement	A sample of units will be selected for measurement. The measurements are recorded in the database. Please see sampling and	A sample of units will be selected for measurement. The measurements are recorded in the database. Please see sampling and	A sample of sites is selected for measurement. The measurements are used to calibrate the model. The measurements and calibration is included in the database.

		monitoring plan for more details.	monitoring plan for more details.	Please see sampling and monitoring plan for more details.

All of this information is captured by the installers and submitted to the CPA implementer. The CPA implementer compiles the documentation and gives them to the CME to be recorded in the electronic database. The following documents are required for each installation:

1. Eskom rebate forms
2. Manufacturer's specifications of the unit
3. Installation form
4. Installation inspection form
5. Monitoring form

The CPA implementer or a representative of the CPA implementer will physically inspect each installation within three months of installation to ensure quality of installation and will only include units that have been correctly installed under the CPA. See monitoring plan for more information. Emission reductions can only be claimed from the date of this inspection to account for lag time. Emission reductions cannot be claimed from the date of installation, but only from the date of the inspection which is conducted within three months of installation.

The CPA implementer will physically inspect a sample of units each year to check that the units are operational.

Please also note that the household will be provided with a manual for the unit upon installation. This manual will provide information on the technology and contact details of the supplier and the CPA implementer in case of problems with the unit.

A system/procedure to avoid double accounting e.g. to avoid the case of including a new CPA that has been already registered either as a CDM project activity or as a CPA of another PoA,

In order to avoid double accounting:

- The serial or barcode number of the unit installed is logged in the electronic database. This is a unique number which identifies each unit installed.

- The details of the location of the installation are recorded to ensure that no double accounting takes place.

- Each installation will be provided with a unique CPA identification number. This information must be captured on a form by the supplier. The form must be signed by the representative of the household. All details from the form must be recorded in the CME's electronic database.

- The CPA implementer will physically inspect a sample of installations to ensure that the serial or barcode number on the unit matches what has been recorded in the electronic database.

The SSC-CPA included in the PoA is not a de-bundled component of another CDM programme activity (CPA) or CDM project activity.

The 'Guidelines on Assessment of Debundling for SCC Project Activities' (Version 3.1, EB 54) is used to demonstrate that the SSC-CPA included in the PoA is not a de-bundled component of another CDM Programme Activity (CPA) or CDM project activity. According to the guidelines, if each of the independent subsystems/measures included in the CPA of a PoA is no larger than 1% of the small-scale thresholds defined by the methodology applied then that CPA of PoA is exempted from performing a de-bundling check.

Solar water heaters: According to Appendix B of the Simplified modalities and procedures for small-scale clean development mechanism project, the threshold for solar energy projects is 64,000m^2. 1% of this threshold is equal to 640 m^2. The collector sizes installed under this PoA typically ranges from 1.5 to 4 m^2 (see technology specifications). Hence, none of the units installed will have a collector area of greater than 640 m^2. No debundling check is required.

The threshold for heat pumps is a saving in electrical energy of 60 GWh per year as per AMS II.C. '*Demand-side energy efficiency activities for specific technologies.*' 1% of this threshold is equal to 600 MWh electrical saving. A typical household electric geyser has an electric element with a capacity of 3 to 4 kW[67]. If we assume that water is heated for 24 hours a day and 365 days a year then the baseline electricity consumption would be between 26.28 and 35.04 MWh per year. The baseline is below the threshold. The savings achieved will be less than the baseline. If we assume that a heat pump of 0.85 kW (see technology specifications) and that the heat pump operates all year round then the project electricity consumption would be 7.44 MWh per year. This is a saving of between 18.84 and 27.6 MWh per year. This is below the threshold of 600 MWh per year and, hence, a debundling check is not required.

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

A contract will be signed by the representative of the household where the unit is installed. This agreement ensures that they are aware that they are participating in the CPA. By signing the contract it is accepted that their solar water heater or heat pump is included in a CPA and that the CPA implementer is the legal owner of the CERs from the installed solar water heater or heat pump.

The CME will also be responsible for pre-approving installers for the PoA. In other words, only installations done by approved installers will be allowed under the PoA. Only the CME can pre-approve installers. This ensures that the technologies installed are of a high quality and that credible installers are used to conduct the installations.

SECTION D. Duration of PoA

D.1. Start date of PoA

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The start date is the date of publication of the PoA-DD for global stakeholder consultation which was on 28/06/2012.

D.2. Length of the PoA

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28 years

[67] North West University. October 2010. An Investigation into the Energy Savings and Economic Viability of Heat Pump Water Heaters Applied in the Residential Sector – A Comparison with Solar Water Heating Systems. Available online from http://solartech-sa.co.za/heatpump_vs_solar.pdf [Accessed 26 March 2012].

SECTION E. Environmental impacts

E.1. Level at which environmental analysis is undertaken

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Environmental analysis as per the requirements of the CDM modalities and procedures is undertaken at PoA level as the impacts of all CPAs will be similar. The PoA does not require any environmental approvals. In addition, the PoA is anticipated to have positive environmental impacts. We do not anticipate these impacts to vary for each CPA.

E.2. Analysis of the environmental impacts

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The National Environmental Management Act (NEMA) governs the Environmental Impact Assessment (EIA) process[68]. NEMA came into effect in 2010[68]. There are three listing notices that were published with the NEMA regulations[68]. Depending on the type and scale of the activity, it may be necessary to do a Basic Assessment of EIA[68]. Listing notice one stipulates activities requiring a Basic Assessment. Listing notice two stipulates activities that require an EIA[68]. Listing notice three stipulates activities that require a Basic Assessment only if they are implemented in a specific geographical area[68]. The installation of solar water heaters and heat pumps in households is not a listed activity in any of these three listing notices[68]. Hence, no Basic Assessment or EIA is required for this programme.
More information on the national EIA law and process available at
http://www.eiatoolkit.ewt.org.za/process/what.html

The objective of the PoA is to improve the efficiency of water heating in existing residential units and new low income households. This involves the installation of either a solar water heater or heat pump in low, middle and upper income households and community residential units. There are no significant anticipated negative impacts on the environment or people from this programme.

The PoA displaces coal-based grid electricity by using renewable energy sources and using energy more efficiently. This results in a reduction in greenhouse gas emissions.

There are no anticipated transboundary impacts as a result of this PoA.

SECTION F. Local stakeholder comments

F.1. Solicitation of comments from local stakeholders

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The stakeholder consultation is done at CPA level as each CPA may cover installations in a different area. Conducting stakeholder consultation at CPA level will ensure that the public is adequately informed about the CPA. The programme covers the whole of South Africa. Hence, it is considered more effective to conduct stakeholder consultation at CPA level so that the public is properly informed.

Local stakeholder consultation must be done at SSC-CPA level. Each CPA must have done the following to invite comments from stakeholders:

1. The CPA implementer must draft an article on the CPA and publish in English and the local language in the local newspaper or publication. The article must describe the project and invite comments on the project. This article can also be sent to any identified interested and affected parties.

[68] Western Cape Government. New NEMA 2010 EIA Regulations. Available online from http://www.westerncape.gov.za/eng/pubs/public_info/N/200703/. [Accessed 26 March 2012].

2. The CPA implementer can also choose to hold a public stakeholder consultation meeting. Should this be the case, then the article drafted above should mention the date, location and time of the meeting.

Should the project participant choose to hold a meeting, this meeting must include a representative from the eThekwini Municipality. In the meeting, the CPA implementer must describe the project and explain how the project will work. The CPA implementer must allow stakeholders to ask questions. All questions must be recorded and responses to these questions must be provided and recorded.

F.2. Summary of comments received

>>
This is not applicable as stakeholder consultation is done at CPA level. However, each CPA must document fully the comments received from stakeholders.

F.3. Report on consideration of comments received

>>
This is not applicable as stakeholder consultation is done at CPA level. However, each CPA must take into account all of the comments received, address the comments and provide feedback via email or post on the comments.

SECTION G. Approval and authorization

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The letter of approval from the South African Designated National Authority (DNA) has been received for this PoA.

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA

A.1. Purpose and general description of generic CPAs

>>
Each CPA will involve the installation of solar water heaters or heat pumps in residential units. A single CPA will consist of both solar water heaters and heat pumps. However, each residential unit can only have a single technology installed (either solar water heaters or heat pumps).

The CPA implementer will apply to the CME to have the CPA included into the PoA. The CPA must meet all the eligibility criteria as set out in the PoA in order to be included into the PoA.

The purpose of the CPAs is to improve the energy efficiency of domestic water heating and reduce greenhouse gas emissions.

SECTION B. Application of a baseline and monitoring methodology

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

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The following methodologies are used for this PoA:

- Solar water heating: Approved methodology small-scale (AMS) I.J '*Solar water heating systems (SWH)*' Version 01, EB 60

- Heat pumps: Approved methodology small-scale (AMS) II.C '*Demand-side energy efficiency activities for specific technologies*' Version 13, EB 48

The following tool was used as part of the PoA:

- '*Tool to calculate the emission factor for an electricity system'* Version 3.0.0, EB 70

B.2. Application of methodology(ies)

>>

The applicability criteria of the methodologies are outlined below. Each CPA must meet the applicability criteria of the methodology:

Approved methodology small-scale (AMS) I.J 'Solar water heating systems (SWH)' Version 01, EB 60

Table 8: The applicability criteria of AMS I.J 'Solar water heating systems (SWH)

No	Applicability Criteria	CPA Adherence	Comply?
1	*This category comprises the installation of residential solar water heating (SWH) systems and commercial SWH systems for hot water production. The SWH systems displace electricity or fossil fuel that would otherwise have been used to produce hot water.*	The CPA involves the installation of residential solar water heating systems. The solar water heating systems displace electricity which was for heating water in the baseline.	Yes
2	*There are two types of projects included in this category: retrofits and new construction. For the purposes of defining baselines and other requirements the following definitions apply:* *(a) Retrofit projects are SWH project(s) that replace existing electric or fossil fuel based water heating system(s) in existing facility(ies);* *(b) New construction projects are: (i) SWH project(s) installed in new facility(ies); (ii) SWH project(s) installed in existing facility(ies) that, prior to the project implementation, do not have installed water heating systems; (iii) SWH project(s) installed in existing facility(ies) which require water heating capacity expansions; or (iv) Replacement of failed solar water heating system(s). This methodology is applicable if it is shown (as per paragraph 8) that for new construction projects, conventional electric or fossil fuel based water heating system(s) would have been installed in the absence of the project activity.*	The CPA involves the following types of projects: a) Retrofits: The CPA will involve the installation of solar water heaters that replace existing electric-based water heating systems; and b) New construction projects: Solar water heaters will be installed in low income houses (RDP houses). These houses are new build and do not have installed water heating systems prior to the installation of the solar water heaters. Solar water heaters may also be installed in community residential units which are existing facilities. In some cases, the solar water heating installations may result in capacity expansions. Solar water heaters will not be installed in households that already have a solar water heating system that	Yes

		has failed. Solar water heaters will be installed in existing low income households that, prior to the project implementation, do not have installed water heating systems. Solar water heater installations in community residential units may result in capacity expansions in the water heating systems. The baseline for this is the installation of conventional electric geysers. Please see demonstration of baseline for confirmation that the baseline is the installation of conventional electric geysers.	
3	*Commercial SWH systems shall include operational indicators that may be easily interpreted by the intended users of the systems and that indicate that water is being heated by solar energy. The minimum requirement for such an indicator is a visible temperature display (thermometer) on the solar preheat storage tank. The thermometer does not require calibration.*	The CPA does not include commercial solar water heating systems.	Yes
4	*To qualify as a small-scale project, the definitions in paragraph 4(d) in the 'General Guidelines to SSC CDM methodologies' (version 15), or the related paragraphs in the latest version of the guidelines are applicable.*	The small-scale threshold for SWH projects in terms of aperture area is 64000 m^2. Only CPAs that do not exceed the threshold are eligible for inclusion in the PoA. If we consider that the collector area of the typical solar water heaters installed under this PoA ranges from 1.5 to 4 m^2 (see technology specifications) then between 16,000 and 42,667 solar water heaters can be installed in a single CPA.	Yes
5	*For residential and commercial SWH projects the hot water consumption rate and temperature at which the hot water is supplied to the load (for example, 40 litres per day at 40ºC), that occur during the crediting period are used to determine emissions savings. The consumption rate (and temperature) is the rate (and temperature) of water actually utilized (for example for personal washing or for an industrial process) and is not the rate (and temperature) at which hot water is produced,*	The energy savings achieved by solar water heaters installed in low, middle and high income households and community residential units is determined using the model. The model-based approach allows for the use of regional or national per occupant values to be used from reliable sources provided the value does not exceed 40 litres per day of hot water consumption. We have used	Yes

	which may be greater than the rate (and temperature) of consumption.	a national per occupant value of 25 litres per person per day[69] for low income households and community residential units. We have used 50 litres per person per day for middle and high income households[70]. As this exceeds 40 litres per day, we will monitor the hot water consumption in a sample of middle and high income households. The outlet water temperature is the temperature at which the thermostat is set. We have used 65°C as the thermostat setpoint[70]. The outlet water temperature is measured during the project. The outlet temperature is measured as the temperature at which hot water is consumed.	

Approved methodology small-scale (AMS) II.C 'Demand-side energy efficiency activities for specific technologies' Version 13, EB 48

Table 9: The applicability criteria of AMS II.C 'Demand-side energy efficiency activities for specific technologies'

No	Applicability Criteria	CPA Adherence	Comply?
1	*This methodology comprises activities that encourage the adoption of energy-efficient equipment/appliance (e.g., lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems) at many sites.* *These technologies may replace existing equipment or be installed at new sites. In the case of new facilities, the determination of baseline scenario shall be as per the procedures described in the general guidance to SSC methodologies under the section 'Type II and III Greenfield projects (new facilities)'.* *The aggregate energy savings by a single*	The CPA involves the installation of heat pumps (energy efficient equipment) at many sites (households). The heat pumps replace existing equipment and will not be installed at new sites. The heat exchanger of the heat pump replaces the electric element of the electric geyser. The electric element is disconnected and cannot be used. The aggregate energy savings by a single project will not exceed 60 GWh per year. Given that a typical household electric geyser has an	Yes

[69] Gleick, P. H. *Basic Water Requirements for Human Activities: Meeting Basic Needs*. Available online from http://www.pacinst.org/reports/basic_water_needs/basic_water_needs.pdf [Accessed 28 March 2012].
[70] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf [Accessed 13 November 2011].

	project may not exceed the equivalent of 60 GWh per year for electrical end use energy efficiency technologies. For fossil fuel end use energy efficient technologies, the limit is 180 GWh thermal per year in fuel input.	electric element with a capacity of 3 to 4 kW[71]. If we assume that water is heated for 24 hours a day and 365 days a year then the baseline electricity consumption would be between 26.28 and 35.04 MWh per year. If we assume that a heat pump of 0.9kW (see technology specifications) and that the heat pump operates all year round then the project electricity consumption would be 7.88 MWh per year. This is a saving of between 18.4 and 27.16 MWh per year. Hence, between 2,209 and 3,260 heat pumps can be installed in a single CPA.	
2	*For each replaced appliance/equipment/ system the rated capacity or output or level of service (e.g., light output, water output, room temperature and comfort, the rated output capacity of air-conditioners etc.) is not significantly smaller (maximum - 10%) than the baseline or significantly larger (maximum + 50%) than the baseline.*	For each replaced electric element, the rated capacity will not be significantly smaller (maximum -10%) than the baseline. This will be determined by documenting the rating of the electric element in the baseline and comparing this to the rated heating capacity of the heat pump to be installed. For example, a conventional electric geyser typically has electric elements that range from 3 to 4 kW[71]. A conventional electric geyser will use 3 kW to produce 3 kW of energy. Hence, if the existing electric geyser has an element with a rating of 3 kW then this will produce 3 kW of energy. This will be compared to the heating capacity of the heat pump installed. The heating capacity of the heat pump installed in a household with a rated electric element of 3 kW must be greater than 3 kW. This will be in the manufacturer's specifications. In some cases, the heating capacity of the heat pump may be greater than the baseline. In these cases, the CPA implementer will either demonstrate that the baseline for the additional capacity is electricity or cap the capacity at the output capacity of the existing electric element.	Yes
3	*If the energy efficient equipment contains*	Refrigerant is used in the heat pumps.	Yes

[71] North West University. October 2010. An Investigation into the Energy Savings and Economic Viability of Heat Pump Water Heaters Applied in the Residential Sector – A Comparison with Solar Water Heating Systems. Available online from http://solartech-sa.co.za/heatpump_vs_solar.pdf [Accessed 26 March 2012].

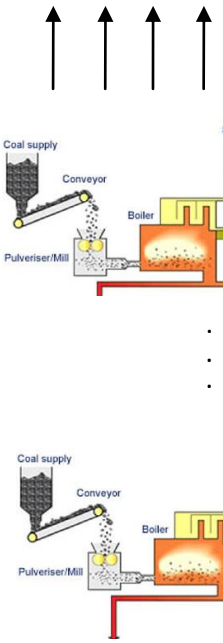
	refrigerants, then the refrigerant used in the project case shall be CFC free. Project emissions from the baseline refrigerant and/or project refrigerants shall be considered in accordance with the guidance of the Board (EB 34, paragraph 17). This methodology credits emission reductions only due to the reduction in electricity consumption from use of more efficient equipment/appliances.	The refrigerants used are predominantly R407C, R410 and R417A (or as stipulated by Eskom, the national electricity provider for South Africa). These refrigerants are CFC free and the project emissions from the refrigerants shall be dealt with in accordance with EB 34, paragraph 17. The refrigerant used in the heat pump unit will be recorded. Should the refrigerant have a global warming potential then this should be accounted for in project emissions. Please see calculation of emission reductions. The methodology credits emission reductions from a reduction in electricity consumption. The approach to calculating the emission reductions ensures that only emission reductions from a reduction in electricity consumption are accounted for. In addition, if the refrigerant has a GWP then this will be accounted for in the project emissions and the emission reductions will be reduced as a result. All refrigerants will be CFC free.	

B.3. Sources and GHGs

>>

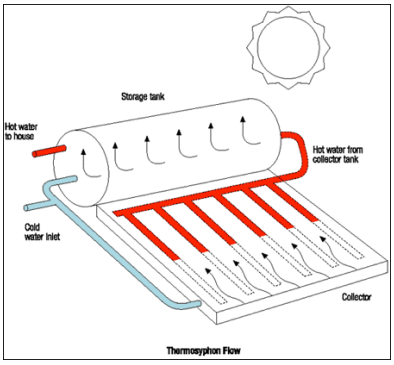
The greenhouse gas reduced through the CPAs under this PoA is CO_2. The reduction takes place through the avoidance of electricity used to heat water, in the absence of the CPAs. The figures[72] below show the source of the emission reductions and the monitoring requirements for both low and high pressure SWHs. The table below the figures summarises the emission sources and greenhouse gases included in the SSC-CPA boundary:

[72] Source of Coal Fired Power Station Image: http://www.worldcoal.org/coal/uses-of-coal/coal-electricity/ Source of Low Pressure SWH Image: http://jamius.com/phpBB3/viewtopic.php?f=2&t=20&start=60 Source of High Pressure SWH Image: http://www.ultisolar.com/post/SR868C9-Solar-Controllers-Solar-Water-Heater-Controllers-Solar-Smart-Controllers.html [Accessed 5 October 2012]



Eskom Grid Electricity

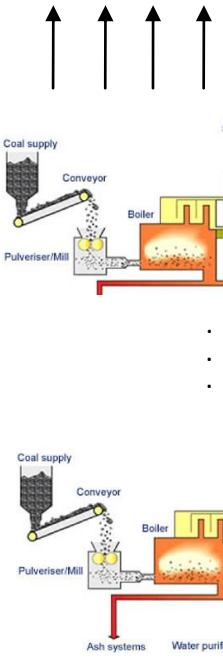
In the absence of the Project, the Baseline would be using grid electricity to heat water. Thus the Grid Emission Factor is monitored.



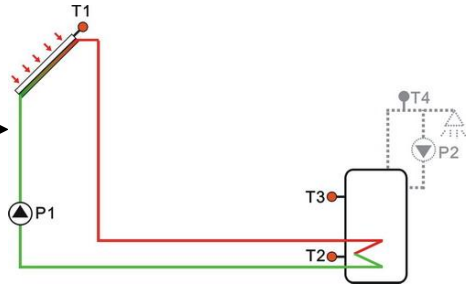
Low Pressure SWH

- No Electrical Back up
- No Circulation Pump
- Monitored to Confirm SWH is Operational
- Calibration of the model is performed
- Monitor outlet water temperature

Figure 13: Low Pressure Solar Water Heater and Avoided Grid Electricity



In the absence of the Project, the Baseline would be using grid electricity to heat water. Thus the Grid Emission Factor is monitored.



High Pressure SWH

- Electrical Water Heating Back up
- Pump to Circulate water through system
- Monitored to Confirm SWH is Operational
- Calibration of the model is performed
- Monitor water consumption and hot water temperature

Figure 14: High Pressure Solar Water Heater and Avoided Grid Electricity

Solar water heaters:

Figure 10: GHG emission sources for solar water heaters within the project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	South African grid electricity production	CO_2	Yes	Only CO_2 emissions from electricity generation should be accounted for in the emission reduction calculation.
		CH_4	No	There are no emissions
		N_2O	No	There are no emissions
Project scenario	Solar Water Heater Thermal Energy Production	CO_2	Yes	High pressure solar water heaters make use of heat exchangers and pumps to circulate the water. This auxiliary equipment may use electricity. This electricity is accounted for in the model by inputting the power required as per the manufacturer's specifications. In addition, there may be times when there is insufficient solar radiation to heat the water. Electricity may be used in these cases to heat the water. However, the model takes into account the solar radiation in the area in which the solar water heater is installed and calculates the savings only due to how much renewable energy can be generated by the solar water heater taking into account the solar radiation. Hence, periods when electricity is used for heating water as no solar radiation is available is accounted for in the model based approach.
		CH_4	No	There are no emissions
		N_2O	No	There are no emissions

For solar water heating installations, the following must be monitored:

1. The grid emission factor in order to determine the baseline; and
2. The operation of the solar water heaters.

There are some other parameters that need to be monitored on an annual basis and in order to calibrate the model. Please see monitoring plan for more information.

The figure[73] below shows the source of the emission reductions and the monitoring requirements for heat pumps. The table below the figure summarises the emission sources and greenhouse gases included in the SSC-CPA boundary:

[73] Source of Coal Fired Power Station Image: http://www.worldcoal.org/coal/uses-of-coal/coal-electricity/ Source of Heat Pump Image: http://www.renovation-headquarters.com/hot-water-heat-pump.html [Accessed 5 October 2010]

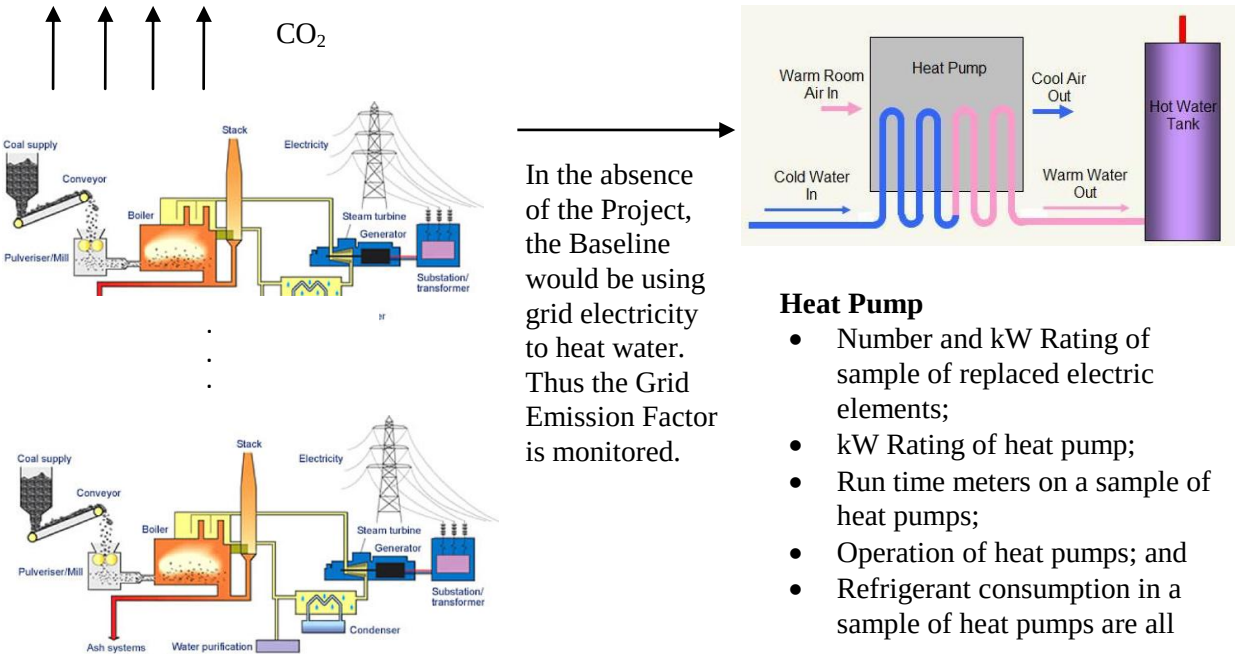


Figure 15: Heat Pump and Avoided Grid Electricity

Heat pumps:

Figure 11: **GHG emission sources for heat pumps within the project boundarySource**		**GHGs**	**Included?**	**Justification/Explanation**
Baseline scenario	South African grid electricity production	CO_2	Yes	The baseline emission for heat pump installations is the use of electricity to heat water.
		CH_4	No	There are no emissions
		N_2O	No	There are no emissions
Project scenario	Heat Pump Thermal Energy Production	CO_2	Yes	Emissions from electricity consumption by the heat pumps.
		CH_4	No	There are no emissions
		N_2O	No	There are no emissions
	Refrigerant consumption	CO_2	Yes	Emissions from refrigerant consumption in the project activity.
		CH_4	No	There are no emissions
		N_2O	No	There are no emissions

For heat pumps, the following must be monitored:

1. The grid emission factor to determine the baseline and project emissions;
2. The number and power of a representative sample of replaced electric elements;
3. Recording the power of the installed heat pump;
4. Metering a sample of units for operating hours using run time meters;
5. The operation of the heat pumps; and

6. The refrigerant consumption in a sample of systems.

B.4. Description of baseline scenario

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Solar Water Heaters

Baseline scenario for existing households

According to the methodology, the baseline is the operating water heating system that existing immediately prior to the installation of a solar water heater.

In South Africa, water is predominantly heated using electric water heating systems[74]. This can be seen from a study conducted by the Department of Energy in 2009 into the national solar water heating market[74]. The study shows that there are approximately 12 million households in South Africa[74]. Of these households, 88% use electricity to heat water[74]. More specifically, 41% of households use an electric geyser and the other 48% use electric stoves or kettles[74]. The remaining 12% of households are not electrified (do not have a connection to the electricity grid)[74].

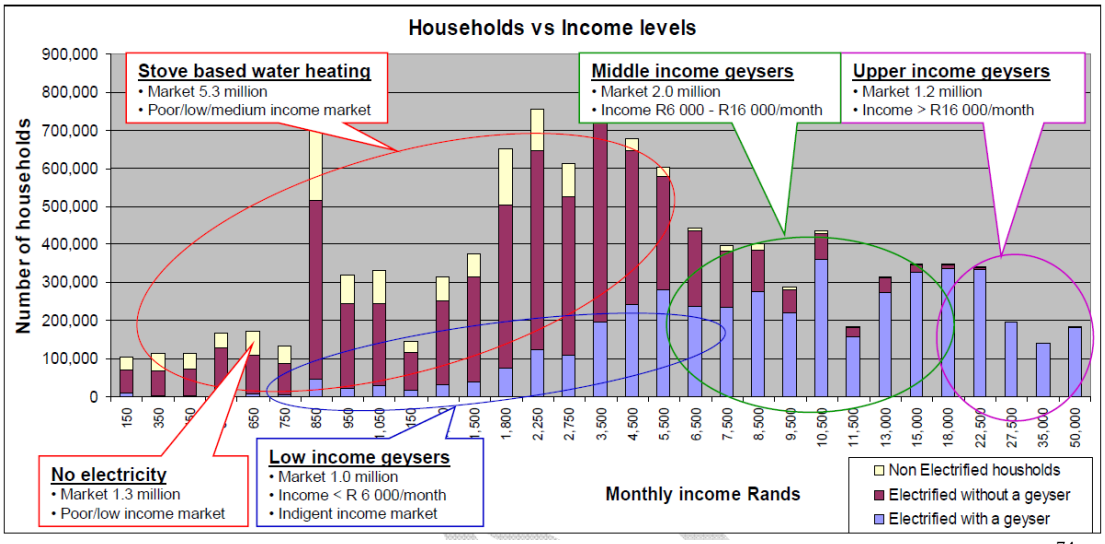

Figure 16: Baseline water heating system and fuel source for households in South Africa[74]

Since all solar water heaters must be installed in grid-connected households, this eliminates the households that are not electrified. The remaining households all use electricity for water heating. Hence, electricity is the baseline fuel source.

According to AMS I.J., the baseline is the operating water heating system and fuel source that existed immediately prior to the installation of the solar water heater. In all existing grid-connected households, the baseline fuel source is electricity.

In middle and high income households, the penetration of electric geysers is 81%[74]. This means that most middle and high income households are using electric geysers for water heating. Hence, the baseline for

[74] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

middle and high income households is electric geysers. The supplier will record the baseline fuel source and the baseline water heating system (size of storage tank, heating capacity of electric geyser etc.) prior to installing the solar water heater in order to ensure that the baseline is electricity and the use of a conventional electric geyser.

The baseline fuel source for community residential units is electricity (all community residential units benefiting from this PoA must be grid-connected) [74]. The residents of community residential units are classified as low-income or poor as they have typically have an income of less than R6,000 per month[74]. Of the electrified households, 21% use electric geysers and the remaining 79% use electric appliances such as kettles and stoves[74]. Hence, the baseline for community residential units is the use of electric appliances.

The baseline fuel source for low income households is electricity (all low income households benefiting from this PoA must be grid-connected) [74]. Of the electrified low-income households, 26% are using electric geysers and 74% are using electric appliances[74]. Hence, the baseline for low-income households is the use of electric appliances.

As can be seen above, the baseline for low income households and community residential units is typically the use of electric appliances. These households do not have a proper water heating system. The reason for this is that the households cannot afford to buy electric geysers (lack of access to funds given the low income per month as documented by the Department of Energy[74]) and they demand less service as they cannot afford a proper water heating system. The warm water service is not installed as a component of low cost housing delivery in South Africa. The National Housing Code determines the minimum requirement to be a metered single standpipe[75].

As demonstrated above, in South Africa water is predominantly heated by electric water heating systems (middle and high income household). If the low income households and community residential units could afford a proper water heating system, the most likely future scenario would be installation of an electric geyser. Hence the baseline for low income households and community residential units is the use of an electric geyser. This is also conservative as the use of an electric geyser to heat the same volume of water is less emissions-intensive than the use of electric appliances.

The PoA will provide low income households and community residential units with access to proper water heating systems which are maintained and monitored to ensure that they are working.

In order to determine the emission reductions of solar water heaters installed in all households, the model-based approach will be used.

Baseline scenario for new build low income households

According to AMS I.J., '*for new construction projects, the baseline system and fuel source (fossil fuel or electricity) assumed to be used for water heating is one that is demonstrated to be typical of new construction, for the given project activity, in the region of the project activity at the time of the start of the project activity. Such demonstration shall include that typical water heating systems in the project region are not solar water heating systems.*'

[75] National Housing Code. Technical and General Guidelines. Available online from http://www.dhs.gov.za/Content/The%20Housing%20Code%202009/CD%20purposes%20=%20Code,%202009/2%20Technical%20&%20General%20Guidelines/1%20Vol%202%20Part%203%20Technical%20and%20General%20Guidelines.pdf. [Accessed 26 March 2012].

Solar water heaters can be installed in new build low income or RDP houses. The methodology for solar water heaters (AMS I.J.) is applicable if it can be shown that for new construction projects, conventional electric water heating systems would have been installed in the absence of the project.

In accordance with the methodology, we have used the "General guidelines to SSC CDM methodologies" to determine the baseline. The baseline is identified as follows:

Step 1: Identify alternatives available to the project proponent that deliver comparable level of service including the proposed project activity undertaken without being registered as a CDM project activity.

The alternatives are as follows:

- Use of electric geyser
- Use of solar water heater or heat pump without being registered as a CDM project activity
- Use of another electric appliance

Step 2: List the alternatives identified above that are in compliance with local regulations

All alternatives listed above are in compliance with local regulations.

Step 3: Eliminate and rank the alternatives taking into account barrier tests specified in attachment A to Appendix B of the simplified modalities and procedures of the SSC CDM.

There are no barriers that prevent the installation of an electric geyser or the use of electric appliances. The baseline fuel source for low income households is electricity (all low income households benefiting from this PoA must be grid-connected)[74]. Of the electrified low-income households, 26% are using electric geysers and 74% are using electric appliances[74].

As demonstrated above, most low income households use electricity for heating water[76]. There is no regulation requiring the installation of solar water heaters on new build low income or RDP houses[77]. Typically, low income or RDP houses are connected to the grid when constructed but are not fitted with a geyser or solar water heater[77]. The owner of the house is responsible for installing a geyser or solar water heater. This is why 74% of low income households use electric appliances for water heating[74].

There are a number of barriers preventing the installation of solar water heaters and heat pumps in low income households. Please see section on additionality (*Section B.1. Demonstration of Additionality for PoA*).

Step 4: If only one alternative remains that is:

- ***Not the proposed project activity undertaken without being registered as a CDM project activity; and***
- ***It corresponds to one of the baseline scenarios provided in the methodology; then the project activity is eligible under the methodology.***

[76] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[77] National Housing Code. Technical and General Guidelines. Available online from http://www.dhs.gov.za/Content/The%20Housing%20Code%202009/CD%20purposes%20=%20Code,%202009/2%20Technical%20&%20General%20Guidelines/1%20Vol%202%20Part%203%20Technical%20and%20General%20Guidelines.pdf. [Accessed 26 March 2012].

If more than one alternative remains that correspond to the baseline scenarios provided in the methodology, choose the alternative with the least emissions as the baseline.

The only alternative remaining are electric heaters and electric appliances. The use of electric geyser to heat the same volume of water is more efficient than the use of electric appliances which were not designed to heat large volumes of water. As such, the emissions are lower from electric geysers. The baseline fuel is electricity and the baseline water heating device is electric geysers.

Please note that the baseline is the same for community residential units where there may be water heating capacity expansions. Community residential units have the same baseline as low income households.

Baseline scenario for heat pumps

In middle and high income households, the penetration of electric geysers is 81%[74]. This means that most middle and high income households are using electric geysers for water heating. Hence, the baseline for middle and high income households is electric geysers. The supplier will record the baseline fuel source and the baseline water heating system (size of storage tank, heating capacity of electric geyser etc.) prior to installing the heat pump in order to ensure that the baseline is electricity and the use of a conventional electric geyser.

The baseline fuel source for community residential units is electricity (all community residential units benefiting from this PoA must be grid-connected) [74]. The residents of community residential units are classified as low-income or poor as they have typically have an income of less than R6,000 per month[74]. Of the electrified households, 21% use electric geysers and the remaining 79% use electric appliances such as kettles and stoves[74]. Hence, the baseline for community residential units is the use of electric appliances.

Community residential units not have a proper water heating system. The reason for this is that they cannot afford to buy electric geysers (lack of access to funds given the low income per month as documented by the Department of Energy[74]) and they demand less service as they cannot afford a proper water heating system.

As demonstrated above, in South Africa water is predominantly heated by electric water heating systems (middle and high income household). If community residential units could afford a proper water heating system, the most likely future scenario would be installation of an electric geyser. Hence the baseline for community residential units is electric geysers. This is also the conservative approach as the use of an electric geyser to heat the same volume of water is more efficient than the use of electric appliances.

The PoA will provide community residential units with access to proper water heating systems which are maintained and monitored to ensure that they are working.

According to the methodology, if the energy displaced is electricity, the emission baseline is determined using one of the two following options:

- Option 1: The product of the baseline energy consumption of equipment/appliances and the emission factor for the electricity displaced
- Option 2: The specific energy consumption of the system in the baseline times the output in project year y times the emission factor for the electricity displaced. This option can only be used where comparable conditions for the output in the baseline and project can be established.

For this PoA, option 1 has been selected so the baseline is the energy consumption of the baseline equipment and the emission factor for the electricity displaced.

Baseline scenario for an increase in output level

In some cases, the installation of heat pumps at community residential units may involve an increase in output level compared to the baseline scenario. According to AMS II.C., project activities involving an increase in output level compared to the baseline scenario are only eligible if they comply with the related and relevant guidance in the General Guidance for SSC methodologies which requires a demonstration that the baseline scenario for the increased amount of output is the same as the baseline scenario defined by this methodology. The baseline for this methodology is the use of electricity to heat water. The baseline is identified below:

Step 1: Identify alternatives available to the project proponent that deliver comparable level of service including the proposed project activity undertaken without being registered as a CDM project activity.

The alternatives are as follows:

- Use of electric geyser
- Use of solar water heater or heat pump without being registered as a CDM project activity
- Use of another electric appliance

Step 2: List the alternatives identified above that are in compliance with local regulations

All alternatives listed above are in compliance with local regulations.

Step 3: Eliminate and rank the alternatives taking into account barrier tests specified in attachment A to Appendix B of the simplified modalities and procedures of the SSC CDM.

There are no barriers that prevent the installation of an electric geyser or the use of electric appliances. The baseline fuel source for low income households is electricity (all low income households benefiting from this PoA must be grid-connected)[78]. Of the electrified low-income households, 26% are using electric geysers and 74% are using electric appliances[79].

As demonstrated above, most low income households use electricity for heating water[74].

There are a number of barriers preventing the installation of solar water heaters and heat pumps in low income households. Please see section on additionality (*Section B.1. Demonstration of Additionality for PoA*).

Step 4: If only one alternative remains that is:

- ***Not the proposed project activity undertaken without being registered as a CDM project activity; and***

[78] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

[79] South African Department of Energy. 5 November 2009. Draft South African National Solar Water Heating Framework and Implementation Plan. Available online from, http://sessa.org.za.resources.s3.amazonaws.com/SWH_DoE_High_Level_%20Framework_Workshop_5Nov.pdf. [Accessed 26 March 2012]

- ***It corresponds to one of the baseline scenarios provided in the methodology; then the project activity is eligible under the methodology.***

If more than one alternative remains that correspond to the baseline scenarios provided in the methodology, choose the alternative with the least emissions as the baseline.

The only alternative remaining are electric heaters and electric appliances. The use of electric geyser to heat the same volume of water is more efficient than the use of electric appliances which were not designed to heat large volumes of water. As such, the emissions are lower from electric geysers. The baseline fuel is electricity and the baseline water heating device is electric geysers.

B.5. Demonstration of eligibility for a generic CPA

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Each CPA must meet the eligibility criteria in order to be included in the PoA. Each CPA must complete the following table:

Table 12: Eligibility criteria for the PoA

No.	Requirement as per standard	Eligibility criteria	Description of how the CPA meets the eligibility criteria	Check by the CME
1	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA	All installations shall take place in residential buildings connected to the grid within the geographical boundaries of South Africa. The CME will check that this eligibility criterion is met by ensuring that all the installations have completed and submitted the Eskom rebate forms. The CME will check the rebate forms. The Eskom rebates are only available to grid-connected households. The rebate forms contain the address of the installed unit so that the CME can check that the unit is installed in South Africa. The CME will perform these checks on a monthly basis for all new installations to ensure that this eligibility criterion is met. The CME will also check	The CPA is located within the geographical boundaries of South Africa. All units are installed in grid-connected residential buildings.	The CPA complies with the eligibility criterion.

		that the units are installed in residential households. The installer will confirm this on installation. In addition, this will be checked during the inspection within three months of installation.		
2	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo);	All solar water heaters and heat pumps installed under the PoA must be uniquely identified by a serial or barcode number that is recorded on installation of the unit. The address and date of each solar water heating and heat pump installation must be recorded on installation of the unit. This information must be captured on the Eskom rebate form. All the relevant details from the form must be recorded in the CME's electronic database. The CME will check the serial or barcode numbers of the units and the addresses and dates of installation recorded on the Eskom rebate forms. These details will be compared with all the units installed thus far under this CPA and other CPAs in the PoA to ensure no double counting. This check will be conducted on a monthly basis by the CME for all new units installed.	All solar water heaters and heat pumps installed under the CPA are uniquely identified by a serial or barcode number that is recorded on the installation of the unit. The address and date of each solar water heater and heat pump installation is recorded and captured. All units can be uniquely identified and emission reductions from each unit are not double counted.	The CPA complies with the eligibility criterion.
3	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	All solar water heating systems and heat pumps installed under this PoA must adhere to applicable SABS standards. The CME will check that the installers are pre-approved.	All solar water heating and heat pump systems installed under this PoA adhere to SABS standards.	The CPA complies with the eligibility criterion.

		This will mean that they have received an SABS certificate for their technology. All units installed under this PoA must be done by an installer that has been pre-approved for the PoA by the CME. The CME will check that the installer is on the CME pre-approved installer database. All solar water heaters and heat pumps installed under the PoA must be new equipment. The installer must be able to provide purchase records from the supplier on request from the CME to indicate that the solar water heater and/or heat pump is new. All technical specifications of the unit must be available in manufacturer's specifications and the type of unit installed must be recorded upon installation of the unit. The CME will record the details of all units supplied by the pre-approved installers in their database. Manufacturer's specifications of all units provided under this PoA will be kept by the CME. The CME will check that the CPA implementer has used one of the pre-approved installers. The type of unit installed will be recorded on installation on the Eskom rebate form and in the CME's database. All relevant technical specifications of the existing water heating device must be recorded	All units are installed by a pre-approved installer. All solar water heaters and heat pumps installed is new equipment. All technical specifications of the unit are available and the type of unit installed is recorded in installation. All relevant technical specifications of the existing water heating device are recorded.	

		such as type of fuel used, type of unit used and size of geyser. This information (particularly the size of the geyser) will be used to inform the sizing calculations of the unit. These sizing calculations must be recorded by the supplier/installer and submitted to the CME to be recorded in the electronic database.		
4	Conditions to check the start date of the CPA through documentary evidence	The start date of the CPA is the date on which the order for the first unit is placed under the CPA. This is captured by the supplier and recorded in the CME's electronic database. The CME will check the date of the first order placed and this will be the start date of the CPA. The CME will also check that this date is not prior to the date of publication of the PoA for global stakeholder consultation.	The start date of the CPA is the date on which the order for the first unit is placed under the CPA. This date is recorded and checked by the CME. This date is not before the PoA was published for global stakeholder consultation by the CME.	The CPA complies with the eligibility criterion.
5	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs	Each CPA must meet the applicability criteria of the applicable methodologies. The applicable methodology for solar water heaters is Approved methodology small-scale (AMS) I.J '*Solar water heating systems (SWH)*' Version 01, EB 60. The applicable methodology for heat pumps is Approved methodology small-scale (AMS) II.C '*Demand-side energy efficiency activities for specific technologies*' Version 13, EB 48. Note that new CPAs must comply with the latest	The CPA meets the applicability criteria of the methodologies. The CME has checked the CPA-DD to ensure that the design of the CPA meets all the applicability criteria of the methodologies applied in the PoA.	The CPA complies with the eligibility criterion.

		version of the methodologies as per EB 65, Annex 3. The eligibility criteria will be updated when new versions of the methodologies become available. The updated PoA-DD and generic CPA-DD will be submitted to the DOE who will submit it to the Board for approval. The new CPA will need to follow the PoA-DD and generic CPA-DD with the updated methodologies. The CME will check the CPA-DD drafted by the CPA implementer to ensure that the applicability criteria of the methodologies are complied with by the design of the CPA.		
6	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality as specified in Section A above	Each CPA must demonstrate additionality in accordance with the procedure as set out under this PoA. The additionality demonstration is checked by the CME and the selected DOE.	The CPA demonstrates additionality in accordance with the procedures set out under the PoA. The demonstration of additionality in the CPA-DD has been checked by the CME and the selected DOE.	The CPA complies with the eligibility criterion.
7	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	Local stakeholder consultation must be completed by the CPA implementer in accordance with the procedures as set out under this PoA. Environmental impact analysis is done at PoA level. The CPA implementer is not required to do an environmental impact assessment. Please see Section E of the PoA for more details. The CME	Local stakeholder consultation has been completed by the CME in line with the procedures set out under the PoA. The environmental impact analysis is done at a PoA level so the CPA implementer does not need to do an environmental	The CPA complies with the eligibility criterion.

		will check the environmental impact analysis and ensure it is in line with the legislation of the host country.	impact analysis. The CME has checked the environmental impact analysis and it is in line with the legislation of the host country.	
8	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance	The CPA implementer must provide the CME with a signed declaration that no official development assistance has been used or will be sourced for the project. In the cases when the CPA implementer is the CME then a signed declaration is not required as the CME will know whether the CPA implementer has used or plans on using official development assistance.	The CPA implementer is not using funding from Annex 1 parties that result in the diversion of official development assistance. The CME has received a signed declaration from the CPA implementer.	The CPA complies with the eligibility criterion.
9	Where applicable, target group (e.g. domestic/commercial/industrial, rural/urban, grid-connected/ off-grid) and distribution mechanisms (e.g. direct installation)	The target group is domestic water heating. This is confirmed by the supplier upon the installation. The CME will also check the CPA-DD to ensure that the CPA is designed to install solar water heaters and heat pumps in residential units.	The target group of the CPA is domestic water heating. The CME has checked the CPA-DD and can confirm that the CPA targets residential households and domestic water heating.	The CPA complies with the eligibility criterion.
10	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys	Each CPA implementer must apply the monitoring plan and the sampling requirements as set out in this PoA. The CPA implementer must produce monthly monitoring reports for the CME which will be checked by the CME.	The CPA implementer will adhere to the monitoring plan and sampling requirements as set out in this PoA. The CME will check the monthly monitoring reports to ensure adherence to the monitoring	The CPA complies with the eligibility criterion.

			plan and sampling plan.	
11	Where applicable, the conditions that ensure that every CPA in aggregate meets the small-scale or microscale threshold criteria and remains within those thresholds throughout the crediting period of the CPA;	The aggregate savings by a single CPA may not exceed 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 heat pumps and solar water heaters and the collector area of the solar water heaters installed. The CPA implementer will be responsible for submitting a monthly report which includes a summary of the collector area installed in the month and the aggregate collector area installed since the start of the CPA. The report must also contain the saving in the month from the heat pumps installed and the aggregate savings for the heat pumps installed since the start of the CPA. The CME will check the monthly reports to ensure that the installations remain below the thresholds.	The aggregate savings by a single CPA will not exceed 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. The CME will check the monthly reports submitted by the CPA implementer to ensure that the installations remain below the thresholds.	The CPA complies with the eligibility criterion.
12	Where applicable, the requirements for the debundling check, in case	Each unit included in the CPA must not be larger than 1% of the small-scale	Each unit does not exceed 1% of the small-scale	The CPA complies with the eligibility

	CPAs belong to small-scale (SSC) or microscale project categories.	thresholds defined by the methodology applied. This means that each solar water heater must not have a collector area of greater than 640 m^2 and each heat pump must not have an annual saving of more than 600 MWh per year. See Section C of the PoA for more detail. A check will be done for each technology offered by a new or existing installer included in the pre-selected installers by the CME. The installers cannot offer technologies that will exceed 1% of the threshold under the PoA.	threshold as defined in the applied methodology.	criterion.
13	Rights to the carbon credits	The owner of the solar water heater or heat pump must cede their rights to the carbon credits. This is done through ensuring that the agreement between the CPA implementer and the resident of the household is signed prior to installation of the unit. In some cases, an agreement can be signed between the installer and the household and the installer and the CPA implementer to cede rights to the carbon credits.	The owners of the heat pumps and solar water heaters cede their rights to the carbon credits through an agreement to either the CPA implementer directly or to the installer. The installers cede their rights to the carbon credits to the CPA implementer.	The CPA complies with the eligibility criterion.
14	For solar water heating installations, the model-based approach is used. The model must be calibrated as per the requirements in the monitoring plan of the PoA.	The model must be calibrated as per the requirements in the monitoring plan. The measurements and calibration results are recorded in the database maintained by the CME.	The model will be calibrated in accordance with the procedures set out in this PoA.	The CPA complies with the eligibility criterion.
15	Operational lifetime of the CPA must not exceed 10 years	The CME will check the CPA-DD to ensure that the operational lifetime of the CPA-DD does not exceed	The operational lifetime of the CPA is 10 years as checked by the	The CPA complies with the eligibility criterion.

		10 years. The CME will ensure that certified emission reductions are only claimed for 10 years for each CPA.	CME.	
16	Starting date of the crediting period of the CPA is the date on which it is included in the registered PoA	The CME will check that the starting date of the crediting period of the CPA is the date on which it is included in the PoA as per eligibility criterion 21. The CME will ensure that the CPA does not generate any certified emission reductions prior to this date.	The starting date of the crediting period is the date on which the CPA is included in the PoA.	The CPA complies with the eligibility criterion.
17	Each household or Community Residential Unit is only allowed one type of installation (either a solar water heater or a heat pump).	The CME will check the address of each installation and crosscheck the address of every new installation with existing installations to ensure that only one unit has been installed in the household. The installer will also check that only one unit is installed. This will be checked again within three months of installation at the inspection.	Only one unit is installed in every household.	The CPA complies with the eligibility criterion.
18	Each CPA must ensure that leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined.	The CME will check the CPA-DD to ensure that leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined and are in line with the PoA-DD and the requirements of the methodologies.	Leakage, additionality, the establishment of the baseline scenario, baseline emissions, eligibility and double counting are unambiguously defined in the CPA-DD.	The CPA complies with the eligibility criterion.
19	Heat pumps must replace existing equipment and cannot be installed at new sites	The heat pumps cannot be installed at new sites. The installer will check the baseline water heating method and this will be recorded in the CME's electronic database.	All heat pumps are installed in existing sites and replace the existing baseline water heating method.	The CPA complies with the eligibility criterion.

		Provided there is a baseline water heating method and the heat pump replaces the existing water heating method then it cannot be considered a new site.		
20	Solar water heaters and heat pumps can only be installed in existing community residential units and middle and high income households. They cannot be installed in new builds.	The CME will ensure that the units are installed in existing community residential units and middle and high income households. The installer will check the baseline water heating method and this will be recorded in the CME's electronic database. Provided there is a baseline water heating method, the community residential unit and middle and high income households cannot be considered new build.	All units are installed in existing community residential units and middle and high income households. This is checked by the CME.	The CPA complies with the eligibility criterion.
21	Each SSC-CPA must be approved by the CME and DOE prior to its incorporation into the PoA.	The CME and DOE must approve the inclusion of the CPA into the PoA prior to it being incorporated into the PoA and being allowed to generate certified emission reductions. The CME and the DOE will both provide approval for inclusion in written form.	The CME and the DOE have both provided approval for inclusion in written form.	The CPA complies with the eligibility criterion.

B.6. Estimation of emission reductions of a generic CPA

B.6.1. Explanation of methodological choices

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The total emission reductions from a typical CPA are calculated as follows. As two methodologies (one for heat pumps and one for solar water heaters) are used in the PoA the total emission reductions are the sum of the emission reductions as calculated from each methodology.

$$ER_y = ER_{SWH,y} + ER_{HP,y} \quad (1)$$

Where:

ERy	Total annual emission reductions (tons CO_2e/year)
$ER_{SWH,y}$	Annual emission reductions from solar water heaters (tons CO_2e/year)
$ER_{HP,y}$	Annual emission reductions from heat pumps (tons CO_2e/year)

Note that emission reductions can only be claimed from the date of this inspection to account for lag time. Emission reductions cannot be claimed from the date of installation, but only from the date of the inspection which is conducted within three months of installation.

Solar water heating systems

The emission reductions from solar water heaters can be calculated as follows. The methodology used to calculate the emission reductions is AMS. I. J. (version 1). The emission reductions from the installation of solar water heating systems are determined using the model based approach.

$$ER_{SWH,y} = ER_{MH,y} + ER_{C,y} + ER_{L,y} \quad (2)$$

Where:

$ER_{SWH,y}$	Annual emission reductions from solar water heaters (tons CO_2e/year)
$ER_{MH,y}$	Annual emission reductions from solar water heaters installed in middle and high income households (tons CO_2e/year)
$ER_{C,y}$	Annual emission reductions from solar water heaters installed in community residential units (tons CO_2e/year)
$ER_{L,y}$	Annual emission reductions from solar water heaters installed in low income households (tons CO_2e/year)

According to the methodology (AMS I.J.), emission reductions are calculated as the energy savings that result from the project implementation multiplied by an emission factor for the electricity displaced.

The energy savings may be determined by using one of the following approaches:

- Model based method - an approved, computerized simulation model is used to determine the annual performance of the baseline system and the project system in order to calculate baseline energy use and project energy use.

- System metering method – involves metering a sample of units. The energy content of the hot water must be measured and integrated, at least one every minute by a thermal meter and recorded on a daily basis.

- Stipulated energy saving method – this method is only applicable to residential solar water heating systems that displace electricity for water heating.

We have selected the model based method for the calculation of the emission reductions from the installation of solar water heating systems. This approach is applicable as all installation are residential solar water heating systems.

The requirements of the model-based approach are outlined below:

No	Requirement	Approach	Meet the Requirement?
i	*An approved, computerized simulation model is used to determine the annual performance of the baseline system(s) and the project system(s) in order to*	The pre-approved model simulation program RETScreen will be used to determine the annual performance of the baseline systems and the project systems in order to calculate baseline and project energy use.	Yes

	calculate baseline energy use and project energy use	RETScreen has been pre-approved by the UNFCCC according to AMS I.J. RETScreen has been developed by Natural Resources Canada (http://www.retscreen.net/ang/home.php) .	
ii	*Model-based input parameters shall include: (a) Characteristics of the baseline system including the fossil fuel or electricity input and output capacity, water heating system efficiency, and storage tank size and insulation; (b) Temperature of water entering the water heating system (e.g., ground water temperature) and average end-use hot water temperature and consumption, (litres per day); (c) Characteristics of the project system including solar collector size and technical and thermal performance ratings, collector orientation, back-up system characteristics, pumping system characteristics, and storage tank size and insulation, and (d) Solar radiation data, i.e. daily or monthly average daily solar insolation data (kwh/m2/day) and ambient temperature data, i.e. daily or monthly average daily values (^{o}C).All model input parameters shall be included in the PDD as well as the output generated by the model*	See table below for model input parameters. All model input parameters shall be included in the CPA-DD as well as the output generated by the model.	Yes
iii	*The computer simulation model shall be used to calculate the baseline and also the project fossil fuel and/or electricity consumption on an annual basis*	The pre-approved model simulation program RETScreen is used to determine the baseline and the project electricity consumption on an annual basis	Yes
iv	If more than one SWH	Average data for all project systems	Yes

	system is installed as part of the project, the temperature of water entering the water heating systems, solar insolation data, and ambient temperature data that are representative of average data for all project systems, can be used. Model input parameters for baseline and project systems must be based on the characteristics of each individual system.	within a 50km radius of the measurement site will be used. The temperature of water entering the water heating systems, solar insolation data, and ambient temperature data will be measured at a measurement site. All installations within a 50km radius of the site will use the values from the measurement site. Model input parameters for the baseline and project systems are based on manufacturer's specifications and the specifications of the unit replaced. These parameters are based on the characteristics of each individual system.	

Model Inputs

The input parameters to the model will include:

Parameter	**Source**	**Comment**
Characteristics of the baseline system including the fossil fuel or electricity input and output capacity, water heating system efficiency, storage tank size and insulation		
Existing water heating method	Installation form and Eskom rebate form	No additional comment
Fuel used for water heating	Installation form and Eskom rebate form	No additional comment
Output capacity	Installation form and Eskom rebate form	No additional comment
Water heating system efficiency	Installation form and Eskom rebate form	No additional comment
Storage tank size	Installation form and Eskom rebate form	No additional comment
Insulation	Installation form and Eskom rebate form	No additional comment
Load type	RETScreen model	The CPA implementer must select whether the load type is a house or apartment etc.
Occupants/number of units	Installation form and Eskom rebate form	The number of occupants per house or the number of units in the community residential units are measured and recorded on the installation form or the Eskom rebate form.
Occupancy rate	If the household is the primary residence then it is assumed that the occupancy rate is 100%	No additional comment
Operating dates per week	If the household is the primary residence then it is assumed that the operating days per week is equal to 7.	No additional comment

Temperature of the water entering the water heating system and average end-use hot water temperature and consumption		
Daily hot water use	The daily hot water use for low income households and community residential units is sourced from a reliable source and is taken as 25 litres per person per day[80]. This is not monitored. The daily hot water use for middle and high income households is monitored (see monitoring plan for more details). The value used for the ex-ante calculation of the emissions reductions is 50 litres per person per day.[81]	Note that the daily hot water consumption of each unit within the community residential unit cannot exceed 100 litres per day irrespective of the number of people living in the unit. Hence, 25 litres per person per day is used, but it is capped at 100 litres per unit.
Temperature	The temperature of the hot water consumed is monitored (see monitoring plan for more details). The value used for the ex-ante calculation of the emissions reductions is 65°C[82] or the thermostat setpoint.	No additional comment
Characteristics of the project system including solar collector size and technical and thermal performance ratings, collector orientation, back-up system characteristics, pumping system charateristics, and storage tank size and insulation		
Solar tracking mode	Installation inspection form	No additional comment
Slope	Installation inspection form	No additional comment
Azimuth	Installation inspection form	No additional comment
Type	Manufacturer's specifications	No additional comment
Manufacturer and model	Manufacturer's specifications	No additional comment
Gross area per solar collector	Manufacturer's specifications	No additional comment
Aperture area per solar collector	Manufacturer's specifications	No additional comment
Fr (tau alpha) coefficient	Manufacturer's specifications	No additional comment
Fr UL coefficient	Manufacturer's specifications	No additional comment
Temperature coefficient for Fr UL	Manufacturer's specifications	No additional comment
Number of collectors	Manufacturer's specifications	No additional comment
Miscellaneous losses from the solar water heater	Manufacturer's specifications	No additional comment
Storage	Manufacturer's specifications	No additional comment

[80] Gleick, P. H. *Basic Water Requirements for Human Activities: Meeting Basic Needs*. Available online from http://www.pacinst.org/reports/basic_water_needs/basic_water_needs.pdf. [Accessed 28 March 2012].

[81] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3__55-61.pdf. [Accessed 13 November 2011].

[82] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3__55-61.pdf. [Accessed 13 November 2011].

Storage capacity/solar collector area	Manufacturer's specifications	No additional comment
Heat exchanger	Manufacturer's specifications	No additional comment
Heat exchanger efficiency	Manufacturer's specifications	No additional comment
Miscellaneous losses from the heat exchanger	Manufacturer's specifications	No additional comment
Pump power/ solar collector area	Manufacturer's specifications	No additional comment
Solar radiation data such as daily or monthly average daily solar insolation data and ambient temperature data (daily or monthly average daily values)		
Climate data	RETScreen model (NASA data as per the methodology). The weather data is measured in order to calibrate the model as per the methodology.	The CPA implementer is required to input the country (South Africa) and the climate data location which is the weather station closest to the project region.
Supply temperature (minimum and maximum)	Calculated based on the weather data in the model. This will be measured to calibrate the model.	See monitoring plan for details on the calibration of the model.

Model Outputs

The model is used to calculate the baseline and project electricity consumption, and consequently the emission reductions, on an annual basis. The output of the model is the energy consumption of the water heating system in the baseline and the energy consumption in the project. The project energy consumption is subtracted from the baseline energy consumption to get the energy savings per type of solar water heater. This must be multiplied by the grid emission factor and the number of geysers to obtain the emission reductions for the group of type i solar water heaters installed in one household category. The emission reductions are discounted if there are any solar water heaters that have not been properly installed or are not operational.

The emission reductions from solar water heaters installed in low income households is provided below:

$$ER_{L,y} = N_{i.L,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,L,y} \quad (3)$$

Where:

$ER_{L,y}$	Annual emission reductions from solar water heaters installed in low income households (tons CO_2e/year)
$N_{i,L,y}$	Number of solar water heaters of type "i" installed in low income households in year y
$I_{SWH,y}$	Percentage of solar water heaters that have been properly installed in year y
$F_{SWH,y}$	Percentage of solar water heaters installed that are operational in year y
$ER_{i,L,y}$	Emission reductions from the installation of a solar water heater of type "i" installed in a low income household in year y

The outputs of the model are a baseline energy consumption and a project energy consumption for a specific type of solar water heater. The difference between these values is the energy savings. The energy savings are multiplied by an emission factor (the emission factor for the grid) to determine the emission reductions ($ER_{i,L,y}$). According to the methodology, the grid emission factor must be calculated in accordance with the provisions in AMS I.D. "Grid connected renewable electricity generation." AMS I.D. refers to the approved tool to calculate the emission factor for the electricity system. This tool is used by the CME to determine the grid emission factor. The grid emission factor is provided to the CPA implementer when being included into the PoA.

The calculation of the emission reductions for solar water heaters installed in low income households is presented below:

$$ER_{i,L,y} = \left(E_{BL,i,L,y} - E_{PJ,i,L,y}\right) \times EF_{CO2,ELEC,y} \quad (4)$$

Where:

$ER_{i,L,y}$ Emission reductions from the installation of a solar water heater of type "i" installed in a low income household in year y

$E_{BL,i,L,y}$ Baseline energy consumption for the low income household in year y where a solar water heater of type "i" will be installed calculated in the model

$E_{PJ,i,L,y}$ Project energy consumption from the installation of a solar water heater of type "i" installed in a low income household in year y calculated in the model

$EF_{CO2,ELEC,y}$ Emission factor in year y (tCO_2/MWh)

The emission reductions from solar water heaters installed in middle and high income households is provided below:

$$ER_{MH,y} = N_{i.MH,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,MH,y} \quad (5)$$

Where:

$ER_{MH,y}$ Annual emission reductions from solar water heaters installed in middle and high income households (tons CO_2e/year)

$N_{i,MH,y}$ Number of solar water heaters of type "i" installed in middle and high income households in year y

$I_{SWH,y}$ Percentage of solar water heaters that have been properly installed in year y

$F_{SWH,y}$ Percentage of solar water heaters installed that are operational in year y

$ER_{i,MH,y}$ Emission reductions from the installation of a solar water heater of type "i" installed in a middle and high income household in year y

The calculation of the emission reductions for solar water heaters installed in middle and high income households is presented below:

$$ER_{i,MH,y} = \left(E_{BL,i,MH,y} - E_{PJ,i,MH,y}\right) \times EF_{CO2,ELEC,y} \quad (6)$$

Where:

$ER_{i,MH,y}$ Emission reductions from the installation of a solar water heater of type "i" installed in a middle and high income household in year y

$E_{BL,i,MH,y}$ Baseline energy consumption for the middle or high income household in year y where a solar water heater of type "i" will be installed calculated in the model

$E_{PJ,i,MH,y}$ Project energy consumption from the installation of a solar water heater of type "i" installed in a middle or high income household in year y calculated in the model

$EF_{CO2,ELEC,y}$ Emission factor in year y (tCO_2/MWh)

The emission reductions from solar water heaters installed in community residential units is provided below:

$$ER_{C,y} = N_{i.C,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,C,y} \quad (7)$$

Where:

$ER_{C,y}$	Annual emission reductions from solar water heaters installed in community residential units (tons CO_2e/year)
$N_{i,C,y}$	Number of solar water heaters of type "i" installed in community residential units in year y
$I_{SWH,y}$	Percentage of solar water heaters that have been properly installed in year y
$F_{SWH,y}$	Percentage of solar water heaters installed that are operational in year y
$ER_{i,C,y}$	Emission reductions from the installation of a solar water heater of type "i" installed in community residential units in year y

The calculation of the emission reductions for solar water heaters installed in community residential units is presented below:

$$ER_{i,C,y} = \left(E_{BL,i,C,y} - E_{PJ,i,C,y}\right) \times EF_{CO2,ELEC,y} \quad (8)$$

Where:

$ER_{i,C,y}$	Emission reductions from the installation of a solar water heater of type "i" installed in a community residential unit in year y
$E_{BL,i,C,y}$	Baseline energy consumption for a community residential unit in year y where a solar water heater of type "i" will be installed calculated in the model
$E_{PJ,i,C,y}$	Project energy consumption from the installation of a solar water heater of type "i" installed in a community residential unit in year y calculated in the model
$EF_{CO2,ELEC,y}$	Emission factor in year y (tCO_2/MWh)

Leakage Emissions

According to AMS I.J., if the equipment is transferred from another activity then leakage must be considered. The equipment is not transferred to another activity so leakage does not need to be considered in this respect.

In addition, if the baseline equipment (replaced equipment) is not destroyed or scrapped then leakage must be considered. In this PoA, the electric element is the piece of equipment replaced. The electric element is disconnected. By disconnecting the electric element, the electric geyser (baseline water heating method) is no longer usable. The installer of the solar water heater must record that the electric element is disabled and this must be checked in the installation inspection which happens within three months of installation. Provided that the electric element has been disconnected, no leakage occurs under this PoA.

In addition, independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Note that the electric element must be present when the independent monitoring is conducted. This will show that the electric element has not be sold off or used in another application. However, the electric element must be disconnected.

If an electric element is found to not have been disconnected in the independent monitoring conducted on an annual basis then the emission reductions from that unit are removed from the total emission

reductions. In other words, no emission reductions can be claimed for that unit and leakage is considered by removing the emission reductions from that unit.

Heat pumps

Baseline Emissions

The baseline emissions consist of the emissions from the electricity used by the existing electric geyser to heat water. In the case of an expansion in capacity, the baseline must be demonstrated to be the installation of an electric geyser (as per the baseline section in this PoA-DD). The baseline emissions will then consist of the emissions from the electricity used by the electric geyser that would have been installed in the absence of the project to heat the required volume of water.

According to the methodology, there are two options for the calculation of the baseline emissions if the energy displaced is electricity. Option 1 was chosen. Option 2 is not used as comparable conditions in the baseline and project case shall not be proved as part of the monitoring requirements of this PoA. Option 1 is the product of the baseline energy consumption of equipment/appliances and the emission factor for the electricity displaced. Option 1 is the more conservative choice for this project as number of heat pumps, rating of heat pumps and operating hours shall be used in the calculations instead of an average. The energy displaced in the project is electricity and thus the baseline emissions are calculated as follows.

$$BE_{HP,y} = E_{BL,y} \times EF_{CO2,ELEC,y} + Q_{ref,BL} \times GWP_{ref,BL} \quad (9)$$

Where:

$BE_{HP,y}$	Baseline emissions in year y (tCO2e)
$E_{BL,y}$	Energy consumption in the baseline in year y (MWh)
$EF_{CO2,ELEC,y}$	Emission factor in year y (tCO_2/MWh)
$Q_{ref,BL}$	Annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked (tonnes per year)
$GWP_{ref,BL}$	Global warming potential of the baseline refrigerant (tCO_2e/t refrigerant)

Equation 9 in the PoA-DD corresponds with equation 1 in AMS II.C.

The baseline equipment does not make use of refrigerants as the baseline is the use of conventional electric geysers (see technology description in Section A.6. As such, this equation can be simplified as follows:

$$BE_{HP,y} = E_{BL,y} \times EF_{CO2,ELEC,y} \quad (9a)$$

Where:

$BE_{HP,y}$	Baseline emissions in year y (tCO2e)
$E_{BL,y}$	Energy consumption in the baseline in year y (MWh)
$EF_{CO2,ELEC,y}$	Emission factor in year y (tCO_2/MWh)

The energy consumption in the baseline is calculated using the equation below (using option 1):

$$E_{BL,y} = \sum_i \left(\frac{n_i \times \rho_i \times o_i}{l - l_y} \right) \quad (10)$$

Where

n_i	Number of devices of the group "i" replaced
ρ_i	Power of the devices of the group "i" baseline devices
o_i	Average annual operating hours of the devices of the group "i" baseline devices
l_y	Average annual technical grid losses during year y for the grid serving the locations where the devices are installed, expressed as a fraction

Equation 10 in this PoA-DD corresponds with equation 2 in AMS II.C.

If the project results in an expansion in the water heating capacity then the baseline is the use of an electric geyser to generate the hot water as demonstrated in the baseline section in the PoA-DD. In this case, the power of the existing electric geyser and the power of the electric geyser that would have installed in the absence of the project in order to heat the additional quantity of water that is heated in the project (due to the capacity expansion) should be accounted for in the baseline.

Project Emissions

The project emissions consist of the electricity consumption used in the project equipment and the consumption of refrigerants, determined as follows:

$$PE_{HP,y} = E_{PJ,y} \times EF_{CO2,y} + PE_{ref,y} \quad (11)$$

Where:

$PE_{HP,y}$	Project emissions in year y (tCO2e)
$E_{PJ,y}$	Energy consumption in the project in year y (MWh)
$EF_{CO2,y}$	Emission factor in year y (tCO_2/MWh)
$PE_{ref,y}$	Project emissions from physical leakage of refrigerant from the project equipment in year *y* (t CO2e/y)

Equation11 in this PoA-DD corresponds with equation 5 in AMS II.C. Note that the equation includes the emissions from refrigerant consumption.

$$E_{PJ,y} = \sum_i \left(\frac{n_i \times \rho_i \times o_i}{l - l_y} \right) \quad (12)$$

Where

n_i	Number of devices of the group "i" replaced
ρ_i	Power of the devices of the group "i" project devices
o_i	Average annual operating hours of the devices of the group "i" baseline devices
l_y	Average annual technical grid losses during year y for the grid serving the locations where the devices are installed, expressed as a fraction

$$PE_{ref,y} = \left(Q_{ref,y}\right) \times GWP_{ref,PJ} \quad (13)$$

$Q_{ref,y}$	Average annual quantity of refrigerant used in year *y* to replace refrigerant that has leaked in year *y* (tonnes/year).
$GWP_{ref,PJ}$	Global warming potential of the baseline refrigerant (tCO_2e/t refrigerant)

Equation 12 in this PoA-DD corresponds with equation 6 in this PoA-DD.

The emission factor of the grid is calculated according to the procedure prescribed in the latest version of the '*Tool to calculate the emission factor for an electricity system*.' The application of this tool is presented in Appendix 4. The CME is responsible for ensuring that the tool is up-to-date and for the calculation of the grid emission factor for South Africa. Each CPA must apply the grid emission factor allocated to them by the CME.

According to the methodology (AMS II.C.), if the energy efficiency technology is equipment transferred from another activity then leakage must be considered. In this PoA, all technology installed in the houses is new technology that has not been previously used.

AMS II.C. states that '*the replaced equipment must be scrapped and that independent monitoring of the scrapping of the replaced equipment must be conducted. The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.*'

In this PoA, the electric element is the piece of equipment replaced. The electric element is disconnected. By disconnecting the electric element, the electric geyser (baseline water heating method) is no longer usable. The installer of the heat pump must record that the electric element is disabled and this must be checked in the installation inspection which happens within three months of installation. Provided that the electric element has been disconnected, no leakage occurs under this PoA.

In addition, independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Note that the electric element must be present when the independent monitoring is conducted. This will show that the electric element has not be sold off or used in another application. However, the electric element must be disconnected.

If an electric element is found to not have been disconnected in the independent monitoring conducted on an annual basis then the emission reductions from that unit are removed from the total emission reductions. In other words, no emission reductions can be claimed for that unit and leakage is considered by removing the emission reductions from that unit.

The emission reductions are calculated as follows:

$$ER_{HP,y} = \left(BE_{HP,y} - LE_{HP,y} - PE_{HP,y}\right) \times I_{HP,y} \times F_{HP,y} \quad (14)$$

Where:

$ER_{HP,y}$	The emission reductions from heat pumps in year y (tCO_2e)
$BE_{HP,y}$	The baseline emissions from heat pumps in year y (tCO_2e)
$LE_{HP,y}$	The leakage emissions from heat pumps in year y (tCO_2e)
$PE_{HP,y}$	The project emissions from heat pumps in year y (tCO_2e)

$I_{HP,y}$ Percentage of heat pumps that have been properly installed in year y
$F_{HP,y}$ Percentage of heat pumps installed that are operational in year y

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

Data / Parameter	**$EF_{CO2,ELEC,y}$**
Unit	tCO_2/MWh
Description	Electricity grid emission factor for the South African national electricity grid
Source of data	The grid emission factor is calculated in accordance with the latest version of the '*Tool to calculate the emission factor for an electricity system*.' The operating margin is fixed for the crediting period of the CPA (ex-ante option selected). The build margin is also fixed for the crediting period of the CPA (option 1 selected). As such, the grid emission factor is fixed for the crediting period of the CPA.
Value(s) applied	0.87
Choice of date or Measurement methods and procedures	Calculated in accordance with the latest version of the '*Tool to calculate the emission factor for an electricity system*.' Note that the CME will calculate the grid emission factor on an annual basis. The CME will allocate a grid emission factor to the CPA implementer at the time of inclusion of the CPA into the PoA. The CPA implementer will use this grid emission factor for the crediting period of the project. The purpose of the CME updating the grid emission factor on an annual basis is so that each CPA being included into the PoA will make use of a grid emission factor calculated based on the latest available data.
Purpose of data	The electricity grid emission factor is used to determine the baseline and project emissions.
Additional comments	No further comment

Data / Parameter	**l_y**
Unit	%
Description	Average annual technical grid losses (transmission and distribution) during year *y*
Source of data	Value from Eskom's 2011 Integrated Annual Report (http://financialresults.co.za/2011/eskom_ar2011/cnb_overview02.php)
Value(s) applied	8.25%
Choice of data or Measurement methods and procedures	Value extracted from Eskom's 2011 Integrated Annual Report (http://financialresults.co.za/2011/eskom_ar2011/cnb_overview02.php)
Purpose of data	The transmission and distribution losses are included in the calculation of the energy savings from the solar water heating systems.
Additional comment	No further comment

Data / Parameter	**Hot water consumption for low income households and community residential units**
Unit	Litres per person per day
Description	Consumption of hot water by low income households and community residential units
Source of data	Gleick, P. H. *Basic Water Requirements for Human Activities: Meeting Basic Needs*. Available online from http://www.pacinst.org/reports/basic_water_needs/basic_water_needs.pdf. [Accessed 28 March 2012].
Value(s) applied	25 litres per person per day for low income households and community residential units
Choice of data or Measurement methods and procedures	According to the methodology: '*regional or national per occupant or per residence values may be used from reliable sources, not to exceed a value of 40 litres per day of hot water consumption per full time resident occupant.*' In line with this, we have used a value below 40 litres per person per day. We have based this value on the basic water need per person. This is the amount of water that each person should be allowed as a basic human right or basic need.
Purpose of data	To calculate the emission reductions from the installation of solar water heating systems in low income households and community residential units.
Additional comment	For community residential units, the volume of water per unit per day is capped at 100 litres. Hence, even if there are more than four occupants in a single unit, the volume of water must be no more than 100 litres per unit per day.

Heat pumps

Data / Parameter	o_i ***baseline***
Unit	hours
Description	Average annual operating hours of the devices of the group of *"i"* baseline devices
Source of data	Estimated based on literature or measurements.
Value(s) applied	To be determined in CPA-DD
Choice of data or Measurement methods and procedures	Literature or measurements data (if available) will be used for ex ante emission reduction calculation.
Purpose of data	Calculation of baseline emissions
Additional comment	No additional comment

B.6.3. Ex-ante calculations of emission reductions

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Equation 1

$$ER_y = ER_{SWH,y} + ER_{HP,y}$$

Year	**ER_y**	**$ER_{SWH,y}$**	**$ER_{HP,y}$**
	tons CO_2/year	tons CO_2/year	tons CO_2/year
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			

Equation 2

$$ER_{SWH,y} = ER_{MH,y} + ER_{C,y} + ER_{L,y}$$

Year	**$ER_{SWH,y}$**	**$ER_{MHC,y}$**	**$ER_{C,y}$**	**$ER_{L,y}$**
	tons CO_2/year	tons CO_2/year	tons CO_2/year	tons CO_2/year
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				

Equation 3

$$ER_{L,y} = N_{i.L,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,L,y}$$

Year	$ER_{L,y}$	$N_{i,L,y}$	$I_{SWH,y}$	$F_{SWH,y}$	$ER_{i,L,y}$
	tons CO_2/year	Number of units	percentage	percentage	tons CO_2/unit
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					

20XX					
20XX					

Equation 4

$$ER_{i,L,y} = \left(E_{BL,i,L,y} - E_{PJ,i,L,y}\right) \times EF_{CO2,ELEC,y}$$

Year	$ER_{i,L,y}$	$E_{BL,I,L,y}$	$E_{PJ,I,L,y}$	$EF_{CO2,ELEC,y}$
	MWh/unit	MWh/unit	MWh/unit	tons CO2/MWh
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				

Equation 5

$$ER_{MH,y} = N_{i.MH,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,MH,y}$$

Year	$ER_{MH,y}$	$N_{i,MH,y}$	$I_{SWH,y}$	$F_{SWH,y}$	$ER_{i,MH,y}$
	tons CO_2/year	Number of units	percentage	percentage	tons CO_2/unit
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					

Equation 6

$$ER_{i,MH,y} = \left(E_{BL,i,MH,y} - E_{PJ,i,MH,y}\right) \times EF_{CO2,ELEC,y}$$

Year	$ER_{i,MH,y}$	$E_{BL,I,MH,y}$	$E_{PJ,I,MH,y}$	$EF_{CO2,ELEC,y}$
	MWh/unit	MWh/unit	MWh/unit	tons CO2/MWh
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				

20XX				
20XX				
20XX				

Equation 7

$$ER_{C,y} = N_{i.C,y} \times I_{SWH,y} \times F_{SWH,y} \times ER_{i,C,y}$$

Year	$ER_{C,y}$	$N_{i,C,y}$	$I_{SWH,y}$	$F_{SWH,y}$	$ER_{i,C,y}$
	tons CO_2/year	Number of units	percentage	percentage	tons CO_2/unit
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					
20XX					

Equation 8

$$ER_{i,C,y} = \left(E_{BL,i,C,y} - E_{PJ,i,C,y}\right) \times EF_{CO2,ELEC,y}$$

Year	$ER_{i,C,y}$	$E_{BL,I,C,y}$	$E_{PJ,I,C,y}$	$EF_{CO2,ELEC,y}$
	MWh/unit	MWh/unit	MWh/unit	tons CO2/MWh
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				
20XX				

Equation 9a

$$BE_y = E_{BL,y} \times EF_{CO2,ELEC,y}$$

Year	BE_y	$E_{BL,y}$	$EF_{CO2,ELEC,y}$
	tons CO_2/year	MWh/year	tons CO_2/MWh
20XX			0.87
20XX			0.87
20XX			0.87
20XX			0.87
20XX			0.87

20XX			0.87
20XX			0.87
20XX			0.87
20XX			0.87
20XX			0.87

Equation 10

$$E_{BL,y} = \sum_i \left(\frac{n_i \times \rho_i \times o_i}{l - l_y} \right)$$

Year	$E_{BL,y}$	n_i	ρ_i	o_i	l_y
	MWh/year	number	MW	hours/year	fraction
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825

Equation 11

$$PE_{HP,y} = E_{PJ,y} \times EF_{CO2,y} + PE_{ref,y}$$

Year	$PE_{HP,y}$	$E_{PJ,y}$	$EF_{CO2,y}$	$PE_{ref,y}$
	tons CO_2/year	MWh	tons CO_2/MWh	t CO_2/year
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	
20XX			0.87	

Equation 12

$$E_{PJ,y} = \sum_i \left(\frac{n_i \times \rho_i \times o_i}{l - l_y} \right)$$

Year	$E_{PJ,y}$	n_i	ρ_i	o_i	l_y
	MWh/year	number	MW	hours/year	fraction
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825
20XX					0.825

Equation 13

$$PE_{ref,PJ} = \left(Q_{ref,PJ,y}\right) \times GWP_{ref,PJ}$$

Year	$PE_{ref,PJ,y}$	$Q_{ref,PJ,y}$	$GWP_{ref,PJ}$
	t CO_2e/year	tonnes /year	t CO_2e/t refrigerant
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			
20XX			

Equation 14

$$ER_{HP,y} = \left(BE_{HP,y} - LE_{HP,y} - PE_{HP,y}\right) \times I_{HP,y} \times F_{HP,y}$$

Year	$ER_{HP,y}$	$BE_{HP,y}$	$LE_{HP,y}$	$PE_{HP,y}$	$I_{HP,y}$	$F_{HP,y}$
	tons CO_2/year	tons CO_2/year	tons CO_2/year	tons CO_2/year	percentage	percentage
20XX			0			
20XX			0			
20XX			0			
20XX			0			
20XX			0			
20XX			0			
20XX			0			
20XX			0			
20XX			0			

20XX			0			

Leakage Emissions

If the technology is equipment transferred from another activity then leakage must be considered. In this PoA, all technology installed in the houses is new technology that has not been previously used.

If the baseline equipment or replaced equipment is not destroyed or scrapped then leakage must be considered. In this PoA, the electric element is the piece of equipment replaced. The electric element is disconnected. By disconnecting the electric element, the electric geyser (baseline water heating method) is no longer usable. The installer of the heat pump and/or solar water heater must record that the electric element is disabled and this must be checked in the installation inspection which happens within three months of installation. Provided that the electric element has been disconnected, no leakage occurs under this PoA.

In addition, independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Note that the electric element must be present when the independent monitoring is conducted. This will show that the electric element has not be sold off or used in another application. However, the electric element must be disconnected.

If an electric element is found to not have been disconnected in the independent monitoring conducted on an annual basis then the emission reductions from that unit are removed from the total emission reductions. In other words, no emission reductions can be claimed for that unit and leakage is considered by removing the emission reductions from that unit.

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	Leakage
Unit	Not applicable
Description	Electric elements for all electric geyser replaced must be disconnected.
Source of data	Installer to record that the electric element has been disconnected.
Value(s) applied	For the purposes of the ex-ante calculation of emission reductions, we have assumed that all electric elements for existing electric water heaters have been disconnected.
Measurement methods and procedures	Installer to record upon installation of the unit. This to be checked by independent monitoring conducted annually.
Monitoring frequency	Installer to record at the time of installation. Independent monitoring to be conducted annually.
QA/QC procedures	Independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected. Note that the electric element must be present when the independent monitoring is conducted. This will show that the electric element has not be sold off or used in another application. However, the electric element must be disconnected. A report is produced and compared to the confirmation by the installers to check that the electric elements have been disconnected. If there are any discrepancies then the CME will take the most conservative approach and discount the emission reductions from solar water heaters or heat pumps installed in households where the electric elements of the existing electric geyser have not been disconnected.
Purpose of data	To determine the leakage emissions
Additional comments	No comment

Data / Parameter	$N_{i,L,y}$
Unit	Number
Description	Number of solar water heaters of type 'i' that have been installed in low income households in year y
Source of data	Electronic database
Value(s) applied	Dependent on number installed – based on installation plan
Measurement methods and procedures	The installer records the installation of the unit and completes both the installer form and the Eskom rebate form. These forms are used to determine the number of solar water heaters of type 'i' that have been installed in low income households in year y
Monitoring frequency	Annually
QA/QC procedures	The number of installed devices is compared with the number of replaced devices to ensure that the numbers match. If the numbers do not match then an explanation for the difference needs to be provided and the lower number is selected.
Purpose of data	To determine the emission reductions from solar water heaters installed in low income households
Additional comments	No comment

Data / Parameter	$N_{i,C,y}$
Unit	Number
Description	Number of solar water heaters of type 'i' that have been installed in community residential units in year y
Source of data	Electronic database
Value(s) applied	Dependent on number installed – based on installation plan
Measurement methods and procedures	The installer records the installation of the unit and completes both the installer form and the Eskom rebate form. These forms are used to determine the number of solar water heaters of type 'i' that have been installed in community residential units in year y
Monitoring frequency	Annually
QA/QC procedures	The number of installed devices is compared with the number of replaced devices to ensure that the numbers match. If the numbers do not match then an explanation for the difference needs to be provided and the lower number is selected.
Purpose of data	To determine the emission reductions from solar water heaters installed in community residential units
Additional comments	No comment

Data / Parameter	$N_{i,MH,y}$
Unit	Number
Description	Number of solar water heaters of type 'i' that have been installed in middle and high income households in year y
Source of data	Electronic database
Value(s) applied	Dependent on number installed – based on installation plan
Measurement methods and procedures	The installer records the installation of the unit and completes both the installer form and the Eskom rebate form. These forms are used to determine the number of solar water heaters of type 'i' that have been installed in middle and high income households in year y
Monitoring frequency	Annually
QA/QC procedures	The number of installed devices is compared with the number of replaced devices to ensure that the numbers match. If the numbers do not match then an explanation for the difference needs to be provided and the lower number is selected.
Purpose of data	To determine the emission reductions from solar water heaters installed in middle and high income households
Additional comments	No comment

Data / Parameter	$I_{SWH,y}$
Unit	Percentage of properly installed solar water heaters
Description	Inspection and acceptance testing within three months of installation
Source of data	Inspection conducted within three months of installation of each unit
Value(s) applied	For the purposes of ex-ante calculation of emission reductions, we have assumed that all the solar water heaters have been properly installed.
Measurement methods and procedures	Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications.
Monitoring frequency	Once within three months of installation.
QA/QC procedures	Results of the inspection will be recorded on the installation inspection form
Purpose of data	Used to determine the number of solar water heaters that are operational
Additional comments	No comment

Data / Parameter	$F_{SWH,y}$
Unit	Percentage of solar water heaters installed that are operational
Description	Failure rate of solar water heaters (expressed as a percentage of solar water heaters that are operational)
Source of data	Monitoring a sample of installations.
Value(s) applied	For the purposes of ex-ante calculation of emission reductions, we have assumed that all the solar water heaters are operating.
Measurement methods and procedures	A sample of units is checked to see that the units are operating. The results of the sample are extrapolated to the entire population group. Please see sampling plan for more details.
Monitoring frequency	A sample of units is checked annually.
QA/QC procedures	Results of the monitoring will be recorded on the monitoring form
Purpose of data	Used to determine the number of solar water heaters that are operational
Additional comments	No comment

Data / Parameter	Characteristics of the baseline water heating system
Unit	Not applicable
Description	The characteristics of the baseline water heating system
Source of data	Eskom rebate form and installation inspection form
Value(s) applied	Not applicable
Measurement methods and procedures	The characteristics of the baseline water heating system must be recorded on installation of the solar water heater. These characteristics include: 1. The type of house (load type) 2. The number of occupants in the residence or the number of units in the residence (occupants/number of units) 3. Whether the house is the primary residence of the occupants (occupancy rate) 4. Operating days per week 5. Type of water heating device – including size of storage and electric element, water heating system efficiency, electricity input and output capacity and insulation
Monitoring frequency	On installation of the new solar water heater
QA/QC procedures	Not applicable
Purpose of data	Data to be used in the model
Additional comments	No additional comments

Data / Parameter	Characteristics of project system
Unit	Not applicable
Description	The characteristics of the solar water heating system installed
Source of data	Manufacturer's specifications and installation form
Value(s) applied	Dependent on unit installed
Measurement methods and procedures	The characteristics of the project system must be recorded on the installation of the solar water heater. The characteristics include: 1. Solar collector size 2. Technical and thermal performance ratings 3. Collector orientation 4. Storage tank size 5. Insulation 6. Solar tracking mode 7. Slope 8. Azimuth 9. Type of solar water heating system 10. Manufacturer and model 11. Gross area per solar collector 12. Aperture area per solar collector 13. Fr (tau alpha) coefficient 14. Fr UL coefficient 15. Temperature coefficient for Fr UL 16. Number of collectors 17. Miscellaneous losses from the solar water heater 18. Storage 19. Storage capacity/solar collector area 20. Heat exchanger 21. Heat exchanger efficiency 22. Miscellaneous losses from the heat exchanger 23. Pump power/ solar collector area All these parameters must be recorded by the CPA implementer in the electronic database prior to installation.
Monitoring frequency	For each new installation
QA/QC procedures	The information recorded on installation will be cross-checked with manufacturer's specifications and also checked in the inspection that happens within three months of installation of the solar water heater.
Purpose of data	Data to be used in the model
Additional comments	No additional comments

Data / Parameter	**Hot water consumption and hot water load profile for middle and high income households**
Unit	Litres per person per day
Description	Consumption of hot water by middle and high income households and hot water load profile
Source of data	The hot water consumption and hot water load profile for middle and high income households is monitored. The value for the ex-ante calculation is sourced from: Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa.* Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf.
Value(s) applied	50 litres per person per day[83]
Measurement methods and procedures	The hot water consumption is measured in a sample of households. The hot water consumption is measured for two periods of 30 days each. The sample is changed each year and the monitoring is repeated. A temporary flow measuring device will need to be used.
Monitoring frequency	Two periods of 30 days each (one in winter and one in summer) on an annual basis. Each year, a new sample is selected.
QA/QC procedures	The measured hot water consumption values will be divided by the number of full time occupants to determine the litres per person per day. This will then be compared with the 50 litres per person per day. The most conservative value will be selected and used in the calculations.
Purpose of data	To determine the emission reductions from the installation of solar water heaters in middle and high income households. Data to be used in the model.
Additional comment	No additional comment

[83] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf. [Accessed 13 November 2011].

Data / Parameter	Outlet water temperature for low income households
Unit	°C
Description	The temperature of the water that has been heated by the water heating system/solar water heater in low income households. This is the temperature at which the water is consumed.
Source of data	The outlet water temperature for low income households is monitored. The value for the ex-ante calculation is sourced from the thermostat setpoint or from: Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf.
Value(s) applied	65°C[84]
Measurement methods and procedures	The outlet water temperature is measured in a sample of households. The outlet water temperature is measured for two periods of 30 days each. The sample is changed each year and the monitoring is repeated. A temporary thermostat will need to be used.
Monitoring frequency	Two periods of 30 days each (one in winter and one in summer) on an annual basis. Each year, a new sample is selected.
QA/QC procedures	The measured outlet temperature values will be measured at the point of consumption and will be compared to the thermostat setpoint. The lowest value will be used and all solar water heater installations in low income households will use the lowest value for outlet water temperature.
Purpose of data	To determine the emission reductions from the installation of solar water heaters in low income households. Data to be used in the model.
Additional comments	No additional comment

[84] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf. [Accessed 13 November 2011].

Data / Parameter	Outlet water temperature for middle and high income households
Unit	^{o}C
Description	The temperature of the water that has been heated by the water heating system/solar water heater in middle and high income households. This is the temperature at which the water is consumed.
Source of data	The outlet water temperature for middle and high income households is monitored. The value for the ex-ante calculation is sourced from the thermostat setpoint or from: Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa.* Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf.
Value(s) applied	65°C[85]
Measurement methods and procedures	The outlet water temperature is measured in a sample of households. The outlet water temperature is measured for two periods of 30 days each. The sample is changed each year and the monitoring is repeated. A temporary thermostat will need to be used.
Monitoring frequency	Two periods of 30 days each (one in winter and one in summer) on an annual basis. Each year, a new sample is selected.
QA/QC procedures	The measured outlet temperature values will be measured at the point of consumption and will be compared to the thermostat setpoint. The lowest value will be used and all solar water heater installations in middle and high income households will use the lowest value for outlet water temperature.
Purpose of data	To determine the emission reductions from the installation of solar water heaters in middle and high income households. Data to be used in the model.
Additional comments	No additional comment

[85] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf. [Accessed 13 November 2011].

Data / Parameter	Outlet water temperature for community residential units
Unit	^{o}C
Description	The temperature of the water that has been heated by the water heating system/solar water heater in community residential units. This is the temperature at which the water is consumed.
Source of data	The outlet water temperature for community residential units is monitored. The value for the ex-ante calculation is sourced from the thermostat setpoint or from: Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf.
Value(s) applied	65°C[86]
Measurement methods and procedures	The outlet water temperature is measured in a sample of households. The outlet water temperature is measured for two periods of 30 days each. The sample is changed each year and the monitoring is repeated. A temporary thermostat will need to be used.
Monitoring frequency	Two periods of 30 days each (one in winter and one in summer) on an annual basis. Each year, a new sample is selected.
QA/QC procedures	The measured outlet temperature values will be measured at the point of consumption and will be compared to the thermostat setpoint. The lowest value will be used and all solar water heater installations in community residential units will use the lowest value for outlet water temperature.
Purpose of data	To determine the emission reductions from the installation of solar water heaters in community residential units. Data to be used in the model.
Additional comments	No additional comment

[86] Meyer, J.P. 2000. *A review of domestic hot water consumption in South Africa*. Available online from http://www.saimeche.org.za/resource/collection/7915CD6C-4630-4CC2-B1A9-D88F283AA600/Meyer-2000_02__600_dpi_-_2000__16_3___55-61.pdf. [Accessed 13 November 2011].

Data / Parameter	Solar radiation data/weather data
Unit	Not applicable
Description	The solar insolation data and ambient temperature
Source of data	RETScreen model - since more than one solar water heating system is installed as part of this project, the solar insolation data and ambient temperature can be representative of all project systems. Currently, the data is sourced from climatic data for South Africa supplied by NASA. The solar radiation data will be measured in order to calibrate the model.
Value(s) applied	Not applicable
Measurement methods and procedures	RETScreen model - since more than one solar water heating system is installed as part of this project, the solar insolation data and ambient temperature can be representative of all project systems. Currently, the data is sourced from climatic data for South Africa supplied by NASA. The solar radiation data will be measured in order to calibrate the model. The measured weather data will be entered into the RetScreen model and the model will determine the inlet water temperature from the entered data. The RETScreen model was pre-approved by the UNFCCC and developed by Natural Resources Canada (http://www.retscreen.net/ang/home.php)
Monitoring frequency	The solar radiation data will be measured in order to calibrate the model. Please see monitoring plan for more detail.
QA/QC procedures	Not applicable
Purpose of data	Data to be used in the model
Additional comments	No additional comments

Heat pumps

Data / Parameter	ρ_i *baseline*
Unit	kW
Description	Power of the devices of the group of "i" for baseline devices
Source of data	Eskom rebate form
Value(s) applied	Dependent on the rating of the electric element of the existing water heating system
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 at the time of installation.
Monitoring frequency	For each new installation
QA/QC procedures	All replaced devices will be kept. A sample of devices will be inspected by an independent third party on an annual basis. Please see sampling plan for more details. The same sample of systems will also have independent verification done by a credible third party of the power of the installed baseline device. The report by the third party must be provided to the DOE. This will be compared to what was recorded at the time of installation of the devices.
Purpose of data	Calculation of baseline emissions
Additional comments	No additional comments

Data / Parameter	$Q_{ref,PJ,y}$
Unit	Tonnes/year
Description	Average annual quantity of refrigerant used in year y to replace refrigerant that has leaked in year y
Source of data	The source of the ex-ante data: Default values for refrigerant charge from manufacturer's specifications. The source of the ex-post data: The household is provided with a manual that contains the contact details of the supplier and CPA implementer. If the household contacts the supplier or the CPA implementer and requires a refrigerant refill then the amount refilled must be recorded. During annual inspection of the operation of the heat pump, the refrigerant levels must be checked. If the refrigerant is refilled then this must be recorded.
Value(s) applied	The amount of refrigerant refilled is a measure of the refrigerant consumption
Measurement methods and procedures	The Average annual quantity of refrigerant used in year y to replace refrigerant that has leaked in year y is monitored as follows: 1. If the household contacts the supplier or CPA implementer and the refrigerant is refilled then the amount refilled must be recorded. 2. During annual inspection of the operation of the heat pumps, the refrigerant levels must be checked. If the refrigerant is refilled then this must be recorded. This will provide an indication of the annual quantity of refrigerant used in year y to replace refrigerant that has leaked in year y. Please see monitoring and sampling plan for more details.
Monitoring frequency	Annually
QA/QC procedures	The amount refilled will be compared with manufacturer's specifications. The amount refilled should not be higher than the manufacturer's specified value of total refrigerant in the heat pump. If the amount refilled is higher, it must be explained by the CPA implementer. If this cannot be explained then the higher consumption will be used.
Purpose of data	This is used to calculate the emissions resulting from the consumption of refrigerant. This is only required if the refrigerant used has a global warming potential.
Additional comments	No additional comments

Data / Parameter	$\rho_{i,project}$
Unit	kW
Description	Power of the devices of the group of "i" for project devices
Source of data	Manufacturer's specifications for heat pump to be installed
Value(s) applied	Dependent on the rating of the heat pump to be installed
Measurement methods and procedures	The power of the nameplate data of the heat pump will be recorded into the database. 100 % of the data shall be recorded.
Monitoring frequency	Check once at installation
QA/QC procedures	Not applicable
Purpose of data	Calculation of project emissions
Additional comments	No additional comments

Data / Parameter	n_i
Unit	number
Description	Number of devices of the group of *"i"* devices replaced, for which the project energy efficient equipment is operating during the year
Source of data	Number of devices replace will be equivalent to the number of heat pumps installed in the households
Value(s) applied	Dependent on the number of heat pumps installed
Measurement methods and procedures	The number of heat pumps installed and electric elements disconnected are recorded in the electronic database
Monitoring frequency	Once at installation of the heat pump
QA/QC procedures	Not applicable
Purpose of data	To determine the baseline and project emissions
Additional comments	No additional comments

Data / Parameter	$o_{i,project}$
Unit	hours
Description	Average annual operating hours of the devices of the group of *"i"* project devices
Source of data	Measurement of the number of operating hours of a sample of units installed using run time meters
Value(s) applied	The values will only be available after measurement
Measurement methods and procedures	A number of heat pumps will be fitted with run time meters to measure the operating hours. Please see the sampling plan for more details.
Monitoring frequency	See monitoring and sampling plan for more details.
QA/QC procedures	Not applicable
Purpose of data	To calculate the project emissions
Additional comments	No additional comments

Data / Parameter	$I_{HP,y}$
Unit	Percentage of heat pumps that are properly installed.
Description	Inspection and acceptance testing within three months of installation
Source of data	Inspection conducted within three months of installation of each unit
Value(s) applied	For the purposes of ex-ante calculation of emission reductions, we have assumed that all the heat pumps have been properly installed.
Measurement methods and procedures	Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications.
Monitoring frequency	Once within three months of installation.
QA/QC procedures	Results of the inspection will be recorded on the installation inspection form
Purpose of data	Used to determine the number of heat pumps that are operational
Additional comments	No comment

Data / Parameter	$F_{HP,y}$
Unit	Percentage of heat pumps installed that are operational
Description	Failure rate of heat pumps (expressed as a percentage of heat pumps that are operational)
Source of data	Monitoring a sample of installations.
Value(s) applied	For the purposes of ex-ante calculation of emission reductions, we have assumed that all the heat pumps are operating.
Measurement methods and procedures	A sample of units is checked to see that they are operating. The results of the sample are extrapolated to the entire population group. Please see sampling plan for more details.
Monitoring frequency	A sample of units is checked annually.
QA/QC procedures	Results of the monitoring will be recorded on the monitoring form
Purpose of data	Used to determine the number of heat pumps that are operational
Additional comments	No comment

Data / Parameter	$GWP_{ref,PJ}$
Unit	tCO_2e/t refrigerant
Description	Global warming potential of refrigerant used in the heat pump
Source of data	The type of refrigerant is given in manufacturer's specifications. The global warming potential of the refrigerant is sourced from Intergovernmental Panel on Climate Change (IPCC).
Value(s) applied	Dependent on refrigerant type
Measurement methods and procedures	Data extracted from the IPCC list of greenhouse gases. The IPCC is checked on an annual basis for any updates in the GWP of the refrigerants in question. For any new units included in the PoA from existing or new pre-selected installers, the type of refrigerant will be recorded. Upon installation of a new unit, the type of unit installed is recorded. This is then matched to a type of refrigerant.
Monitoring frequency	The type of unit installed is monitored for each new installation as is the type of refrigerant used in the unit installed. The IPCC GWPs of the refrigerants are monitored on an annual basis for any updates.
QA/QC procedures	The number of a certain type of unit installed over a month is compared to installer's records to crosscheck. The type of unit installed is also checked at the inspection which happens within three months of installation. The type of unit is then matched to a refrigerant using the manufacturer's specifications for the unit.
Purpose of data	The global warming potential of the refrigerant gas is used to determine the emissions that result from refrigerant loss.
Additional comment	No further comment

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

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Roles and Responsibilities

The CME and the CPA implementer have a number of roles and responsibilities under the PoA. The roles and responsibilities are described below. The CME has the following responsibilities:

- The CME is responsible for communication with the DOE and the CDM EB or UNFCCC.
- The CME is responsible for selecting and approving which CPAs are allowed to be included in the PoA. The CME checks the CPA against the eligibility criteria of the PoA.
- The CME is responsible for pre-selecting/pre-approving installers. The CME has control over what installers are used in the CPA in order to ensure quality of installation. The CME pre-approves installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards.

- For community residential units, the CME has control over what installers are used in the CPA in order to ensure quality of installation. The CPA implementer selects the CRU where it will manage the installation of solar water heaters. The CME goes out to tender for installers for the selected CRU. The CME appoints installers based on a number of criteria such as the type of technologies offered by the installers and the adherence of the technologies to national standards.

- The CME is responsible for managing and maintaining a central electronic database to record information for each installation. The CPA implementer provides the CME with the required information.

- The CME is responsible for updating the calculation of the grid emission factor.

- The CME is responsible for checking that the unit/household is not included in another CPA of the same PoA or a different PoA. The CME is also responsible for checking that the CPA is not included in another PoA.

- The CME can also conduct periodic checks (at least annually) of each CPA to ensure that monitoring is being conducted correctly and that the rules and requirements of the PoA are being adhered to in the CPA.

The CPA implementer has the following responsibilities:

- For low income households, the CPA implementer selects an installer from the list of installers approved by the CME. The CPA implementer also selects the low income area where it will manage the installation of solar water heaters and ensure that the units are correctly installed. The CPA implementer is also responsible for maintaining the units for ten years after the installation. In order to do this maintenance, the CPA implementer needs to have a maintenance programme in place.

- For community residential units, the CPA implementer selects the CRU where it will manage the installation of solar water heaters.

  For middle and high income households, the CPA implementer will contact a number of credible installers which have reliable technology. The CPA implementer also provides the household with a discount for the units installed. The CPA implementer uses the revenue from the carbon credits to manage (managing a database of interested households, matching them with installers and monitoring installation of the units) and promote the project and to get more middle and upper income households to express an interest in having a unit installed ensuring awareness creation.

- There is an agreement between the household and the CPA implementer regarding carbon credit ownership. The household cedes rights to the carbon credits to the CPA implementer.

- The CPA implementer provides the CME with the required information for each installation. Some of this information has been captured by the installers (Eskom rebate form, installation form and manufacturer's specifications). Some of this information is captured by the CPA implementer (installation inspection form and monitoring form). The CPA implementer compiles the documentation and gives them to the CME to be recorded in the electronic database. The following documents are required for each installation: Eskom rebate form, manufacturer's specifications of the unit. Installation inspection form and monitoring form.

- The CPA implementer or a representative of the CPA implementer will physically inspect each installation within three months of installation to ensure quality of installation and will only include units that have been correctly installed under the CPA.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the solar water heater or heat pump. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- The CPA implementer is responsible for monitoring the operation of a sample of solar water heaters and heat pumps to ensure operation.

- The CPA implementer is responsible for calibrating the model as per the requirement of the PoA and for monitoring the outlet water temperature and the hot water flowrate as per the requirements of the PoA. See section below for more details

- The CPA implementer is responsible for monitoring the amount of refrigerants used and the operating hours of the heat pumps as per the requirements of the PoA.

- The CPA implementer must produce a monthly monitoring report for the CME on the progress with the CPA and all relevant monitoring details as specified under this PoA.

The installers also have a number of functions to perform such as capturing all information correctly on installation.

Training

Owing to the number of roles and responsibilities, training is important. The CME will be responsible for training the CPA implementer on the rules and requirements of the PoA. The CME will also be responsible for training the installers on what is required in terms of the PoA. The CPA implementer is responsible for ensuring that the installers are performing properly by checking the documentation submitted by the installer (Eskom rebate form, installation form and manufacturer's specifications) and checking the unit three months after installation.

In order to train the CPA implementer and the installer, the CME will provide the relevant parties with the PoA that sets out the rules and requirements and with all the required forms. The CME will also have a training workshop when new CPAs are added onto the programme in order to train the CPA implementer.

All data is stored for two years after the end of the crediting period.

Solar water heating systems

Solar water heating installations in middle and high income households will be monitored as follows:

- The installer must document the sizing calculations of the solar water heating system. The sizing calculations must be done so that the average annual, daily amount of water heated by the system is less than or equal to the average annual, daily hot water demand for a typical installation.

At the time of installation the installer records the number of people in the household, the baseline and project water heating system characteristics and whether or not this is the primary residency of the occupants. This data is required in the model.

The installer must check at the initial site visit that the household is residential and not commercial or industrial and that the household is grid-connected (prior to installation of the unit). At installation, all project system characteristics of the unit installed must be captured. The number of the specific type of units installed must be recorded. The installer must disconnect the electric element of the conventional electric geyser and record that this has been done.

- Upon installation of the solar water heating system, the installer is required to record all details of the project system and also the slope, azimuth and solar tracking mode.

  These parameters will be checked at the same time as the sample of systems is checked to ensure operation and compliance with manufacturer-required maintenance procedures.

- The installation date of each solar water heating system will be recorded by the installer.

- Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications. Acceptance testing will be documented and confirm system operation, per design specifications, and change-of-operating modes over a range of typical operating conditions. At this stage, it must be checked that the electric element of the baseline electric geyser has been disconnected and is not working. In addition, the CPA implementer must check that only one unit is installed in the household.

- Emission reductions can only be claimed for systems that are operational and in compliance with manufacturer-required maintenance procedures. A sample of systems will be checked annually to ensure that they are operating and are in compliance with manufacturer-required maintenance procedures. The sample size will be selected to meet a 90% confidence interval and 10% margin of error. Please see the sampling plan for more information on how the sample size will be determined.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the solar water heater. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- The CPA implementer is responsible for monitoring the hot water flowrate and hot water load profile and outlet water temperature as required by the methodology. A sample of systems is selected on an annual basis. See sampling plan for more details. The hot water flowrate and hot water load profile and temperature of the hot water consumed is monitored. The monitoring takes place annually in a sample of systems for two periods of 30 days each. One of these periods must be in the summer months and the other period must be in the winter months. A temporary flow measuring device and thermostat will be used to monitor the hot water consumption flowrate and load profile and the temperature of the hot water consumed. This will be used to adjust the values used in the model for middle and high income households. In all cases, the most conservative value is used for the outlet water temperature and the volume of water consumed per person per day.

- The model must be calibrated. The following parameters must be measured: weather data (solar insolation data and ambient temperature) and inlet and outlet water temperatures. This will be done for two periods of 30 days (one in winter and one in summer). These values will be used to check the values used in the model. The water flowrate and the outlet water temperature are already monitored and these monitored values will be used to calibrate the model. The baseline and project system characteristics are all recorded for each installation and used in the model. The parameters measured are linked to the climatic conditions in the area. The results from the measurement site will be used for all installations within a 50 km radius of the installation as weather patterns are similar within this area[87]. Hence, the weather data will be measured at this measurement site and the results will be used for all installations within a 50 km radius of the measurement site. The weather data measured will be used to calibrate the model.

- Independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Solar water heating installations in low income households will be monitored as follows:

- Upon the initial site visit or installation of the solar water heater, the installer must record the characteristics of the baseline water heating system (fuel type and water heating method) and the characteristics of the project system (solar collector area, tilt and orientation of the solar collectors and tank volume).

- The installer must check at the initial site visit that the household is residential and not commercial or industrial and that the household is grid-connected (prior to installation of the unit). At installation, all project system characteristics of the unit installed must be captured. The number of the specific type of units installed must be recorded. The installer must disconnect the electric element of the conventional electric geyser and record that this has been done.

- Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications. Acceptance testing will be documented and confirm system operation, per design specifications, and change-of-operating modes over a range of typical operating conditions. At this stage, it must be checked that the electric element of the baseline electric geyser has been disconnected and is not working. In addition, the CPA implementer must check that only one unit is installed in the household.

- Emission reductions can only be claimed for systems that are operational and in compliance with manufacturer-required maintenance procedures. A sample of systems will be checked annually to ensure that they are operating and are in compliance with manufacturer-required maintenance procedures. The sample size will be selected to meet a 90% confidence interval and 10% margin

[87] The rationale for the selection of the 50 km radius is based on measurements from three (3) weather stations near Nelson Mandela Bay, namely Addo [33° 34'E; 25° 42' S; Altitude 85m], Jansenville [32° 59'E; 25° 36' S; Altitude 60m] and East London [33° 01'E; 27° 49' S; Altitude 155m]. Between these three sites the maximum variance in annual average global radiation is 2 %, between Addo and Jansenville, which are in 115 km distance from each other. Eberhard Anton, A 1990, "A solar Radiation Data Handbook for Southern Africa", p 62 – 69.

of error. Please see the sampling plan for more information on how the sample size will be determined.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the solar water heater. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- The CPA implementer is responsible for monitoring the outlet water temperature as required by the methodology. A sample of systems is selected on an annual basis. See sampling plan for more details. The temperature of the hot water consumed is monitored. The monitoring takes place annually in a sample of systems for two periods of 30 days each. One of these periods must be in the summer months and the other period must be in the winter months. A temporary thermostat will be used to monitor the temperature of the hot water consumed. This will be used to adjust the values used in the model for low income households. In all cases, the most conservative value is used for the outlet water temperature.

- The model must be calibrated. The following parameters must be measured: weather data (solar insolation data and ambient temperature) and inlet and outlet water temperatures. This will be done for two periods of 30 days (one in winter and one in summer). These values will be used to check the values used in the model. The water flowrate and the outlet water temperature are already monitored and these monitored values will be used to calibrate the model. The baseline and project system characteristics are all recorded for each installation and used in the model. The parameters measured are linked to the climatic conditions in the area. The results from the measurement site will be used for all installations within a 50 km radius of the installation as weather patterns are similar within this area[88]. Hence, the weather data will be measured at this measurement site and the results will be used for all installations within a 50 km radius of the measurement site. The weather data measured will be used to calibrate the model.

- Independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Solar water heating installations in community residential units will be monitored as follows:

- The installer must document the sizing calculations of the solar water heating system. The sizing calculations must be done so that the average annual, daily amount of water heated by the system is less than or equal to the average annual, daily hot water demand for a typical installation.

[88] The rationale for the selection of the 50 km radius is based on measurements from three (3) weather stations near Nelson Mandela Bay, namely Addo [33° 34'E; 25° 42' S; Altitude 85m], Jansenville [32° 59'E; 25° 36' S; Altitude 60m] and East London [33° 01'E; 27° 49' S; Altitude 155m]. Between these three sites the maximum variance in annual average global radiation is 2 %, between Addo and Jansenville, which are in 115 km distance from each other. Eberhard Anton, A 1990, "A solar Radiation Data Handbook for Southern Africa", p 62 – 69.

At the time of installation the installer records the number of people in the household, the baseline and project water heating system characteristics and whether or not this is the primary residency of the occupants. This data is required in the model.

The installer must check at the initial site visit that the household is residential and not commercial or industrial and that the household is grid-connected (prior to installation of the unit). At installation, all project system characteristics of the unit installed must be captured. The number of the specific type of units installed must be recorded. The installer must disconnect the electric element of the conventional electric geyser and record that this has been done.

- Upon installation of the solar water heating system, the installer is required to record all details of the project system and also the slope, azimuth and solar tracking mode.

  These parameters will be checked at the same time as the sample of systems is checked to ensure operation and compliance with manufacturer-required maintenance procedures.

- The installation date of each solar water heating system will be recorded by the installer.

- Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications. Acceptance testing will be documented and confirm system operation, per design specifications, and change-of-operating modes over a range of typical operating conditions. At this stage, it must be checked that the electric element of the baseline electric geyser has been disconnected and is not working. In addition, the CPA implementer must check that only one unit is installed in the household.

- Emission reductions can only be claimed for systems that are operational and in compliance with manufacturer-required maintenance procedures. A sample of systems will be checked annually to ensure that they are operating and are in compliance with manufacturer-required maintenance procedures. The sample size will be selected to meet a 90% confidence interval and 10% margin of error. Please see the sampling plan for more information on how the sample size will be determined.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the solar water heater. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- The CPA implementer is responsible for monitoring the outlet water temperature as required by the methodology. A sample of systems is selected on an annual basis. See sampling plan for more details. The temperature of the hot water consumed is monitored. The monitoring takes place annually in a sample of systems for two periods of 30 days each. One of these periods must be in the summer months and the other period must be in the winter months. A temporary thermostat will be used to monitor the temperature of the hot water consumed. This will be used to adjust the values used in the model for low income households. In all cases, the most conservative value is used for the outlet water temperature.

- The model must be calibrated. The following parameters must be measured: weather data (solar insolation data and ambient temperature) and inlet and outlet water temperatures. This will be done for two periods of 30 days (one in winter and one in summer). These values will be used to check the values used in the model. The water flowrate and the outlet water temperature are

already monitored and these monitored values will be used to calibrate the model. The baseline and project system characteristics are all recorded for each installation and used in the model. The parameters measured are linked to the climatic conditions in the area. The results from the measurement site will be used for all installations within a 50 km radius of the installation as weather patterns are similar within this area[89]. Hence, the weather data will be measured at this measurement site and the results will be used for all installations within a 50 km radius of the measurement site. The weather data measured will be used to calibrate the model.

- Independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Heat pumps

The methodology applied to heat pump installations requires the following to be monitored:

- The installer is required to record technical information regarding the existing water heating system in the household at the initial site visit. The power of the baseline device must be recorded. In addition, the sizing calculations and the selection of the heat pump technology must be documented at either the initial site visit or installation. The installer must check at the initial site visit that the household is residential and not commercial or industrial and that the household is grid-connected (prior to installation of the unit). At installation, all project system characteristics of the unit installed must be captured. This includes the global warming potential of refrigerant used in the heat pump. The number of the specific type of units installed must be recorded. The installer must disconnect the electric element of the conventional electric geyser and record that this has been done.

- Upon installation of the unit, the household representative is presented with a manual for the operation of the heat pump. The manual contains the contact details of the installer and the CPA implementer. If there is a problem with the unit then the household can contact either the installer or the CPA implementer. The problem and solution must be recorded and form part of the monitoring forms that the CPA implementer prepares and submits to the CME.

- Within three months of the installation, each system will be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications. At this stage, it must be checked that the electric element of the baseline electric geyser has been disconnected and is not working. In addition, the CPA implementer must check that only one unit is installed in the household.

- The installation date of each solar water heating system will be recorded by the installer.

[89] The rationale for the selection of the 50 km radius is based on measurements from three (3) weather stations near Nelson Mandela Bay, namely Addo [33° 34'E; 25° 42' S; Altitude 85m], Jansenville [32° 59'E; 25° 36' S; Altitude 60m] and East London [33° 01'E; 27° 49' S; Altitude 155m]. Between these three sites the maximum variance in annual average global radiation is 2 %, between Addo and Jansenville, which are in 115 km distance from each other. Eberhard Anton, A 1990, "A solar Radiation Data Handbook for Southern Africa", p 62 – 69.

- Emission reductions can only be claimed for systems that are operational and in compliance with manufacturer-required maintenance procedures. A sample of non-metered systems (systems that are not monitored for operating hours) will be checked annually to ensure that they are operating and are in compliance with manufacturer-required maintenance procedures. The sample size will be selected to meet a 90% confidence interval and 10% margin of error. Please see the sampling plan for more information on how the sample size will be determined.

- Monitoring should include the monitoring of the operating hours of a sample of heat pumps installed using run time meters. The sample size will be selected to meet a 90% confidence interval and 10% margin of error. Please see the sampling plan for more information on how the sample size will be determined and the sampling plan.

- The monitoring includes the monitoring of the power of devices replaced. The power of all devices replaced is recorded. All devices are kept. For a sample of devices, an independent third party will perform physical verification of the power of these devices. Please see sampling plan for more details. The report by the third party will be made available to the DOE.

- The annual quantity of refrigerant refilled to replace of the amount of refrigerant consumed will be monitored. The monitoring method involves: if there is a problem with the unit then the household can contact the supplier or CPA implementer. If this problem is the refrigerant and a refill is required then the amount refilled and the type of refrigerant must be recorded. At the annual inspection of the operation of the unit, the amount of refrigerant will be checked. If a refill is required then the amount refilled and the type of refrigerant must be recorded. This must form part of the monitoring report. The refrigerant only needs to be monitored if it has a global warming potential in accordance with the Intergovernmental Panel on Climate Change (IPCC).

- Independent monitoring of the disconnected ("scrapped") electric elements must be conducted. The monitoring will be conducted by an independent third party that is not associated with the CME or CPA Implementer and that can demonstrate their independence from the project (i.e. not an installer on the pre-selected installer database). The independent third party will conduct this monitoring on an annual basis and will check that the number of units installed in the year match the number of disconnected electric elements in existing electric geysers. The independent third party will also check that these electric elements are properly disconnected and cannot be used by the household or reconnected.

Sampling Plan

1. Sample size to check operation of units

   Sampling approach, assumptions and justifications:

   The population under study is not homogeneous, but instead consists of several subpopulations which are known (or thought) to vary. According to the Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2), in this case, it is better to take a simple random sample from each of these sub-populations separately. This is called stratified random sampling. The subpopulations are called the strata.

   - Heat pumps in Community Residential Units
   - Heat pumps in middle and high income households

- Solar water heaters in low income households
- Solar water heaters in Community Residential Units
- Solar water heaters in middle and high income households

To confirm the number of operating systems, the population is divided into the strata as defined above. Note that it is important that all metered sites are removed from the population before a simple random sample is taken of each stratum. The reason for removing all metered sites (sites being measured in the year for outlet water temperature, hot water consumption and load profiles and operating hours) is that AMS II.C requires that a sample of non-metered systems is checked for operation. Also note that the heat pumps selected in the simple random sample to confirm the number of operating systems is also checked for refrigerant refill.

An explanation of the sampling equation is provided below:

The Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2) states the following: '*Where there is no specific guidance in the applicable methodology, project proponents shall use 90/10 confidence/precision as the criteria for reliability of sampling efforts. This reliability specification shall be applied to determine the sampling requirements for each individual parameter value determined through a sampling effort*.' In addition, AMS I.J specifies the use of 90/10 confidence/precision. As such, we have used this.

In accordance with the 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' (Version 01.0, EB 67, Annex 6), equation 5 is used for stratified random sampling. Note that this equation is used for each stratum to determine the sample size for each stratum.

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where:

$$V = \frac{SD^2}{\overline{p}^2}$$

n	Sample size
N	Total number of households
SD	Expected standard deviation
$\overline{p}$	The overall proportion
1.645	90% confidence level
0.1	10% relative precision

The sample size is calculated for each CPA by each CPA implementer. A minimum sample size of 30 must be used for calculations returning minimum values of less than 30.

2. Solar water heaters: sample size for monitoring the hot water consumption and hot water load profile for middle and high income households

Temporary flowmeters will need to be installed on a sample of solar water heater installations in middle and high income households in order to measure the hot water consumption of the household and hot water load profile. The sampling design is provided below:

Sampling approach, assumptions and justifications:

- Explanation of sampling equation: The sample size calculation was extracted from the 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6. This equation is used for simple random sampling so it is applicable to this situation.

- Objectives and Reliability Requirements: The Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2) states the following: '*Where there is no specific guidance in the applicable methodology, project proponents shall use 90/10 confidence/precision as the criteria for reliability of sampling efforts. 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 90 % probability of falling in the range of ± 10 % of the true population value (often denoted as 90/10 precision).

- Target Population: The target population is the solar water heaters installed in middle and high income households.

- Sampling Method: The sampling method will be simple random sampling. The database will annually allocate the solar water heating installations for inspection by an automated random number generator. Flowmeters will be installed for two periods of 30 days each for the year in question on the installations selected. The months will be one in winter and one in summer. The CPA implementer will install the meters on the installations for a period of one month in summer and one month in winter. The meters will record the hot water consumption and hot water load profile of the household and this information will be used to inform the calculations of the emission reductions from solar water heaters installed in middle and high income households.

- Sample size: The sample size is determine using the following formula (equation 19 from 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6):

$$n \geq \frac{1.645^2 \, NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where:

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

n	Sample size
N	Total number of households
Mean	Expected mean
SD	Expected standard deviation
1.646	90% confidence level
0.1	10% relative precision

The sample size is calculated for each CPA by each CPA implementer. A minimum sample size of 30 must be used.

3. Solar water heaters: sample size for monitoring the outlet water temperature

Temporary thermostats will need to be installed on a sample of solar water heater installations in order to measure the temperature of the hot water consumed. The sampling design is provided below:

Sampling approach, assumptions and justifications:

- Explanation of sampling equation: The sample size calculation was extracted from the 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6. This equation is used for simple random sampling so it is applicable to this situation.

- Objectives and Reliability Requirements: The Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2) states the following: '*Where there is no specific guidance in the applicable methodology, project proponents shall use 90/10 confidence/precision as the criteria for reliability of sampling efforts. 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 90 % probability of falling in the range of ± 10 % of the true population value (often denoted as 90/10 precision).

- Target Population: The target population is the solar water heaters. The installations are categorised as follows:
    - Solar water heater installations in middle and high income households (these will be the same units as the units where hot water consumption is measured)
    - Solar water heater installations in low income households
    - Solar water heater installations in community residential units

- Sampling Method: The sampling method will be simple random sampling. The database will annually allocate the categorised solar water heating installations for inspection by an automated random number generator. Thermostats will be installed for two periods of 30 days each for the year in question on the installations selected. The months will be one in winter and one in summer. The CPA implementer will install the thermostats on the installations for a period of one month in summer and one month in winter. The meters will record the temperature of the hot water consumed and this information will be used to inform the calculations of the emission reductions from solar water heaters installed in each category.

- Sample size: The sample size is determine using the following formula (equation 19 of 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6):

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where:

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

n	Sample size
N	Total number of households
Mean	Expected mean
SD	Expected standard deviation
1.645	90% confidence level
0.1	10% relative precision

The sample size is calculated for each CPA by each CPA implementer. A minimum sample size of 30 must be used.

4. Sample size for monitoring the operational hours for heat pumps

Run time meters will need to be installed on a sample of heat pumps in order to measure the operating hours of the heat pump.

The sampling design is provided below:

Sampling approach, assumptions and justifications:

- Explanation of sampling equation: The sample size calculation was extracted from the 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6. This equation is used for simple random sampling so it is applicable to this situation.

- Objectives and Reliability Requirements: The Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2) states the following: '*Where there is no specific guidance in the applicable methodology, project proponents shall use 90/10 confidence/precision as the criteria for reliability of sampling efforts. 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 90 % probability of falling in the range of ± 10 % of the true population value (often denoted as 90/10 precision).

- Target Population: The target population is the heat pumps installed in middle and high income households and community residential units.

- Sampling Method: The sampling method will be simple random sampling. The database will annually allocate the heat pump installations for inspection by an automated random number generator. Run time meters will be installed for a period of two months for the year in question on the installations selected. The months will be one in winter and one in summer. The CPA implementer will install the meters on the installations for a period of one month in summer and one month in winter. The run time meters will record the operating hours of the heat pumps and this information will be used to inform the calculations of the project emissions for heat pumps.

- Sample size: The sample size is determine using the following formula (equation 19 from 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6):

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where:

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

n	Sample size
N	Total number of households
Mean	Expected mean
SD	Expected standard deviation
1.645	90% confidence level
0.1	10% relative precision

The sample size is calculated for each CPA by each CPA implementer. A minimum sample size of 30 must be used.

5. Sample size for monitoring the power of replaced devices for heat pumps

Sampling approach, assumptions and justifications:

In accordance with the methodology AMS II.C., physical verification of the power of a sample of devices replaced must be possible. For each installation, the power of the device replaced is recorded. All replaced devices are kept and a sample of these replaced devices is physically inspected by the DOE. Not only does the DOE conduct an inspection, but before verification an independent entity will conduct a pre-verification and prepare a report. The report by the independent third party will be presented to the DOE for verification.

Sampling approach, assumptions and justifications:

- Explanation of sampling equation: The sample size calculation was extracted from the 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6. This equation is used for simple random sampling so it is applicable to this situation.

- Objectives and Reliability Requirements: The Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 02.0, EB 65, Annex 2) states the following: '*Where there is no specific guidance in the applicable methodology, project proponents shall use 90/10 confidence/precision as the criteria for reliability of sampling efforts. 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 90 % probability of falling in the range of ± 10 % of the true population value (often denoted as 90/10 precision).

- Target Population: The target population is the heat pumps installed in middle and high income households and community residential units.

- Sampling Method: The sampling method will be simple random sampling. The database will annually allocate the heat pump installations for inspection of the power of the device replaced by the heat pump. The allocation will be done by an automated random number generator. Physical verification of the power of the devices replaced (electric elements replaced) by the heat pumps is conducted by an independent third party to see if there is agreement between what has been written on the Eskom rebate form and what is actually the case.

- Sample size: The sample size is determine using the following formula (equation 1 from 'Best Practices Examples Focusing on Sample Size and Reliability Calculations' Version 01.0, EB 67, Annex 6):

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

Where:

$$V = \frac{p(1-p)}{p^2}$$

n	Sample size
N	Total number of households
p	Expected proportion (proportion expected to match)
1.645	90% confidence level
0.1	10% relative precision

The sample size is calculated for each CPA by each CPA implementer. A minimum sample size of 30 must be used.

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

Organization	eThekwini Municipality
Street/P.O. Box	PO Box 1014 Durban 4000
Building	City Hall
City	Pixley KaSeme Street
State/Region	Durban
Postcode	4001
Country	South Africa
Telephone	
Fax	
E-mail	morgand@durban.gov.za
Website	
Contact person	
Title	Head of the eThekwini Energy Office
Salutation	Mr
Last name	Morgan
Middle name	
First name	Derek
Department	eThekwini Energy Office
Mobile	
Direct fax	+27 31 311 1089
Direct tel.	+27 31 311 1139
Personal e-mail	

Appendix 2: Affirmation regarding public funding

Not applicable as public funding is not used in this PoA.

Appendix 3: Application of methodology(ies)

Not applicable

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

Application of the "Tool to calculate the emission factor for an electricity system" Version 3.0.0

The methodological tool to calculate the emission factor for an electricity system determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "operating margin" (OM) and "build margin" (BM) as well as the "combined margin" (CM). The operating margin refers to existing power plants whose electricity generation would be affected by the proposed CDM project activity. The build margin reflects the power units whose construction would be affected by the proposed CDM project activity. The tool follows six steps in order to calculate the operating margin, build margin and the combined margin:

Step 1: Identify the relevant electricity systems.
Step 2: Choose whether to include off-grid power plants in the project electricity system (optional).
Step 3: Select a method to determine the operating margin (OM).
Step 4: Calculate the operating margin emission factor according to the selected method.
Step 5: Calculate the build margin (BM) emission factor.
Step 6: Calculate the combined margin (CM) emissions factor.

Step 1: Identify the relevant electricity systems

The connected electricity system is defined as the South African national electricity grid. The project displaces grid electricity from the national electricity grid of South Africa. The DNA has not published a delineation of the electricity system for South Africa.

The South African electricity sector is a monopoly with Eskom (the national utility) dominating both the generation and distribution of electricity in the country[90]. Eskom generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers as well as to redistributors.

The regional generation and consumption of Eskom transmission grids are interlinked and no distinction can be made between provincial or sectoral generation and consumption. For example: Cape Town, although located close to a nuclear power station, receives electricity via the transmission line from coal-fired power stations in Mpumalanga. The whole SA transmission system is taken as a homogenous mix of electricity supply by all generators.

Eskom is responsible for the supply of over 95%[91] of South Africa's electricity and is also responsible for the transmission of electricity. Eskom owns and operates the following electricity generation plants:

Table A: Eskom power plants

Plant Name	Installed Capacity (MW)	Commissioning date	Reinstallation or commissioning date	Fuel type
Ankelig	1327	01/10/2007		Gas

[90] Edkins, M., Marquard, A. And Winkler, H. Energy Research Centre. University of Cape Town. June 2010. *Assessing the effectiveness of national solar and wind energy policies in South Africa*. Available online from http://www.erc.uct.ac.za/Research/publications/10Edkinesetal-Solar_and_wind_policies.pdf. [Accessed 16 November 2010].

[91] Creamer Media. March 2010. *South Africa's Electricity Industry 2010*. Page 7. Available online from http://www.esco.org.za/pdf/new/Electricity_Overview%202010.pdf. [Accessed 16 November 2010].

Gourikwa	740	01/10/2007		Gas
Arnot	1980	1971	1971	Coal
Duvha	3450	1980	1980	Coal
Hendrina	1895	1970	1970	Coal
Kendal	3840	1988	1988	Coal
Kriel	2850	1976	1976	Coal
Lethabo	3558	1985	1985	Coal
Matimba	3690	1987	1987	Coal
Majuba	3843	1996	1996	Coal
Matla	3450	1979	1979	Coal
Tutuka	3510	1985	1985	Coal
Koeberg	1800	1984	1984	Nuclear
Acacia	171	1976	1976	Gas
Port Rex	171	1976	1976	Gas
Colley Wobbles	42	1985	1985	Hydro
First Falls	6	1979	1979	Hydro
Gariep	360	1971	1971	Hydro
Ncora	2	1983	1983	Hydro
Second Falls	11	1979	1979	Hydro
Van Der Kloof	240	1977	1977	Hydro
Drakensberg	1000	1981	1981	Pumped storage
Palmiet	400	1988	1988	Pumped storage
Camden	1600	1966	2005	Coal
Grootvlei	1200	1969	1969	Coal
Komati	1000	1961	1961	Coal

The information in the table above was obtained from the Eskom website (www.eskom.co.za). In order to find the information, CDM must be typed into the search function. The first result must be opened and the link to the CDM calculation table must be opened.

The pumped storage plants can be excluded as they are not electricity generation plants, but only a means of electricity storage.

The remaining 5% of the electricity supplied onto the national electricity grid is generated by a combination of municipal power plants and Independent Power Producers (IPPs). There is no central database with a list of the power plants connected to the grid. There is also a lack of publically available information on the amount of electricity generated by each plant and supplied to the grid and the amount of fuel used to generate the electricity. A literature review or search was done to understand the non-Eskom generation. The following information was obtained:

Table B: Information available on non-Eskom power plants[92]

[92] This information was obtained from a number of different sources which are referenced below:

- Project Design Document: New Energies Commercial Solar Water Heating Programme in South Africa – information obtained from The National Energy Regulator of South Africa
- Orvika Rosnes and Haakon Vennemo Econ Pöyry, in association with Norplan and Power Planning Associates. March 2009. Powering Up: Costing Power Infrastructure Spending Needs in Sub-Saharan Africa.
- The South African Department of Minerals and Energy. Energy Security Master Plan – Electricity. 2007-2025.

Plant Name	Installed Capacity (MW)	Commissioning date	Reinstallation or commissioning date	Fuel type
Athlone	180	1960s	Currently not operational	Coal
Kroonstad	30		Currently not operational	Coal
Swartkops	240		Currently not operational	Coal
Bloemfontein	103	1967	Currently not operational	Coal
Orlando	300		Currently not operational	Coal
Rooiwal	300	1963	206 MW net maximum capacity	Coal
Pretoria West	170	1952	100 MW net maximum capacity	Coal
Roggebaai	50	1981		Kerosene
Athlone	40	1972	Currently not operational	Kerosene
Port Elizabeth	24		Currently not operational	Kerosene
Johannesburg				Kerosene
Pretoria West	24		Currently not operational	Kerosene
Orlando	176		Currently not operational	Kerosene
Lydenburg				Hydro
Ceres				Hydro
Piet Retief				Hydro
Steenbras				Pumped storage
Tongaat Hulett Amatikulu				Bagasse coal
Tongaat Hulett Darnell				Bagasse coal
Tongaat Hulett Felixton				Bagasse coal
Tongaat Hulett Maidstone Mill				Bagasse coal
Transvaal Suiker Ltd				Bagasse coal
Mittal Vanderbijlpark	100			
Kelvin		1965		Coal
Sasol Syn Fuels	282			Coal

- ECON commissioned by the World Bank. 2007. Costing Power Infrastructure Investment Needs in Africa.
- Bethlehem Hydro website
- Darling Wind Farm Website

Sasol Chem Industries	11		Capacity addition in 2008 to increase generation from 11 MW to 42 MW	Coal
Friedenheim				Hydro
Bethlehem Hydro	7	2009		Hydro
Darling Wind Farm	5.2	2008		Wind
Coega Wind Farm	1.8	2010		Wind
Newcastle cogeneration	18	2011		Gas

Steenbras can be excluded as it is not a power plant, but rather a pumped storage facility which stores power and does not generate power.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

Option 1 was selected for the purposes of the calculation of the emission factor for this project. Hence, only grid power plants are included in the calculation. This is reflective of the baseline for the CPAs where electricity is sourced from the national grid.

Step 3: Select a method to determine the operating margin (OM)

In accordance with the tool, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) must be based on one of the following methods:

- Simple OM; or
- Simple adjusted OM; or
- Dispatch data analysis OM; or
- Average OM.

Of these four methods anyone can be used, however the simple OM method can only be used if low-cost/must-run resources constitute less than 50 % of total grid generation in average of the five most recent years. The Tool states that *''Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants."*

The following Eskom-owned power plants are low-cost/must-run power plants:

- Koeberg (nuclear power plant)
- Colley Wobbles (hydro power plant)
- First Falls (hydro power plant)
- Gariep (hydro power plant)
- Ncora (hydro power plant)
- Second Falls (hydro power plant)
- Van Der Kloof (hydro power plant)

The total grid generation over 5 years is calculated in the table below. Please note that the information is obtained from the Eskom website. In order to find the information, CDM must be typed into the search function. The first result must be opened and the link to the CDM calculation table must be opened. In addition, since Eskom supplies 95% of the electricity on the grid, we calculated the total grid electricity

generation as the electricity generated by Eskom power plants and imports divided by 95%. The non-Eskom generation was treated as low-cost/must-run in order to conservatively estimate the percentage of electricity on the grid generated by low-cost/must-run power plants. This was done as information was not available in a central database in the public domain on non-Eskom generation.

Table C: Generation of Eskom power plants for 5 years and calculation of percentage of the grid that is low-cost/must-run resources

	Generation (MWh)				
Plant Name	**2006-2007**	**2007-2008**	**2008-2009**	**2009-2010**	**2010-2011**
Ankerlig				23 367	130 241
Gourikwa				22 612	62 233
Arnot	15 938 102	11 905 060	11 987 281	13 227 864	12 194 878
Duvha	31 550 562	23 622 732	21 769 489	22 581 228	20 267 508
Hendrina	16 083 288	13 756 351	12 296 687	12 143 292	11 938 206
Kendal	34 164 855	26 517 420	23 841 401	23 307 031	25 648 258
Kriel	22 468 695	17 762 398	18 156 686	15 906 816	18 204 910
Lethabo	32 052 833	25 701 723	23 580 232	25 522 698	25 500 366
Matimba	34 983 880	29 021 742	26 256 068	27 964 141	28 163 040
Majuba	22 828 565	23 680 971	22 676 924	22 340 081	24 632 585
Matla	30 864 194	24 549 833	21 863 400	21 954 536	21 504 422
Tutuka	23 389 829	20 980 242	21 504 122	19 847 894	19 067 501
Koeberg	-	-	-	-	-
Acacia	-	-	-	-	992
Port Rex	-	-	-	-	5 507
Colley Wobbles	-	-	-	-	-
First Falls	-	-	-	-	-
Gariep	-	-	-	-	-
Ncora	-	-	-	-	-
Second Falls	-	-	-	-	-
Van Der Kloof	-	-	-	-	-
Drakensberg	-	-	-	-	-
Palmiet	-	-	-	-	-
Camden	2 815 982	5 171 057	6 509 079	7 472 070	7 490 836
Grootvlei	-	237 138	1 249 556	2 656 230	3 546 952
Komati	-	-	-	1 016 023	2 060 141
Imports[93]	11 483 000	11 510 000	12 189 000	13 754 000	15 446 000
Total (Eskom and imports)	278 623 785	234 416 667	223 879 925	229 739 883	235 864 576
Total Grid	293 288 195	246 754 386	235 663 079	241 831 456	248 278 501
Total (non-Eskom)	14 664 410	12 337 719	11 783 154	12 091 573	12 413 925
Total low-cost/must-run electricity	14 664 410	12 337 719	11 783 154	12 091 573	12 413 925
Total low-cost/must-run electricity as a percentage of the	5%	5%	5%	5%	5%

[93] Eskom. 2011. Annual Integrated Report. Available online from http://financialresults.co.za/2011/eskom_ar2011/fact_sheets_11.php. [Accessed 6 September 2012]

total grid electricity					

Hence, at the most, the electricity grid consists of 50% low-cost/must-run resources. This makes sense as a result of the fact that, according to the South African Department of Energy, almost 90.0 percent (%) of South Africa's electricity is generated in coal-fired power stations[94]. This means that over 90.0% of the total electricity on the grid is not generated from low-cost/must-run power plants. Hence, the simple operating margin was used to calculate the operating margin. If low-cost/must-run resources ever increase above 50% then the simple operating margin cannot be used.

For the Simple OM the emission factor can be calculated using either of the two following data vintages:

- Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CPA-DD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period, or
-
- Ex post option: The year in which the project activity displaces grid electricity, required emissions factor to be updated annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1, or y-2) should be used throughout all crediting periods.

The ex-ante option was selected. Hence the operating margin was calculated based on data from the following three years:

- 2008-2009
- 2009-2010
- 2010-2011

This is the latest available data in the public domain. This data is only available for Eskom power plants. There is no central database of non-Eskom generation. We were unable to find the electricity generation and fuel consumption for all non-Eskom power plants. As such, we all non-Eskom generation were given an emission factor of 0 tCO2e per MWh in order to be conservative in the calculation of the grid emission factor. This is as per the tool which states that "If for a power unit m only data on electricity generation is available, an emission factor of 0 tCO_2/MWh can be assumed as a simple and conservative approach."

In addition, since Eskom supplies 95% of the electricity on the grid, we calculated the total grid electricity generation as the electricity generated by Eskom power plants and imports divided by 95%. The non-Eskom generation is calculated as the total grid electricity generation minus the Eskom generation and imports.

The information used to calculate the operating margin is as follows:

Table D: The generation and fuel consumption of Eskom's coal power plants

	Generation (MWh)	**Fuel Consumption (tons of coal)**

[94] South African Department of Energy. 2010. Available online from: http://www.energy.gov.za/files/electricity_frame.html. Accessed 21 September 2010.

Plant Name	2008-2009	2009-2010	2010-2011	2008-2009	2009-2010	2010-2011
Arnot	11 987 281	13 227 864	12 194 878	6 395 805	6 794 134	6 525 670
Duvha	21 769 489	22 581 228	20 267 508	11 393 553	11 744 606	10 639 393
Hendrina	12 296 687	12 143 292	11 938 206	7 122 918	6 905 917	7 139 198
Kendal	23 841 401	23 307 031	25 648 258	15 356 595	13 866 514	15 174 501
Kriel	18 156 686	15 906 816	18 204 910	9 420 764	8 504 715	9 527 185
Lethabo	23 580 232	25 522 698	25 500 366	16 715 323	18 170 227	17 774 699
Matimba	26 256 068	27 964 141	28 163 040	13 991 453	14 637 481	14 596 842
Majuba	22 676 924	22 340 081	24 632 585	12 554 406	12 261 833	13 020 512
Matla	21 863 400	21 954 536	21 504 422	12 689 387	12 438 391	12 155 421
Tutuka	21 504 122	19 847 894	19 067 501	11 231 583	10 602 839	10 191 709
Camden	6 509 079	7 472 070	7 490 836	3 876 211	4 732 163	4 629 763
Grootvlei	1 249 556	2 656 230	3 546 952	674 538	1 637 371	2 132 979
Komati	-	1 016 023	2 060 141	-	664 497	1 271 010

Table E: The generation and fuel consumption of Eskom's diesel power plants

	Generation (MWh)			Fuel Consumption (litres diesel)		
Plant Name	**2008-2009**	**2009-2010**	**2010-2011**	**2008-2009**	**2009-2010**	**2010-2011**
Ankerlig	-	23 367	130 241	-	7 459 437	41 305 580
Gourikwa	-	22 612	62 233	-	6 884 155	19 144 089

Table F: The generation and fuel consumption of Eskom's kerosene power plants

	Generation (MWh)			Fuel Consumption (litres kerosene)		
Plant Name	**2008-2009**	**2009-2010**	**2010-2011**	**2008-2009**	**2009-2010**	**2010-2011**
Acacia	-	-	992	-	-	444 957
Port Rex	-	-	5 507	-	-	281 941

Table G: The generation and fuel consumption of imports

	Generation (MWh)			Fuel Consumption		
Plant Name	**2008-2009**	**2009-2010**	**2010-2011**	**2008-2009**	**2009-2010**	**2010-2011**
Imports	12 189 000	13 754 000	15 446 000	-	-	-

Table H: The generation and fuel consumption of non-Eskom power plants

	Generation (MWh)			Fuel Consumption		
Plant Name	**2008-2009**	**2009-2010**	**2010-2011**	**2008-2009**	**2009-2010**	**2010-2011**
Non-Eskom	11 783 154	12 091 573	12 413 925	-	-	-

Step 4: Calculate the operating margin emission factor according to the selected method

Simple OM

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}} \quad \textbf{(1 and 2)}$$

Where:

$EF_{grid,OMsimple,y}$	= Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,m,y}$	= Amount of fossil fuel type *i* consumed by power plant/unit m in year y (mass or volume unit)
$NCV_{i,y}$	= Net calorific value (energy content) fossil fuel type *i* in year y (GJ/mass or volume)
$EF_{CO2,i,y}$	= CO_2 emission factor of fossil fuel type *i* in year y (tCO_2/GJ)
$EG_{m,y}$	= Net electricity generated and delivered to the grid by power plant/unit m in year y (MWh)
m	= All power plants/units serving the grid in year y except low-cost/must-run power plants/units
i	= All fossil fuel types combusted in power plant/unit m in year y
y	= Three most recent years for which data is available at the time of submission of the CPA-DD to the DOE for validation.

The emission factors and calorific values for kerosene and diesel were from the IPCC 2006 Guidelines. The emission factors and the calorific values were taken as the default values at the lower limit of the uncertainty at a 95% confidence interval. The calorific values for coal were sourced from Eskom's 2011 Integrated Annual Report. The emission factor for coal was taken as the lower limit of uncertainty at the 95% confidence level. The following values were used:

Table I: The emission factors and calorific values of the fuels

Fuel Type	**NCV (GJ/ton)**	**EF_{CO2} (tCO_2/GJ)**
Coal (other bituminous coal)	2009: 19.10 2010: 19.22 2011: 19.45	0.0895
Kerosene	42	0.0697
Diesel	41.4	0.0726

The density of Kerosene was required in order to convert from litres of Kerosene into tons of Kerosene. The density of Kerosene was 810 kg/m^3.[95]

The density of diesel was required in order to convert from litres of diesel into tons of diesel. The density of diesel was 800 kg/m^3.[46]

The simple operating margin was calculated to be the following for each year:

Table J: Summary of the operating margin per year for the South African national electricity grid

Year	**OM simple**	**Generation (MWh)**	**Weighting (%)**
2008-2009	0.88	235 663 079	32%
2009-2010	0.87	241 831 456	33%
2010-2011	0.88	248 278 501	34%

[95] The Physics Hypertextbook. Available online from http://physics.info/density/. Accessed 11 November 2011.

The operating margin was calculated to be **0.88 tCO_2/MWh**.

Step 5: Calculate the build margin (BM) emission factor

In terms of vintage of data, project participants can choose between one of the following options:

- Option 1: For the first crediting period, the build margin emission factor must be calculated *ex ante* based on the most recent information available on the units already built for sample group *m* at the time of the CDM-PDD submission to the DOE for validation.

- Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity.

Option 1 has been selected which does not require monitoring of the build margin during the crediting period of the first CPA. However, the CME will need to monitor the grid emission factor every year to calculate a new grid emission factor with the latest available information for use in any new CPAs being included in this PoA.

The following information was used to determine which power plants must be included in the build margin:

Eskom Power Plants:

Table K: Commissioning dates of Eskom power plants

Plant Name	**Commissioning date**	**Reinstallation or commissioning date**
Arnot	1971	1971
Ankelig	2007	2007
Gourikwa	2007	2007
Duvha	1980	1980
Hendrina	1970	1970
Kendal	1988	1988
Kriel	1976	1976
Lethabo	1985	1985
Matimba	1987	1987
Majuba	1996	1996
Matla	1979	1979
Tutuka	1985	1985
Koeberg	1984	1984
Acacia	1976	1976
Port Rex	1976	1976
Colley Wobbles	1985	1985
First Falls	1979	1979
Gariep	1971	1971
Ncora	1983	1983
Second Falls	1979	1979
Van Der Kloof	1977	1977
Drakensberg	1981	1981
Palmiet	1988	1988
Camden	1966	2005

Grootvlei	1969	1969
Komati	1961	1961

Non-Eskom Power Plants:

Table L: Commissioning dates of non-Eskom power plants

Plant Name	**Commissioning date**
Rooiwal	1963
Pretoria West	1952
Roggebaai	1981
Lydenburg	1983
Ceres	Unknown
Piet Retief	1950
Kelvin	1965
Friedenheim	1998
Bethlehem Hydro	2009
Darling Wind Farm	2008
Coega Wind Farm	2010
Newcastle cogeneration	2011

The power plants to be included in the build margin were identified as follows:

a) The set of five power units that started to supply electricity to the grid most recently are:

- Newcastle Cogeneration (2011)
- Coega Wind Farm (2010)
- Bethlehem Hydro (2009)
- Darling Wind Farm (2008)
- Ankelig (2007)
- Gourikwa (2007)

The Ankelig and Gourikwa power plants were commissioned one the same date. As such, we have included both power plants.

The annual electricity generation of the above 5 plants is as follows:

Table M: The generation of the 5 most recently built power plants

Year	Generation (MWh)
2010-2011	472 794

Bethlehem has been excluded as it is registered as a CDM project. See below:

- The set of five power units that started to supply electricity to the grid most recently are:

- Newcastle Cogeneration (2011)
- Coega Wind Farm (2010)
- Darling Wind Farm (2008)
- Ankelig (2007)
- Gourikwa (2007)

The annual electricity generation of the above 5 plants is as follows:

Table N: The generation of the 5 most recently built power plants

Year	Generation (MWh)
2010-2011	411 474

However, there is no date for the commissioning of the Ceres hydropower project. We know that Ceres was built before 2001 as it is mentioned in a report done in March 2001 by the CSIR and ECN entitled *Accelerating the Market Penetration of Renewable Energy Technologies in South Africa* (http://www.ecn.nl/docs/library/report/2001/c01052.pdf).

b) The annual generation of the national electricity grid is as follows:

Table O: The total generation of the national electricity grid

Year	Generation (MWh)
2010-2011	231 958 234 (excluding Bethlehem hydro)

The set of Eskom power plants that started to supply electricity to the grid most recently and comprise 20% of the total annual generation of the grid are as follows:

Table P: The five most recently built power plants and their percentage contribution to the grid

Plant Name	Generation (MWh)	Percentage of total generation
Newcastle Cogeneration (2011)	157 680	0.07%
Coega Wind Farm (2010)	15 768	0.01%
Darling Wind Farm (2008)	45 552	0.02%
Ankelig (2007)	130 241	0.06%
Gourikwa (2007)	62 233	0.03%

The five most recently built power plants do not constitute 20% of the grid. Hence, additional power plants need to be included:

Table Q: The most recently built power plants that constitute 20% of the total grid electricity generation

Plant Name	Generation (MWh)	Percentage of total generation

Newcastle Cogeneration (2011)	157 680	0.07%
Coega Wind Farm (2010)	15 768	0.01%
Darling Wind Farm (2008)	45 552	0.02%
Ankelig (2007)	130 241	0.06%
Gourikwa (2007)	62 233	0.03%
Ceres (unknown, but before 2001)	8 760	0.00%
Friedenheim (1998)	17 520	0.01%
Majuba (1996)	24 632 585	10.62%
Kendal (1988)	25 648 258	11.06%

c) The largest annual generation is provided by the most recently built power plants that constitute 20% of the grid.

d) Since three of the Eskom power plants selected started to supply electricity to the national grid more than ten years ago, we would need to exclude the power plants and include Bethlehem Hydro which is registered as a CDM project. Since Bethlehem Hydro only constitutes 0.03% of the total annual generation of the grid, we needed to proceed to the next step as the power plants remaining after the removal of Friedenheim, Majuba and Kendal do not constitute 20% of the grid.

e) We included power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprised 20% of the total annual generation of the grid. This new set is presented below:

Table R: The new set of power plants

Plant Name	**Generation (MWh)**	**Percentage of total generation**
Newcastle Cogeneration (2011)	157 680	0%
Coega Wind Farm (2010)	15 768	0%
Darling Wind Farm (2008)	45 552	0%
Ankelig (2007)	130 241	0%
Gourikwa (2007)	62 233	0%
Ceres (unknown, but before 2001)	8 760	0%
Bethlehem Hydro	61 320	0%
Friedenheim (1998)	17 520	0%
Majuba (1996)	24 632 585	11%
Kendal (1988)	25 648 258	11%

f) The following power plants were included in the calculation of the build margin:

Table S: The power plants that make up the build margin

Plant Name	**Generation (MWh)**	**Percentage of total generation**

Newcastle Cogeneration (2011)	157 680	0%
Coega Wind Farm (2010)	15 768	0%
Darling Wind Farm (2008)	45 552	0%
Ankelig (2007)	130 241	0%
Gourikwa (2007)	62 233	0%
Ceres (unknown, but before 2001)	8 760	0%
Bethlehem Hydro	61 320	0%
Friedenheim (1998)	17 520	0%
Majuba (1996)	24 632 585	11%
Kendal (1988)	25 648 258	11%

The build margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(12)}$$

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/GJ)
m = Power units included in the build margin
y = Most recent historical year for which power generation is available

The CO_2 emission factor of each power unit m ($EL_{EL,m,y}$) should be determined as per the guidance in step 4(a) for the simple OM, using options A1, A2, A3, using for y the most recent historical year for which power generation data is available and using for m the power units included in the build margin. Option A2 must be applied given that the set of power units selected is based on step f ($SET_{sample\text{-}CDM\text{->}10yrs}$).

The emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad \textbf{(3)}$$

$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$\eta_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (ratio)
$EF_{CO2,m,i,y}$ = Average CO_2 emission factor of fossil fuel type i used in power unit *m* in year y (tCO_2/GJ)

In order to obtain the average net energy conversion efficiency of the power plants included in the build margin, we need to identify which technologies the power plants use so we can match the technology to a default efficiency factor. The technology of the power plants is included below:

Table T: The technology of the power plants

Plant Name	Technology	Default efficiency factor
Ankelig	Open cycle	39.5% (operational in 2007)
Gourikwa	Open cycle	39.5% (operational in 2007)
Majuba	Unknown	37% (operational before 2000) – conservative as the highest default efficiency value has been taken from Annex 1 for units operational before 2000.
Kendal	Unknown	37% (operational before 2000) – conservative as the highest default efficiency value has been taken from Annex 1 for units operational before 2000.
Newcastle cogeneration	Combined cycle (after 2000)[96]	60%

The build margin was calculated to be 0.87 tCO_2e/MWh.

Step 6: Calculate the combined margin emissions factor

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad \textbf{(13)}$$

$EF_{grid,BM,y}$ = Build Margin CO_2 emission factor in year y (tCO_2/MWh)

$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh)

w_{OM} = Weighting of operating margin emissions factor (%)

w_{BM} = Weighting of build margin emissions factor (%)

The following default values should be used for w_{OM} and w_{BM}:

- Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.

- All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.

The combined margin emission factor for the project was calculated to be 0.87 tCO_2/MWh.

[96] IPSA. Newcastle, KwaZulu Natal. Available online from: http://www.ipsagroup.co.uk/projects/newcastle-kwazulu-natal. [Accessed 6 September 2012].

Appendix 5: Further background information on the monitoring plan

Not applicable

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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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