FUNDING THE IMPLEMENTATION OF SOLAR WATER HEATING IN LOW-INCOME HOUSING IN SOUTH AFRICA THROUGH THE CLEAN DEVELOPMENT MECHANISM

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ABSTRACT

Purpose: This study investigated whether the Clean Development Mechanism (CDM) could assist with the funding of low-pressure solar water heaters in low-cost housing in South Africa. It aimed to identify the minimum requirements for the CDM to succesfully act as a funding mechanism.

Methodology: In this mixed-method study, qualitative methods, including a literature review, interview and case study, were used to inform the quantitative part of the study by identifying the key variables that had to be considered in developing a financial model that allowed the identification of the parameters that would make the CDM a viable funding mechanism.

Findings: It was found that the Clean Development Mechanism by itself cannot fund the installation of 110l LP-SWH in low-cost housing in South Africa. For a CDM programme to be financially viable the CER prices should be at levels above R80 each and the price per LP-SWH should be less than R3 388.

Limitations: In determining the feasibility parameters the study only considered two variables: the CER price and the capital costs of a LP-SWH unit.

Value of the paper: The paper offers policy makers and financial institutions an indication of the feasibility of the CDM as a financing mechanism for LP-SWH in low-income housing.

KEYWORDS

Low cost housing, Kyoto protocol, clean development mechanism, funding, low cost housing, low-pressure solar water heaters

INTRODUCTION

The installation of solar water heaters in low-income housing in South Africa is driven by three factors: government policy on reducing greenhouse gas emissions through renewable energy, demand-side management initatives by power producer Eskom, and a government commitment to sustainable human settlement. These three drivers are also opening up different funding avenues for the installation of solar water heating. One of the avenues that are being explored is the Clean Development Mechanism (CDM) instituted under the Kyoto Protocol to encourage developed countries to invest in projects that have the ability to reduce carbon emissions in developing countries. The CDM has the potential of creating a revenue stream by creating and selling carbon credits on the international carbon exchanges. In essence, the revenue stream created by the selling of carbon credits allows the investor to capitalise the future revenue stream to obtain project finance to develop carbon-reducing project in developing countries.

This study investigated whether the Clean Development Mechanism could assist with the funding of low-pressure solar water heaters in low-cost housing in South Africa. Its aim was to identify the minimum requirements for the CDM to succesfully act as such a funding mechanism.

BACKGROUND

South Africa's energy supply is dominated by coal, with 96% of electricity generated by fossil-fuel based power stations, which makes South Africa one of the 20 top greenhouse gas (GHG) emitters in the world [1]. South Africa committed at the fifteenth meeting of the Conference of the Parties (COP) to the United Nations Framework Convention on the Climate Change (UNFCCC) in Copenhagen to reduce its Greenhouse Gas emissions by 34% by 2020 and a further 8% by 2025 [2]. This commitment was restated at the COP17 meeting in Durban in 2011. Further pressure to encourage the use of renewable energy came in the shape of the national electricity crisis of 2008 and Eskom's continued struggles to meet peak demand, let alone generate excess capacity [3]. As household consumption accounts for approximately 35% of peak demand, with hot water production constituting 40% of that demand [4], solar hot water heating offered a quick win to both the demand management pressures experienced by Eskom and the government's GHG commitments.

In response, the National Solar Water Heating Programme (NSWHP) was established in 2008, an initiative that aimed to install 1 million domestic solar water heating (SWH) systems by 2014. The programme consisted of a subsidy scheme for low pressure SWH (LP-SWH) systems for low income households and a high pressure rebate scheme for low income households. To date over 350 000 solar geysers have been installed under this programme, the bulk of which were in low income housing projects [5]. To achieve a target of one million SWH installations by March 2015, approximately 25,000 installations per month will be required between January 2013 and March 2015 [6]. The Department of Energy has allocated a further R 4.7 billion over the next three years towards this target. Given that the government subsidy programme has since 1994 provided 3.3 million low cost housing units in the country, and there is an estimated backlog of a further 2.1 million [7], the NSWHP can only provide for a small fraction of the possible market for LP-SWH. Finding alternative funding for further expansion in this market is a critical consideration both for government's GHG targets and Eskom's need to manage peak demand.

A number of grant-funded programmes aimed at improving the energy efficiency of low-income housing have been implemented, however upscaling these have not proven viable in the open market. One of these, the Kuyasa project in Khayelitsha, did hold out some hope for an alternative funding mechanism. It was the first registered CDM project in South Africa, as well as the world's first Gold Standard Project, and the first such project to harness the combined energy savings achieved through improved thermal efficiency in a large low-cost housing scheme to establish supressed demand as a valid CDM methodology[8]. Part of this project included the installation of LP-SWH systems on more than 2 000 low income houses. The success of Kuyasa has prompted the registration of two other CDM PoA's specifically for LP-SWH. The first of these was registered by the Solar Academy of Sub-Saharan Africa in 2010, and between July 2010 and May 2012 the project succeeded in rolling out over 80 000 units, aiming to achieve the installation of 229 000 units within three years. The programme uses the subsidy supplied under the NSWHP to cover the unit costs and installation, while the Carbon Emmission Reduction (CER) revenue is intended to cover maintenance for 10 years and ensure profitablity for SASSA. The second project has been registered by the Standard Bank of South Africa. This second project will be used as a case study to answer the main research question underpinning this paper: whether the Clean Development Mechanism could provide a viable funding source for the implementation of low-pressure solar water heaters in low-cost housing in South Africa.

METHODOLOGY

The study set out to identify the minimum requirements for the CDM to act as a viable funding source for the installation and maintenance of LP-SWH systems. To obtain and test the data required a combination of qualitative and quantitative research methodologies.

A detailed literature review provided a thorough understanding of the Clean Development Mechanism, the registration requirements and process, and its suitability for the funding, in its entirety or partially, of low-pressure solar water heaters in the low-cost housing sector in South Africa. This information was supplemented by an interview with a market authority in the specific area of the registration of a CDM programme for the financing of LP-SWHs for low-cost housing in South Africa to determine the specific financial aspects relating to the capital and operational costs of participating in a CDM programme. The purpose of the interview was to obtain financial information and operational processes that are not available in the public domain. The interview and literature identified the key variables that had to be considered. These included the minimum required carbon credit prices, the optimum capital costs for the installation of the LP-SWHs, and the balance required between these two factors to create a financially viable funding model. The third component of the qualitative part of the study consisted of a case study of a CDM programme that focuses solely on the installation and maintenance of LP-SWHs in the low-cost housing segment in South Africa. The purpose of the case study investigation was to extract relevant information pertaining to the funding of low-pressure solar water heaters in low-cost housing. The data obtained from the literature review, the interview and case study was used to create a financial model, which constituted the quantitative part of the study. The financial model was used to manipulate two variables (the initial capital costs and carbon credit prices) to identify the parameters within which a CDM programme would provide a viable funding avenue for the installation and maintenance of low-pressure solar water heaters in low-cost housing in South Africa. The research methodology is illustrated in Figure 1 below.

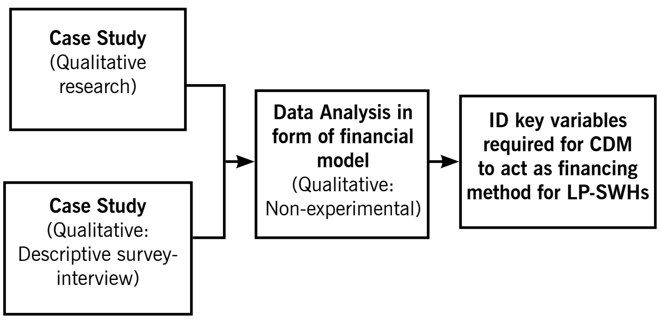

Figure 1: Research methodology.

UNDERSTANDING THE CLEAN DEVELOPMENT MECHANISM

In 1992, at the Earth Summit in Rio de Janeiro, Brazil, the United Nations created the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC established a non-binding goal of stabilising greenhouse gas emissions at the 1990 levels by 2000. The UNFCCC came into effect in 1994. Countries that formed part of the UNFCCC were divided into two categories based on their respective rights and obligations under the Treaty. Annex I countries consist of industrialised countries that have committed to take the lead in reducing greenhouse gas emissions, in the light of their responsibility for past emissions. The Annex I parties are further divided into either an Annex II party or an Economy in Transition (EIT). Annex II countries include parties and members of the Organisation for Cooperation and Development (OECD) as of 1992, including European nations and the European Union (EU), Canada, the US, Japan, Australia, New Zealand and Turkey, whilst EIT includes industrialised countries mainly from the former Soviet Union, and from Central and Eastern Europe [9] . Non-Annex I countries are subject to lighter obligations, which reflect their less advanced industrial development and their lower greenhouse gas emissions to date.

By 1995, both Annex I and Non-Annex I parties commenced negotiations to establish a more binding agreement, resulting in the 1997 Kyoto Protocol. The Protocol required the various nations that are party to the UNFCCC to agree to a collective reduction in the amount of greenhouse gas emissions by Annex I countries. The affected countries (Annex I) each committed to different targets, based on their economic positions and ability to reduce GHG emissions without severely damaging their economies. The Kyoto Protocol came into effect on 16 February 2005 [10].

The Kyoto Protocol created three flexible mechanisms to allow Annex I countries to reduce their GHG emissions. These mechanisms provided Annex I countries with the option of either reducing GHG emissions at home, or in Non-Annex I countries, should it be cheaper to do so. The mechanisms provided are International Emissions Trading (IET), the Joint Implementation Mechanism (JI) and the Clean Development Mechanism (CDM). Ormel et al [11] explains the flexible mechanisms as follows: International Emissions Trading allows Annex I countries to transfer parts of their allowed emissions (assigned-amount units) to another Annex I country. The Joint Implementation mechanism allows Annex I countries to claim credit for emission reductions that arise from an investment in other Annex I countries. The Clean Development Mechanism allows Annex I countries to implement emission-reduction projects in Non-Annex I countries to achieve sustainable development and to generate certified emission reductions (CERs) for use by the investing country or company.

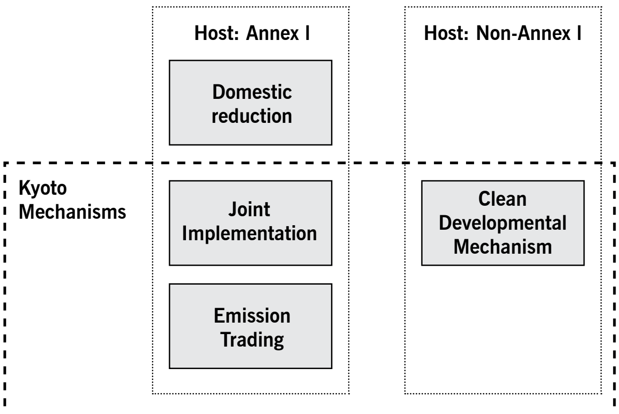

Figure 2: Kyoto Protocol flexible mechanisms [11].

From Figure 2 it is clear that the main difference between CDM and the other two Kyoto flexible mechanisms is that the CDM is the only mechanism wherein the host nation is not an Annex I country. This factor makes the CDM the only mechanism that is available to South Africa as a developing country to employ so as to obtain alternative finance from the trading of carbon credits.

The Clean Development Mechanism (CDM) allows Non-Annex I countries to participate in "emissions trading" using a project-based approach on projects wherever it is the cheapest globally. The emission reductions generated from a project activity can be quantified, certified and traded. The rules and modalities of the CDM are contained in the Marrakesh Accords. CDM projects need to promote sustainable development in the host countries (developing nations) and it must lead to emission reductions that are quantifiable, measureable and will reduce carbon emissions in the long term. The flow of funds from the developed countries towards the developing countries and subsequently the flow of carbon emission reduction credits (CERs) back to the developed countries is depicted in Figure 3 below.

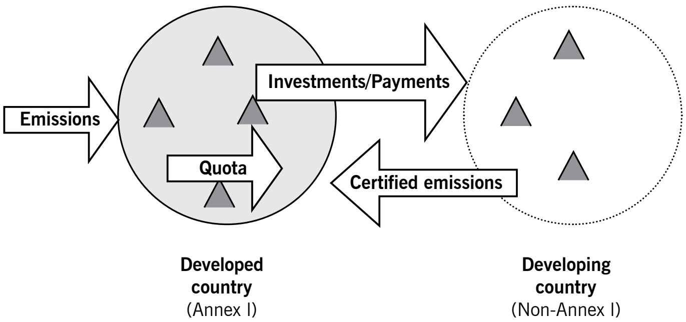

Figure 3: CDM flow of funds [12].

The Clean Development Mechanism was designed to aid the financing of certified project activities, which includes implementing green technologies in low-cost housing with the aim of reducing the residential units' carbon footprint by employing green technologies like low pressure solar geysers, compact fluorescent light bulbs (CFLs) and ceiling insulation.

According to the Department of Energy [12], of the 316 CDM projects submitted to the Designated National Authority, 228 are classified as Project Idea Notes (PINs) and 88 Project Design Documents (PDDs). Of the 88 PDDs, only 21 have been registered with the CDM Executive Board as CDM Projects and only eight projects are applicable to the low-cost housing sector. Of the eight CDM projects only two, the Kuyasa Low-Cost Urban Housing Energy Project and the SASSA Low-Pressure Solar Water Heating Programme, have been or are currently being implemented. The Standard Bank Low-Pressure Solar Water Heater Programme for South Africa has been approved in the second quarter of 2012 and Standard Bank in conjunction with International Carbon is currently investigating a few projects across South Africa in which to implement the CDM programme [13]. The eight low-cost housing CDM programmes make use of either energy-efficient or renewable energy technologies. The technologies employed by the eight projects are either a mixture between the various technologies or employ one of the following technologies: low-pressure solar geysers, CFL or LED lighting. The split between the abovementioned technologies are summarised in Figure 4 below:

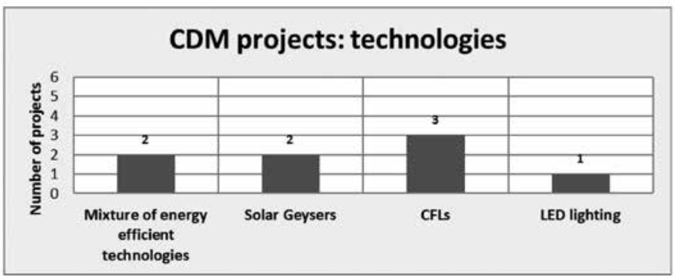

Figure 4: Technologies used in current CDM projects in South Africa [12]

CDM projects have the ability to produce carbon credits (CERs) that could assist the developers of low-cost housing projects by selling the CERs to create an additional stream of income. The selling of the carbon credits combined with possible governmental subsidies could potentially finance the installation of green technologies without adding unnecessary costs to the developer or the end users.

CARBON TRADING

Developed nations see carbon as a new commodity form and an asset class in its own right [14]. The term carbon income/trading is, in essence, derived from the trading of Carbon Emission Reductions credits (CERs). Carbon as an asset class is regulated through emission trading systems whereby the trading is market driven and governed by supply and demand forces. The following is a hypothetical example offered by the European Union in the brochure EU Action against Climate Change, showing how differences between companies' marginal abatement costs provide the stimulus for the creation of a market in emission reduction credits.

"Two companies, A & B, each emit 100 000 metric tons of CO_2 per year and each has been allocated allowances of 95 000 metric tons under their respective National Allocation Plans. Therefore, each will be 5 000 metric tons short unless some action is taken, either to make the reduction to fit the cap or to buy credits on the market, currently trading at around €3 per metric ton. For company A, the cost to cut 10 000 metric tons is €5 per metric ton, and it therefore decides to make that reduction. For company B, the marginal abatement cost is €15 per metric ton, and it is therefore cheaper for the company to buy on the market. The net result of these decisions is that company A receives €50 000 for the sale of its 5 000 metric ton surplus emission cuts and therefore fully recovers the cost of its reduction. For company B, with the much higher marginal abatement costs, the cap has been met at a cost of €50 000, instead of the €75 000 it would have cost to make the required reduction in-house." [15]

CDM regulations stipulate that a real right can be acquired for a CER and they are transferable. The result is that once a CDM project is registered, the resultant CERs can be traded, transferred or delivered even before a CDM project begins [14]. The legal basis for the trading of CERs are Emission Reduction Purchase Agreements (ERPA).

The current economic conditions in Europe are unfavourable for the trading of CERs. The lack of economic activity and more specifically industrial production in Europe has severely lowered the demand for CERs as can be seen in Figure 5, which illustrates the volume of CERs traded over the last four years. Indications are that the current low demand for CERs is likely to continue for the next two years due to the depressed economic recovery forecasts in Europe.

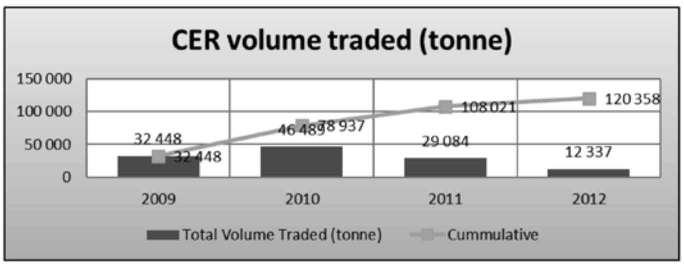

Figure 5: CER volume traded (tonne) [16].

CER prices are a direct result of supply and demand factors of mainly European countries. The lack of demand and the current oversupply of CERs in the market resulted in the average price of CERs being lowered by approximately 70% since mid-2011. Figure 6 illustrates the current, historical and forecast data for CERs [17]. From the data is is clear that the current low price levels are likely to continue until 2012.

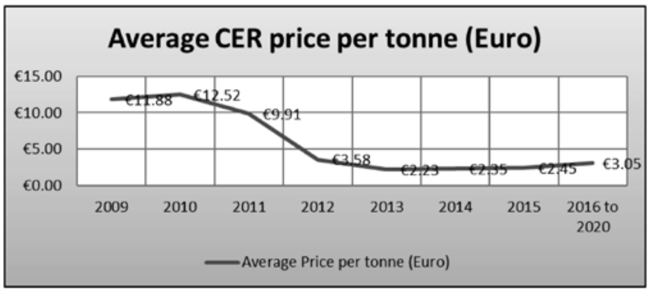

Figure 6: Average CER prices per tonne [17].

CASE STUDY: STANDARD BANK LOW-PRESSURE SOLAR WATER HEATER PROGRAMME FOR SOUTH AFRICA

BACKGROUND INFORMATION

The Standard Bank South Africa (SBSA) programme will install SABS-approved non-pressure solar water heating systems to low-income households free of charge or at a minimal cost. The programme will make use of a combination of Eskom rebates and carbon finance. The CDM programme works as follows: SBSA is the legal owner of the Programme of Activities (PoA) with the rights to implement the programme in any part of South Africa as long as the project makes use of low-pressure SWH and caters for the low-income housing sector. International Carbon manages the PoA on behalf of SBSA in terms of the qualifications of the projects as well as the packing and implementation thereof.

Depending on the location of a specific project, a data-capturing company is appointed to monitor the project during the full life cycle of the project. The data captured by this company is used by SBSA to trade CERs on an annual basis. Depending on the location of the project and the developer of the specific low-cost development, a supplier meeting the requirements as per the PoA will be appointed to install, maintain and monitor the low-pressure SWH to ensure compliance with the life cycle of the PoA. The supplier enters into a CDM Programme Activity (CPA) agreement with SBSA. The supplier applies for an SWH subsidy from Eskom for the total number of units to be installed in the project. To be able to do this, the installer has to first enter into an agreement with the households/beneficiaries of the low-cost housing units to be fitted with the SWH. Finally, SBSA enters into an agreement with the respective households to claim the carbon rights generated by the SWH to be installed. This provides SBSA with the legal right to claim the generated CERs without facing potential future financial claims from the households. Figure 7 below illustrates the implementation framework to be followed under the Standard Bank LP-SWHs CDM programme:

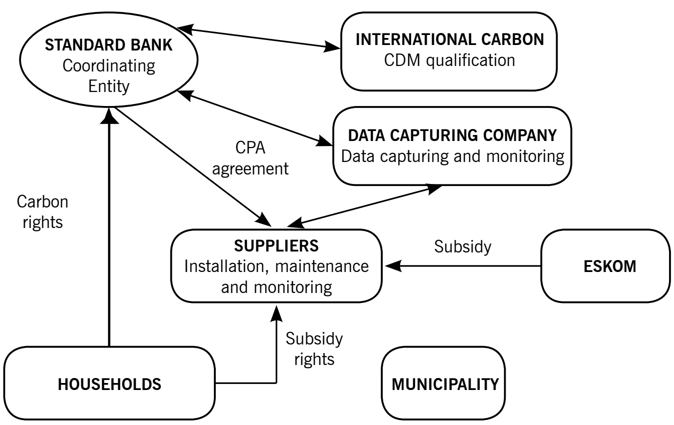

Figure 7: SBSA implementation framework [13].

All SWH's installed in this programme must be passive (no pump to circulate the water or transfer water or heat transfer fluid between the collector and the storage tank) low-pressure systems [13]. This includes vacuum tube collectors and flat plate systems. Both direct and indirect systems can be installed with this programme. With the direct system, water from the main household water supply is circulated between the collector and storage tank, and the water is heated directly without transfer fluids, whereas the indirect system uses non-toxic antifreeze in the collector. All low-pressure SWHs done under the SBSA PoA must comply with the SABS Standard Specifications for SWH systems SANS 6211-1:2003, SANS 151-2009 and SANS 1307: 2003.

FINANCIAL FUNDAMENTALS DERIVED FROM CDM PROGRAMME (CASE STUDY)

The amounts and calculations are based on confidential information obtained from Standard Bank South Africa and Tasol. The figures have been derived from actual projects that have been or are currently being implemented in South Africa. For purposes of this study a sample size of 3 500 units was used, based on information obtained from Sinclair [17]. CERs are predominantly traded in Europe. For purposes of this study all amounts will be given in South African Rand. The currency exchange rate used was quoted on Tuesday, 6 November 2012 and is therefore subject to change depending on the date. The exchange rate (ZAR/EUR) used was 11.16 [18]. The Rand Euro exchange rate will have an effect on the financial viability of the CDM programmes due to its changing value. This will have either a positive or a negative effect on the financial viability of the CDM programme. The project duration as indicated in the CPA was pegged at 10 years. The 10 years is based on the average lifespan of an SABS-approved 110l low-pressure solar water heater [13].

The capital costs involved in the implementation of a CPA are the registration of the PoA and the purchasing of the 100l LP-SWH. The cost of registering a Programme of Activities (PoA) is approximately R1 674 000 [17]. It is estimated that this specific PoA would be used on at least 15 projects in South Africa. The result is that proportionally each of the 15 PoAs will incur a registration cost of R111 600. The capital cost required to purchase and install the 110l low-pressure solar water heaters are in the order of R3 987.

Due to the ten-year project lifespan a number of operational costs are incurred. The main costs are United Nations insurance charges, annual verification fees, annual monitoring costs, and annual CME (Carbon Market Europe) fees are set out in Table 1.

Table 1: CDM operational costs [17].

No.	Cost description	Annual allowance (Year 1)
1	UN insurance charges (price per CER)	R0.11
2	Annual verification fees	R7 440
3	Annual monitoring costs	R131 600
4	Annual CME fees	R111 600

Certified Emission Reduction Credits (CERs) are 100% determined by supply and demand factors. Standard Bank PLC [13] indicated that an average 1.3041 t-CO2 would be saved per annum per LP-SWH, resulting in 1.4041 CERs per LP-SWH per year for a period of ten years. Eskom's current rebate for a SABS-approved 110l LP-SWH is R4 240 [13].The CER values used in this financial model are derived from forecasts received from Standard Bank South Africa [17] as set out in Table 2..

Table 2: CER price forecasts [17].

Year	CER estimated price (€)	CER estimated price (R)
2012	€3,58	R39,94
2013	€2,23	R24,89
2014	€2,35	R26,23
2015	€2,45	R27,34
2016 to 2020	€3,05	R34,04

The finance costs are dependent on the origin of the finance. For the purpose of this research proposal, no finance costs were included in the financial calculations. This is because Standard Bank South Africa and SASSA, as the sole owners in South Africa with a registered CDM programme for the installation of LP-SWH on low-cost houses, are supplying the funding and operation of the CDM programmes through shareholder equity and potential surplus funds derived from the respective CDM programmes. The supposed profits derived from the CDM programmes provide SBSA and SASSA with a return on their equity.

Furthermore, allowance must be made for replacement costs of broken units. It was estimated that 10% of all units will have to be replaced on an annual basis, at a capital costs for a 110l LP-SWH of R3 987. All abovementioned costs are current and need to be adjusted annually to compensate for inflation. Due to the future uncertainties, our current inflation rate of 5.5% [19] was used across the financial model. For the purpose of this model, a discount rate equal to the current prime interest rate of 8.5% was used.

The final model includes as costs the initial costs (CPA registration and installation of LP-SWH), the operational costs (insurance charges, verification and monitoring costs, CME costs, and unit replacement costs) and as project income the subsidy available per unit under the NSWHP and the income from trading of CERs.

Description	Totals	2012	2013 - 2017	2018 - 2022
Estimated Project Costs				
Initial Costs	- R 14,066,100	- R 14,066,100	R 0	R 0
Operational Costs & Finance Cost	- R 5,558,146	- R 251,149	- R 2,300,429	- R 3,006,568
Total Estimated Costs per annum	- R 19,624,246	- R 14,317,249	- R 2,300,429	- R 3,006,568
Total Estimated Income per annum	R 16,468,005	R 15,022,323	R 113,597	R 119,709
Cash flow per annum	- R 3,156,241	R 705,073	- R 2,186,832	- R 2,886,859
Accumulated cash flow	- R 3,156,241	R 705,073	- R 1,481,759	- R 4,368,617

Summary	Forecast prices
Estimated Project Costs	- R 19,624,246
Estimated Project Income	R 16,468,005
Project Profit / (Loss)	- R 3,156,241
NPV	- R 3,467,924
PI	0.76

Figure 8: Case study cash flow and summary.

From the figures illustrated in Figure 8 it is clear that in the current depressed carbon market the CDM is unable to fund both the capital and operational costs required for the installation and maintenance of low-pressure solar water heaters in the low-cost housing market of South Africa. With the current low CER prices, it would not be possible to implement a financially viable CPA unless the programme developer is also the manufacturer of the LP-SWH and is able to manufacture it at significantly lower prices than used in this financial model.

To determine a set of conditions that would support the implementation of a viable CDM programme, a number of alternative scenarios were considered based on variability in the main factors influencing the financial viability of the CDM programme. These factors are:

- CER prices as determined by international market conditions and the prevailing exchange rates at the time of trading cost per LP-SWH unit; and
- The capital cost of low pressure SWH.

To create scenarios in which the minimum conditions can be determined for a financially viable CDM programme, a set of financial viability requirements must first be set. Cloete [20] suggests that investors prefer the Profitability Index (PI) in some instances so as to compare similar investments. The Profitability Index is calculated by dividing the present value of cash flow by the initial investment cost. Due to the nature of the financial model (cash flow) the PI will be used to determine the set of the minimum required conditions. For the purpose of this study a minimum PI of 1.15 has been set to determine the minimum conditions for a financially viable CDM programme. A PI of 1.0 merely provides the investor with a return that is equal to his initial investment. All ratios below 1.0 provide a negative return. In the first scenario, all costs and inputs remain the same as illustrated in the above except for the CER inputs, which were spread across a range from R50 to R150. The purpose of the exercise was to determine the minimum price per CER to provide a PI of 1.15. Figure 9 illustrates the adjusted cash flow and summary.

Description	Totals	2012	2013 - 2017	2018 - 2022
Estimated Project Costs				
Initial Costs	- R 14,066,100	- R 14,066,100	R 0	R 0
Operational Costs & Finance Cost	- R 5,558,146	- R 251,149	- R 2,300,429	- R 3,006,568
Total Estimated Costs per annum	- R 19,624,246	- R 14,317,249	- R 2,300,429	- R 3,006,568
Total Estimated Income per annum	R 22,371,481	R 15,524,680	R 684,680	R 684,680
Cash flow per annum	R 2,747,235	R 1,207,431	- R 1,615,748	- R 2,321,888
Accumulated cash flow	R 2,747,235	R 1,207,431	- R 408,318	- R 2,730,206

Summary	Forecast prices	CER @ R 50	CER @ R 100	CER @ R 150
Estimated Project Costs	- R 19,624,246	- R 19,624,246	- R 19,624,246	- R 19,624,246
Estimated Project Income	R 16,468,005	R 17,350,494	R 19,860,987	R 22,371,481
Project Profit / (Loss)	- R 3,156,241	- R 2,273,752	R 236,741	R 2,747,235
NPV	- R 1,592,336	- R 1,023,972	R 566,536	R 2,157,045
PI	0.76	0.93	1.04	1.15

Figure 9: Scenario 1 cash flow and summary.

Based on the above calculations a minimum price of R150 per CER is required to produce a Profitability Index of 1.15. This figure is highly unlikely in light of historical CER prices, which peaked at approximately R140 (with the current exchange rate) per CER in mid-2010 [17]. In the next scenario only the purchase price for a 100l LP-SWH was adjusted. The other inputs remained the same as per the original case study. Four variations were tested to obtain a Profitability Index of 1.15 or higher. The results are described in Figure 10.

Description	Totals	2012	2013 - 2017	2018 - 2022
Estimated Project Costs				
Initial Costs	- R 10,577,475	- R 10,577,475	R 0	R 0
Operational Costs & Finance Cost	- R 5,084,269	- R 251,149	- R 2,095,017	- R 2,738,103
Total Estimated Costs per annum	- R 15,661,744	- R 10,828,624	- R 2,095,017	- R 2,738,103
Total Estimated Income per annum	R 16,468,005	R 15,022,323	R 668,845	R 776,838
Cash flow per annum	R 806,262	R 4,193,698	- R 1,426,172	- R 1,961,265
Accumulated cash flow	R 808,262	R 4,193,698	R 2,767,526	R 806,262

Summary	Forecast prices	LP-SWH @ 5% DISCOUNT	LP-SWH @ 10% DISCOUNT	LP-SWH @ 15% DISCOUNT	LP-SWH @ 20% DISCOUNT	LP-SWH @ 25% DISCOUNT
Price per PL-SWH	*R 3,987*	*R 3,788*	*R 3,588*	*R 3,389*	*R 3,190*	*R 2,990*
Estimated Project Costs	- R 19,624,246	- R 18,831,746	- R 18,039,245	- R 17,246,745	- R 16,454,244	- R 15,661,744
Estimated Project Income	R 16,468,005	R 16,468,005	R 16,468,005	R 16,468,005	R 16,468,005	R 16,468,005
Project Profit / (Loss)	- R 3,156,241	- R 2,363,740	- R 1,571,240	- R 778,739	R 13,761	R 806,262
NPV	- R 1,592,336	- R 893,977	- R 195,617	R 502,743	R 1,201,102	R 1,899,462
PI	0.89	0.92	0.98	1.05	1.11	1.18

Figure 10: Scenario 2 cash flow and summary.

Based on the above-illustrated cash flow a discount rate of 25% would be required to obtain a PI that is equal or better than the minimum of 1.15. Neither of the two scenarios illustrated above is in itself a viable option. A combination of the two scenarios should deliver the required Profitability Index. Four scenarios were tested to determine whether an acceptable combination could be formed to deliver the required PI. These are described in Table 3.

Table 3: Summary of scenarios.

Discount on LP-SWH	5%	10%	15%	15%
CER price	R50	R50	R50	R80

The outcome of the four combinations are summarised in Figure 11. From this illustrated cash flow it is clear that only the fourth combination, 15% discount on the LP-SWH (@ R3 389 each) and CER price of R80, could deliver the required Profitability Index of 1.15.

Description	Totals	2012	2013 - 2017	2018 - 2022
Estimated Project Costs				
Initial Costs	- R 11,972,925	- R 11,972,925	R 0	R 0
Operational Costs & Finance Cost	- R 5,273,820	- R 251,149	- R 2,177,181	- R 2,845,489
Total Estimated Costs per annum	- R 17,246,745	- R 12,224,074	- R 2,177,181	- R 2,845,489
Total Estimated Income per annum	R 18,673,950	R 15,022,323	R 365,163	R 365,163
Cash flow per annum	R 1,427,205	R 2,798,248	- R 1,812,019	- R 2,480,326
Accumulated cash flow	R 1,427,205	R 2,798,248	R 986,230	- R 1,494,097

Summary	Forecast prices	LP-SWH @ 5% DISCOUNT + CER @ R50	LP-SWH @ 10% DISCOUNT + CER @ R50	LP-SWH @ 15% DISCOUNT + CER @ R50	LP-SWH @ 15% DISCOUNT + CER @ R80
Price per PL-SWH	*R 3,987*	*R 3,788*	*R 3,588*	*R 3,389*	*R 3,389*
Estimated Project Costs	- R 19,624,246	- R 18,831,746	- R 18,039,245	- R 17,246,745	- R 17,246,745
Estimated Project Income	R 16,468,005	R 17,304,590	R 17,304,590	R 17,304,590	R 18,673,950
Project Profit / (Loss)	- R 3,156,241	- R 1,527,156	- R 734,656	R 57,845	R 1,427,205
NPV	- R 1,592,336	- R 367,920	R 330,440	R 1,028,799	R 1,856,896
PI	0.89	0.97	1.03	1.08	1.15

Figure 11: Cash flow and summary of four scenarios.

SUMMARY AND CONCLUSION

This study set out to determine whether the Clean Development Mechanism could either fund in its entirety or assist with the funding of sustainable green technologies in the low-cost housing market of South Africa. It investigated two CDM programmes, namely the SASSA Low-Pressure Solar Water Heating Programme and the Standard Bank Low-Pressure Solar Water Heating Programme for South Africa. Currently it is believed that the Clean Development Mechanism, as one of the Kyoto Protocol's flexible three mechanisms, cannot fund the installation of 110l LP-SWH in low-cost housing in South Africa. The current low CER prices do not a create sufficient revenue stream to fund the installation and operation of a CDM project. For a CDM programme to be financially viable the CER prices should be at levels above R80 each and the price per LP-SWH should be less than R3 388.

The CDM has the potential to assist with the funding of LP-SWH for low-cost housing in South Africa and so assist with the provision of a basic service such as safe hot water without placing an unnecessary burden on the environment by producing greenhouse gases. It is highly unlikely that the CDM will ever be in a position to fund LP-SWH in its entirety, but its supportive role to subsidies such as the ESKOM rebate system is undeniable. Other options to increase the fundability of LP-SWH is to either increase the value of the ESKOM rebates, or to attempt to obtain the LP-SWH at a lower price and finally, attempt to implement a system whereby the beneficiary should pay a monthly service levy to the holder of the CDM programme.

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