Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 75 (2015) 495 – 501

Energy Procedia

The 7th International Conference on Applied Energy – ICAE2015

Low-income housing residents' challenges with their government install solar water heaters: A case of South Africa

Clinton Aigbavboa*

Department of Construction Management & Quantity Surveying, University of Johannesburg, Johannesburg, 2028, South africa

Abstract

This paper investigate the challenges faced by the occupants' of low-income housing with their government installed solar water heaters in South Africa, Tshwane Metropolitan Municipality. The paper primarily investigates the challenges faced by the housing occupants since the solar heaters were installed in their low income houses. The data used in this paper were derived from both primary and secondary sources. The primary data was obtained through the survey method, while the secondary data was derived from the review of literature. The primary data for the study was collected through a structured questionnaire survey distributed to a sample of low-income households in a metropolitan municipality in South Africa. The household survey revealed that the low-income housing residents' occupants' faces challenges with regards to the leakage of the solar heaters and the noise from the heaters whenever the hot water taps are opened. The study gives an insightful view of the importance of using solar water heaters in energy conservation and lessening electricity financial constraints on the low-income households. The study adds to the knowledge on low income housing solar water heating in South Africa, with specific emphasis on the challenges faced by the occupants'. Further, findings from the study could be used for the development of sustainable structures in order to give access to energy and hot water to the poor and providing a better path to the improvement of life and empowerment through alternative energy usage in low-income households' in South Africa.

Peer-review under responsibility of Applied Energy Innovation Institute

Keywors: Housing occupants; Low-income housing; Solar Water Heaters; South Africa

1. Introduction

The earth has witnessed an exceptional growth in the human population and in the size of the global economy, with the population quadrupling to 7 billion and global economic output, expressed as gross domestic product (GDP), increasing about 20-fold [1] in the past 100 years. This significance change has

* Corresponding author. Tel.: +27-11-559-6398; fax: +27-11-559-6630.
E-mail address: caigbavboa@uj.ac.za.

Peer-review under responsibility of Applied Energy Innovation Institute
doi:10.1016/j.egypro.2015.07.437

been accompanied by fundamental changes in the scale, intensity and character of society's relationship with the natural world [2]. This fundamental changes in scale and intensity has come with a negative consequence which can only be rectified by the collective sustainable responsibilities of the estimated 7 billion people. For instance, around the world, cities account for two thirds of global energy demand, 60% of water consumption, and 70% of greenhouse gas emissions (GHG), which is a result of the increased demand for energy [3]. There is considerable scientific evidence that the increase in atmospheric concentrations of GHGs due to human-induced (antropogenic) GHG emissions is having a noticeable effect on climate leading to global warming. The only solution to global warming as recommended by numerous scholars and researchers is the adaptation of innovative sustainable technologies which will help cities meet the growing demands. Prime amongst this technologies is the adaptation of renewable solar water heating systems. Renewable Energy Technologies (RETs) offer a potential solution to the challenge of meeting our energy demand while simultaneously limiting the impact energy consumption has on the environment [4] [5].

Moving to renewable energy resources is necessary not only to fight climate change, but also to find a solution to ever-dwindling and increasingly expensive fossil fuels. Estimates suggest that in the year 2020, more than 50 percent of worldwide investments in the power plant market will be for the expansion of renewable energy resources like water, sun, and wind energy. Hence, in support of the infrastructure drive in renewable power generation projects on the African continent, Siemens International has established its Wind Power Center of Competence for Africa and the Middle East in South Africa. Whilst South Africa has very good solar and wind resources the total adaptation of renewable energy technologies has been slow to take off [6]. Edkins et al. [6] informed that more than 90% of South Africa's electricity is generated from the burning of coal. Currently, the South African state-owned electricity generation utility (Eskom), has 27 operational stations in South Africa that make up 40.7 GW of the country's capacity. Additional capacity is from imports and Independent Power Producers (IPPs), resulting in a total capacity of about 43.5 GW, which aims to supply the forecasted peak demand of 36 GW (over 220 TWh). The South African government drive towards the adaptation of Solar Water Heating (SWH) is driven by high expectations for the impact of solar water heating technology to address the country's electricity challenge, mitigate greenhouse gas emissions (which is not a priority), create employment and alleviate poverty [7] [8], which are the major emphasis.

Solar Water Heaters (SWHs) is a RET that uses thermal energy from the sun for the purposes of heating a property's hot water supply. SWHs can function in both residential and commercial applications, but are most cost-effective in properties that use larger amounts of hot water. SWH use solar radiation for heating water. The provision of hot water using SWH technologies in South Africa has the benefit of providing quality local government infrastructure services, saving low-income households money over the long term and mitigating GHG emissions associated with fossil fuel usage amongst others. Therefore, the aim of the present study is to investigate the challenges faced by the occupants' of low-income housing with their government installed solar water heaters in the Tshwane Metropolitan Municipality of South Africa. The paper primarily investigates the challenges faced by the housing occupants since the solar heaters were installed in their low income houses. The study gives an insightful view of the importance of using solar water heaters in energy conservation and lessening electricity financial constraints on the low-income households. The study adds to the knowledge on low income housing occupants in South Africa, with specific emphasis on the usage of solar water heaters and the challenges encountered by the housing occupants. Further, findings from the study could be used for the development of sustainable structures in order to give access to energy and hot water to the poor and providing a better path to the improvement of life and empowerment through alternative energy usage in low-income households' in South Africa.

2. Research Methodology

The research method can be deemed to be quantitative in nature as a face-to-face and self-administered questionnaire survey where employed. Where the respondent were not literate, face-to-face administration was used and where they are literature, self-administration was engaged. The questionnaire survey led to the compilation of the primary data. Structured questionnaire was used to conduct interviews with 80 low-income housing beneficiaries at Nellmapius subsidised low-income housing locations in the City of Tshwane, Gauteng Province of South Africa. The Gauteng Province has the highest number of low-income houses with SWH, which contributed as one of the reason for the site of study. The target populations were the residents of the low-income houses which had SWHs installed in their homes in Nellmapius. These households had all benefited from the government housing subsidy scheme. The questionnaire was administered to the head of households or their spouses. One household head per house was engaged in the interview/questionnaire administration. Beneficiaries were randomly selected from areas visited; these were interviewed based on the fact the SWHs had been installed in their homes for more than three month and likewise they have lived in the houses for more than one month. All households from each location had an equal chance to be drawn and to occur in the sample. Out of the 80 questionnaires used for the field survey (sample frame), 60 were received back; representing a seventy five percentage (75%) of the total sampled frame which was usable. The data collected were analysis using descriptive statistics in the form of response percentages and mean item scores (MIS) because of the type of questions that were asked. RII in the mean score table stand for relative importance index. The data presentation and analysis made use of frequency distributions and percentages of all the respondents. These information extracted from the respondents were identified during the course of the literature review and does not form part of an existing valid survey instrument as no survey of such had been conducted in the area relating to the research focus.

3. Findings and Discussion

Findings emanating from the questionnaire survey with regards to the socio-economic and demographical background of the respondents revealed that 65% of the respondent were male, while 35% were female. All respondents were black Africans and where all within the age groups of 21 – 65 years. None where above 65 years. The present findings thus concurs with the findings of other studies relating to the background of the occupants of low-income housing in South Africa [9] [10] [11] [12]. Further findings revealed that 38.3% respondents had more than 5 people living in their houses, while 26.7% had 5 people living in their houses and 11.7% had two people living in the allocated subsidised house and only 3.3% of the respondents' lives alone, which also concurs with the work of Aigbavboa and Thwala [9]. Also, aspect of the occupants household employment revealed that a majority of the (38.3%) household had only one employed person, while, another 23.3% informed that only two persons where employed in their household, a further 28.3% indicated that none were employed in their household. This directly correlated with the highest educational qualification of the respondents, where it was found that a majority (65%) of the respondents only have matric (school leaving certificate) qualification, while 5% had no form of education and a combined percentage of 30% either had a diploma degree or a certificate qualification. None of the respondents had a B/M-degree or its equivalent. The finding relating to the employment status of the respondents agrees with the high level of unemployment among the Black African group in South Africa; which can be attributed to the low-level of education as a result of the previous educational system in the country which prevented Black Africans and other race groups from an inclusive education and other issues beyond the scope of the present study; such as breakdown of the apprenticeship system which enhanced skills development, minimum wages that prevent employers from

employing staff at a rate both parties would be prepared to work for/pay and overly protective Labour Laws (for employees) making it less attractive to hire new staff amongst others).

For instance, the number of unemployed in South Africa increased by 100 000 people to 4.6 million between the fourth quarter of 2012 and the first quarter of 2013, as reported by Statistics South Africa. The estimate, took the country's official unemployment to 25.2% from 24.9% in the fourth quarter of 2012 as stated by the StatsSA in its Quarterly Labour Force Survey (QLFS). It should be noted that the official definition of unemployment in South Africa is someone aged between 15 and 64 who is without work, but who looks for work and is available to take up employment or open a business. The definition thus conforms to the present study's age group finding, which revealed that all respondents were within the age group of 21-65 years. With the establishment of democracy in 1994, many South African unemployed people became hopeful that there was going to be employment for everyone. This was further reinforced by the adoption of the Reconstruction and Development Programme (RDP), and the promises made by the developed countries to assist South Africa in its development endeavours [9]. When the RDP concept could not adequately fulfil the expected, the South African democratic government opted for a neo-liberal approach (which advocates for less government involvement in the economic activity) to economic development by adopting the Growth, Employment and Redistribution (GEAR) policy, a supply-side policy in 1996. However, to date, the GEAR policy has not helped to stop the increasing tide of unemployment and retrenchments as industries are concerned with cutting costs (of which, labour costs are often the highest) to meet global competition; hence, the high level of unemployment in the country.

Findings relating to the monthly income of the respondents, revealed that 85.7% of them earns less than R3 000 ($335) per month, while another 14.3% earns between R3 000 – R6 000 ($335 - $670) per month. None of the respondents earns beyond the reported amount. This findings concurs with other research findings [9] [10] and thus can be related to the previous findings on the educational and employment history of the respondents.

Table 1: Available amenities in low-income houses

Amenities	Present	Not Present	Active	Not Active
Electricity	100%	-	100%	-
Water connection	100%	-	100%	-
Solar Water Heaters	100%	-	98.3%	1.7%
Sanitary fittings	100%	-	100%	-
Water tapes	100%	-	100%	-
Kitchen Sink	100%	-	56.2%	43.8%

Assessment of the available amenities in the houses revealed that all surveyed household had electricity and water connection, and all were fitted with Solar Water Heaters (SWH); had sanitary fittings in their toilets, a running water tap and likewise a kitchen sink (Table 1). Further findings relating to the functionality of the SWH revealed that only 1.7% of the respondents' indicated that the installed SWH were not working, while 98.3% informed that the installed SWH in their homes where fully functioning as they receive hot water from the SWH. Also, 56.2% of the respondents' further informed that their kitchen sink is active, while 43.8% informed theirs ware inactive.

In addition to the above, when the extent of impact the installed SWH has on the respondents based on some factors as drawn from the reviewed literature were assessed, Table 2 gives a summary of the respondents' level of agreement. The survey findings revealed that having consistent hot water supply was the highest impact the SWH installation has on the respondents with a mean item score of 4.08 which was

ranked first, followed by reduction in the cost of electricity at MIS of 3.57 and having extra saving with an MIS of 3.00 as a result of not having to pay for heating of water. However, the reduction in the use of energy and carbon were ranked 5th and 6th, as these were not priorities to the respondents'.

Table 2. Level of impact of installed SWH

Impact	MIS	Ranking
Having Consistent hot water supply	4.08	1
Provide Reduce electricity cost	3.57	2
Saving	3.00	3
Eliminate load shedding	2.93	4
Reduce use of energy	2.78	5
Reduction of carbon emission	2.67	6

This particular finding did not concur with the previous work of Mokwena [13] where it was found that it is possible to strike a balance between addressing the immediate needs of the citizens and addressing climate change concerns. However, with the installed SWH, there is a reduction in the emission of GHG which would have been generated had other means of water heating had been implored- howbeit, the extent of reduction is not the focus of the current study. The level of education of the respondents' would have played a role in the present findings with a limited knowledge about climate change. Furthermore, when the challenges of having the SWH installed in the houses were assessed, it was revealed that 36.6% of the respondents complained of water leakage followed by disturbing noise form the SWH during the day (20.0%) whenever the hot water taps are opened and overflowing of water of the roof– thus resulting in noise nuisance in the house. Also, 8.3% of the occupants informed that water take time to get hot, while 10.0% also stated the challenges of having to replace the water supply pump as a result of consist failure which causes the heated water to overflow.

Findings thus agrees with the South Africa Green Economy Accord which recognised that the installation of SWH systems can help with climate-change goals and increase the number of South Africans who have access to hot water as the findings have shown. However, the saving from non-payment of electricity from heating water will help create jobs (informal trading) thus giving the low-income households some leverage as findings showed that in most household only one person was employed. Also, the findings further concurs with the work of Winkler and Thorne's [13] theory of suppressed demand which states that low-carbon technology is able to reduce future carbon emissions of a household. Installation of SWH in low-income households, which do not have an electric geyser; and can substitute the fossil fuel used for heating water manually, but also prevent households from buying an electric geyser once they have the financial means to do so. Hence, electricity demand is suppressed as a result of poverty or lack of infrastructure, and low-carbon technologies which prevent future carbon emissions becomes the effective interventions for reducing GHG emissions as stated by the United Nations Framework Convention on Climate Change (UNFCCC) and reduction of poverty and unemployment to an extent.

4. Conclusion

This paper explored the performance of solar water heaters installed in low income houses in a low-income housing in Tshwane metropolitan municipality of South Africa, and the challenges faced by the occupants' since the solar heaters were installed in their low income households. Results from household

questionnaire surveys showed that the residents of the low income housing were not satisfied with the solar water heaters installed in their homes as they faced challenges which almost makes the SWH burdensome to the housing occupants'. Findings thus revealed that the occupants' had encountered some challenges with regards to the leakage of the solar heaters and insistent noise from the heaters whenever the hot water taps are opened. The study reveals how the use of solar technology has improving the quality of life of the low-income households. The study also reveals how the use of solar technology has improving the quality of life of the low-income households. It also revealed the importance of using SWH in energy conservation and lessening electricity financial constraints on low-income households. The study adds to the knowledge on SWH installation in low income housing in South Africa, with specific emphasis on the impact and challenges faced by the housing occupants' since the solar water heaters were installed in their houses.

References

[1] Maddison, A. Historical Statistics for the World Economy: 1–2001 AD, (2009). Available from: http://www.ggdc.net/maddison/. (Accessed 23 March, 2014).

[2] Steffen, W., Crutzen, P. J., McNeill, J. R.. The Anthropocene: are humans now overwhelming the great forces of nature? Ambio. 36(8), 614–621, (2007).

[3] McNeill, J.R. Something New Under the Sun: An Environmental History of the Twentieth Century. Norton, New York, (2000).

[4] Getchell, M. Investigating the Barriers to the Adoption of Solar Water Heating in Oregon MPP Essay. Submitted to Oregon State University. In partial fulfilment of the requirements for the degree of Master of Public Policy, (2013).

[5] Reddy, S., Painuly, J. Diffusion of renewable energy technologies - barriers and stakeholders' perspectives', Renewable Energy, 29 (9): 1431–1447, (2004).

[6] DME [Department of Minerals and Energy]. Capacity building in Energy Efficiency and Renewable Energy. Report no. 2. 3. 4. - 19. Economic and Financial Calculations and Modelling for the Renewable Energy Strategy Formulation. Department of Minerals and Energy: Pretoria, (2004).

[7] M. Edkins, M., Marquard, A., Winkler, A. South Africa's renewable energy policy roadmaps. United Nations Environment Programme Research Project. UCT. Cape Town, (2010).

[8] Afrane-Okese, Y. Draft Strategic Framework & Implementation Plan for South African National Solar Water Heating, Overall Recommended High Level Strategic Framework, presented at the National Solar Water Heating Conference. Building Consensus on Accelerating the Rollout of Solar Water Heaters in South Africa. Johannesburg, South Africa, (2009).

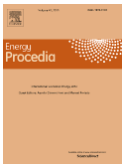
[9] Aigbavboa, C.O., Thwala, W.D. An appraisal of housing satisfaction in South Africa low income housing scheme. The International Journal of Construction Management, 12(1), 1-21, (2012).

[10] Aigbavboa, C.O. An evaluation of the post occupancy experience of housing subsidy beneficiaries in South Africa: A case study of Gauteng. Construction Management and Quantity Surveying. Johannesburg, University of Johannesburg. Masters dissertation, (2010).

[11] Charlton, S., Kihato, C. Reaching the poor? An analysis of the influences on the evolution of South Africa's housing programme. In: Udesh Pillay, Richard Tomlinson, Jacques Du Toit (Eds): Democracy and Delivery: Urban Policy in South Africa. Cape Town: HSRC Press, pp. 252-282, (2006).

[12] Mkuzo, T.M. An assessment of the quality of housing delivery in the nelson Mandela bay Municipality: the beneficiaries' perspective (2008 -2010). Port Elizabeth, South Africa, Nelson Mandela Metropolitan University: 1-129, (2011).

[13] Mokwena, L. Municipal Responses to Climate Change in South Africa, The case of eThekwini, the City of Cape Town, and the City of Johannesburg. Centre for Policy Studies: Cape Town, (2009).



Biography

Dr. CO Aigbavboa holds a Master's degree in Construction Management and a PhD degree in Engineering Management respectively. He also holds a certificate in Good governance in Africa from the Thabo Mbeki Africa Leadership Institute in the University of South Africa (UNISA). His field of expertise and research specialisation is sustainable human development, with the focus on: sustainable housing regeneration (urban renewal and informal housing), leadership in low-income housing, post occupancy evaluation and green job creation. His research draws concurrently and are applicable to construction industry development via the development of emerging contractors, the economics of infrastructure development, and the adaptation of building information modelling as a solution to the eradication/minimisation of urban and rural housing shortages. He is permanently employed at the University of Johannesburg's Department of Construction Management and Quantity Surveying where he lectures at both the undergraduate and postgraduate levels. He is currently the editor of the Journal of Construction Project Management and Innovation, accredited by the South Africa Department of Higher Education and Training.