Energy Policy 106 (2017) 75–84

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

The potential and reality of the solar water heater programme in South African townships: Lessons from the City of Tshwane

Claire Curry[a], Judith A. Cherni[b,*], Maxwell Mapako[c]

[a] Bloomberg New Energy Finance, New York, USA
[b] Centre for Environmental Policy, Imperial College London, 14 Prince's Garden, London SW71AN, UK
[c] Enterprise Creation for Development Unit, Council for Scientific and Industrial Research, South Africa

ARTICLE INFO

Keywords:
Solar water heaters
Urban poverty
South Africa
Tshwane
Eskom
Electricity

ABSTRACT

The South African solar water heater (SWH) programme is part of national policy to improve the country's electricity security, an innovative strategy to provide indigent households with free solar water heaters. The study assesses the effects of the government programme for poor townships on reduction of household electricity consumption, decline in energy poverty, and reduction in CO2 emissions; and estimates the impact of SWH on reducing electricity demand nationwide. It reports results from fieldwork carried out in the City of Tshwane to measure both quantitatively and qualitatively the success of the project's deployment in townships. Although households register average savings of 27% on their monthly electricity bills and off-peak electricity demand has reduced significantly in the area, a variety of problems prevented the project from attaining the desired level of impact. Difficulties encountered include technical faults with the heaters combined with nonavailability of maintenance; a rise in water consumption; lack of community engagement leading to apathy; and dearth of owner training leading to underuse. The gap between inflated estimates and real savings is discussed. Expanding the programme could generate jobs but significant challenges remain.

1. Introduction

South Africa has a strong industrial base heavily reliant on electricity with over half the population living in urban areas. Yet, the country also suffers from extreme wealth inequality and a large proportion of the population (45%) is in poverty (Statistics SA, 2014). South Africa has an HDI index of 0.658, making it 118th in the world – on a par with other mid-developed countries (UNDP, 2013). Life expectancy, at 62 years old is a consequence of the HIV/AIDS epidemic that affects 5.5 million South-Africans (World Bank, 2015a). The official unemployment rate is 25% (World Bank, 2015b). However, if those able to work but not seeking employment are included, the figure rises to 40% (Bhorat, 2007). The unemployment rate among 15–24 year olds is very high, at 51%, the majority of whom are poor black South Africans (Jones, Personal Communication 1 February 2011). Since 1994, 1.6 million homes have been built to house low-income families as part of the Reconstruction and Development Programme (RDP) (World Bank, 2011).

Almost one-fifth of South Africans live in government-subsidized dwellings (Statistics South Africa, 2011). In 2011, the legislation set a R3,000/household/month income level, below which a family is considered "indigent" and may apply for government grants (Tumagole, Personal Communication, June, 2011). A household income of below R 1600/month was defined as the "poverty line" (making 57% of South African households officially poor in 2011; Central Intelligence Agency, 2011; Sustainable Energy Africa, 2006; Statistics South Africa, 2001).

These problems have led South Africa to need not only a reliable electricity infrastructure for its industries and businesses, but also cheap electricity to cater for the large numbers of poor. Currently South Africa relies on coal for its electricity, with a very small capacity margin now in real danger of becoming insufficient to supply electricity to the whole country. This reliance on fossil fuels has resulted in South Africa contributing 39% of Africa's CO_2 emissions, while having less than 5% of the continent's population (US Energy Information Administration, 2012). In an endeavour to address these problems, the electricity regulator increased electricity prices to raise funds to build more power stations - plunging yet more people into energy poverty.

In order to stave off energy poverty, reduce CO_2 emissions, and lower peak electricity consumption, the South African government has embarked on a programme to provide indigent households with free solar water heaters as part of a larger national strategy significantly to

* Corresponding author.
E-mail address: j.cherni@imperial.ac.uk (J.A. Cherni).

http://dx.doi.org/10.1016/j.enpol.2017.03.028
Received 2 June 2016; Received in revised form 30 January 2017; Accepted 10 March 2017

increase the role of renewables in generating energy. The Department of Energy set a goal to replace 100,000 GW h of power generation with renewable energy by 2013 in South Africa. It estimated 23% of this target could be met by solar water heating (Eskom, 2011a).

The first round of solar water heater installations was completed in June 2011, with further rounds taking place in 2015.

Reducing poverty in townships, mitigating climate change and improving national electricity security through the *Solar Water Heater Programme* represents an innovative and ground-breaking approach for the South African government. However, no evaluation of the programme has ever been undertaken prior to the current study. While plentiful data exist about the need to replace energy systems in grid-connected areas to provide off-grid solutions, and about policy targets, there is much less information on the success or otherwise of the solar water heater project in achieving its socio-economic, environmental and technical goals. Such an evaluation is particularly helpful in assessing the true extent of the programme's success and in providing lessons should the government of South Africa wish to replicate this type of investment in other urban areas of the country.

The study assesses the effects of the government Solar Water Heater Programme for poor townships on the reduction of household electricity consumption, the decline in energy poverty, and the drop in CO_2 emissions. It also evaluates the effect of SWH implementation on water use and costs, and appraises SWH popularity with users.

2. SWH: addressing urban energy poverty

Off-grid systems, particularly solar technology, offer a viable energy alternative for urban areas. Hot water is often not seen as a basic need. However, without a way of cleanly heating large amounts of water for cooking, washing and drinking, an increased risk of disease will continue to disproportionately impact the poor (Manganye and Dintchev, 2009). Even for households with access to electricity, boiling the kettle to obtain hot water is inefficient, time consuming and expensive.

The benefits of solar water heaters include: reduced electricity demand at peak times, reduction of CO_2 emissions, less deforestation, and job creation (Prasad, 2007; SEPCO, 2004; Srinivasan, 2006; Gadgil, 2007; Manganye and Dintchev, 2009). Barriers to SWH implementation include the impact of cloudy days and the high levels of maintenance required; and the fact that government energy policy is often focused solely on conventional electricity-generating energy sources. There is also a belief among poor householders that items like SWHs are not a good investment because they do not directly generate income (Srinivasan, 2006; Langniss and Ince, 2004; SEPCO, 2004; Manganye and Dintchev, 2009; Karekezi, 2002).

However, a number of barriers also exist relating to SWH deployment. Since the presence of sunlight is essential for them to heat water, absence of sunlight on cloudy days or at night can cause problems of supply. Although SWH are simple to manufacture, they require a relatively high level of maintenance to continue working year on year – clearly, a major barrier in communities where ongoing maintenance is not provided. Moreover, SWHs require a constant source of water to heat. Many of the poorest households do not have running water so solar water heaters are not relevant for them (Langniss and Ince, 2004). In fact, today the largest customer base for solar water heaters in South Africa comprises middle-and upper-class households, hotels and safari lodges (Manganye and Dintchev, 2009, Karekezi, 2002). This means solar water heater companies normally market their product to the relatively wealthy and SWHs are perceived as middle-class items. This mindset inhibits both sales to and take-up by the poor, and producers need to see SWH technology as viable in terms of their market. Governments and non-profits also sometimes fail to see the relevance of solar water heaters for this section of society. In general, these agencies are more focused on electricity-generating schemes as a way of helping the poor in developing countries, in part because families can generate revenue through electricity from PV panels in a way that hot water from solar water heaters readily cannot (Srinivasan, 2006; SEPCO, 2004).

Previous research into solar water heaters has focused on the top-down success of a project (i.e., number of SWHs installed; e.g., Winrock International, 2002); and on its success in terms of benefits accruing to government (Manganye and Dintchev, 2009). There has also been concentration on purely modelling -based assessments of the potential success of *ideal* projects (Ijumba et al., 2008), while still other research has tended to use evidence from pilot projects (e.g., Dintchev et al., 2008). There has been a glaring absence of research to canvass the opinions of those who actually matter, the ostensible target audience - poor householders - and a failure to assess SWH implementation's impact on electricity use, water demand, bills and user's quality of life. Unfortunately, little research has emerged from countries where government has been in charge of promoting and, in some cases, financing distribution.

SWHs have found a market in most developed parts of the globe. Also China, India, Indonesia and Northern Africa all have large SWH industries. In India, the government promised to deploy 1 million SWH by 2012 (Langniss and Ince, 2004). The case of Israel is illustrative of what long-term energy policy can achieve. For decades, the Israeli government has regulated the installation of SWH for domestic use, with 85% of Israeli households having solar water heating systems (Sterman, 2009; Kreith and Goswami, 2007).

In the early 1990s, the government of Rizhao, China, decided to turn the city into a centre of environmental and industrial excellence based on its generous sunlight resources (Liu and Singh, 2009). A programme to retrofit all government buildings with SWHs was implemented, coupled with considerable government investment in SWH technology research. Rizhao has a larger proportion of urban poor than the rest of China so it was clear that SWHs had to be cheaper to allow them to be affordable to the target population. The research paid off and the costs were brought down in line with those of electric heaters (costing about 4–5% of the average annual income of a city dweller). The city government actively promoted the use of SWHs and arranged campaigns, seminars and advertising to promote their benefits as widely as possible. By 2007, after 15 years, 99% of households in central Rizhao had SWHs, the city is consistently listed among the top ten in China for air quality, and such has been the initiative's success that it has attracted clean energy investment.

The success of this project highlights four salient points: desirability, availability, accessibility, and affordability. Previously, SWHs were not accessible to the urban poor because the units were not affordable. When the city and regional government worked together with the SWH industry, however, they became cheaper, their manufacture and installation were standardized and more of them became available. A successful campaign educated people as to the benefits of SWHs and increased their desirability. Fifteen years on, SWHs are chosen by the urban poor because they are affordable, available and accessible.

This case also illustrates two other characteristics of successful energy delivery programmes: partnership between public and private institutions, and the long timeframe required for the project to come to fruition. Energy delivery projects often take decades to achieve their goals and it is important for the political will to be there for the duration, just as it was in Rizhao (Liu and Singh, 2009; Sustainable Cities, Worldwatch Institute, 2007).

There have been various small programmes centred on SWH provision in Egypt, which have provided 429 SWHs benefiting 3790 people. The projects work by targeting poor peri-urban areas and educating the local communities in a series of seminars which highlight the local and global benefits of SWHs. Households are required to contribute a certain amount towards the purchase of their SWH, thereby giving worth to the SWH in the household's eyes while simultaneously helping to finance the project. As a result, private and