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Potential for solar water heating in Zimbabwe

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Abstract

This paper discusses the economic, social and environmental benefits from using solar water heating (SWH) in Zimbabwe. By comparing different water heating technology usage in three sectors over a 25-year period, the potential of SWH is demonstrated in alleviating energy and economic problems that energy-importing countries like Zimbabwe are facing. SWH would reduce coincident electricity winter peak demand by 13% and reduce final energy demand by 27%, assuming a 50% penetration rate of SWH potential demand. Up to $250 million can be saved and CO_2 emissions can be reduced by 29% over the 25-year period. Benefits are also present at individual consumer level, for the electricity utility, as well as for society at large. In the case of Zimbabwe, policy strategies that can support renewable energy technologies are already in current government policy, but this political will need to be translated into enhanced practical activities. A multi-stakeholder approach appears to be the best approach to promoting widespread dissemination of SWH technologies.

Keywords: Solar water heating; Demand-side management

Contents

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1. Introduction

Shortages of modern energy carriers have become a major obstacle to economic growth in Zimbabwe. Energy imports and infrastructure continue to drain scarce convertible currency. Zimbabwe has been importing between 35% and 60% of its electricity requirements since 1996 because of inadequate internal power generation capacity. While available power plant capacity declined by at least 15%, maximum demand has increased by 25% since 1990. Demand is forecasted to grow from 2000 MW in year 2000–3000 MW by 2010 and over 4000 MW by 2020 [1].[1] Around US$1.5–2 billion is required to meet investments needed in the power sector over the next decade [3,4]. On the other hand, the national electricity utility has accumulated debts with foreign suppliers. IMF [5] estimates the Zimbabwe Electricity Supply Authority (ZESA)s foreign debt to be about US$240 million.[2] ZESA has been forced to load shed consumers and this has severely affected industrial, mining and agricultural production. Government measures of preferential allocation of limited hard currency for energy imports are still inadequate to meet full needs. The consequences have been high inflationary pressures and huge economic losses.

Water heating inflicts a significant burden on Zimbabwe's national energy system: it accounts for at least 13% of the national winter (June–July–August) peak demand for electricity and about 8% of the annual electricity consumption. It contributes to energy scarcity and unnecessary foreign currency expenditure in the economy. On an individual level, water heating also significantly increases energy expenditure and erodes individual welfare. Additionally, energy scarcity has adverse impact on functioning of the whole economy, especially the productive sectors. In the past, ZESA has operated a ripple control demand-side management (DSM) programme to control domestic water heaters during peaks periods in three major cities and managed to shave off about 7% of system peak. However, the performance of the ripple control system is reported to be presently poor and this requires costly and extensive refurbishment. It will also cost ZESA US$177 for each ripple relay receiver [6]. Solar water heating (SWH) offers a partial but significant contribution to resolution of these problems by reducing electricity demand, energy expenditure and improving general societal welfare.

This paper investigates the potential of SWH in alleviating energy and economic problems in a developing country setting by making a comparative evaluation of water heating practices in the domestic, health and tourism sectors in Zimbabwe. The objectives are to demonstrate by scenario analysis the economic, social and environmental benefits that accrue from using solar water heating as opposed to conventional water heating technologies in the period 2005–2030 for the domestic, health, and tourism sector.

This paper is organized as follows: Section 2 describes the national characteristics followed by current water heating practices in Section 3 and technologies in Section 4. The development of SWH in the country is presented in Section 5 after which the methodology for estimating thermal water heating demand as well as SWH scenarios are described in Section 6. Results of scenario analysis are then discussed in Section 7, followed by discussion of the results in Section 8. Conclusions and recommendations are presented in Sections 9 and 10, respectively.

2. National characteristics

Zimbabwe is located in central southern Africa and lies wholly within the tropics, extending from about 15°S to 22°S and from 25°E to 33°E. Its territory extends over 390,000 km^2 with a population density of about 30 km^{-2}. The climate is generally cool for a tropical country with mean maximum temperatures ranging between 22 and 36 °C in the hot season (August–November), while mean minimum temperatures range between 10 and 24 °C in the cool season (May–August). The global annual solar insolation is between 2000 and 2200 kWh/m^2 with a 15–25% insolation variation between the seasons [7].

Zimbabwe's 2002 population census showed that the country has a population of about 11.6 million of which 34% live in urban areas and 66% are in rural areas. There are

[1] These estimates are based on a growing economy, but due to continued economic decline in the country, more conservative projections have been developed, e.g. SAPP [2] estimate that maximum demand in Zimbabwe will grow to 2527 MW by 2010.

[2] In 2005–2006 financial year, ZESA made a loss of US$372 million [2].