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Solar water heating initiative in Oman energy saving and carbon credits

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ABSTRACT

By the virtue of its position astride the tropic of cancer, Oman has an important potential of solar energy. Despite these important resources the uses of this renewable energy was limited to few and simple utilization as public lighting or park meter. Recently, the renewable energy sector in Oman is considered as a national priority to supply the future energy demand. This paper investigates the potential of solar water heater application in Oman through a preliminary case study in the Seeb district. The RETScreen Clean Energy Project Analysis Software is an advanced mathematical model to evaluate the energy production and savings costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies. This preliminary study shows that this renewable energy technology has eco-environmental benefits to Oman. The dissemination of the solar water heaters in Oman requires necessarily the contribution of the Government in order to make them. Instead of paying subsidies for the electricity consumed by electric water heaters, the Government can invest in sharing half of the capital cost. The clean development mechanism could help to foster the diffusion of the SWHs in Oman by providing certified emission reduction incentives to the Government.

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1. Introduction

Techniques for harnessing energy from the sun for water heating have been commercially available since the 1800s. Development of the solar water heaters (SWHs) has mainly concentrated on how they look like and the types of material they use. The purpose of using sun radiations to heat water instead of a combustible source or power plant-produced electricity is to lessen the amount of pollutants introduced into the environment and atmosphere.

Geographic location, system design, collector orientation, and collector size will determine how much energy can be provided for domestic hot water heating. It has been demonstrated in [1] that Oman is blessed with a huge amount of solar energy which can serve many purposes. Solar energy in Oman can meet all of domestic hot waters' needs.

The household sector is the largest consumer of electricity in Oman. According to the 2008 annual report of Authority for Electricity Regulations [2], the residential customers consume around 54.7% of the total electricity supplied to customers. It is known that air-conditioning is the highest load consumption; however, electric water heating is also a major electric energy consumer. Water heating in Oman may account for approximately 20–25% of the total electric energy used in a typical single-family home. An elec-

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tric water heater is the single biggest energy user of all appliances in the home after air conditioners.

SWH can be used in any climate, and the fuel they use (sunshine) is free. However, solar water heating systems may require periodic maintenance and have a relatively high initial cost. The payback period however is different depending on the cost of energy for heating water and the incentives used by governments. In areas like Oman, where electricity is used for water heating, the payback periods are expected to be shorter than for areas that use natural gas for water heating.

By replacing electric energy or fossil fuel use for water heating with solar energy, environmental carbon emissions associated with water heating are reduced or eliminated. SWHs became relevant for the Clean Development Mechanism (CDM) because they are implicated directly in the reduction of GHG while contributing to the sustainable development. Purohit and Michaelowa [3] undertook a detailed study about the potential of the CDM for the SWHs usage in India. The study indicates that there is a vast theoretical potential of CO_2 mitigation by the use of Solar Water Heater in India. The annual Certified Emissions Reductions (CERs) potential of Solar Water heaters in India could theoretically reach 27 million tones. According to Capacity Development for the CDM [4], presently, there are already 3 SWHs projects (all in India) which were approved by the executive board of the CD4CDM.

Several countries have put in place incentive programs to support the cost of installing renewable energy systems. In 2005, Spain became the first country in the world to require the installation of photovoltaic electricity generation in new buildings, and the second to require the installation of solar water heating systems in 2006 [5]. Australia adopted the mandatory regulation for solar thermal for new construction in 2006 as well. SWH systems have become popular in China, where basic models start at around US$190, much cheaper than in Western countries (around 80% cheaper for a given size of collector). It is believed that at least 30 million Chinese households now have one solar water heater, and that the popularity is due to the efficient evacuated tubes which allow the heaters to function even under gray skies and at temperatures well below freezing [6].

However, most of countries in the Gulf region have not yet adopted any policy to encourage the usage of SWH. This is due to the highly subsidized cost of fossil fuel energy for electricity production [7].

This paper demonstrates the benefits of using SWH in Oman through a case study application to the Seeb district. The study was conducted using the RETScreen software. Section 2 presents the technologies of SWHs and the performances of the SWHs. Section 3 describes the application of the RETScreen software for the analysis of the SWHs system. Section 4 considers a case study application for the Seeb district and presents the results obtained. Section 5 highlights the CDM potential of SWHs in the Seeb district. Section 6 concludes the paper.

2. Solar water heater technologies

SWHs can be used for domestic hot water, pool heating and also space heating needs. SWH systems include storage tanks and solar collectors. A typical domestic SWH system diagram is shown in Fig. 1. There are two types of solar water heating systems: active (forced circulation), which have circulating pumps and controls, and passive, which do not.

In warm countries, such as Oman, a passive water heater is considered a suitable option. It consists of a water tank integrated into or located above a solar collector. In an integrated collector storage system, also called batch water heater, the water is heated and stored inside the collector.

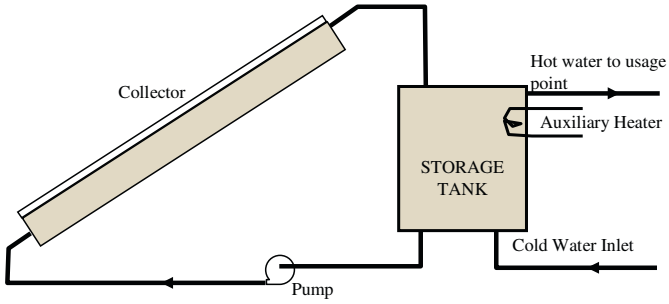

Fig. 1. Diagram of a solar active SWH system.

There are several types of solar collectors. Most of them are roof-mounted and consist of a flat copper plate, painted black, which has water tubes attached to the absorber plate. The solar radiation (energy) falls on is absorbed by the copper plate. The heat energy is transferred to water flowing in the tubes. The absorber plate is mounted in an adequate casing with a clear covering and insulation to protect the absorber plate from losses of heat energy. Other collectors include also an integrated collector and storage system and the evacuated tube collector. Integral collector and storage systems combine the function of hot water storage and solar energy collection into one unit. Evacuated tube collectors produce higher temperature water and are more complex than flat plate collectors. Evacuated tube collectors consist of a series of tubes that contain a heat pipe which absorb solar energy and transfer it to a liquid medium. The tubes are evacuated (vacuum) so that there is very little heat loss from the tube.

The energy performance of SWH system is influenced by a number of environmental and technical factors. For instance, these factors may include energy resource such as the amount of solar radiation hitting the solar collectors, and design elements such as the collector type (e.g. glazed, unglazed or evacuated tubes), area and efficiency, as well as the solar tracking mode (i.e. fixed, one-axis, azimuth or two-axis tracker), the slope and the azimuth (physical orientation) of the solar water heater. Other factors may include the required end-use water temperature and the supply temperature of the water available.

The performance of service hot water systems with storage is estimated with the *f-Chart* method. The method is explained in detail in Chapter 20 of [8] and summarized in RETScreen Engineering and Case Studies Textbook, Solar Water Heating Analysis Project Chapter [9]. The purpose of the method is to calculate *f*, the fraction of the hot water load that is provided by the solar heating system (solar fraction). Once *f* is calculated, the amount of renewable energy that displaces conventional energy for water heating can be determined.

3. RETScreen software application

The RETScreen Software Solar Water Heating Project Model is used to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for the SWH project in Seeb region. The software was designed for projects ranging in size from solar collectors for small-scale domestic hot water applications, for indoor and outdoor swimming pools for residential, commercial and institutional buildings, and for large-scale industrial processes and aquaculture applications, to improved water heating system designs including solar collector installation, hot water temperature and use reduction, and improved pipe insulation [10].

The software contains a database of typical daily hot water use for loads such as houses, apartments, hotels and motels, hospitals, offices, restaurants, schools, laundry rooms and car washes. The Energy Model and Solar Resource & Heating Load worksheets are