Renewable and Sustainable Energy Reviews 42 (2015) 643–656

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Promotion of building-integrated solar water heaters in urbanized areas in China: Experience, potential, and recommendations

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ARTICLE INFO

Article history:
Received 14 April 2014
Received in revised form
16 October 2014
Accepted 18 October 2014

Keywords:
Solar water heater
Building-integrated
Urban
China
Barriers
Policy
Content

ABSTRACT

The paper reviews the Chinese policies on promoting building-integrated solar water heaters (SWHs) in urbanized areas and the corresponding experiences in implementing city-level demonstration programs using the Changjiang River (CJR) region as a study area. The progress of implementation, barriers, and effective promotion models are discussed. Furthermore, the installation potential of the SWHs in the study area are analyzed and compared with the achievements made to date. Finally, detailed policy recommendations are presented.

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http://dx.doi.org/10.1016/j.rser.2014.10.044
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1. Introduction

The building sector is a significant contributor to energy consumption and carbon emission. In China, building energy (excluding biomass energy in the rural area) was estimated to be approximately 20% of the final energy consumption in 2010 [1,2]. This percentage is expected to grow [3], driven by rapid urbanization and the desire for better living conditions. The application of renewable energy (RE) in buildings is a promising solution to the conflict between the growing energy demand and environmental protection. Since 2006, the Ministry of Housing and Urban–Rural Development (MoHURD), in co-operation with other authorities, has promoted solar PV installation, solar thermal use, and shallow geothermal energy in buildings [4]. Among these RE sources, solar water heaters (SWHs) and ground-source heat pumps (GSHPs) are not only mature technologies, but are also economically viable for large-scale deployment in buildings.

Water heating is estimated to account for 27% and 14% of the total energy consumed in residential buildings and commercial buildings, respectively [5]. The increasing need for hot water and space heating are the principle driving forces of solar thermal use in China. In the mid- and long-term RE development plan [6] released in 2007, the Chinese government set targets for solar collectors and coal substitution capability of 300 million m^2 and 60 million tons of coal equivalent (toce), respectively, to be met by 2020. On the other hand, the worldwide installation of solar collectors by 2020 is expected to reach 1.5 billion m^2, including 500 million m^2 in the European Union [7], 300 million m^2 in the U.S., 80 million m^2 in Japan, and 20 million m^2 in India[8].

The Chinese government views the building sector as a vital building block in changing the country's energy structure. The MoHURD is leading the promotion campaign with two main objectives: an increase in building floor area with building-integrated RE systems and establishment of an infrastructure to support a national deployment. Six years have passed since the start of this promotion campaign, which has consumed billions (RMB) of the national budget. The SWH market has yet to mature. Whether the existing promotion model is sustainable and can support the next level of national deployment remains questionable. Greater challenges lie ahead: a large stock of existing buildings and diversified climatic conditions across the country. Therefore, the objective of this study was to tackle this question by analyzing lessons and experiences learned from these demonstration works and their implications for future promotion. This paper reviews the development of SWH application in urban buildings in China and the MoHURD's promotion policies. We summarize the experiences, barriers, SWH potential, and future policy implications based on field studies in the Changjiang River (CJR, also referred to as the Yangtze River) region during 2011.

2. Development of SWHs in China

Although low in terms of per capita installations, China is the leading country in total solar thermal use. According to the International Energy Agency [9], China installed 60% of the world's solar collectors in 2009. Fig. 1 shows the growth of SWH application in China based on several official sources. The National Bureau of Statistics of China has reported growth in total solar collector area in rural regions (mostly residential buildings) since 2000 [10]. The MoHURD has been tracking the installations of building-integrated SWHs in urbanized areas and reporting them in applied building floor area since 2006. In the central government's annual report on China's policies and actions for addressing climate change, the total solar collector area was reported from 2007 to 2011 [11]. Total national installations consist of total rural installations plus total urban installations, where the latter can be further subdivided into building-integrated and non-building-integrated installations. The non-building-integrated urban installations, however, are rarely reported. Rural installation has been increasing steadily since 2001; however, the total urban installation (building integrated and non-integrated together) has increased more rapidly, largely due to the MoHURD's promotion effort. In 2011, the total collector area reached over 200 million m^2 [12] and the total building area installed with integrated SWHs reached 2.15 billion m^2 in urbanized areas [13,14]. However, significant disparities in progress exist among provinces or municipalities. According to the annual survey of the MoHURD[13], the leading five provinces and one municipality (in descending order: Jiangsu, Zhejiang, Shandong, Beijing, Yunnan, and Anhui) contributed 85% of the total urban installations by 2011. The national average installation rate (ratio of total building area installed with SWHs to the total building floor area) in urban buildings was 9%, whereas in Beijing and Yunnan, the rates exceeded 40%.

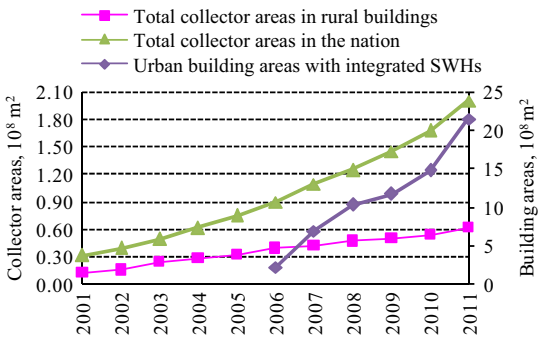

Fig. 1. Growth of SWH application in buildings from 2001 to 2011 in China [2,10–13].

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