Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 70 (2015) 402 – 408

Energy Procedia

International Conference on Solar Heating and Cooling for Buildings and Industry, SHC 2014

Analysis for common problems in solar domestic hot water system field-testing in China

Chunni Yao[a], Bin Hao[a,]*, Shan Liu[a], Xilin Chen[b]

[a]*Center of Science and Technology of Construction, Ministry of Housing and Urban-Rural Development, Beijing 100835, China*
[b]*Beijing University of Civil Engineering and Architecture, Beijing 100044, China*

Abstract

China's total urban solar thermal application area has gone up to 2.7 billion square meters by the end of 2013. Domestic solar hot water system, as a main form of solar thermal applications in the building sector, is widely used by city residents. It can substitute conventional energy and meet the residents' need of domestic hot water,. But how is the practical effect? To get the real results, it needs field-testing or monitoring. In China, field-testing is most common used. At present, through analyzing a large number of actual test data, we discovered that there are some common problems about the indicators and methodologies used in the field-testing. Some indicators do not reflect the purpose of the energy-saving design. Some test data deviates from the normal range of value. After communicated with several large organizations, we identified some difficulties in the actual field-testing, especially some data is hard to monitor. In order to better represent building energy efficiency, and fully address the ability of renewable energy substituting conventional energy, this article make an in-depth analysis of common problems occurred in solar domestic hot water system field-testing to identify shortcomings based on existing data. The final goal is to identify more effective system field-testing indicators and methods to better reflect the actual results and evaluate solar domestic hot water systems.

Peer-review by the scientific conference committee of SHC 2014 under responsibility of PSE AG

Keywords: Solar domestic hot water system, System field-testing, Common problems

* Corresponding author. Tel.: +86-10-58934233; fax: +86-10-58934232.
E-mail address: haobin@chinaeeb.com.cn

Peer-review by the scientific conference committee of SHC 2014 under responsibility of PSE AG
doi:10.1016/j.egypro.2015.02.141

1. Introduction

Solar energy could replace conventional energy to make alternative solutions for hot water needs of the people, making the solar domestic hot water system as the main form of light to heat application in buildings. The application scale has been gradually expanded. By the end of 2013, China's urban solar thermal applications floor area has been up to approximately 2.7 billion square meters. The solar collector area is about 300 million square meters.

Back in 2006, the Shenzhen Municipal makes simulation on solar illumination conditions according to their geographical latitude, the sun elevation angle, etc., drawing about the conclusion that the 12-storey residential building can basically meet the basic requirements of solar illumination condition. Then the Shenzhen Municipal promulgated the "Shenzhen Special Economic Zone Building Energy Conservation Ordinance ", for the first time making mandatory policy that 12-storey new building must be designed and installed the solar thermal system. After that most of other provinces follow it. Hainan, Zhejiang, Hebei, Jiangsu, Shanxi, Hubei, Ningxia, Shandong provinces also make mandatory policy that 12-storey new building must be designed and installed solar thermal systems. With the progress of the national urbanization to accelerate, balcony solar hot water systems gradually come into high-rise buildings market. Qinghai, Wuhan provinces began to try to force the 18-storey new buildings follow the installation[1]. Jinan city in Shandong recently promulgated the policy which requires 100 meters and below buildings to design and install solar thermal systems. With the "The Twelfth Five" is approaching the end, Beijing requires all new buildings in the urban-rural region regardless of building height to be designed and installed solar thermal systems, whose construction drawing should be reviewed. Solar hot water system mandatory policy is expanding in the geographical scope.

According to the relevant evaluation standard, solar fraction ratio is the formulary evaluation indicator of solar domestic hot water systems. The reference indicators for the evaluation, for example, conventional energy substitution volume, project cost-effective, environmental and economic benefit, also depend on the solar fraction ratio. The solar fraction ratio is a very important indicator, not only is the system design parameter, but also is the base to calculate conventional energy substitution volume and other indicators. In actual project evaluation, how can solar fraction reflect the system operating performance? Calculation of the conventional energy substitution volume is scientifically accurate? How is the system field-testing operability? Based on test data of Chinese solar domestic hot water system, this paper makes in-depth analysis with the aim to point out deficiencies, bring about more effective indicators and methods to evaluate solar domestic hot water system.

2. Solar hot water system testing method

According to the standard <Evaluation standard for application of renewable energy in buildings>, solar hot water system tests should be tested after running at least 3 days after installation and commissioning. Some requirements during the testing is as follows: the average ambient temperature is at the range from 8 ℃ to 39 ℃. average flow rate of the ambient air is not more than 4m/s. Solar radiation at least four days should be in the following four sections: J1<8MJ/m2•day, 8MJ/m2•day≤J2<13MJ/m2•day, 13MJ/m2•day≤J3<18MJ/m2•day, J4 ≥18MJ/m2•day [2].

2.1. Testing and assessment content

Testing and assessment content Includes testing indicators and calculating ones. Testing indicators include inlet temperature, outlet temperature and flow rate for heat collector system, ambient temperature, ambient air flow. Indicators to be calculated include the collecting heat from solar heat collector (Qc), conventional energy consumption (Q_{fz}), hot water storage tank heat loss coefficient, the solar collector system efficiency (η), solar fraction ratio (f), the amount of conventional energy substitution volume (tce), the project cost-effective. What is needed to be evaluated by calculating is: environmental benefit, economic benefit and demonstration spreading effect.