

CURRENT PROMOTION AND SUBSIDY OF THE SOLAR WATER HEATING SYSTEM IN TAIWAN

Keh-Chin Chang

Department of Aeronautical and Astronautical Engineering
National Cheng Kung University
1 University Road
Tainan, Taiwan, 700
e-mail: kcchang@mail.ncku.edu.tw

Tsong-Sheng Lee

Aerospace Science and Technology Research Center
National Cheng Kung University
2500 Section 1, Chung-Cheng South Road
Kueijen, Tainan, Taiwan 711
e-mail: lee@astrc.iaalab.ncku.edu.tw

Kung-Ming Chung

Aerospace Science and Technology Research Center
National Cheng Kung University
2500 Section 1, Chung-Cheng South Road
Kueijen, Tainan, Taiwan 711
e-mail: kmchung@astrc.iaalab.ncku.edu.tw

Ya-Feng Lien

NCKU Research and Development Foundation
2500 Section 1, Chung-Cheng South Road
Kueijen, Tainan, Taiwan 711
e-mail: gigilyf@ckmail.ncku.edu.tw

ABSTRACT

Solar water heating system has been commercialized during the last two decades in Taiwan. The government worked out an issue of "Measure of promoting Solar Hot-Water System" to promote the utilization of solar energy for hot water production in 2000. This created an economic incentive for the end users. The annual growth rate is up to 9.5 % in 2003. The data shows that most of the new systems have been installed in newly built residences and are mainly used by the homeowners (about 97 %). The regional popularization analysis indicates the limited installation of solar water heating systems in the metropolis area. In the eastern Taiwan's district and remote islands, the problems of climate conditions, availability of localized installers/dealers, and installing capital cost should be addressed.

1. ENERGY SITUATION IN TAIWAN

Taiwan is a densely populated island that is endowed with limited natural resources. The government established the Energy Commission under Ministry of Economic Affairs (MOEA) in November 1979 to formulate and implement the national energy policy.

The rapid economic development has created substantial increase in the energy consumption over the past two decades. The average annual growth rate was 5.8% between 1980 and 2000, and is projected to decrease to 2.1 % between 2000 and 2010 [1]. The total primary energy supply was 113.23 million kiloliter of oil equivalent in 2002, of which 33.10 was from coal, 49.26 % from oil, 6.80 % from liquid petroleum gas, 0.77 % from natural gas, 1.39 % from hydropower, and 8.68 % from nuclear energy. However, the ratio of indigenous energy (oil, natural gas, and hydropower) to total primary energy supply is only about 2.21% in 2002 [1].

2. RENEWABLE ENERGY

Energy issues affect every aspect of modern society. These issues have been of primary concerns since the second oil crisis and Gulf War. The problems of energy are associated with distribution, access, and security of supply [2]. Particularly for the energy deficient countries and remote islands/areas, the renewable energy appears to be sustainable and clean source of energy derived from nature [3-5]. For example, the renewable energy accounted for 14.4 % of Turkey's total primary energy supply in 1999 [6]. In addition, the development and use of renewable energy are vital to the impact of the United

Nations Framework Convention on Climate Change. This is associated with a balance between the economic development, energy supply, and environmental quality.

Among various forms of renewable energy, solar energy is the most wide spread use in many countries in the world [3-8]. In Cyprus, 6.5 % of the annual energy demand is provided from solar energy. This energy is mainly used in the domestic sector (93.5 %) for hot water production [7]. The popularization of residential solar water heating systems (SWHS) is up to 80 % in Israel. The installed area of solar collector in the world was more than nine millions square meters in 2001, of which 70 % was in Mainland China [9].

Taiwan is ideally located to take advantage of solar energy technologies. The Energy Commission has ever established an incentive program for SWHS installation from 1986 to 1991. The installed area of solar collector increased from 5,000 m² to 80,000 m² per year in that program. It did help greatly to build up the SWHS industry in Taiwan. Further, the National Energy Conference was convened to actively prompt the utilization of new and clean energy in May 1998. The government adopted "Renewable Energy Development Plan" in 2002, and is proposing "Renewable Energy Development Bill" to establish a legal environment for the renewable energy and to facilitate sustainable utilization of renewable energy [1]. The R&D programs of renewable energy include (1) Wind power generation; (2) Photovoltaic energy; (3) Solar energy; (4) Geothermal energy; (5) Ocean energy; and (6) Biomass energy. The renewable energy is projected to be 3 % of total energy supply by the year of 2020 [1].

For the SWHS installation, the total installed area of solar collector in Taiwan is up to 1,000,000 square meters in 2000. However, the SWHS installation rate dropped in recent years. Expanded promotion is required. In order to encourage the use of solar water heater, MOEA has issued a "Measure for promoting Solar Hot-Water System" in 2000. The objective of this incentive program is to accelerate SWHS installation. In this paper, the status of SWHS installation in Taiwan [10] is reported, and the performance of the present promotion program is analyzed.

3. PROMOTION OF SWHS

3.1 Measure for Promoting SWHS

According to the "Measure of Promoting Solar Hot-Water System", the Energy Research Laboratories of Industrial Technology and Research Institute (ITRI)

conducts a standard testes. The performance tests of SWHS include the efficiency, optical and thermal properties of the solar collector (e.g. η , F_{RU_L} , and $F_R(\tau\alpha)$). The Research and Development Foundation of National Cheng Kung University has been authorized to organize an operation unit to carry the tasks, which include filing and auditing of applications, allocation of the funding, and appealing process.

A set of SWHS includes a storage tank and the associated piping in addition to the solar collectors. The government provides the financial incentive to the end users based on the installed area (A_c) and the type of solar collectors, which include glazed or unglazed flat-plate type solar collectors, and vacuum-tube type solar collector. To prompt the SWHS installation in the remote islands, the amount of subsidy is double.

3.2 Commercialization of SWHS

There are various possible problems faced during the life of a SWHS. The proper design and the quality of the installation can radically affect the reliable operation of SWHS. According to the Measure, all the qualified installers, products, and manufacturers, which are eligible for this financial incentive program, must possess a certification or a license issued by the Energy Commission of MOEA. Between 2000 and 2003, there were 173 qualified installers/dealers, 205 qualified products, and 25 qualified manufacturers. It is noted that 96 % of qualified installers/dealers are located in the west Taiwan district.

Out of the 205 qualified products, there are 148 products assembled by the installers themselves. The metallic (stainless or copper) flat-plate type solar collectors account for 78 % SWHS, and the remaining 22 % is the vacuum-tube type solar collector. Almost all the metallic flat-plate type solar collectors are produced domestically, while some of the vacuum-tube absorbers are imported. Most of SWHS are permanently connected to an electric booster.

4. STATUS OF FINANCIAL INCENTIVE PROGRAM

4.1 Installation of SWHS

There are two major types of installed solar collectors for a SWHS in Taiwan. In Table 1, it can be seen that the flat-plate type solar collectors with metal absorbers and glass cover are widely used to transform solar energy into heat. They represent 90.6~94.9 % market share in 2001~2003. The remaining 5.1~9.1 % comes

from the vacuum-tube type solar collectors. Moreover, 97.2~97.4 % of installed solar collectors are used for the production of hot water for the homeowners (Table 2), in which mainly $A_c \leq 10 \text{ m}^2$ (residential system, Table 3). Very few commercial systems (over 100 m^2 , such as hotel and hospital) were installed from 2001 to 2003, and this is the portion which must be further promoted. The remaining SWHS are for the showering of rooming house (dormitory), swimming pool heater, and the manufacturing process.

TABLE 1: INSTALLED UNITS BASED ON TYPE OF SOLAR COLLECTOR

Type	2001	2002	2003
Flat plate	12,039	13,310	15,413
Vacuum	650	1,383	1,135

TABLE 2: APPLICATION ANALYSIS OF SWHS

Application	2001	2002	2003
Homeowner	12,636	14,644	16,479
Dormitory	50	45	61
Other	3	4	8

TABLE 3: INSTALLED AREA ANALYSIS OF SWHS

A_c, m^2	2001	2002	2003
Below 10	12,363	14,310	16,087
11-100	318	377	457
Above 100	8	6	4

The installed units of SWHS at each quarter from July 2000 to December 2003 are shown in Fig. 1. To conform the Enforcement Act of Administrative Procedure, MOEA issued the "Guidelines of Promoting Solar Hot-Water System" to substitute the original Measure in early 2003. There was temporary suspension for the application of financial incentive. The installation of SWHS dropped at the first quarter (2,695 installed SWHS units) followed by a significant increase at the second quarter (4,768 installed SWHS units). Overall, the installation rates have gradually increased by year. According to the survey by the Energy Research Laboratories of ITRI, it is also noted that 96.5 % of installed SWHS in Taiwan file this financial incentive program.

The statistics of installed area of solar collector in four major districts and remote islands in Taiwan are shown in Fig. 2. It can be seen that installation of SWHS is mainly in the central and southern Taiwan districts, Fig. 2a. The southern Taiwan district has the most favorable sunlight conditions. Residential and commercial sectors

installed SWHS with a longer annual sunshine duration and higher average solar intensity. In the central Taiwan district, the high installation rate of SWHS was mainly due to the re-construction project after the 921 severe earthquake in 1999. A SWHS becomes a standard feature for a lot of newly built homes, and this will be elaborate later. The installed area of SWHS in the northern Taiwan district is considerably lower than those of the central and southern Taiwan districts, but goes up with this financial incentive program. In the eastern Taiwan district and remote islands, Fig. 2b, there are quite few installed SWHS units. It is attributed to typhoon effect, limited local qualified installers/dealers, and higher capital cost of SWHS compared with the conventional heating systems, e.g. LPG burner and electric heater.

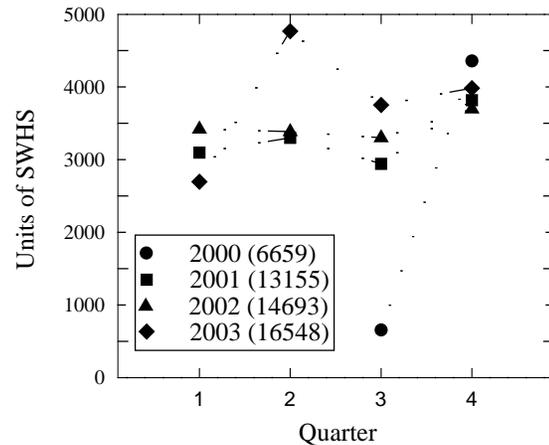


Fig. 1: Installed units of SWHS

4.2 Effectiveness of Government Incentives

In 1980s, the USA initiated state government incentives for solar installation. Lancaster and Berndt [11] indicated the property tax exemptions do not appear to be effective in promoting alternative energy development. The data on sale tax exemptions and grant or loan programs are inconclusive. However, the application of solar energy in Germany was up to 30 % annual growth from 1995 to 2001. As a result, the incentive program created substantial impact on the solar energy industry. The installed area of solar collector reached $900,000 \text{ m}^2$ in 2001 [9]. In Taiwan, the incentive program is obviously also critical for the promotion of SWHS installation. Based on the annual data of Construction and Planning Administration of Ministry of Interior and Energy Research Laboratories of ITRI since 1987, the installed area of solar collector

and the permitted floor area of building use are shown in Fig. 3. It can be seen that the SHWS installation area varied with the permitted floor area of building use before 2000. This indicates that the SWHS installation is mainly for newly built homes. In addition, the government incentive program initiated in 2001 shows a strong impact on the SWHS installation. The installed area of solar collector was 56,500 m² in 1999, and increased about 29 % (25,907 m² with financial incentive out of 72,800 m² total installed area) despite of the decline in permitted floor area of building use in 2000. The annual growth of SWHS installation was 3.7 % in 2001 and 2002, and increased up to 9.5% in 2003. It is also noted that there are about 70 % of the installed SWHS within this financial incentive program for new homeowners.

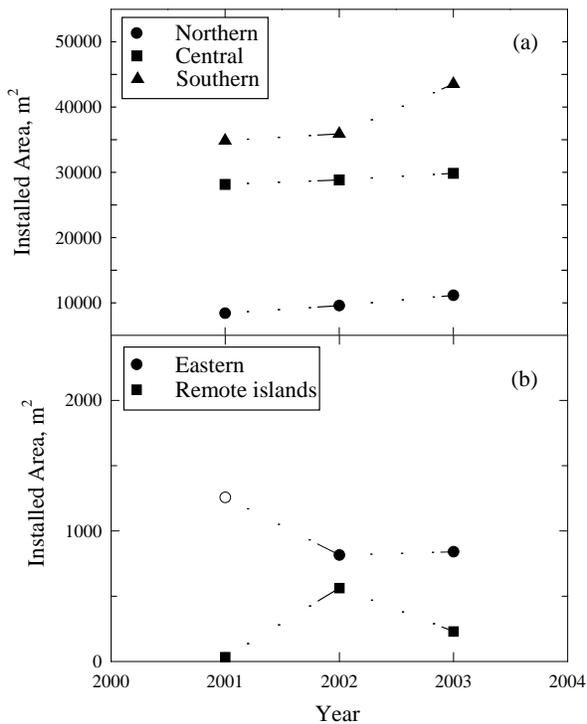


Fig. 2: Installed area of solar collectors

5 CONCLUSIONS

Taiwan has a promising potential for the application of solar energy. Solar water heating system is now a reliable and mature product here. The installation of systems and maintenance (climate conditions) are of great concerns to meet the demand of users. Other than the government financial incentive program, lower capital cost (payback period) and availability of local

installers/dealers are considered to be the major issues for the popularization of SWHS. The problem of limited commercialization system installation needs to be further addressed.

6 ACKNOWLEDGMENTS

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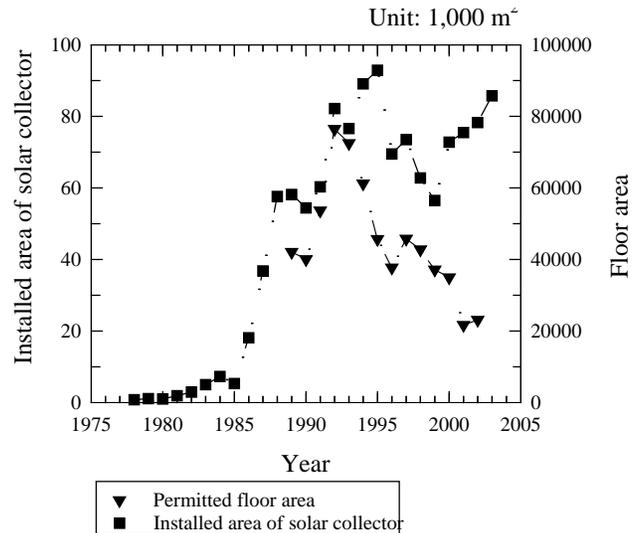


Fig. 3: Installed area of solar collector vs. permitted floor area of building use

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