

OUTLOOK OF SOLAR WATER HEATERS IN TAIWAN

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ABSTRACT

Solar water heater has been commercialized during the last two decades in Taiwan. The government initiated the incentive programs during 1986-1991 and 2000-2004. This created an economic incentive for the end users. The total installed area of solar collectors was more than one million square meters. The data shows that most of the solar water heaters are mainly used by the domestic sector for hot water production (about 97 %). The potential market of SWH in Taiwan is associated with the climatic condition, population structure, urbanization, building type of housing and status of new construction.

1. INTRODUCTION

The Taiwan area with 36,000 square kilometers includes Taiwan proper, the Penghu Islands, Green Island, Orchid Island, and Tiaoyutai Islets. The island measures 377 km long and 142 km wide at its widest point. The central Mountain Range slopes gently to a broad and fertile plain in the west. In the east, the mountains descend precipitously to the Pacific. The island's uplands are so extensive that only about one-fourth of Taiwan is arable [1].

Taiwan is densely populated (about 22,600,000 in 2003) with limited natural resources. The ratio of indigenous energy (oil, natural gas, and hydropower) to total primary energy supply is only about 2.21% in 2002. To comply with the needs of the government's continuing economic construction projects and the changes in the international economic and energy situations, the Energy Policy of the Taiwan Area was established. It is expected that the

renewable energy will share 3% of primary energy supply in 2020 [2].

The Bureau of Energy, Ministry of Economic Affairs (MOEA) of Republic of China (ROC) has promoted the research and development of renewable energy in last two decades. Taiwan's climate is subtropical, and is ideally located to take advantage of solar thermal energy technology, Figs. 1 and 2. The government has established the subsidy programs for solar water heaters (SWH, 1986-1991 and 2000-2004). It was found that the subsidy programs were obviously critical for the promotion and installation of residential SWH. The installed area of solar collectors increased significantly, and was up to 1,000,000 square meters in 2000. However, the popularization of SWH in domestic sector is only 3.5 %.

A comprehensive survey of the households installing SWH in 2001-2004 was conducted. The objective of the survey is to forecast the number of SWH that will be installed. Decision makers in the energy sector might make use of it in their rational decision making process of implementing more compressive programs to promote the installation of SWH in Taiwan. The present paper tends to address the potential market of SWH in Taiwan, which includes the influence of climate, population structure, urbanization, and building type of housing.

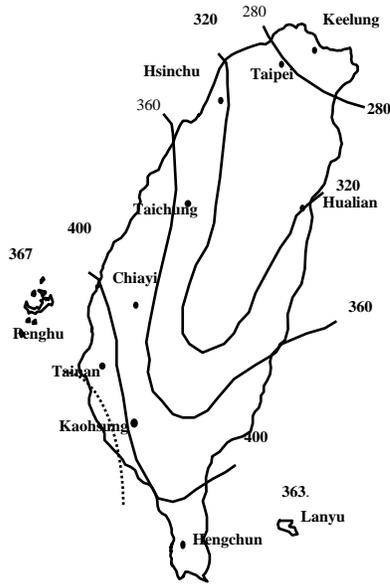


Figure 1 Global radiation in Taiwan, Langley/day [1]

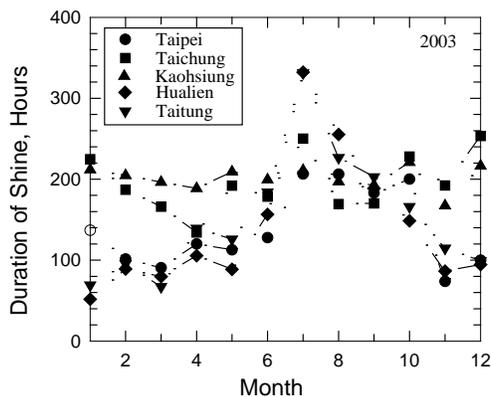


Figure 2 Duration of sunshine hours

2. SOLAR WATER HEATERS IN TAIWAN

Production of SWH in Taiwan was initiated in about 1978. However, the number of installed SWH is quite limited due to higher capital cost compared with conventional ones, e.g. LPG burner or electric heater. To the development of indigenous alternative and renewable energy resources, the government initiated a six-year incentive program (1986-1991) to promote the installation of SWH. The industry of SWH expanded very quickly and reached about 60,000 square meters per year in the area of solar collectors, in which were mainly for hot water production by the domestic sector. The typical SWH was of thermosyphon type and consisted of glazed or unglazed flat-plate solar collectors. In

addition, the incentive program built up not only the standard of application for renewable energy, but also created substantial change in the SWH industry in Taiwan, Fig. 3. However, the installation of SWH slowed down during 1995-1999. To further promote the application of solar thermal energy, the government initiated another incentive program for four and half years (July 2000-2004). The annual growth rate of installed area of solar collectors was about 3.7 % in 2001 and 2002, and increased up to 9.5% and 28.8 % in 2003 and 2004 [3]. Currently, the total installed area of solar collectors in Taiwan is more than one million square meters.

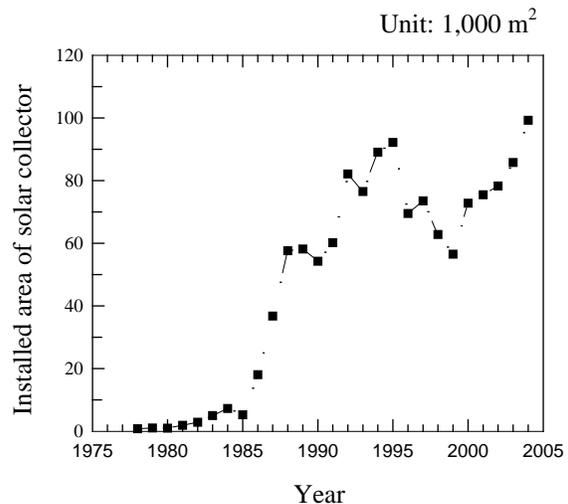


Figure 3 Installed area of solar collector

3. USERS OF SWH

A general survey of the SWH users was conducted in 2001-2004. There are about ten thousands separate households. It is found that there are only 10% of the households replacing the old systems, in which the age of the systems ranged from 5 to 15 years. For the first time users, the motivation of installing SWS is of interest. The survey indicated that energy conservation and safety are the major concerns. Promotion of local dealers and recommendation from the SWH users are also critical. This indicates the increasing public interest in energy saving and concern for the environment. The survey also showed that there were 86% systems using running water. The very aggressive underground water (ph \approx 5) in some northern Taiwan district contributed to the corroded solar collectors and degraded performance of the systems. More than 95% systems had an electrical boost element installed, in which most of the systems are capable of safely supplying hot water to the households.

The survey also indicated that almost 90% systems were installed on the roof of housing. Since the composition of housing in urban and rural communities is essentially not the same, this affects the popularization of SWH in individual districts. According to Directorate General of Budget Accounting and Statistics (DGBAS, ROC), the urban community includes main-metropolitan (more than one million residents) and secondary metropolitan (0.3 to 1 million residents). The installed systems per thousand households in the main metropolitan (including Taipei, Taoyuan, Taichung, Tainan and Kaohsiung) are shown in Fig. 4a. It can be seen that the incentive program (2000-2004) has a great impact on the popularization of SWH, particularly in the southern Taiwan (e.g. Tainan and Kaohsiung) which is due to higher solar insolation or duration of sunshine hours, Figs. 1 and 2. There are also more systems installed in the secondary metropolitan (Hsinchu and Chiayi), and the popularization of SWH in rural-urban community increases significantly during the second period of incentive program, Fig. 4b.

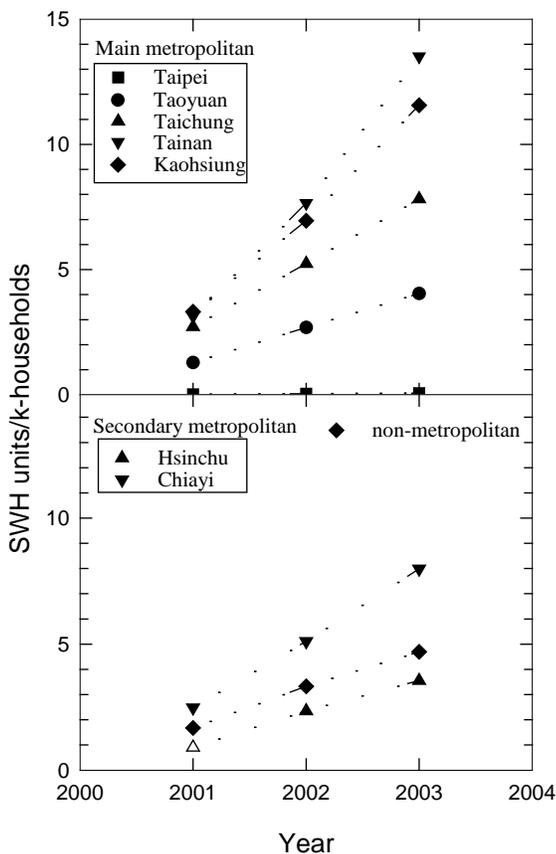


Figure 4 Systems installed in urban and rural community

The type of housing and completion of housing construction are the other concerns. In Fig. 5, two thirds of households with SWH installed are considered to be new construction.

The completion of housing construction ranges between 1 to 3 years. This implies that the popularization of SWH might be strongly coupled with the status of new construction. In addition, Taipei metropolitan consists of about 32% of total households in Taiwan. However, the popularization of SWH is very low. This is contributed not only to climatic condition but also to housing status. Based on the population census in 1995, the housing status in Taiwan district (excluding Taipei and Kaohsiung cities) and Taipei metropolitan is shown in Fig. 6 [4]. The composition of housing in Taiwan and Taipei metropolitan is apparently different. In Taiwan district, over 60% housing are cottage or duplex house which are more probable of installing SWH on the roof. However, apartment and congregate housing are the major types of housing in Taipei metropolitan (almost 80%). Limited residential SWH is expected as the results of survey. The government may need to take the other strategy to promote the installation of SWH, e.g. commercial systems (swimming pool or dormitory).

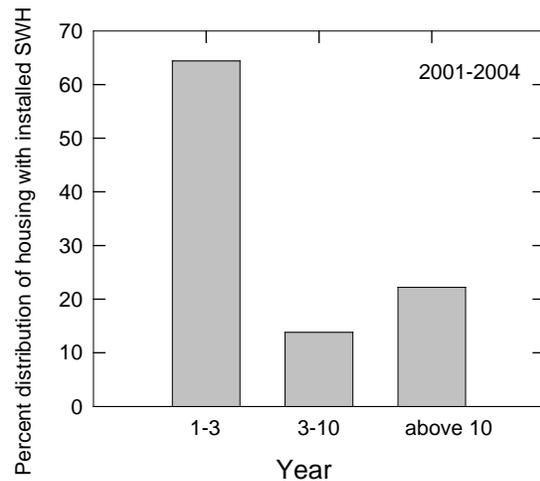


Figure 5 Completion of housing construction with SWH

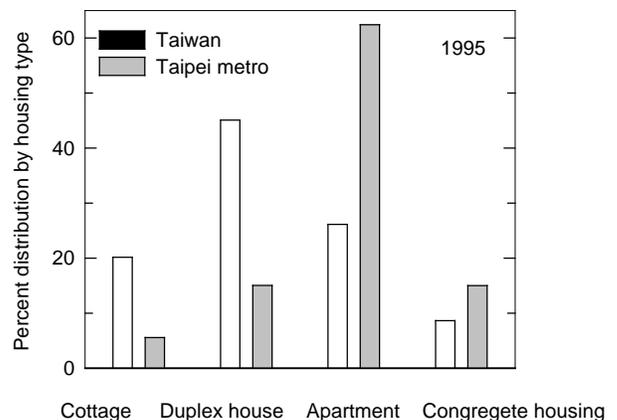


Figure 6 Housing status

3. POPULARIZATION OF SWH

As mentioned above, popularization of SWH in Taiwan is strongly coupled with the status of new construction. According to Construction and Planning Agency, Ministry of Interior [5], the occupancy permit by uses for new construction is classified as 11 types (namely housing, store with housing, factory, office, hotel, warehouse, school, hospital, recreational ground, farmhouse and others). In Fig. 7, the floor area of housing and store with housing shows similar trend with the variation of total floor area. A peak is observed in 1994. The construction business is declining between 1995 and 2002, which corresponds to the decline of installed area of solar collectors between 1995 and 1999, Fig. 3. For the concerns of residential SWH, the units of housing and store with housing are shown in Fig. 8. In 1994, there is more than 0.3 million new housing. This corresponds to peak installed area of solar collectors as shown in Fig. 3. During 2000-2004, the second period of incentive program of the government has a drastic effect on the popularization of SWH. To further visualize the effect of the status of new construction on the installed area of solar collectors, the data in Figs. 3 and 7 are re-plotted in Fig. 9. From 1988 to 1999, the installed area of solar collectors is coupled with the total floor area or floor area of housing and store with housing reasonably well. The ratio increases after 2000, which is associated with the second period of incentive program. It is expected that the potential market of SWH in Taiwan will be coupled with the status of new construction after the end of incentive program.

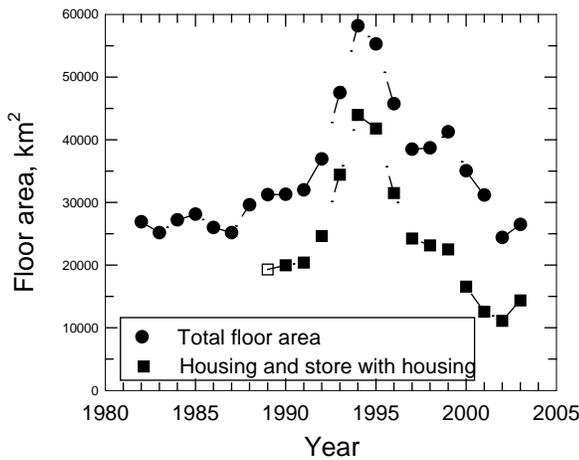


Figure 7 Floor area of occupancy permit for new construction

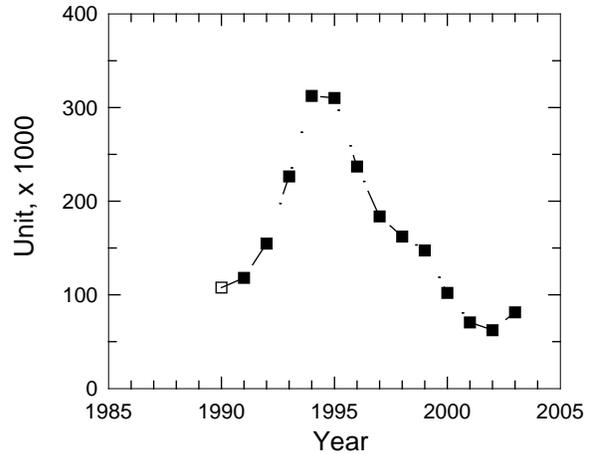


Figure 8 Units of new housing

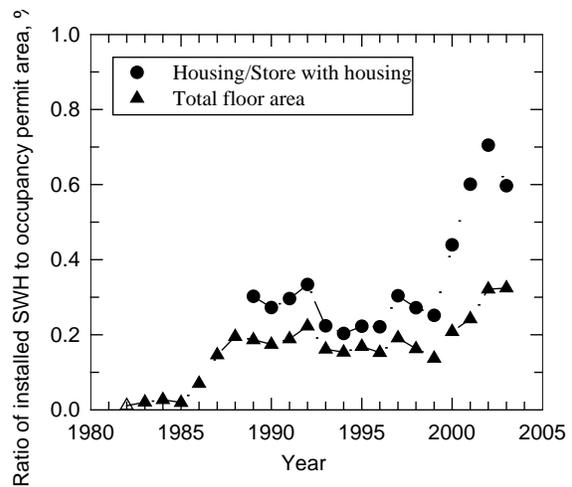


Figure 9 Installed area of solar collectors to floor area of new construction

4. CONCLUSIONS

Taiwan has large potential for harnessing solar energy, and the SWH industry has matured. With the well-organized and concerted efforts taken by the government, there are increasing public interests in energy conservation. The potential SWH market is strongly related to the status of new construction. For the popularization of SWH in the northern districts, particularly in Taipei metropolitan, the government may take some other strategies.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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