Effects of Technological Measures on Costs

INFO Sheet B02

Description:	*The cost effects of technological measures on component and on system level were analysed in a Swiss study. A summary is given with this Info Sheet.*
Date:	28.05.2018
Authors:	Daniel Philippen, Marco Caflish, Michel Haller, Stefan Brunold (SPF, CH)
Download possible at:	http://task54.iea-shc.org/

Introduction

The potential to reduce market prices of turn-key domestic solar thermal systems in Switzerland was recently analysed within a study[1] financed by the Swiss Federal Office of Energy. The study focussed on the cost effect of new technological approaches regarding single components and the whole heating system. Based on a market survey for single and multi-family buildings, the cost structure of actual offers for solar thermal systems in existing buildings in Switzerland was analysed. Relevant cost drivers were identified, strategies for implementing new and cheaper technologies were proposed, and their possible effect on the market prices was quantified.

Structure of Current Market Prices and Heating Costs of Solar Thermal Energy

According to the results of the market survey (Fig. 1), the average cost of a typical solar hot water system for single-family houses (SFH) without considering the boiler is 16’918 CHF incl. VAT (with subsidies 3'000 CHF less).

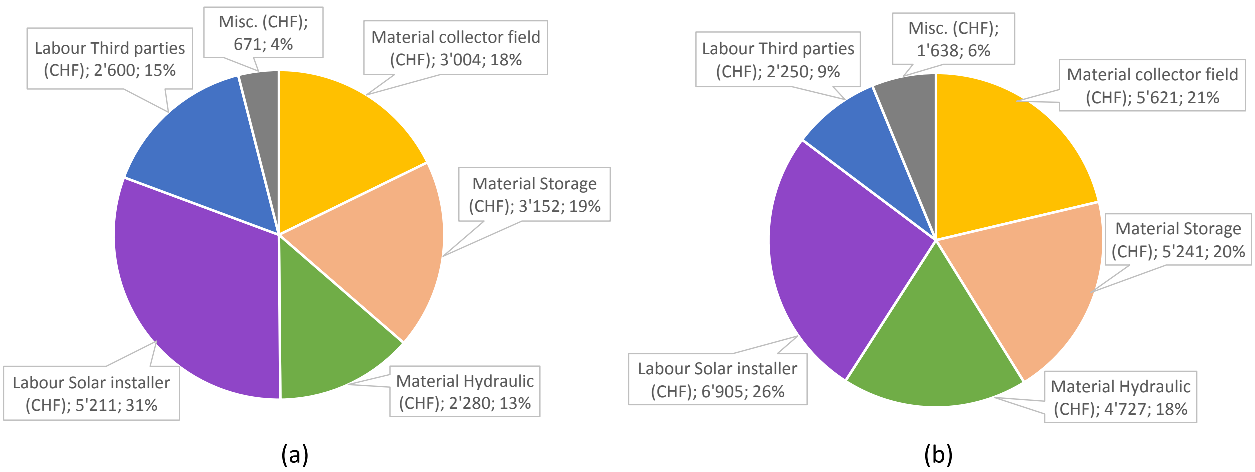

Figure 1: Composition of Swiss average total costs of solar thermal systems for the provision of hot water for (a) single-family buildings (total 16’918 CHF) and (b) multi-family buildings (total 26’383 CHF), incl. 8 % VAT.

The specific system costs per square meter of collector surface and without the conventional part of the boiler are 2’470 CHF/m^2. For solar hot water systems for multi-family houses (MFH), the average specific

[1] Report (in German language) see: www.spf.ch/Resotech

costs without the conventional part of the boiler are 1’685 CHF/m^2, with the total costs varying greatly according to the size of the system. The share of labour costs in the total investment costs is 50% for installations in SFH. The share of labour costs in MFH is smaller with 41 %.

In a reference plant for solar hot water preheating in MFH (natural gas + solar thermal), the Levelized Costs of Heat (LCoHs, i.e. the costs to avoid a fossil energy carrier per kWh[2]), amount to 0.13 CHF per kWh incl. VAT (with subsidies 0.10 CHF/kWh). For the entire solar-gas system, heat generation costs of 0.19 CHF/kWh result. These heat generation costs are compared to a possible alternative system for MFH (a combination of photovoltaics and heat pump for hot water) which achieves heat generation costs of 0.22 CHF/kWh.

Effects of Different Technological Measures on Costs

For a reference domestic hot water system for MFH, measures to reach cost reductions were analysed and their effects on investment, operating and maintenance costs were quantified. The effects were discussed and assessed together with companies from the Swiss solar thermal market. The reference system has a flat plate collector field of 17 m^2 and a cluster of two heat storages of 750 litres each, used for warm water storage and solar pre-heating. In the following an overview on the measures for cost reduction is given.

Use of pre-insulated plastic pipes

With some of the measures analysed, a temperature limitation in the solar pipes can be achieved which enables the use of inexpensive plastic pipes for heating installations. The estimations apply both to plastic-metal composite pipes and to pure plastic pipes. Besides reduced material costs, the installation time can be reduced for the use of pre-insulated heating pipes and press-fittings as well. In the study, the overall cost reduction through this measure was assessed to be 9 % of the total investment costs.

Over-heating protection: Collectors

Overheating-safe collectors can mainly be based on mechanisms which – once a certain temperature is reached in the collector – ensure that the absorption is strongly reduced, or that the heat loss of the collector is sufficiently increased. Ideally, the collector should have a very high efficiency at temperatures up to approx. 70 °C and at temperatures above virtually its power is switched off. Depending on the maximum achievable temperature, the temperature limitation can enable the use of inexpensive materials for the collector and the hydraulics. In addition, safety components such as pressure compensation vessels can be scaled down or omitted. In the study, it was estimated that with the use of collectors with over-heating protection together with plastic piping the investment cost of the system can be reduced by 9 % and the maintenance costs by 65 %. A restriction is that no costs for the mechanism itself were taken into account, as the mechanism of the protection is not clear.

---

[2] Louvet, Y., Fischer, S., Furbo, S., Giovannetti, F., Mauthner, F., Mugnier, D., Philippen, D., Vajen, K., 2017. Entwicklung eines Verfahrens für die Wirtschaftlichkeitsberechnung solarthermischer Anlagen: die LCOH Methode, in: 27. Symposium Thermische Solarenergie. Bad Staffelstein, Germany.

Over-heating protection: Drainback systems

Overheating protection in a drainback system is achieved by draining the fluid from the collectors before reaching excessive temperatures. The collectors themselves thus reach normal stagnation temperatures of around 200 °C, the remaining hydraulic components reach significantly lower temperatures depending on the drain temperature, which enables the use of plastics, e.g. for piping. The savings in components and maintenance that can be achieved with drainback compared to conventional systems were analysed for both glycol- and water-drainback systems. The highest savings were estimated for the water-drainback system together with plastic piping. They sum up to 12 % less investment cost and 65 % less maintenance costs.

Large door-passing plastic storage

Especially in existing MFH when a larger boiler with a solar system should be installed, the situation is common that the storage volume needed cannot be brought into the cellar all at once because of narrow stairways and doors. Thus, additional costs can occur due to the need to weld on-site or due to the installation of several small storage tanks as a cluster. In the study, the effect on costs was analysed when instead of two 750-litre DHW storages of the reference system, one rectangular, door-passing, and non-pressurized storage made of plastic with a volume of 1,500 litres is installed. The effects for a system with non-emptying collectors and a drainback system were assessed. The cost reduction results mainly from reduced specific storage costs and a less extensive pipework. In the drainback system the largest costs reductions can be reached with 12 % for the investment and 65 % for the maintenance costs.

Further non-technical measures

Due to the relevance of labour costs for solar thermal systems, measures in the field of work organisation were also considered. Two measures were quantified. In addition, various cost drivers were identified, which are listed below but whose impacts on costs were not quantified.

Coupling with roof refurbishment: A relevant cost reduction can be achieved in many cases if the installation of the solar system is done together with a refurbishment of the roof. Here, a reduction of the investment costs for the solar system is expected to be around 7 % (flat roof assumed).

"Solar one-stop shop": Often several companies are needed to install a solar thermal system, namely the heating installer, an electrician, a core driller, an insulation installer, and a roofer. As cost reduction measure a decrease of the amount of companies needed was analysed. However, integrating all or most of the above listed crafts into one company reduces the investment cost around only 1 %.

Further cost drivers: In the discussions with installers, various further reasons were mentioned, which often lead to additional costs for solar systems. These reasons are:

- Several trips to the construction site (possible reasons: insufficient coordination with third parties, lack of small parts in the assembly car, etc.).

- New constructions: too many individual steps leading to demand for coordination with other crafts, additional costs if construction crane was dismantled before the collectors were brought to the roof.

Effects of Combined Technological Measures on Costs

As a key result the study shows the importance of mechanisms that keep the temperatures in the hydraulic system at a level which allows for using plastic materials. This means high temperatures above around 100 °C have to be avoided in all system parts with the possible exception of the solar collectors. This temperature limitation can be realized either with new collector concepts that do not generate temperatures above 100 °C or with system concepts that guarantee a retention of high temperatures in the collectors (e.g. drain back systems). With this temperature limitation low-priced hydraulic components from the heating mass-market can be used.

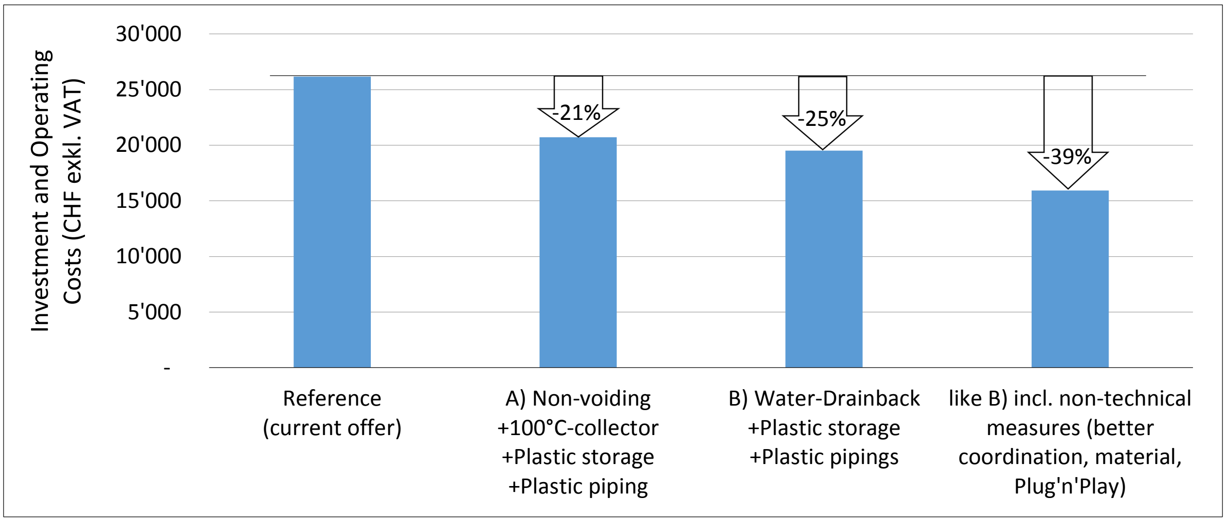

Figure 2: Reducing the investment and operating costs of a typical solar thermal system for hot water preheating in apartment buildings.

A maximum cost reduction by technical measures is achieved by using a water-drainback system with cubic plastic storage and plastic pipes (Fig. 2, Variation B). Compared to the reference plant, the investment and operating costs as well as the LCoHs can be reduced by 25%. The LCoHs will then be 0.09 CHF/kWh, which is approx. 0.02 CHF higher than current natural gas prices for MFH. A system concept with plastic components (storage tank and pipes) and collectors with overheating protection at 100 °C achieves lower savings of 21% (Variant A). By including further non-technical reduction measures, which would have to be achieved primarily through better coordination during installation, the selection of simpler materials and the simplest commissioning, costs can be reduced by a total of 39 %.

For the study generally existing concepts for components and systems and also inexpensive mass-produced components from the heating market are used, while temperature limitations are met by suitable system design or components. Hence, the measures proposed to reduce costs for solar thermal systems by up to

39 % can be reached fast and without the need for fundamentally new developments. We are currently investigating these measures and concepts in a follow-up study at our institute in order to demonstrate their feasibility and possible implementation in production.