Reference System, Switzerland
Solar Domestic Hot Water System for Multi-Family House

INFO Sheet A11

Description:	*Definition of a reference solar thermal domestic hot water system with gas auxiliary for multi-family houses, Switzerland*
Date:	03.01.2017, revised 10.04.2018[1]
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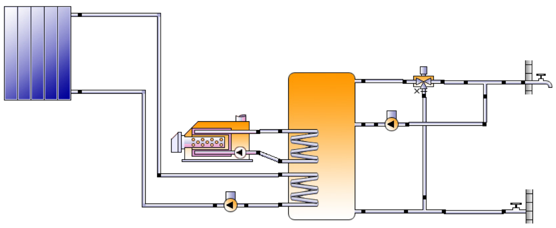
Download possible at:	http://task54.iea-shc.org/

Introduction

This document describes a Swiss reference solar domestic hot water (SDHW) system for multi-family houses that uses a gas burner as auxiliary. The system is modelled in the simulation software Polysun [1] with template No. 8a that was adapted for a larger heat demand of a multi-family house. The reference system is taken from [2]. The costs for investment and maintenance of the gas burner (the device) are allocated to the room heating and are not taken into account here. However, the costs of gas for preparing DHW are included into the calculation.

Hydraulic Scheme of the System



Key data	
Collector area (one collector)	2.5 m^2
Heat store volume	300 l
Location	Switzerland, Rapperswil
Hemispherical irradiance on horizontal surface	$\Sigma G_{hem,hor}$ =1143 kWh/(m^2 a)
Lifetime of system	30 years

Levelized Cost of Heat (LCoH)

LCoHs solar part without VAT	**0.21 SFr/kWh**
LCoHc conventional part without VAT	**0.18 SFr/kWh**
LCoHo complete system without VAT	**0.19 SFr/kWh**

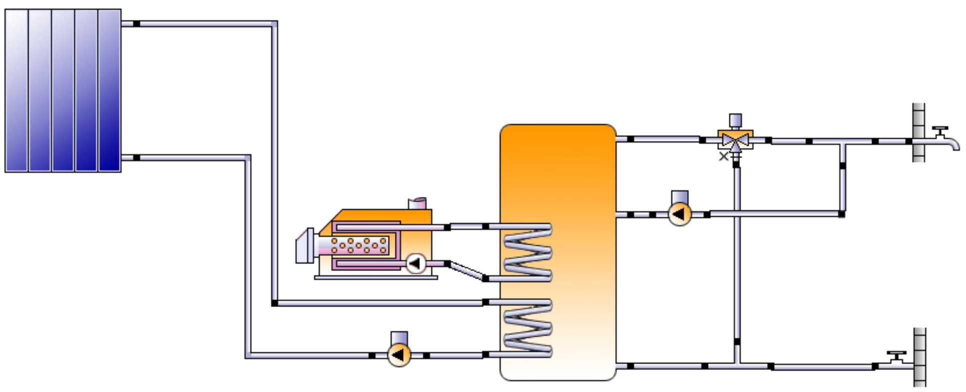
Definition of the Reference System

Basic Information

Location	Switzerland, Rapperswil
Type of system	Domestic hot water system
Weather data including - Beam irradiance on horizontal surface - Diffuse irradiance on horizontal surface - Ambient temperature in hourly values	test reference year Rapperswil (TRY) $G_{beam,hor.}$ = 526 kWh/m^2 $G_{diff.,hor}$ = 578 kWh/m^2 T_{amb} = 10.1 °C
Collector orientation - Collector tilt angle to horizontal - South deviation of collector - Resulting hemispherical irradiance on tilted surface	 45 ° south = 0° 1’143 kWh/(m^2 a)
Load information including - Average inlet temperature of cold water - Cold water inlet temperature amplitude throughout year - Tapping profile - Tapping temperature - Draw off volume per day - Heat demand (DHW) per year	 10 °C 0 K Wohngebäude (VDI6002) 60 °C 644 L/d 14‘735 kWh/a

Solar Thermal System

Hydraulic scheme of reference system



Collector information	
Total absorber area of the collectors	15.5 m²
Maximum collector efficiency	0.79
Incidence angle modifier for direct irradiance	Ambrosetti
Incidence angle modifier for diffuse Irradiance	0.89

Linear heat loss coefficient	4.14 W/(m²K)
2nd order heat loss coefficient	0.0071 W/(m²K²)
Effective heat capacity	5.6 kJ/K
Heat store parameters	
Heat store volume	1500 l
Auxiliary volume for DHW preparation	500 l
Set temperature for DHW	60 °C (-0 K/+10 K)
Overall heat loss capacity rate of store	2.5 W/K
Maximum heat store temperature	80 °C
Ambient temperature of heat store	20 °C
Solar thermal controller and hydraulic piping	
Total pipe length of collector loop	30 m
Inner diameter of collector loop pipe	20 mm
Temperature difference collector start-up	6 K
Temperature difference collector shut-off	2 K
Operating hours of solar loop pump	2576 h
Conventional system	
Type of auxiliary heating	Gas condensing boiler
Boiler capacity	15 kW
Efficiency factor of boiler	0.9
Cost calculation	
Overall costs solar thermal part with VAT (8 %)	24613 SFr
Cost per kWh gas	0.093 SFr/kWh
Gas savings due to solar thermal	8727 kWh/a
Type and amount of incentives	No incentives considered
Lifetime of system (earlier replacement of some parts considered)	30 a
Yearly operation and maintenance cost of solar part	142 Fr/a
Fractional energy savings	35 %
Interest rate	1 % p.a.
Inflation rate	0 % p.a.
VAT rate	8 %
Rise in price of grid-bound energy carriers	1 % p.a.
LCoHs solar part with VAT [3,4]	0.21 SFr/kWh
LCoHc conventional part with VAT	0.18 SFr/kWh
LCoHo complete system with VAT	0.19 SFr/kWh
Energy carrier avoidance costs with VAT [2]	0.13 SFr/kWh

References

[1] Polysun simulation software, Version 9.09, Vela Solaris, 2016.

[2] ReSoTech (2016): „*Reduktion der Marktpreise solarthermischer Anlagen durch neue technologische Ansätze Teil 1: Potenzialanalyse und Lösungsansätze, Schlussbericht*“. SPF on behalf of Swiss Federal Office of Energy.

[3] Louvet, Y., Fischer, S. et. al. (2017): “*IEA SHC Task 54 Info Sheet A1: Guideline for levelized cost of heat (LCoH) calculations for solar thermal applications*“. URL: http://task54.iea-shc.org/.

[4] Louvet, Y., Fischer, S. et.al. (2017): “*Entwicklung einer Richtlinie für die Wirtschaftlichkeitsberechnung solarthermischer Anlagen: die LCoH Methode*“. Symposium Thermische Solarenergie, Bad Staffelstein.

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[1] To avoid confusion with the results of other works ([1], [8], [9]) also using the notion of LCoH for solar thermal systems, new acronyms were introduced in this Info Sheet. As previous studies have considered different assumptions for the definition of the terms of the LCoH equation, it does not make sense to compare the values they obtained with the LCoHs, LCoHc and LCoHo values defined here. A detailed explanation of the differences between the approaches chosen in the framework of IEA-SHC Task 54 and in the Solar Heat Worldwide report [9] can be found in Info Sheet A13 [10].