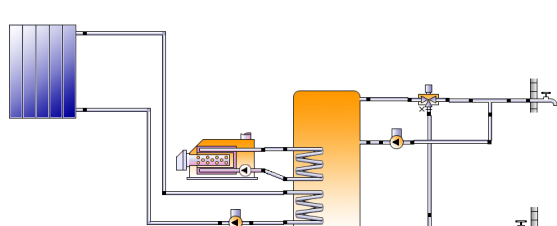


Description:	<i>Definition of a reference solar thermal domestic hot water system with gas auxiliary for multi-family houses, Switzerland</i>
Date:	03.01.2017, last revision 12.11.2017
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Download possible at:	http://task54.iea-shc.org/

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	$\Sigma G_{\text{hem,hor}} = 1143 \text{ kWh}/(\text{m}^2 \text{ a})$
	Lifetime of system	30 years

Levelized Cost of Heat (LCoH)

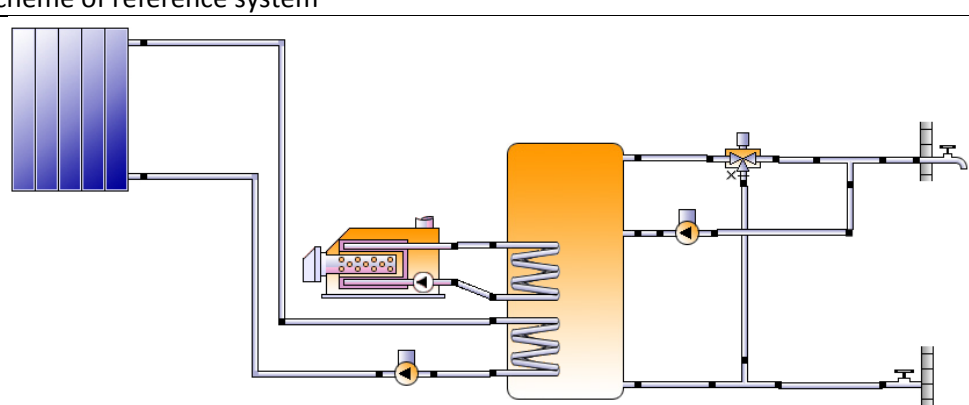
LCoH solar part without VAT	0.21 SFr./kWh
LCoH conventional part without VAT	0.18 SFr./kWh
LCoH complete system without VAT	0.19 SFr./kWh

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) $G_{\text{beam,hor.}} = 526 \text{ kWh/m}^2$ $G_{\text{diff.,hor.}} = 578 \text{ kWh/m}^2$ $T_{\text{amb}} = 10.1 \text{ }^\circ\text{C}$
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 m ²
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/(m ² K)
2nd order heat loss coefficient	0.0071 W/(m ² K ²)
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.
LCOH solar part with VAT [3,4]	0.21 SFr./kWh
LCOH conventional part with VAT	0.18 SFr./kWh
LCOH 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 – Reduktion der Marktpreise solarthermischer Anlagen durch neue technologische Ansätze
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- [3] Y. Louvet, S. Fischer et. al. IEA SHC Task 54 Info Sheet A1: Guideline for levelized cost of heat (LCOH)
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