Description:	*Definition of the reference solar domestic hot water (SDHW) system, Denmark*
Date:	22.09.2017, revised 10.04.2018[1]
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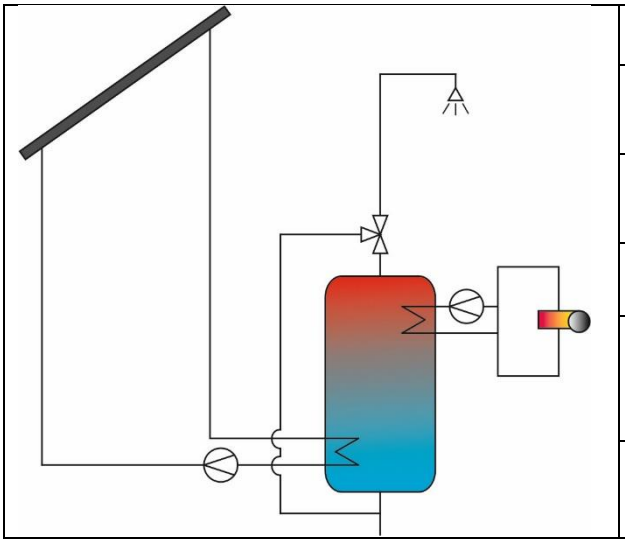
Download possible at:	http://task54.iea-shc.org/

Intro

This info sheet gives information on a reference solar domestic hot water system for Denmark.

Hydraulic Scheme of the System



Key data	
Collector area (one collector)	2.36 m²
Heat store volume	255 l
Location	Copenhagen, Denmark
Hemispherical irradiance on horizontal surface	$\Sigma G_{hem,hor}$ =1150 kWh/(m² a)
Lifetime of system	30 years

Levelized Cost of Heat (LCoH)

LCoHs solar part without VAT	**0.0962 €/kWh**

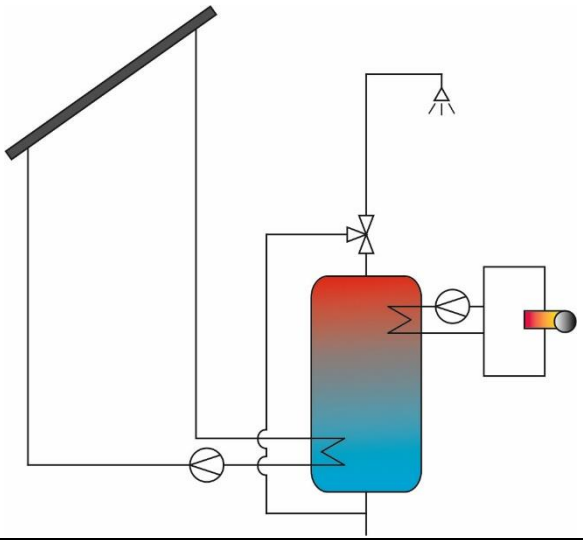
Definition of reference System

The basic information appears from the table below.

Basic Information

Location	Denmark
Type of system	Solar Domestic hot water system
Weather data including - Beam irradiance on horizontal surface - Diffuse irradiance on horizontal surface - Ambient temperature in hourly values	Danish Test Reference Year (TRY)
Collector orientation - Collector tilt angle to horizontal - South deviation of collector	 45° 0°
Load information including - Average inlet temperature of cold water - Cold water inlet temperature amplitude throughout year - Tapping profile - Tapping temperature - Space heating load profile (in case of space heating application)	Yearly hot water consumption: 1700 kWh Average inlet temperature of cold water: 10°C Cold water inlet temperature amplitude: 0 K Hot water drawn at 7 am, noon and 7 pm in three equally sized volumes Tapping temperature: 50°C

Solar Thermal System

Hydraulic scheme of reference system	
Collector information	
Number of collectors	1

Collector aperture area	2.36 m²
Maximum collector efficiency	0.827
Incidence angle modifier for direct irradiance	$K_\theta = 1 - \tan^{3.7}(\theta/2)$
Incidence angle modifier for diffuse irradiance	0.87
Linear heat loss coefficient	3.247 W/(m²K)
2nd order heat loss coefficient	0.020 W/(m²K²)
Effective heat capacity	6.0 kJ/(m²K)
Heat store parameters	
Heat store volume	255 l
Auxiliary volume for DHW preparation	95 l
Set temperature for DHW	50.5°C
Overall heat loss capacity rate of store	2.0 W/K
Maximum heat store temperature	95°C
Ambient temperature of heat store	20°C
Solar thermal controller and hydraulic piping	
Total pipe length of collector loop	34 m
Inner diameter of collector loop pipe	8 mm
Temperature difference collector start-up	10 K
Temperature difference collector shut-off	0.1 K
Electric consumption of solar thermal controller	2 W
Operating hours of solar thermal controller per year	8760 h
Electric consumption of solar loop pump	30 W
Operating hours of solar loop pump	2100 h
Electric consumption of other el. components	-
Conventional system	
Type of auxiliary heating	Gas condensing boiler
Boiler capacity	23 kW
Daily hot water tank heat loss	2 kWh
Efficiency factor of boiler	0.9
Cost calculation	
Heat store unit	1350 €
Solar collector	670 €
All other components	630 €
Installation	1350 €
Overall costs	4000 €
Cost calculation	
Type of incentives	-
Type and amount of incentives	-
Lifetime of system	30 year
Yearly maintenance cost	13 €
Collector gain	850 kWh
Yearly solar fraction	50 %
Cost per kWh electric energy	0.28 €
VAT rate	25 %

LCoH [1,2]	0.0962 €/kWh

References

[1] 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/.

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

[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].