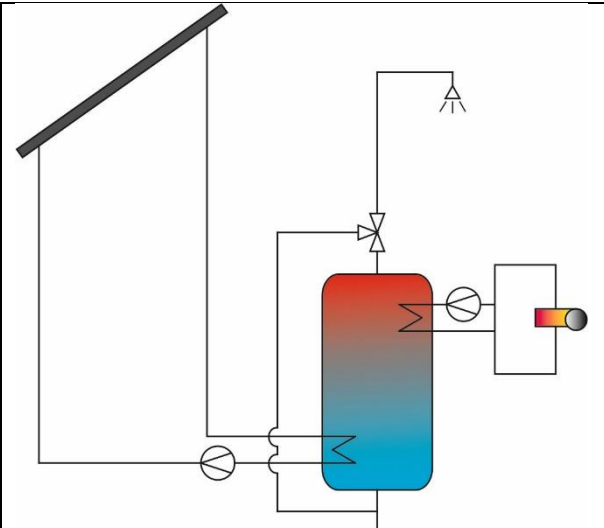


Description:	Solar Domestic Hot Water System
Date:	22.09.2017, last revision: 12.11.2017
Authors:	Simon Furbo, Janne Dragsted (Technical University of Denmark)
Download possible at:	<a href="http://task54.iea-shc.org/">http://task54.iea-shc.org/</a>

## Intro

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

## Hydraulic Scheme of the System

	<b>Key data</b>	
	Collector area (one collector)	2.36 m <sup>2</sup>
	Heat store volume	255 l
	Location	Copenhagen, Denmark
	Hemispherical irradiance on horizontal surface	$\Sigma G_{\text{hem,hor}} = 1150 \text{ kWh}/(\text{m}^2 \text{ a})$
	Lifetime of system	30 years

## Levelized Cost of Heat (LCOH)

LCOH solar part without VAT	0.0962 €/kWh
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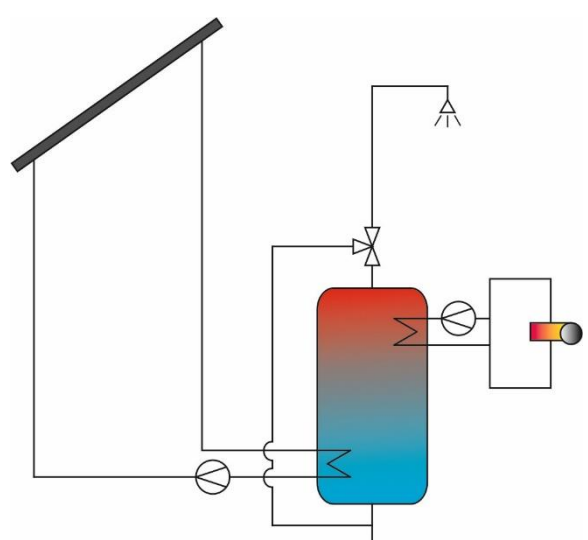
## Definition of reference system

The basic information appear 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	
<b>Collector information</b>	
number of collectors	1

collector aperture area	2.36 m <sup>2</sup>
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/(m <sup>2</sup> K)
2nd order heat loss coefficient	0.020 W/(m <sup>2</sup> K <sup>2</sup> )
effective heat capacity	6.0 kJ/(m <sup>2</sup> K)
<b>heat store parameters</b>	
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
<b>Solar thermal controller and hydraulic piping</b>	
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	-
<b>conventional system</b>	
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
<b>cost calculation</b>	
heat store unit	1350 €
solar collector	670 €
all other components	630 €
installation	1350 €
Overall costs	4000 €
<b>Cost calculation</b>	
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 %

*Reference System, Denmark*

*Solar Domestic Hot Water system, single-family house*

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LCOH [1,2]	0.0962 €/kWh
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## References

- [1] Y. Louvet, S. Fischer et. al. IEA SHC Task 54 Info Sheet A01: Guideline for levelized cost of heat (LCOH) calculations for solar thermal applications“, March 2017. Download: <http://task54.iea-shc.org/>
- [2] Y. Louvet, S. Fischer et.al. Entwicklung einer Richtlinie für die Wirtschaftlichkeitsberechnung solarthermischer Anlagen: die LCOH Methode. 27. May 2017. Symposium Thermische Solarenergie, Bad Staffelstein.

Reference System, Denmark  
Solar Domestic Hot Water system, single-family house

INFO Sheet A12

Logg of Revisions

Date	Page	Revision	Author
previous file name: Info Sheet Reference.docx			
07.11.2017	1	re-named info sheet to AR14	M.Meir
	1	Re-formatted header	
	4	added references 1 and 2	
	3	added cross reference to references 1 and 2	
12.11.2017	1	header: - renamed infosheet from AR14 to A13 - small name change: " Solar Domestic Hot Water system, single-family house"	M. Meir