Chapter:	Preliminary investigations
Date:	November 2014 / update September 2017
Size:	12 pages
Description:	This fact sheet presents some useful evaluation and calculation tools to run for SDH systems opportunity and feasibility studies. Most of them provide solar collector area pre-sizing, energetic performance results and financial evaluation.
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Available in:	English
Version id:	2.6-2
Download possible at:	www.solar-district-heating.eu

Contents

List of tools

Name	Developer	Availability	Short description
Dedicated SDH tools			
F-easy	PlanEnergi	Free download: www.solarkey.dk/f-easy/f-easy.xlsx	Yearly base, provides pre-sizing and economical figures to integrate solar in existing DH
Fjernsol-II (v145)	PlanEnergi	Free download: www.solarkey.dk/software.htm (only in Danish)	Hourly based calculations for Danish locations. Monthly based outputs, presizing + economical figures, comparison between several collectors
ScenoCalc Fernwärme	Solites	www.scfw.de	Free and open-source excel based tool for yield prediction of solar thermal plants feeding into district heating systems, based on the international solar keymark standard calculation tool ScenoCalc.
SOLID Concept tool	SOLID	Not in the full version	Monthly based, solar yield prediction + economical figures, comparison between several collectors
SDH Online Calculation Tool	SOLITES	www.sdh-online.solites.de	Simple online tool for opportunity studies ; 2 types of solar integration: centralized and distributed
SUNSTORE-4	CIT Energy Management	Free	Feasibility Evaluation Tool Yearly base, provide pre-sizing and economical figures
Generic tools			
ENERGY PRO	EMD International A/S	Free demo version (no saving ability and “demo” printed on output pages) www.emd.dk/energyPRO	SDH system model to be created (The modules “DESIGN” and “FINANCE” are the main ones necessary.)
POLYSUN ®	VelaSolaris	Free demo version on the website	SDH system model to be created

TRNSYS	University of Wisconsin Madison, USA	http://www.trnsys.com/	Dynamic Simulation tool SDH system deck to be created
RETSCREEN	Natural Resources Canada	Free download French and English version	Excel based SDH model has to be created

F-easy

Description

f-easy is a tool for a first approach of sizing and economical balance. It is based on the estimations described in the fact sheet “Feasibility study” (no. 2.3)[1]

Input and output

Main input:

- District heating annual production (MWh)
- Annual solar irradiation on horizontal (kWh/m²)
- Available land area and price of the land (m² et €/m²)
- Distance between solar collector and district heating connection (km)
- Average operating temperature on the network side (°C)
- Acceptable heat production price (€/MWh)

It is possible to adjust more detailed parameters mainly related to costs.

Main results:

- Collector area and used land area (m²)
- Storage volume (m^3)
- Total investment and simple payback time (€ and years)
- Solar fraction (%)
- (Simple) payback time (years)

Benefits and limits

f-easy is a simple and easy tool to be used in a first approach, for opportunity case studies. Calculations are made from ratio and solar production is a rough estimation. Most inputs parameters can be chosen whether it should be a user input or estimated by the tool itself. This way f-easy can be used for different means, e.g. to test the influence of the district heating network temperatures or checking the payback time when varying the price of the (solar) heat.

[1] www.solar-district-heating.eu/Documents/SDHGuidelinesDiscussionBoard/23Feasibilitystudy.aspx

Fjernsol II

Description

Fjernsol II calculates the energy output from a solar collector field installed in an existing district heating network. It also provides the price of the produced solar heat which can be compared with the heat price from alternative heat sources. Solar production is estimated monthly.

Input and output

Main inputs:

- Collector efficiency expression coefficients and size
- On-site installation characteristics
- district heating operating condition (temperatures)
- financial parameters

Main outputs:

- graphs and table
- solar performances (solar yield, solar fraction, etc…)
- energy price of the solar solution in €/MWh

Benefits and limits

Fjernsol II allows a one-glance comparison between several cases. The calculation of solar production is validated only for sub-sized installation (solar production << district heating load). It does not take into account any storage and assumes that all solar heat can be used.

It is developed for typical Danish conditions and it is therefore not possible to choose another location than Denmark and the collector orientation is fixed at a tilt of 30° facing due south.

If the user has obtained several offers, these can quickly be evaluated in order to see which one provides the lowest heat price taken into account both the performance of the collectors and the total price of the solar system.

ScenoCalc Fernwärme

Description

ScenoCalc Ferwärme is a free Excel based tool for calculation of the yield of solar thermal plants feeding into district heating networks. It is based on the international solar keymark standard calculation tool ScenoCalc.

Input and output

Main input:

- Weather: choose between 3 or copy/paste meteonorm data
- Components of the system (storage, heat exchangers, pipes, load..)
- Collector type from a database
- Collector area, azimuth and slope (…)
- Properties of different components of the system
- Load / temperatures in the district heating network

Main results:

- Yearly solar delivery to the district heating network (also monthly and hourly available)
- Graphs and tables

Benefits and limits

ScenoCalc Fernwärme is at the moment only available in German. It was validated by comparison with TRNSYS simulations and is a very user-friendly tool to predict the yield of large-scale solar thermal plants.

The tool can only calculate a limited number of simple system configurations, and is not adapted to detailed investigations of system components or control strategies.

Concept tool SOLID

Description

Concept tool SOLID is a tool for a first approach of sizing and gives out a monthly solar yield; it could compare different collector technologies; basis data is Meteonorm

Input and output

Main input:

- Complete data set of Meteonorm (copy and paste in one table in excel, very easy!!)
- Mean temperature of collector in °C
- Collector type
- Number and sizes of collector
- Distance between col. rows (front to front) in m
- Losses in solar loop (collector field --> storage) in %
- Losses in distribution (storage --> user) in %
- Financial parameters like total investment costs, interest rates, energy prices etc.

Main results:

- Specific monthly solar system yield
- Graphs and tables
- Financial analysis (very rough payback calculation!!!)

Benefits and limits

Concept tool SOLID is a simple and easy tool to be used in a first approach, for opportunity case studies.

If it should be available for the whole consortium it has to be adapted specifically

SDH Online Calculation Tool

Description

The SDH Online Calculation Tool is based on TRNSYS simulation results and is a really user-friendly first approach tool to get a first idea of dimensioning and economics of a solar district heating plant. The tool is available for central solar district heating plants and distributed solar district heating plants (decentral feed-in).

TYPE 1 - Distributed solar district heating plant

Inputs

Collector area [m²], azimuth [°] and slope [°]

Collector type [flat plate, flat plate high-temperature, CPC, ETC]

Location and meteorological data [now available: 3 sites in Germany]

Net operation temperatures

Economical data (default data is available)

Outputs

Collector efficiency and yield

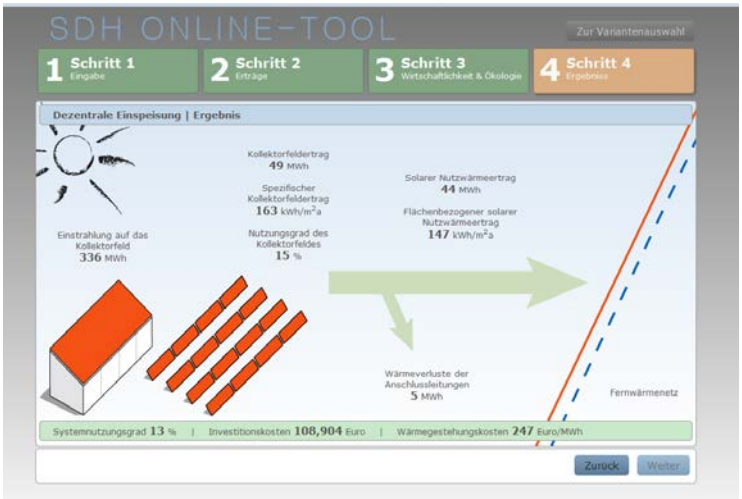
Solar net losses

Useful heat fed-in the net

Efficiency of the system

Investment costs

Heat production costs



Screenshot of the user interface for distributed SDH plant

TYPE 2 – Central solar district heating plant

Inputs

In addition to the inputs for the decentralized integration, the following inputs are needed :

Specific storage volume

Heat demand

Outputs

In addition to the inputs for the decentralized integration, the following inputs are needed :

Storage performances

Solar fraction

Primary energy and CO2 savings if data about alternative energy is given by the user

Screenshot of the user interface for central SDH plant

Benefits and limits

It is available online, user-friendly and fast.

It enables the user to easily compare different dimensioning possibilities.

It is specifically designed for Solar District Heating.

So far the tool will be available in German language only, and only for three climates in Germany.

Only the most basic choices can be made by the user.

Sunstore-4 Feasibility Evaluation Tool

Description

SUNSTORE-4 is a tool for a first approach of sizing and feasibility evaluations of large scale SDH plants. The tool has been created as a part of a SUNSTORE-4 EU project. There is a possibility to compare up to 5 different hybrid system concepts, including large scale solar heating system, seasonal or short term energy storage, biomass boiler system, heat pump and even ORC for electricity. The SUNSTORE-4 tool has 5 different default concepts included, but not all of the concepts need to be studied and shown on the results summary table. The minimum number of concepts chosen for feasibility evaluation is one.

The results give the investment cost and the resulting heat price with the selected hybrid concepts. Comparison is made between the selected concepts and the traditional DH system. Additionally, sensitivity analyses can be made with each concept, where the component prices and fuel prices can be changed to see how much it affects the heat price.

Input and output

Main input:

- District heating annual production (GWh/a)
- Design power of the DH plant (MW)
- Annual solar irradiation on horizontal (kWh/m²)
- Energy prices for biomass, electricity, feed-in tariff of electricity, DH heat price of the alternative system (€/MWh)
- Investment conditions- required discount rate (%) and calculation period for the investment (years)

Technical input data for the hybrid concepts:

- Net heat load coverage for the solar system, biomass system and heat pump (%)
- Annual solar collector efficiency (%)
- Type of thermal storage (pit, borehole, excavation conditions)
- Storage volume/collector area (m^3/m^2)
- Storage heat losses (%)
- Biomass boiler efficiency (%)
- Seasonal performance factor of the heat pump
- Estimated full load hours for the Heat pump (% from the full load hours of the plant)
- Electricity output of the ORC, if included to the system (%)

Input data for the investment cost of the system components:

(Default values or own data can be chosen for the following points)

- Solar collector system (collector cost, operation and maintenance cost, cost for land and levelling)
- Energy storage (pit storage, borehole storage, water tank storage)
- Heat pump system (HP cost, cost for operation and maintenance)
- Biomass boiler system (investment cost, cost for operating and maintenance)
- Biomass boiler system with ORC (investment cost, cost for operating and maintenance)

Main results:

- Total heat cost of the selected hybrid SDH system (€/MWh)
- Total investment of the hybrid SDH system (M€)
- Total heat production cost (k€/MWh)
- Contribution to the heat price of the different system components (€/MWh)
- Comparison of the heat price of the different hybrid SDH concepts and traditional DH system (€/MWh)

Specific results of the hybrid concepts:

- Needed collector area (m^2)
- Needed storage volume (m^3)
- Net solar heat gain (GWh/a)
- Investment cost (M€) and annual cost (k€/a)of solar collectors, thermal storage and total solar system
- Heat cost per net solar gain (€/MWh), and contribution to the total heat cost (€/MWh; %)
- Biomass system heat gain (GWh/a)
- Design power of biomass boiler (MW)
- Investment (M€) and annual cost (k€/a) of biomass boiler system
- Heat cost per net biomass boiler gain (€/MWh), and contribution to the total heat cost (€/MWh; %)
- Heat pump system heat gain (GWh/a)
- Design power of heat pump (MW)
- Investment (M€) and annual cost (k€/a) of heat pump system
- Heat cost per net heat pump gain (€/MWh), and contribution to the total heat cost (€/MWh; %)
- ORC design power (MW) and ORC net electricity production (GWh/a)
- ORC investment (M€) and annual cost (k€/a), (cost is given as combined with a biomass system)
- ORC annual income (k€/a)

Benefits and limits

SUNSTORE-4 is a simple and easy tool to be used in a first approach, for opportunity case studies. Calculations are made from ratios and production is a rough estimation. Default hybrid concepts are included to the feasibility tool, no additional system concepts can be added.

The SDH fact sheets addresses both technical and non-technical issues, and provide state-of-the-art industry guidelines to which utilities can refer when considering/realizing SDH plants. For further information on Solar District Heating and the SDHtake-off project please visit www.solar-district-heating.eu.

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