Date:	*15 September 2017*
Description:	*This report contains a summary of the key results obtained in Subtasks A – D of Task54 until September 2017.*
Authors:	*Dr. Michael Köhl, Sandrin Saile, Dr. Stephan Fischer, Dr. Michaela Meir, Prof. Dr. Gernot Wallner*

Contents

Introduction

This task aims at the purchase price reduction for end-users of installed solar thermal systems in the domestic hot water sector. Envisaged is the reduction of the purchase price up to 40% contrasted to applied reference systems by the following measures:

- Simplified system design
- Less but innovative cost-efficient materials
- Standardized components, subcomponents and installation
- Low production costs
- Plug & play systems for a simplified installation
- Reduced maintenance and operation costs
- Improved marketing and consumer-oriented design

Task54 was inaugurated in October 2015 and will be terminated in October 2018.

Subtask A – Market success factors and cost analysis

One central effort in Subtask A was to define so-called reference systems for different countries and different system types. Reference systems are needed to identify and quantify the proposed cost reduction measures by. So far, reference systems for the most important Central-European markets have been worked out in close collaboration with Subtask B. The identified reference system types are (non-solar) conventional heating, DHW heating in single family houses and in multi-family buildings, further solar combisystems for DHW preparation and space heating. At least two more reference systems are in progress: One for Southern-European climate based on the so-called thermosiphon concept and one for Norway, serving as a reference to investigate cost reduction for building-integrated and drain-back solar heating systems.

In order to compare different designs and technological solutions with one another, a tool is needed to identify the costs of the heat produced by solar thermal systems over their life time. The levelized cost of heat (LCOH), a measure based on the concept of levelized cost of energy, widespread in the electrical power sector, was chosen. This concept builds on the work of the FRoNT project [1] who laid the foundations for the application of the method to any heating technology. It aims at detailing the methodology to calculate the levelized cost of the heat substituted by solar thermal energy. Furthermore, an extension of the concept is suggested in order to estimate the cost of the heat generated by the entire solar assisted heating system, or the conventional sources of heat supply. The Task 54 approach to LCOH is published in Info Sheet A 2.2 [2]. The reference systems including calculated LCOH will be published on the Task 54 homepage in individual info sheets in October and November 2017. The reference systems defined in Subtask A serve as comparison for the optimized systems investigated in Subtask B. Calculations of optimized LCOH will be conducted in Spring / Summer 2018.

Subtask B –
System design, installation, operation and maintenance

Definition of standardized components

The work related to cost reduction by **product standardisation and reduction of product variety in China** by M. Guangbai (Linuo Paradigma) revealed a **cost reduction of 9 %** in the production costs for Chinese standard thermosiphon systems.
A standardised **solar hot water storage** was defined within the German project KoST (volume 300 l, optimised surface/volume ratio, class B European eco labelling directive, one pipe circulation suppression). First estimations of the manufactures show a **cost reduction in production of 5 to 10 %**.
The first proposal for a **standardised solar collector** (2.6 m2 gross area, 2000 x 1300 x 80 mm, 4 connections, plug in connectors) has been developed also in the German project KoST. Collector manufactures are presently checking with their suppliers the potential cost reduction.

Technical aftersales costs

The work related to a **flat plate collector with a temperature limit of 120°C** developed by ISFH and KBB showed that the temperature limitation can lead to a **significant cost reduction for the hydraulic system as well as for the maintenance costs**. First investigations by SPF have shown that the cost reduction within the hydraulic installation amounts to 67% in material and 33% in labour costs. Estimations of ISFH have shown that the yearly maintenance costs can be reduced to 40 % due to the lower temperatures within the hydraulic circle.

Cost optimization of reference systems

The **sensitivity analysis and LCoH Calculation** on improved (compared to the reference system) SDHW systems in Germany carried out by ITW within the KoST project showed a **variety of possibilities for a** significant cost reduction.

New proposals for a 40% price reduction

Conico Valves showed that water-based vacuum-tube solar systems with automatic thermosiphonic (back-up) frost protection **using Thermo-Differential Valve technology** can result in a significant **reduction of the investment and operation costs** due to the fact that no controller and solar heat exchanger is needed.

The work for domestic hot water system in multifamily houses performed by SPF showed c**ost reduction potentials of between 21 % and 39 %** depending on the assumptions. The drivers of the cost reduction are the **investment and operation cost due to a temperature restriction of the collector to 100 °C** and the use of **polymeric storage tanks and piping.**

Using the thermal performance parameters of the **heat pipe flat plate collector** developed by ISFH/KBB the **energy savings** of the German solar domestic hot water system have been calculated using TRNSYS. The

LCoH calculation was performed taking into account the findings from ISFH/KBB. The result showed that the costs for the kWh solar heat could be **reduced by 38 %**.

Subtask C – Cost-efficient materials, production processes and components

The main focus of Subtask C is to evaluate the potential of novel materials and processes for significant cost reductions of solar thermal systems. Therefore, projects dealing with the identification of major cost drivers, the material substitution and functional integration and the development of innovative, cost-efficient processes and components were initiated. The installation of the system is the most critical cost driver for European domestic hot water and space heating systems. While significant cost reductions have been achieved in the production of single components, especially collectors, the current systems, primarily based on metals, do not allow for cost-efficient installation. In contrast, small thermosiphon systems for hot water preparation are already cost-efficient. The main deficiency of such systems is the limited reliability and lifetime.

Polymeric materials exhibit an excellent functional integration capability and as evidenced in numerous applications facilitate easy installation. These unique characteristics can be exploited just for mass products. Hence, special attention in Subtask C was given to the development of three classes of polymeric materials including polypropylene (PP) absorber and liner materials, glass-fibre reinforced polyamides (PA-GF) for pressurized components and high-temperature resistant polyphenylene sulfide (PPS) for extruded absorbers. Detailed property requirement profiles were deduced or the most critical components (especially absorber). Special polymer grades were developed Together with the raw material manufacturers Borealis, Schulman and Solvay and meanwhile commercialized. The novel PP grade is widely used for swimming pool absorbers (Magen) but also overheating protected absorbers of pumped or thermosiphon systems (Aventa, Magen, Sunlumo). The PA-GF grade is used for components of integrated storage collectors (GreenOneTec and KIOTO) and pre-fabricated hydraulic units (Sunlumo). The PPS material is extruded to large area absorbers by Aventa, which is currently planning a significant extension of the extrusion facility in Norway.

Significant cost reductions (> 20%) but also ecological benefits (lower energy payback time and less greenhouse gas emissions) were achieved for four types of novel systems:

- Pumped hot water systems with 1 m^2 modular polymer collectors, flexible piping and polymer-based storage (concept Sunlumo)
- Thermosiphon systems based on extruded PP absorber sheets or pipes (Aventa and Magen)
- Integrated storage collector with polyamide based storage component (GreenOneTec and KIOTO)

- Pumped space heating system with façade and roof integrated collectors based on extruded PPS absorbers and polycarbonate (PC) glazing

However, it was also demonstrated in Task 54 that polymer based systems with modular collectors of similar size to conventional flat-plate collectors (~ $2m^2$) do not allow to overcome the cost dilemma of central European systems for domestic hot water and space heating.

Subtask D –

Dissemination, information and stakeholder involvement

Data collection on installation

A data collection on installation costs, obstacles and time-consuming factors in the installation process was conducted as input to Subtasks A, B and C. Starting in 2016, a questionnaire in English, German and French was distributed amongst installers and planners of solar thermal systems in Task 54 countries. Investigated was the installation effort for three system types: Domestic hot water systems, combined systems and thermosiphon systems.
The overall feedback was scarce. Until May 2017, Task 54 received results for 21 systems (3 for Austria, 5 for France, 2 for Romania, 2 for Denmark, 6 for Germany and 3 from Switzerland). It has been shown that installers are hesitant to cooperate because of a lack in confidence or a lack in time. Despite a broad dissemination of the questionnaire, those sent to personal contacts were more likely to be answered. This shows the relatively big gap between those working with actual customer contact and those working in research. Yet, the results obtained already provide good insights into the current installation landscape and also highlight the difference we find between the investigated markets. For instance, hourly installation costs range between 12 € (Romania) and 100 € (Austria), hours of installation or the number of person months vary accordingly. The numerical results obtained in the questionnaire so far are summarized in the annex of this report.
Additional insights were provided by free text answers. E.g. on the question how to improve installation in general the majority opted for standardized montage sets, detailed mounting videos, better cooperation of installers, sharing of best practices and some others. The most time-consuming part of the installation process, on the other hand, appear to be all tasks connected to piping. Furthermore, a number of improvements for maintenance were suggested, e.g. automatic monitoring, accurate commissioning, reliable hydraulic connections, and others.

In general, one can see that there are considerable differences between installation practices and costs in each country which strengthens Task 54's assumption that each market must be approached on its own terms. Although the results obtained today are not numerous enough for a scientifically sound evaluation, they are good indicators for the needs of the respective installation scenes. Some of these issues are already tackled by Subtasks A, B and C (e.g. tele-monitoring, standardisation of components).

Additional results were provided by the Netherlands, Austria and Germany (analysis of 100 BAFA invoices) between May 2017 and September 2017. D. Mugnier, Tecsol and will evaluate them and present the final results in early October 2017.

Stakeholder involvement

Next to the installers and planners of solar thermal systems which were targeted with the data collection on installation described above, industry federations and industry partners were singled out as decisive stakeholders of IEA SHC Task 54. Therefore, a close cooperation with Solar Heat Europe (formerly ESTIF) in Brussels has been established. Next to promoting Task 54's work to industry partners among Europe they collaborate with Task 54 in sharing the results of the recently finished FROnT project which laid the groundwork for LCoOH calculations and studies on customer experience. FROnT was presented at the last Task 54 meeting in Rapperswil. In addition, Task 54 was invited to the Solar Heat Europe's industry day in May 2015 where the first Task 54 workshp was embedded.
Furthermore, contact was established to a German start up business called Thermondo which aims at disrupting the established value and distribution chain by an all in one concept – planning, installing and maintaining a heating system suitable to the customers wishes with their own group of installers. Further solar thermal companies were scouted on this years' international trade fair for heating and sanitary technologies ISH 2017 in Frankfurt, Germany.

Public relations

Task 54 public relation efforts span from a strong online presence on http://task54.iea-shc.org/ and on twitter where the latest news of Task 54 but also news of the entire solar thermal sector are communicated daily. Additionally, Task 54 publishes articles in online magazines, newsletters and scientific publications as shown in http://task54.iea-shc.org/publications. Latest results are published in the format of Info Sheets, downloadable on http://task54.iea-shc.org/info-sheets or in scientific articles in conferences and magazines.
They are supplemented by two dissemination workshops in Brussels in May 2017 and in Linz in October 2017 (upcoming, linked to an industry round table). Newsletters are published annually to a hot list of contacts of Task 54 stakeholders. This mailing list is continually updated by Task 54 members.

References

[1] Baez, M.J., Larriba Martínez, T., 2015. "Technical Report on the Elaboration of a Cost Estimation Methodology", No. D.3.1. Creara, Madrid, Spain.

[2] Info Sheet A2.2 - LCOH for Solar Thermal Applications - Guideline for levelized cost of heat (LCOH) calculations for solar thermal applications. http://task54.iea-shc.org/info-sheets

[3] Info Sheet C1.1 - Cost Drivers and Saving Potentials: Cost reduction in production phase, cost reduction due to easy installation on site, cost reduction by energetically improved design. http://task54.iea-shc.org/info-sheets

[4] Info Sheet C1.2 - Cost Drivers and Saving Potentials: Metal Substitution, Cost reductions. http://task54.iea-shc.org/info-sheets

Annex

Results of the Installation questionnaire v4 obtained until May 2017.

	Ref	Country	Type	Size coll	Size tank	Manufacturer	Refurb.	New	Price	Number of man hours	Number of persons	Hourly inst. Cost	O&M contract?	O&M time/y
1	AT-1-1	Austria	DHW-MFH	153	14000	ökotech	0	100	75 000	150	2	100	Y	100
2	AT-1-2	Austria	DHW-MFH	500	29000	ökotech	?	?	250 000	700	5	100	Y	100
3	AT-1-3	Austria	DHW-MFH	2415	60000	ökotech	20	80	1 270 000	1050	5	100	Y	150
4	CH-1	Switzerland	DHW-SFH	5	500	Tisun	100	0	16 000	40	4	85	N	2
5	CH-2-1	Switzerland	DHW-MFH	12.5	800	Solarpartner	35	65	17 000	35	3	?	N	*14*
6	CH-2-2	Switzerland	DHW-MFH	20	?	Solarpartner	55	45	?	22	4	?	N	*12*
7	FR-1-1	France	DHW-MFH	42	2000	Viessmann			61 750	800	4	45	Y	20
8	FR-1-2	France	DHW-MFH	24	750	Viessmann	50	50	47 750	600	2	45	Y	8
9	FR-1-3	France	DHW-MFH	163	4000	Viessmann			133 200	1800	4	45	Y	30
10	FR-2	France	Combi System-SFH	15	500	Solisart	70	30	19 000	80	2	45	Y	2
11	FR-3	France	DHW-SFH	4	300	Alliantz	95	5	4 500	32	2	45	Y	1.5
12	RO-1	Romania	Combi System-SFH	14	1000	Westech solar	15	85	5 500	32	2	12	Y	2
13	RO-2	Romania	DHW-SFH	2.8	300	Westech solar	25	75	2 500	16	2	12	Y	1
14	DK-1	Danemark	DHW-SFH	4	200	?	70	30	3 670	24	2	53	Y	1
15	DK-2	Danemark	Combi System-SFH	8	300	?	60	40	6 000	32	2	53	Y	1
16	DE-1	Germany	DHW-SFH	4.5	300	Wikora	80	20	8 500	55	2	45	Y	2
17	DE-2	Germany	Combi System-SFH	11	1000	Wikora	20	80	12 300	90	3	45	Y	2
18	DE-3	Germany	DHW-SFH	6	400	Sonnenkraft	80	20	5 000	25	2	53	N	2
19	DE-4	Germany	Combi System-SFH	15	2000	Sonnenkraft	80	20	15 000	35	2	53	N	2
20	DE-5	Germany	Combi System-SFH	22.5	3250	Wagner	90	10	15 188	79	2	45	N	8
21	DE-6	Germany	Combi System-SFH	30	7000	Eurotherm	90	10	23 250	135	2	45	N	8

Ref	Country	Type	Size coll	Size tank	Price/m²	Hours/m²	M² /installing worker	Yearly Est. O&M labour costs on total cost
AT-1-1	Austria	DHW-MFH	153	14000	490	1.02	77	13.3%
AT-1-2	Austria	DHW-MFH	500	29000	500	0.71	100	4.0%
AT-1-3	Austria	DHW-MFH	2415	60000	526	2.30	483	1.2%
CH-1	Switzerland	DHW-SFH	5	500	3 200	0.13	1	1.1%
CH-2-1	Switzerland	DHW-MFH	12.5	800	1 360	0.36	4	?
CH-2-2	Switzerland	DHW-MFH	20	?	?	0.91	5	?
FR-1-1	France	DHW-MFH	42	2000	1 470	0.05	11	1.5%
FR-1-2	France	DHW-MFH	24	750	1 990	0.04	12	0.8%
FR-1-3	France	DHW-MFH	163	4000	817	0.09	41	1.0%
FR-2	France	Combi System-SFH	15	500	1 267	0.19	8	0.5%
FR-3	France	DHW-SFH	4	300	1 125	0.13	2	1.5%
RO-1	Romania	Combi System-SFH	14	1000	393	0.44	7	0.4%
RO-2	Romania	DHW-SFH	2.8	300	893	0.18	1	0.5%
DK-1	Danemark	DHW-SFH	4	200	918	0.17	2	1.4%
DK-2	Danemark	Combi System-SFH	8	300	750	0.25	4	0.9%
DE-1	Germany	DHW-SFH	4.5	300	1 889	0.08	2	1.1%
DE-2	Germany	Combi System-SFH	11	1000	1 118	0.12	4	0.7%
DE-3	Germany	DHW-SFH	6	400	833	0.24	3	2.1%
DE-4	Germany	Combi System-SFH	15	2000	1 000	0.43	8	0.7%
DE-5	Germany	Combi System-SFH	22.5	3250	675	0.29	11	2.4%
DE-6	Germany	Combi System-SFH	30	7000	775	0.22	15	1.5%