SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

TASK 68

Efficient Solar District Heating Systems – Considering higher temperatures and digitalization measures

ANNEX

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Task 68

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1. Definitions

No new definitions to include.

2. Purpose and Objectives

Heat is the largest energy end-use, accounting for 50% of global final energy consumption in 2018 and contributing to 40% of global carbon dioxide (CO2) emissions. Of the total heat produced, about 46% was consumed in buildings for space and water heating at relatively low temperatures. Regarding the heat supply of buildings, district heating systems play an important role and are well-established in many countries since they typically enable efficient resource utilization.

However, most district heating networks in Europe and worldwide still operate with supply temperatures over 80 to 120°C (*medium-high temperature*), which is still typically produced by caloric power plants. Currently available solar district heating (SDH) systems are mainly operated with flat-plate collectors providing either heat at lower temperatures or with lower efficiency in case of higher temperatures.

To increase the efficiency of SDH systems, the **purpose** of the Task is to investigate how:

- **to provide the heat most efficiently at the desired temperature** level either directly by solar (e.g., combining flat-plate collectors with other solar collectors) or indirectly by solar by combining solar collectors with other technologies (e.g., solar collectors with heat pumps) focusing on the system aspect instead of single technologies.
- **to take a next step regarding digitalization measures** in order to allow for more efficient data preparation (e.g., regarding the gathering, storing, validation, and visualizing of data) and data utilization (e.g., regarding control strategies, automatic fault detection, predictive maintenance aspects, open data)
- to make SDH systems **more competitive and business appealing** by exploring new business models and finding ways how to reduce costs
- to **raise awareness for solar technologies** and disseminate the **knowledge regarding SDH systems,** especially for medium-high temperature heat, by collecting and providing best practice examples, country reports, and data and insights from real installations.

The **objectives** of the Task are to:

- Continue the work on Solar District Heating systems from Task55 and former Tasks.

- Provide an overview on the **present state-of-the-art of solar collector technologies** for providing ***medium-high temperature heat*** (80 – 120°C).
- Provide an overview on **possible SDH system configurations** (combination of technologies) in order to efficiently provide *medium-high temperature heat* either directly by solar or by combining solar with other technologies.
- Give an overview and examples of present state-of-the-art **digitalization measures** regarding **data preparation**, i.e., how data can be gathered, stored, distributed, validated.
- Give an overview and examples of present state-of-the-art of **digitalization measures regarding data utilization**, i.e., advanced control strategies, automatic monitoring.
- Explore and **propose possible new business models** for SDH systems in general but also considering medium-high temperature heat as well as digitalization measures.
- Investigate **ways of cost reductions** in the balance of systems (BOS) for SDH systems in general but also considering medium-high temperature systems. In particular, to investigate possibilities for cost reduction based on the insights from measurement data analysis.
- **Gather results** and **operating experience** from SDH systems in general, in particular, systems efficiently providing medium-high temperature heat by solar (directly or indirectly).
- Provide scenarios **how to decarbonize the district heating** sector and investigate, collect and compare EU wide grant mechanisms for SDH systems

3. Activities

Main activities of the SHC Task are grouped into the following Subtasks.

3.1 Subtask A: Concepts for Efficiently Providing Solar Heat at Medium-High Temperature Level

The main objective of Subtask A is to develop concepts, models and performance measures in order to efficiently provide solar heat by SDH systems, with a particular focus on medium-high temperature heat.

Specific objectives of Subtask A are:

- Requirements and concepts for planning and design of SDH systems, with a particular focus on medium-high temperature heat.
- Configuration/scaling of systems
- Modeling of different technologies on component and system level
- Performance and efficiency definitions
- Testing methods and standardization

Activities

- *A1: Comparison of different collector technologies for providing medium-high temperature heat with respect to technical and economic characteristics* (with Subtask C). This activity will pinpoint the strengths and differences in the technologies, for example, regarding the requirements for the place of installation, the achievable temperatures, or economic aspects (in Subtask C).
- *A2: Collection of requirements and concepts necessary to efficiently plan, design, and scaling-up SDH systems*, especially considering medium-high temperature heat. This activity will provide best practice examples (with Subtask D) for SDH systems to make it easier to set up such systems and establish new business models (with Subtask C).
- *A3: Analysis of existing simulation tools for the simulation of efficient SDH systems*. This activity will give particular attention to medium-high temperature heat. Models are therefore necessary on a component as well as on a system level. On a component level, models of various collector technologies are essential but also models of other components that can be combined with solar technology to provide heat at a medium-high temperature level efficiently (e.g., heat pumps). On a system level, it must be ensured that the different component models can be combined in order to model and simulate entire systems. Based on these models' sensitivity analyses can be conducted to find optimal design parameters of systems. To support the market, it would be best to develop and publish an easy to use calculation tool if none are available.
- *A4: Define performance and efficiency measures for SDH systems on component (e.g., on collector level) and system level*, with a special focus on medium-high temperature heat. Furthermore, to propose standardized testing methods and monitoring equipment for long-term quality assessment to achieve a uniform assessment of the technologies. This activity will have to look for the current methods and standards available and will evaluate their suitability.

3.2 Subtask B: Data Preparation & Utilization

The main objective of Subtask B is to increase the efficiency of SDH by taking a next step regarding digitalization aspects, especially regarding data preparation and utilization.

Specific objectives of Subtask B are:

- Automated gathering, storing, and distribution of data
- Validation of data
- Analysis/Monitoring/Detection techniques
- Advanced control strategies for plants/systems
- Open data approaches

Activities

- *B1: Describe and propose efficient solutions to gather, store and distribute data from heterogeneous devices on a single- but also multi-plant level*. This activity will look

at the current state-of-the-art techniques, structures, and solutions and propose ways to set up and run an efficient Information, Communication, and Technology (ICT) platform for handling a large amount of data. Furthermore, it is planned to compare different solutions regarding data handling (e.g., open source vs. commercial products) and pinpoint strengths and weaknesses to help operators/users find the ones that suit them best.

- *B2: Develop guidelines for the validation of data from SDH systems*. These guidelines shall describe certain criteria and measures for validating data so that other Subtasks and activities can build on this validated data. Furthermore, to achieve a reasonable comparison between annual results of different plants and different operating conditions (e.g., regarding annual irradiation, demand, etc.), measures shall be described on how to normalize the data to see if systems operate on a constant level or if aging effects may occur.
- *B3: Collect, describe, develop and apply techniques for analysis, monitoring, and fault detection of data*. This activity shall provide a summary of available techniques for analysis, monitoring, and fault detection. Furthermore, it shall give concrete examples of their benefits and insights by applying some of them to data from SDH systems (with Subtask D). Within this Task, it is planned to investigate statistical methods for data evaluation.
- *B4: Comparison of state-of-the-art available control strategies on sub- (component level) and superordinate level (=system level)*. Participants will collect possible advanced control strategies, name their requirements regarding data and computational resources, and estimate their economic benefit for SDH systems, primarily focusing on medium-high temperatures (with Subtask C).
- *B5: Develop and define requirements and concepts for open data approaches.* This activity will focus on a win-win situation between data providers (e.g., operators) and data users (e.g., researchers, but also the clients purchasing heat). This win-win situation can be, for example, achieved for those scientific results based on open access data so that the operator can benefit from the insights. Furthermore, this work shall define certain key measurements/data points (e.g., heat output, temperature levels, efficiency, etc.) and provide templates for different levels of data details (e.g., 3 levels: public, technical details, research-level details). Furthermore, this Task shall address data ownership and data protection issues and how they can be handled (with Subtask C), as well as suggestions for open data exchange protocols that clients and third-party mobile app developers can use. Finally, the activity should present a roadmap on how an open data future could look like and name concrete advantages to convince more operators to share their data (with Subtask D).

3.3 Subtask C: Business Models

The main objective of Subtask C is to evaluate and identify new business models and find ways to make SDH systems more business appealing (e.g., by reducing the costs).

Specific objectives of Subtask C are:

- Investigate current risks and barriers for the success of SDH systems
- Investigate the requirements and needs of district heating grids to integrate solar heat
- Investigate and propagate possible financing and investment schemes for SDH systems
- Ways and possibilities of cost reduction for SDH systems regarding CAPEX and OPEX
- Investigate how energy policy can act as enabling factor for SDH systems aiming at a medium-term subsidy-free situation.

Activities

- *C1: Collect and provide an overview of financing and investment schemes worldwide for SDH systems*. This activity aims to provide a clear picture regarding the possibilities for financing SDH systems and their requirements.
- *C2: Evaluate, discuss and propose possible new business models for efficient SDH systems*. This work will give a special focus to medium-high temperature or/and digitalization aspects.
- *C3: Define a standard, certain criteria, or a seal of approval for planners/designers of SDH systems*. This work will evaluate measures to provide investors with certain security for their investments and a guaranteed lifetime of SDH systems (together with Subtask A – lifetime assessment by modeling and simulation). Furthermore, more data on the successful projects and the analysis of this data in Subtask B could help increase investors' trust in SDH systems.
- *C4: Collect, list, and compare measures and possibilities to reduce the costs of SDH systems*. For this purpose, the first step is to collect and share knowledge to break down current CAPEX and OPEX, e.g., by considering a BOM (bill of material). Then several measures regarding cost reduction should be discussed and evaluated (e.g., innovative concepts, material research, upscaling, collaboration, etc.). In particular, it should be analyzed to what extent the findings from the data analysis (from Subtask B) can help reduce costs, e.g., through more efficient control strategies or by identifying improvements regarding the design and planning of such systems (from Subtask A).

3.4 Subtask D: Use Cases and Dissemination

The main objective of Subtask D is to gather data and insights from real installations and to disseminate the knowledge to industry and the public.

Specific objectives of Subtask D are:

- Description of the installation
- Summary of demo applications
- Policy-oriented document for the promotion of efficient temperature SDH systems, especially focusing on medium-high temperatures
- Country reports regarding SDH systems to derive a holistic view on the global

situation
- Industry workshops

Activities

- *D1: Collect and provide an overview of efficient SDH installations* as well as their description and structure, especially providing medium-high temperatures. This activity aims to demonstrate/validate/prove the performance of SDH systems directly or indirectly by solar (e.g., collectors together with heat pumps). The findings of the demo installations should be considered in Subtask A regarding concepts, and the available data should be used and evaluated in Subtask B.
- *D2: Provide valuable future scenarios as well as qualitative and quantitative targets for the solar sector and policymakers*. For this reason, a clear picture of the future heat demand of European countries should be developed, and estimations should be provided on how much heat and at which temperature level can be supplied by solar. Furthermore, it is planned to compare solar technology with other technologies where the levelized costs of heat should be included for a reasonable comparison. In particular, efficient combinations of technologies should be highlighted together with their concrete benefits.
- *D3: Prepare and manage industry workshops*. During the Task, workshops should be organized together with partners from industry and planners of SDH systems to share their experience and knowledge and aim for synergy. This should help to achieve fast and efficient dissemination of the Task outcomes as well as provide a possibility to collect feedback on the task outputs.
- *D4: Prepare appealing documents for industry and the public* to increase knowledge regarding efficient SDH systems, the benefits from data, and ways to cut costs. The activity aims to produce acceptable content for the target audience (stakeholders see under 6), using all other Subtasks' results and findings as the content provider.

4. Expected Results/Deliverables

The deliverables allocated to the 4 Subtasks will be:

Subtask A: Concepts for Efficiently Providing Solar Heat at Medium-High Temperature Level

D.A1 Report for activity A1 and A2: Comparison of different collector technologies especially considering medium-high temperature heat and best practice examples

D.A2 Report for activity A3: Analysis of existing simulation tools for the simulation of medium-high temperature SDH systems, if necessary, creation of a new easy to use calculation tool

D.A3 Report for activity A4: Performance and efficiency measures for efficient SDH systems, especially considering medium-high temperature heat

D.A4: Subtask report with management issues

Subtask B: Data Preparation & Utilization

D.B1 Report for activity B1 & B2: Efficiently gather/store/distribute data together with validation measures
D.B2 Report for activity B3: Techniques for analysis, monitoring and fault detection of data
D.B3 Report for activity B4: Comparison of state-of-the-art and advanced control strategies on sub- (component level) and superordinate level (=system level)
D.B4 Report for activity B5: Open data approaches
D.B5 Subtask report with management issues

Subtask C: Business Models

D.C1 Report for activity C1 & C2: Overview of financing and investment schemes and possible new business models
D.C2 Report for activity C2: Standards and quality criteria for planners and designers of SDH systems
D.C3 Report for activity C4: Measures and possibilities to reduce the costs of SDH systems
D.C4 Subtask report with management issues

Subtask D: Use Cases and Dissemination

D.D1 Report for activity D1: Overview of efficient SDH systems especially providing medium-high temperatures
D.D2 Report for activity D2: Future scenarios and targets for the solar sector
D.D3 Report for activity D3: Industry workshops
D.D4 Report for activity D4: Factsheets for industry and public regarding the task outcomes
D.D5 Subtask report with management issues

5. Rights and Obligations of Participants

In addition to the obligations enumerated in Article 4 of the SHC TCP Implementing Agreement:

(a) A Participant must undertake and complete all agreed activities and contribute to all or to a specific of the tasks outlined in Section 3 and 4 of this Annex in a timely manner.

(b) Each Participant must actively participate in working meetings and other activities such as seminars and workshops.

(c) Each Participant shall provide timely, detailed reports on the results of their work carried out to the Subtask Leader and Operating Agent.

(d) Each Participant must contribute to one or more Task deliverables and shall participate in the editing and reviewing of draft reports and other outputs of the Task and Subtasks.

(e) Each participating institution/company shall collect, assess and report to the Operating

Agent data on solar district heating and cooling systems in their country.

(f) The IEA SHC shall participate in reviewing draft reports of the Task and Subtasks.

(g) Every six months, before each Expert meeting, each Participant shall provide a brief status report of their work, including a list of publications and organized seminars/workshops, to the Operating Agent.

(h) *Task Meetings*. Each country will bear the costs of its own participation in the Task, including necessary travel costs. The cost of organizing meetings will be borne by the host country and could be subsidized by a meeting fee paid by all Participants to the host.

(i) *Individual Financial Obligations*. Aside from providing the resources required for performing the work of the Subtasks in which they are participating, all Participants are required to commit the resources necessary for activities that are specifically collaborative in nature and would not be part of activities funded by national or international sources. Examples include the preparation for and participation in Task meetings, co-ordination with Subtask Participants, contribution to the documentation and dissemination work, and Task-related R&D work that exceeds the R&D work carried out in the framework of the national (or international) activity.

(j) *Task-Sharing Requirements*. The Participants agree on the following funding commitment:

(1) Each Participant (country) will contribute to this Task a minimum of 2 person-months per year of the Task. This means that each participating country shall commit to the Task a minimum of 6 person-months over the period of 3 years.

(2) Participation in the Task requires participation in at least one of the Subtasks.

(3) Subtask Leaders will contribute with a minimum of around 2.5 person-months per year for the duration of the Subtask.

(4) The Operating Agent will contribute a minimum of around 3 person-months per year to the Task.

(5) Participation may partly involve funding already allocated to a national (or international) activity, which is substantially in agreement with the scope of work outlined in this Annex.

(6) Aside from providing the resources required for performing the work of the Subtasks in which they are participating, all Participants are required to commit the resources necessary for activities that are specifically collaborative in nature and would not be part of activities funded by national or international sources. Examples include the preparation for and participation in Task meetings, co-ordination with Subtask Participants, contribution to the documentation and dissemination work, and Task-related R&D work that exceeds the R&D work carried out in the framework of the national (or international) activity.

The level of effort to be contributed by each country will be specified in a "Letter of National Participation" signed by the Operating Agent and the Executive Committee representative within 3 months from the start date of the Task.

Participation may partly involve funding already allocated to a national (or international) activity that is substantially in agreement with the scope work outlined in this Annex. Aside from providing the resources required for performing the work of the Subtasks in which they are participating, all Participants are required to commit the resources necessary for activities that are specifically collaborative in nature, and that would not be part of activities funded by national or international sources. Examples include the preparation for and participation in Task meetings, co-ordination with Subtask Participants, contribution to the documentation and dissemination work, and Task-related R&D work that exceeds the R&D work carried out in the framework of the national (or international) activity.

6. Management

(a) Austria, acting through Viktor Unterberger from BEST GmbH, is designated as Operating Agent.

(b) *The Operating Agent*. The rights, obligations, and responsibilities in addition to those indicated in the SHC TCP Implementing Agreement and the organization of the work under this Annex enumerated in Section 5 of this Agreement, the Operating Agent shall:

(1) Be responsible for the overall management of the Task, including overall co-ordination and communications with the Executive Committee.

(2) Prepare the detailed Program of Work for the Task in consultation with the Subtask Leaders and the Participants and submit the Program of Work for approval to the Executive Committee.

(3) Provide semi-annual reports to the Executive Committee on the progress and the results of the work performed under the Program of Work.

(4) Manage the preparation and distribution of the results described in Section 4 in this Annex.

(5) At the request of the Executive Committee, organize workshops, seminars, conferences, and other meetings.

(6) Provide to the Executive Committee after completion of the Task a final management report for approval at an Executive Committee Meeting.

(7) In co-ordination with the Participants, use its best efforts to avoid duplication with activities of other related programs and projects implemented by or under the auspices of the Agency or by other competent bodies.

(8) Provide the Participants with the necessary guidelines for the work they carry out and report with minimum duplication.

(9) Perform such additional services and actions as may be decided by the Executive Committee, acting by unanimity.

(10) Manage the intended cooperation with the IEA DHC by:

a. Coordinate the cooperation on behalf of the IEA SHC task

b. Participate at IEA DHC meetings whenever possible

c. Supervise the integration of input provided by the IEA DHC in the IEA SHC task.

d. Communicate with the IEA DHC representatives to ensure that projects do not cover significant research that is already performed under the IEA SHC Task.

(c) *The Subtask Leaders*. Subtask Leaders shall be a Participant that provides to the Subtask a high level of expertise and undertake substantial research and development in the Subtask field. The Subtask Leaders shall be proposed by the Operating Agent and designated by the Executive Committee, acting by unanimity of the Participants. Changes in the Subtask Leaders may be agreed to by the Executive Committee, acting by unanimity of the Participants.

A Subtask Leader for each of the foregoing Subtasks will:

(1) Coordinate the work performed under that Subtask.

(2) Assist the Operating Agent in preparing the detailed Program of Work.

(3) Direct technical workshops and provide the Operating Agent with written summaries of workshops results.

(4) Edit technical reports resulting from the Subtask and organize their publication.

(5) May arrange meetings in between or in association with Task Experts Meetings.

(6) Collaborate with the Operating Agent and other Subtasks and contribute to the preparation, production, and distribution of the results described in Section 4 in this Annex within the framework of the Task dissemination plan.

(7) Attend each semi-annual Task meeting as well as expert or industrial meetings.

(8) Support the operating agent in any cooperation activity with other TCPs (e.g., IEA-DHC).

(d) *Meetings:* There will be Task Experts Meetings at intervals of approximately six (6) months. Subtask Leaders may arrange meetings in between or in association with Task Experts Meetings. Attendance at the Task Experts Meetings of the Task will be mandatory.

(e) It is intended to organize expert/industry workshops every year, directly linked to Task meetings. The overall scope and objectives of the Task and the different Subtasks will be described on the Task webpage. The server should be able to process an automatically distributed electronic newsletter.

7. Admission, Participation and Withdrawal of Participants

For purposes of this Annex, the provisions of the SHC TCP Implementing Agreement shall apply.

8. Information and Intellectual Property

For purposes of this Annex, in case of conflict with the provisions of the Implementing Agreement, the following provisions shall prevail:

(a) For arising information regarding inventions, the following rules shall apply:

(1) Arising information regarding inventions shall be owned in all countries by the inventing Participant. The inventing Participant shall promptly identify and report to the Executive Committee any such information along with an indication whether and in which countries the inventing Participant intends to file patent applications; and

(2) Information regarding inventions on which the inventing Participant intends to obtain a patent protection shall not be published or publicly disclosed by the Operating Agent or the other Participants until a patent has been filed, provided, however, that this restriction on publication or disclosure shall not extend beyond twelve months from the date of reporting of the invention. It shall be the responsibility of the inventing Participants to appropriately mark Task reports that disclose inventions that have not been appropriately protected by filing a patent application.

(b) The inventing Participant shall license proprietary information arising from the Task for non-exclusive use as follows:

(1) To Participants in the Task:
   a. On the most favorable terms and conditions for use by the participants in their own country; and
   b. On favorable terms and conditions for the purpose of sub-licensing

others for use in their own country.

(2) Subject to sub-paragraph above, to each Participant in the Task for use in all countries, on reasonable terms and conditions; and

(3) To the government of any Member country and nationals designated by it for use in such country to meet its energy needs.

Royalties, if any, under licenses pursuant to this paragraph shall be the property of the inventing Participant.

9. Entry into Force, Term and Extension

This Annex shall enter into force on 1st of April 2022 and shall remain in force for a period of 3 years until 31st of March 2025. At the conclusion of that period, this Annex can be extended by at least two Participants, acting in the Executive Committee, for a period to be determined at that time, provided that in no event shall the Annex continue beyond the current term, or actual termination, of the TCP