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Zusammenfassung

Der IEA SHC Task 68 hat das Ziel, neue Entwicklungen bei der Integration von Solarenergie in Fernwärmenetze weiter voranzutreiben und international zu verbreiten. Dabei wird der Fokus auf Mittel- und Hochtemperaturanwendungen mit neuen Kollektortechnologien sowie die Kombination von Solarwärme mit Wärmepumpen, neue Datenanalysemethoden und wirtschaftliche Umsetzungen gesetzt. Eine Beteiligung der schweizerischen Forschung an dieser internationalen Zusammenarbeit ermöglicht das Übertragen weltweiter Fortschritte in die Schweiz, so dass der momentan stark forcierte Ausbau der Fernwärme von diesen Erkenntnissen profitieren kann. Dieser Bericht rapportiert die Schweizer Teilnahme im zweiten Jahr des internationalen Tasks.

Résumé

La task 68 de l'AIE SHC a pour objectif de faire progresser les nouveaux développements en matière d'intégration de l'énergie solaire dans les réseaux de chauffage urbain et de les diffuser au niveau international. L'accent est mis sur les applications à moyenne et haute température avec de nouvelles technologies de capteurs et la combinaison de la chaleur solaire avec des pompes à chaleur, de nouvelles méthodes d'analyse des données et des mises en œuvre économiques. La participation de la recherche suisse à cette collaboration internationale permet de transférer les progrès mondiaux en Suisse, de sorte que le développement du chauffage à distance, actuellement en plein essor, puisse profiter de ces connaissances. Ce rapport rend compte de la participation suisse à la deuxième année de cette tâche internationale.

Summary

The IEA SHC Task 68 aims to promote new developments in the integration of solar energy into district heating networks and to disseminate them internationally. The focus is on medium and high temperature applications with new collector technologies and the combination of solar heat with heat pumps, new methods for data analysis and economic implementations. The participation of Swiss research in this international cooperation enables the transfer of global progress to Switzerland, so that the currently strongly pushed expansion of district heating can benefit from these findings. This document reports on Swiss participation in the second year of the international task.

Contents

1 Introduction

1.1 Task 68

Large-scale solar district heating provides a solution to provide cheap renewable energy to district heating systems, which - on a worldwide scale - still widely use fossil energy carriers. In Denmark, which played a pioneering role in solar district heating, large-scale systems with a total of more than 1,250,000 m² of collector surface reliably supply heat and achieve production costs of less than 40 EUR/MWh (without subsidies).

The predecessor Task 55 of IEA-SHC has dealt with the adaption and the spread of the positive Danish experiences to other countries. The many successful projects have triggered a real boom, especially in our neighboring countries. Austria, for example, decided in 2021 to promote large-scale solar thermal systems above 5000 m^2 with a total of 45 million euros, and in Germany so many large-scale systems are in the planning and implementation stages that the total collector area installed in large-scale systems will double to approx. 250,000 m^2 by 2024.

Therefore IEA-SHC has decided to continue the work started in Task 55 and further develop the spread of large-scale solar district heating systems. In addition to continuing the successful work from Task 55, the **purpose** of the Task is to investigate how:

- **To provide 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 cost.
- **To raise awareness for solar technologies** and disseminate the **knowledge regarding SDH systems**, especially for medium to high temperature heat, by collecting and providing best practice examples, country reports, and data and insights from real installations.

1.2 Situation in Switzerland

District heating networks offer an opportunity to transform the Swiss heat supply, which is still strongly dominated by fossil heat carriers, towards renewable energies. There are more than 1000 heating networks [1] in Switzerland, and the heat supply from the district heating sector is expected to at least double its capacity by the year 2050. Especially in densely built cities, it is very difficult to supply buildings individually with heat from renewable energies. For this reason, the large Swiss cities have decided to massively expand district heating systems.

Zurich, Geneva, Basel and Lausanne have decided to invest more than five billion CHF in total in the construction of district heating systems.

The integration of solar heat and heat storage can replace fossil fuels for off-peak and peak loads, and save wood, a very valuable fuel for renewable energy supplies. Internationally, such systems are built in growing numbers. This development has not yet reached Switzerland, although research results indicate a large potential here as well.

- The SFOE's **SolCAD** [2] project has shown that more than one third of all Swiss district heating networks are suitable for the integration of solar heating systems due to their energy sources and the availability of large roof areas.
- The SFOE project **BioSolFer** and a **feasibility study focusing on the canton of St. Gallen** have shown that solar heat production prices below fossil fuel prices are possible without subsidies. In cantons with favorable subsidy conditions, heat production prices below 50 CHF/MWh are possible, which is often already below the fuel prices for wood.

In several ongoing national research projects (DeCarbCH, BigStoreDH, IceGrid, SolarCADII, TriSolHP), the integration of solar heat and heat storage in Swiss district heating networks is being further investigated.

Through the participation of the SPF Institute for Solar Technology of the OST - Ostschweizer Fachhochschule and the IGT institut de genie thermique of the HEIG-VD- haute ecole d'ingénierie et de gestion - Vaud in the international Task 68 of the IEA-SHC, these projects and the Swiss research landscape as a whole should benefit from international findings and experience and the results of the national projects should be disseminated internationally.

1.3 Objectives

The objective of the project is to transfer international research progress regarding the integration of solar heat and heat storage in efficient heating networks to Switzerland and to coordinate and communicate the results of national research projects with the international research community. Furthermore, the task 68 represents also an interesting opportunity to develop our network in order to initiate new international collaboration and participate to EU projects.

2 Activities and results

2.1 Participation in Task meetings

The 5rd IEA TASK 68 meeting took place from 8.-9.3.2024 in a hybrid form. SPF (F. Ruesch and A. Bohren) took part in these meetings to connect with international experts and to discuss the work of SPF. The international networking is important as there is not yet sufficient expertise available in Switzerland, especially when it comes to the realization of larger district heating systems with solar thermal and big thermal storages. Further more, SPF participated in the review of task deliverables and contributed wit informations on available collector data.

Regarding HEIG-VD activities, the exchange with AEE-INTEC initiated in 2022 during the IEA Task 68 meeting was continued in 2024. The results of the SolarCADII solar thermal field have been used to test the HarvestIT and Sunpeek applications. The latter software, SunPeek, is the first open-source implementation of the performance assessment for solar thermal collector fields to the recently developed standard ISO24194. In practice, the aim of these applications is to compare the in-situ thermal performance of large solar thermal fields with the performance of a single solar collector tested according to the ISO 9806 under laboratory conditions, in order to detect abnormal degradation of the solar thermal array. Initial results have confirmed that the performance of the SolarCADII solar thermal arrays is consistent with the expected behaviour. This collaboration led to a joint presentation during the ISEC 2024 – 3rd International Sustainable Energy Conference in Graz/Austria (see Communication section below) and to the contribution to the guide to the ISO 24194:2022 (as part of Subtask B).

HEIG-VD participated online to the 5th IEA SHC Task 68 meeting, which was held in Graz on the 8 and 9 of April 2024. HEIG-VD also attended the EUROSUN conference in Cyprus in August 2024 to present the initial results of the OptiCADSol project (impact of the coupling of a solar thermal installation with a biomass boiler on the boiler operation, see Communication section below) and to attend 2 days of IEA/SHC Task 68 meetings organized in the margins of EUROSUN 2024. HEIG-VD also actively participated in this meeting in the activities of subtask A (simulation models), B (digital solutions) and C (Business Cases) Data and experience drawn for the SolarCADII was disseminated in these meetings trough direct intervention and contribution to the final Task68 report. In particular, as mentioned above, 3 month of monitoring data were used to assess SunPeek functionalities in SubTaskB; the comparison between the 2 dynamic simulation models (TRNSYS and Polysun) adopted in the project will be included in the final report of SubTaskA; while the SolarCADII business model will contribute to the know-how base of taskC.

2.2 Cooperation in the Subtasks

The IEA SHC Task 68 is divided into four subtasks. Contributions and collaborations within the Subtasks were discussed and set up during the task meetings. In the following section, a summary of the contributions of SPF and HEIG in the different subtasks is given:

Subtask A: Concepts for efficiently providing solar heat at medium-high temperature level.

Lead: Magdalena Berberich, Solites, Germany

Contribution SPF:

- Test and evaluation of new collectors. SPF is the European leading test house when it comes to district heating collectors. The main European manufacturers (e.g. Arcon, Absolicon, Soliterm, Meriaura, Ritter) are testing at SPF and some other test are ongoing that cannot be mentioned yet.
- Andreas Bohren as chairmen of the Solar Keymark Network and Convenor of collector testing norms CEN/TC 312/WG1 (EN 12975) and ISO/TC 180/WG4 (ISO 9806) ensures the connection of Task 68 with the international standardization and testing community. The ISO 9806 is in revision and will be published in an updated version in 2025. This new version will be better adopted to district heating collectors and is better linked to the standards of the IEC TC 117 (Solar thermal electric plants) where standards for large size collectors such as parabolic trough collectors or Fresnel type collectors are developed. The new version will also include tools for LCA and GHG compensation.
- It was also informed that there is already a standard for the rating of the field performance (ISO 24194:2022) which is based on the last version of the ISO 9806. This standard is also under revision and input was provided to align better with the ISO 9806. In parallel the IEC/TC 117 is developing a similar standard for solar thermal electric plants: Code of solar field performance test for parabolic trough solar thermal power plants. This project caused some distortion because the mathematical model for the performance calculation is incompatible with the model for the ISO 9806. In the meantime, and after intervention of ISO TC 180 this project was stopped and will be relaunched.
- Furthermore different tools are currently developed and implemented for the rating and evaluation of the field performance such as Scenocal Fernwärme (https://www.scfw.de/), sunpeek (https://sunpeek.org/), etc.

Contribution HEIG-VD:

- Characterization and modelling of TVP evacuated flat plate collectors for medium-high temperatures under real conditions (SOLARCADII P&D project).
- Influence of the integration of a large-scale solar thermal plant on the efficiency and start/stop cycles of a biomass-based DHN (OptiCADSol project, Ongoing).
- Comparison of simulations in Polysun and TRNSYS (for SOLARCAD II project)
- Experiences from the monitoring of a large scale solar thermal plant for a heating network (SolarCAD II project)

Subtask B: Data preparation & utilization

Lead: Sabine Putz, SOLID, Austria

Contribution SPF:

- SPF contributes to the Task 68 report on open data in summarizing available Collector test data from international Solar Keymark database and the national “Kollektorliste”.

Contribution HEIG-VD:

- Operating data and analyses of the SOLARCADII P&D project.
- Optimization of the regulation & control system of the SOLARCAD II plant.
- Validation of simulation models using measured data from SOLARCADII project. A collaboration with AEE-INTEC has already been initiated to test the HarvestIt and Sunpeek applications with the measurements collected in SolarCADII project.

Subtask C: Business models

Lead: Luuk Beurskens, TNO, Netherlands.

Contribution HEIG-VD:

- Development of cost functions for large-scale solar thermal plants in Switzerland (projects: SolInd and SolInd2 in collaboration with SPF).
- Analysis of different business and financing models for large-scale solar thermal plants (Projects: SolCAD and SolInd2)

Subtask D: Use Cases and Dissemination

Lead: Joakim Byström, Absolicon, Sweden

Contribution SPF:

- SPF promotes solar district heating in various presentations in Switzerland.
- Promotion of solardistrict heating within DeCarbCH. Publication of factsheets “Solarenergie für Wärmenetze”
- Integration of Task findings in lectures (A. Häberle: Solar Heating and Cooling, M. Haller: CAS Energiespeicher - Theorie und Praxis)

Contribution HEIG-VD:

- The dissemination of the Task 68 results is ensured by the organization of events (e.g. symposium "Optimisation Energétique") and through teaching (CAS CAD: CAS on district heating organized by IGT/HEIG-VD).
- The SOLARCADII project results were published in an article (Duret, A., Jobard, X., Pauletta, S., Lasvaux, S., Frossard, M., & Demonchy, G. (2024). Dynamic simulation and life cycle analysis of a 784m^2 solar thermal plant with evacuated flat plate collectors coupled to a district heating network. *Thermal Science*, *28*(5 Part B), 4369–4379.)
- The initial results of the OptiCADSol project were communicated during the EUROSUN2024 conference in Cyprus (X. Jobard, S. Pauletta, A. Duret & Q. Francois (2024). Optimizing Energy and Economic Performance of Solar-Biomass Systems for Rural District Heating: A Technical and Financial Analysis, *EUROSUN 2024 proceedings*)

3 National and international cooperation

The aim of this project is to collaborate with the international community, to integrate findings of the Swiss projects in the communications of the international task and to spread international findings in Switzerland.

Together with other experts from Task 68, Florian Ruesch works as an international expert for the evaluation of large-scale solar projects for a foreign founding agency (Details are confidential).

In the reporting period, the national flagship project SwissSTES concerning large seasonal TES for district heating networks was proposed and accepted, which is a collaboration between relevant academic and industry partners in Switzerland. A subtask leader of Task 68 (solites) acts as an international board member in this Swiss consortium. In addition to the general connection of large STES for DH networks, two topics of SwissSTES are of special interest for the Task:

1. Case study Bern Wankdorf+ with ewb: integration of solar energy and a seasonal TES underneath a parking lot.
2. Development of a pit cover with integrated mounting system for solar energy system (thermal or PV) with Paul Bauder AG.
3. The SWEET-SOUR project BILS (Bubble in the lake storage), dealing with a new concept of storages to support district heating systems is terminated by the end of 2023. This concept is further developed in SwissSTES.

HEIG-VD had different meetings and information exchanges with AEE-INTEC in 2024 in order to use their Harvest-It and Sunpeek applications with the SOLARCADII data. This collaboration led to a joint communication during the 3rd International Sustainable Energy Conference (ISEC 2024) In Graz/Austria.

HEIG-VD collaborated also with other IEA Task 68 experts to write a guide on the new ISO 24194:2022 intitled "Guide to ISO 24194:2022 Power Check". This task was coordinated by Daniel Tschopp from AEE-INTEC.

4 Communication

The project was presented at the “SPF Industry Day” and several events of the DeCarbCH project. A presentation concerning solar district heating was held at the “National District Heating Forum” of the VFS in Jan. 2023 [3] with nearly 500 participants from the district heating community and at the “Symposium Solarenergie und Wärmepumpen 2023, Fokus Wärmenetze” [4].

The topic of solar thermal district heating was presented and discussed in the Swissolar focus event “Chancen für die Solarwärme” on 14. November 2023 Oberburg bei Burgdorf.

A set of factsheets regarding solar thermal energy in district heating were realized in collaboration with the project DeCarbCH and published on the SPF Website [5].The topics are: 1: Flat Plate Collectors, 2: Evacuated Tube Solar, 3: Parabolic Trough Collectors, 4: Vacuum

Flat Plate Solar Collector, 5: Photovoltaic Thermal Collector, 6: Cost and Economics, 7: Grid integration of solar heat.

HEIG-VD realized several communications on projects related to the Solar District Heating:

1. Presentation of SOLARCADII results during the 18th SDEWES conference in September 2023 on Croatia
2. Presentation of the Life Cycle Analysis of the SOLARCADII installation during the 2023 CISBAT conference in Lausanne in September 2023
3. Presentation on the opportunity of Solar Heat for DHN applications during the "Journée du développement du solaire" organized by the energy service of Canton Vaud on the 6th of October 2023.
4. X. Jobard, S. Pauletta, A. Duret & Q. Francois (2024). Optimizing Energy and Economic Performance of Solar-Biomass Systems for Rural District Heating: A Technical and Financial Analysis, EUROSUN 2024 proceedings
5. Tschopp, D., Ohnewein, P., Hamilton-Jones, M., Zauner, P., Feierl, L., Moser, M., Zellinger, M., Kloibhofer, C., Koren, M., Mehnert, S., Duret, A., Jobard, X., Pauletta, S., Giovannetti, F., Schiebler, B., & GesmbH, S. (2024). SunPeek Open-Source Software for ISO 24194 Performance Assessment and Monitoring of Large-Scale Solar Thermal Plants. International Sustainable Energy Conference - Proceedings
6. Duret, A., Jobard, X., Pauletta, S., Lasvaux, S., Frossard, M., & Demonchy, G. (2024). Dynamic simulation and life cycle analysis of a 784m2 solar thermal plant with evacuated flat plate collectors coupled to a district heating network. Thermal Science, 28(5 Part B), 4369–4379.

5 Publications

Solar Collector Technologies for District Heating; IEA SHC Task 68 Report; Stefan Abrecht, Dominik Bestenlehner, Luuk Beurskens, Andreas Bohren, Lukas Feierl, Dirk Krüger, Klaus Lichtenegger, Alex Mellor, Yuvaraj Pandian, Dimitris Papageorgiou, Pedro Rubio, Sebastian Schramm, Luis M. Serra, Marcel Wagner, Johannes Werner, Michael Zellinger; 2024, DOI: 10.18777/ieashc-task68-2024-0002

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[1] D. Hamgartner und A. Hurni, „Liste «Thermische Netze» Auswertungsbericht 2021“, energieschweiz, Bern, Endbericht, 2022.

[2] D. vonGunten *u. a.*, „SolCAD – Rapport final Potentiel du solaire thermique dans les chauffages à distance en Suisse“, Bern, Schlussbericht, Dez. 2021.

[3] F. Ruesch, „Dekarbonarisierung mit thermischen Netzen-Die Rolle der Solarthermie“, gehalten auf der Fernwärme-Forum 2023, Spreitenbach, 25. Januar 2023.

[4] A. Bohren, „Welcher Kollektor für welches Wärmenetz?“, gehalten auf der Symposium Solarenergie und Wärmepumpen 2023, Fokusthema: Thermische Netze, Rapperswil, 2. November 2023.
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