

2019 HIGHLIGHTS

Task 55 – Towards the Integration of Large SHC Systems in DHC Networks

THE ISSUE

Megawatt-scale solar thermal district heating (SDH) systems are gaining increased attention globally. Ambitious projects have already been implemented in numerous countries, including Austria, Germany, Italy, France, Spain and Norway. Large-scale SDH systems and their large-sized seasonal storages are attractive options because they offer a cost-effective and low carbon heat supply. Due to this fact, these large systems will become even bigger and likely grow from MEGA to almost GIGA-sized installations, they will be able to meet the increasing energy demand of city districts as well as entire cities.

Compared to conventional heat generation systems, the effective operation of a SDH network and its seasonal storage can guarantee a primary energy consumption reduction of >70% in thermal needs. However, the actual integration of large solar thermal systems into existing and new networks faces several challenges. Expertise on the integration of large solar thermal systems into district networks is limited. Therefore, SHC Task 55 is collecting and disseminating technical and economic solutions to leverage large-scale solar thermal district heating and cooling systems worldwide.

OUR WORK

SHC Task 55 provides a platform for practitioners and scientists to present the benefits and challenges of solar thermal district heating (SDH) and solar thermal district cooling (SDC) systems. Task experts are collecting research results on options and measures to realize sophisticated SDH and SDC systems by focusing on characteristics of solar thermal systems, technical and economic specifications of district heating networks that are relevant for the integration of solar thermal systems and hybrid technologies, analyses of system components and their integration, modular designs of large SDH/SDC systems, and economic requirements of large SDH/SDC systems in different market regions.

SHC Task 55 is collaborating with the IEA Technology Collaboration Programme on District Heating and Cooling including Combined Heat and Power (DHC TCP) on this project.

Participating Countries

Austria

Canada

China

Denmark

Finland

France

Germany

Spain

Sweden

United Kingdom

Task Period

2016 – 2020

Task Leader

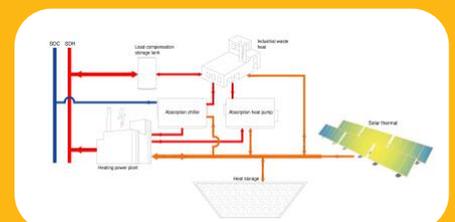
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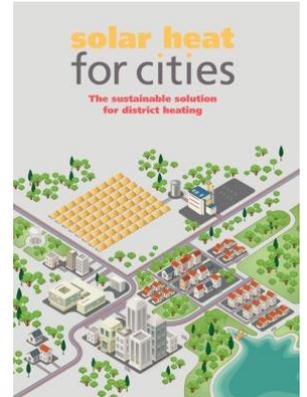
KEY RESULTS IN 2019

Brochure “Solar heat for cities - The sustainable solution for district heating”

This brochure designed for investors contains useful info charts and general information about large-scale SDH as well as several case studies of SDH installations in Denmark, China, Serbia, Austria, France, Latvia and Germany. You can download the brochure at <http://task55.iea-shc.org/publications>.

SDH markets are growing in Denmark, Germany and China, and new markets are starting in France, Italy, Poland, Spain and other countries. To increase the market share of SDH in new and existing markets, there is a need for better communication.

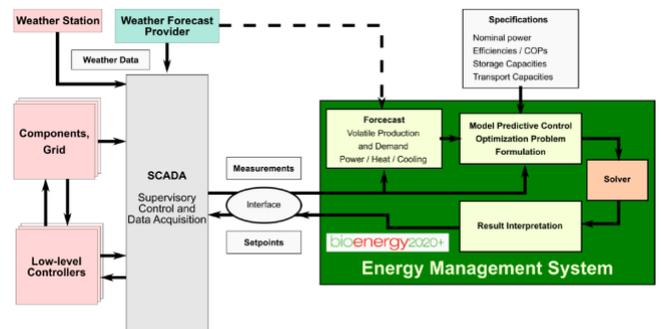
The brochure is designed to raise awareness and interest in this technology and to facilitate the entry of investors into SDH by answering key questions. Successful case studies and testimonials that prove the key advantages of using SDH are a core part of the brochure. To meet the needs of the stakeholders, the seven sponsors, as well as other experts, worked together in a task force to set up the content, and all the Task 55 experts served as reviewers to ensure high-quality content.



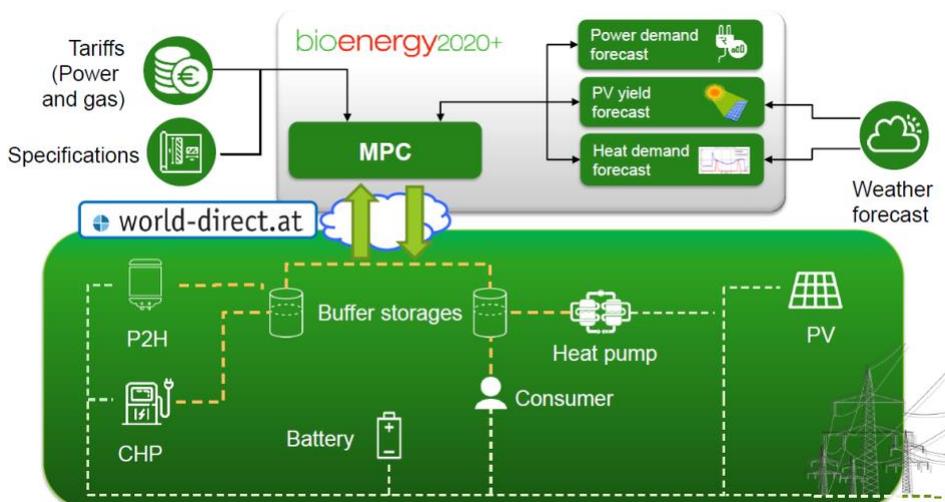
Modular Energy Management System (EMS) for the Operation of Cross-Sectoral Energy Systems

A Modular Energy Management System (EMS) developed by Bioenergy 2020+ was implemented in two sites. The EMS calculates a strategy of operation by solving an optimization problem with the following characteristics:

- Modular composition of configurations
- Implementation of MILP (mixed integer linear programs) for on/off decisions
- Adaptive self-learning forecast for volatile production and demand (multi-linear regression for continuous, discrete Markov chain for switching processes)
- Time-variable energy prices and availabilities



Implementation in a building complex in Innsbruck, Austria is shown below.



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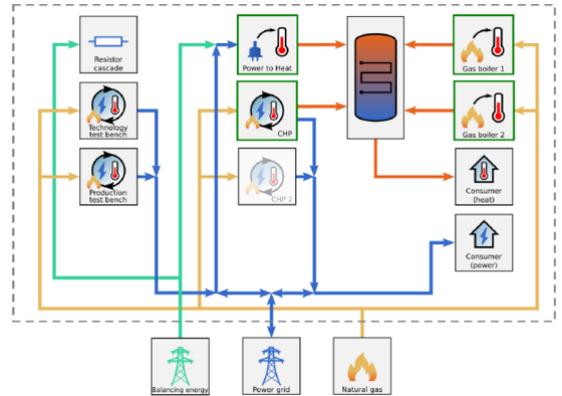
Towards the Integration of Large SHC Systems in DHC Networks

Implementation in a factory for CHP units shown below had the following special challenges:

- Participation in the balancing energy market
- Limited control possibilities (only influence on set-points of gas boilers to control TES temperature and of power-to-heat and CHP production to control power import/export)

Main results:

- Forecast for PV yield, heat and power demand have good accuracy in the first implementation
- Good performances of EMS including heat requires good low-level control concepts (appropriate concepts for HVAC control, SCADA, PLC, communication)
- Low-level controllers operating at high efficiency are necessary when handling electrical power
- Obtaining recent (= low latency) and frequent (= high frequency) and consistent (= no outages) data is a challenge when not directly connected to a SCADA system
- Constantly changing circumstances is a challenge for real implementation (need for continuously new information on system configuration when changing during EMS development and on low-level controllers and plant capabilities)
- Challenges linked to TESs:
 - Determining a single meaningful value for the state of charge of thermal storages is hard
 - Changing temperatures lead to changing parameters (storage capacities, transport capacities, COP, heat losses, etc.)



Integrating Heat Pumps into SDH Systems

Large-scale thermal energy storage (TES) will be required regardless of the future composition of the energy system. In solar district heating systems (SDH), the solar contribution can be significantly increased with large-scale TES. A heat pump (HP) can be integrated into the SDH system to further reduce or even replace the fossil backup (BU). The electricity consumed by the HP has to be considered in relation to the reduction or replacement of fossil energy. The time of electricity consumption and the composition of the electricity mix must be considered. Results show that heat pumps can be integrated in SDH systems with the aim of achieving a higher share of REs and thus reducing/replacing the use of fossil fuels. The mismatch between (electricity) demand and RE availability should be considered, e.g., by means of time dependent primary energy conversion factors. Integration of a HP in a SDH can have environmental benefits, but careful planning is required, and time of electricity use has to be considered. With constant PE factor, the benefit of using a HP is overrated. However, first of all, a significant reduction of the energy demand of the building stock is a prerequisite for a sustainable energy system.

Key Events

Solar Academy Webinar

In March 2019, Task 55 participants shared the latest results of the Task. To watch the recorded webinar, visit <https://www.iea-shc.org/solar-academy/webinar/shc-into-dhc-systems>.

Solar Academy Workshop “Solar Heat Networks: Policy, Planning, Design and Performance

The UK’s Department of Business, Energy and Industrial Strategy (BEIS) is investing GBP 320 million of capital funding into low-carbon heat networks. To foster knowledge among planners, engineers, administrators and utilities on how to integrate solar energy into these networks, BEIS, in cooperation with the IEA Solar Heating and Cooling Programme, organized a 1-day workshop in London in March 2019.

SHC 2019 Conference

Sabine Putz, the Operating Agent of Task 55, gave a keynote on “Large Scale Solar District Heating.” She was also interviewed on solar heat in cities and the role model of large-scale district heating in Denmark as part of the IEA SHC conference video series. To watch this interview plus others, visit <https://www.iea-shc.org/videos/shc-2019-interviews>.



Christian Holter, SOLID, Austria (left) and Jan-Erik Nielsen, PlanEnergy, Denmark (right).



Richard Hall, IEA SHC Vice-Chair and co-organizer of the workshop.