IEA SHC Task 69: Solar Water Heating for 2030

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Introduction

Over at IEA SHC Task 69 headquarters, we know that solar hot water technologies performed the initial excavation and groundwork for the solar energy transition. We also know that the road to high renewable energy levels passes right through solar hot water technologies. This is because water heating takes a surprising amount of energy. For example, a 15-minute shower requires > 4.5 kWh of heat (assuming a modern <10 L/minute water-efficient fixture and a 30ºC temperature boost). On average, domestic water heating accounts for ~16% of the primary energy used in residential buildings[1], but in some countries, it can exceed 50%. This high energy demand—coupled with the fact that heating and storing hot water is relatively straight-forward—has (historically) enabled solar thermal water heaters to serve as society's renewable energy vanguard.

How do we know the sustainable energy roadmap includes solar hot water? We know this because hot water represents a critical—and inexpungable—slice of the energy pie. Hot water systems also provide a massive, pre-existing storage capacity. A single hot water tank stores ~15kWh of energy (250L and ΔT ~50ºC), which can be used to soak up excess electricity. In addition, the global water heating market is steadily growing (e.g., more people are using more hot water each year)[3], but much more of the primary energy needs to be derived from solar energy to achieve the 1.5ºC Paris Agreement limits and country emissions reductions targets by 2030[4]. China, for example, is projected to have the world's largest economy by 2030 *and* it has committed to reaching carbon neutrality by 2060[5]. At present, ~40% of the energy used in Chinese residential buildings is directed towards hot water heating. The IEA recently released a report entitled, 'Net Zero by 2050', which states an intermediary goal of 400 million dwellings using solar thermal for heating and cooling, up from ~250 million today[6]. With retirements, this indicates that over 200 million new solar thermal systems are going to be needed by 2030, as is depicted in Figure 1. In addition to emissions targets, this will be driven by smarter and more reliable systems, cost reductions, and the desire by households to become more sustainable and energy independent.

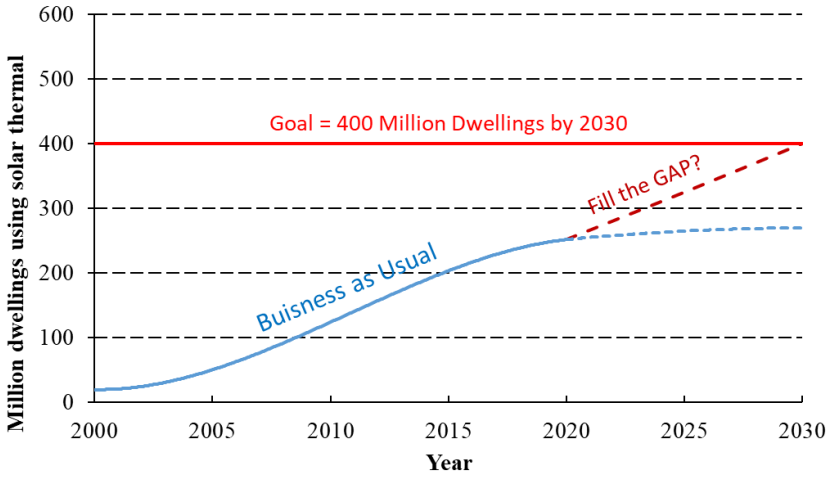

Fig. 1. Millions of dwellings using solar thermal. (IEA target for 2030 in 'Net Zero by 2050' [6] *is shown as solid red line). Task 69 aims to help 'fill the hot water gap' via thermosyphon and PV solar systems.*

The Task's Scope

The demand for hot water is increasing globally, and many IEA SHC member countries have set targets to encourage a higher fraction of their energy production to come from solar technologies by 2030. However, the solar share of this is low. In 2018, only 2.1% of space and water heating demand was met by solar thermal, through evacuated tube thermosyphon systems in China. Task 69 will focus on the development path and best practices for two technologies that are expected to play the biggest role in the solar hot water market in 2030: solar thermal thermosyphon and solar photovoltaic (PV) derived hot water heating systems. It will define the market status, core technical issues for development, and the trainings/standards needs for two cost-effective and reliable solar water heater technologies (thermosyphon and PV solar hot water heating systems). Task 69 will rely heavily on international knowledge among participants from different IEA SHC member country regions to consider differences in economic development, solar resources, regulations, and other factors (i.e., GN SEC vs. Europe). Investigating 'smart' systems for thermosyphons and 'integrated' systems for PV-driven systems is a key part of the scope, including how to overcome barriers to further deployment (e.g., harmonisation) in different climates and markets. As such, Task 69 will identify opportunities to improve the performance, cost, and reliability of solar water heaters with the aim of accelerating the rollout of best practices for these technologies. To achieve these objectives, the work is organized into the following Subtasks:

Subtask A: State-of-the-art and Operating Environments in Different Regions (Leader: Daniel Tschopp/Christoph Rohringer - AEE INTEC, Austria, d.tschopp@aee.at)

Objectives

- Prepare a holistic literature review of available solar technologies used for solar hot water systems, with focus on the identified dominant technologies of thermosyphon and PV2Heat.
- Get market feedback/needs on versatile, best practice, SHWs designs
- Document possible SHWs configurations for best practice in each region
- Evaluate the new systems (including smart components/ control) economic potential and benefits for end users and countries emission target plans.

Deliverables

No.	Deliverable	Date
A.1	Report on most dominant solar water heating systems and state-of-the-art reviews for thermosyphon and PV2Heat	02/2024

	technologies, analysis of market regions and potential for solar water heating.	
A.2	Documentation of success stories and market barriers in relevant regions.	12/2024
A.3	Report on emerging products and research trends for SHW.	06/2025

In 2023, we are making progress on A.1-A.3, which includes running a manufacturer Survey/Questionnaire, which will provide insights on the state of the art. These results will be presented at the APSRC.

Subtask B: Thermosyphon Hot Water Systems (Leader: Bojia Li -- China Academy of Building Research, China, libojia@outlook.com)

Objectives

- Evaluate thermosyphon systems in terms of their technical and economic potential to 'move the needle' on renewable energy targets.
- The potential for improving performance of thermosyphons
- Investigate emerging installation requirements (such as aesthetics)
- Design SHW system using various thermal options (i.e., SHWs-without Aux heater, with Aux heater, and with smart component)
- Components comparative analysis with conventional systems.

Deliverables

No.	*Deliverable*	*Month*
B.1	Report of thermosyphon system potential	12/2023
B.2	Survey of failure modes and effects and suggestions	12/2023
B.3	Report on durability and reliability improving research and technical results	12/2024
B.4	Report on energy-saving & GHG reduction methods along with current and future trends	6/2025

In 2023, experimental testing has been undertaken on several thermosyphon systems for their energy and GHG savings potential in collaboration with an industry partner Sunrain. These results, along with insights from a thermosyphon manufacturer survey will be presented at the APSRC.

Subtask C: Solar Photovoltaic Hot Water Systems (Co-Leaders - Dean Clift - RMIT/Rheem, Australia, dean.clift@rheem.com.au & George Bennett - Department for Business, Energy and Industrial Strategy (BEIS), UK, George.Bennett2@beis.gov.uk)

Objectives

- Educating policy makers about benefits of solar photovoltaic diverters.
- Harmonization of product standards (reducing trade barriers).
- Achieving representation with buildings standards (including building standards).
- Developing calculation methods which would enable the technology to have representation in Net Zero roadmaps.

Deliverables

No.	*Deliverable*	*Month*
C.1	Expert Network, Expert Questionnaire / Interviews and Case Studies	12/2024
C.2	Systematic International Literature Review + Market Review	06/2024
C.3a	Technology / Policy Brief	06/2024
C.3b	New ISO Solar Energy Vocabulary	12/2024

C.3c	Reference Models + Solar Heat Worldwide Chapter	06/2024
C.4	Solar PV Hot Water Technology Harmonisation Strategy	06/2025
C.5	Implementation of Solar PV Hot Water Technology Harmonisation	06/2025

In 2023, the CRC RACE for 2030 Solarshift Project has been going well and several modelling/analysis results have been achieved regarding the use of excess PV for water heating. A snapshot of these results along with insights from a recent PV hot water survey will be reported.

Subtask D: Training and Standards (Leader: Jianhua Fan - Technical University of Denmark, Denmark, jifa@dtu.dk)

Objectives

- Improve and revise the current Standards.
- Propose new standards for PV SHWs
- Prepare training materials (workshops) about principle, system sizing and installation.

Deliverables

No.	Deliverable	Month
D.1	Report on needs for new Standards or Standards updates and the status of selected warranty and certification networks.	12/2024
D.2	Facilitate Training	12/2023 & 12/2024
D.3	Needs Assessment Report (Training)	06/2024
D.4	Report on success stories	06/2024

In 2023, Subtask D has been reviewing national and international Standards for solar hot water. The results of this review, along with a summary of the training will be showcased at APSRC.

Conclusions

Overall, Task 69 represents an international and collaborative effort between researchers, industry, and testing laboratories to identify and implement opportunities to improve the performance of future solar water heaters. Although other technologies are available, our focus will be on thermosyphon systems and PV water heaters. We believe these two technologies will have the highest level of adoption across a broad range of meteorological climate zones and economic development by 2030. The proposed task aims to assist local technology rollouts and cross-fertilise development globally. However, for Task 69 to be successful, we are actively seeking experts from the APSRC community to help identify market opportunities, add technical knowledge, and help us identify and solve key issues with these technologies.

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