SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

# Technology Position Paper

## Price Reduction of Solar Thermal Systems

May 2020

# Contents



This document was prepared by Dr. Michael Köhl, Fraunhofer ISE, Germany, and Operating Agent of *SHC Task 54: Price Reduction of Solar Thermal Systems* of the Solar Heating and Cooling Technology Collaboration Programme.

**The results and recommendations in this position paper are primarily aimed at policymakers and associations for solar thermal applications worldwide. It also targets the management levels and marketing departments of solar thermal manufacturers and distributors as well as all staff with the authority. It means to strengthen solar thermal's positioning in the heating and cooling market. Journalists and PR specialists can use the information for customer-oriented communication and promotion of solar thermal.**

# 1 Motivation

The number of solar thermal installations has been declining in the past years, while photovoltaic solar energy use has been booming.[1] This trend stands in opposition to the fact that the need for domestic hot water is steadily increasing worldwide. To strengthen the competitiveness and market uptake of solar thermal applications, Task 54[2] of the International Energy Agency's Solar Heating and Cooling Technology Collaboration Programme (IEA SHC) investigated the entire solar thermal value chain with respect to technical and non-technical cost reduction potentials and ways to make the technology more attractive to the end-user[3].

# 2 Current Status

The solar thermal heat market can be differentiated by the location's climatic situation and the system's purpose: cooling, heating, domestic hot water production, and swimming pool heating.

**Solar cooling** was the subject of several dedicated IEA SHC Tasks (25, 38, 53) and is discussed in the respective Technology Position Papers.

**Solar heating** is mainly used in the moderate climatic regions in central Europe and Canada, e.g., where different system technologies can be found. District heating systems with big seasonal storages and large fields of solar collectors offer cost reductions due to their large collector area and professional installation. See the results of SHC Task 55.

**Domestic hot water (**DHW) systems are basically different for sunny climates and moderate climates. The typical systems for sunny climates are thermosiphon systems. Here, the heat storage is located above the collectors and loaded by gravity. More efficient systems, equipped with a controller and a pump, are needed for moderate climates. These are often integrated into conventional heating systems to serve as back-up. Therefore, an increasing number of solar thermal systems are sold by heating companies, which are not really in favor of solar thermal technologies.

[1] For a detailed overview of past and current market developments please refer to the annual statistics report *Solar Heat Worldwide*. The 2019 edition details data on PV-Thermal technologies: https://www.iea-shc.org/solar-heat-worldwide
[2] Duration: October 2015 – October 2018
[3] More information and publications: http://task54.iea-shc.org/

Unglazed collectors for **swimming pool heating**, mainly consisting of polymeric materials, are popular in the USA but have no significant impact on greenhouse gas reduction.

Current barriers to the distribution of solar thermal were identified and grouped.

Monetary barriers:

- **Upfront investment** for a solar thermal system has to be paid back by the savings from the fuel used by the conventional heating system. **The investment costs for the conventional heating system** remain the same when the solar thermal system is simply added, leading to higher heating costs.
- **No transparency of costs for the end-user** (high margins in multiple distribution channels, maintenance costs not foreseeable, no straightforward calculation tool, or visualization of costs over time).
- **Competition with other renewable energy sources**, for example, surplus Photovoltaic Power used for heating or thermal storage.

Non-monetary barriers:

- **Reluctance of installers, planners, and heating companies to 'market'** solar thermal because they still prefer the familiar, easy-to-install conventional systems.
- **Solar thermal technology lacks attractiveness** and has a poor image (plumbing instead of electrical installation).
- **Lack of awareness** that solar thermal technology will be a major future energy source.
- **Insufficient training/education** of all stakeholders, from heating companies to planners, installers, and end-users.

# 3 Cost Reduction Potential

Individual research projects showed that there is room for cost reductions in materials, components, and systems. In addition, the studies revealed that cost reduction is not the only way to strengthen solar thermal's positioning in the future heating and cooling market. Economic considerations must be made alongside any technical innovation and call for a radical transformation of the entire solar thermal sector. Distribution models must be re-designed and show a stronger orientation towards customer needs, for example, by downsizing multi-level distribution channels to direct sales with online marketing and trade options. Simplified installation or subcontracting models for specialized solar thermal installations may further reduce margins. In any future scenario, solar thermal costs and financing options must be evident and easy to understand from the beginning. To this end, a calculation tool was developed for the Levelized Cost of Heat (LCoH)[4,5] of solar thermal or other heating applications.

Bringing solar thermal closer to the potential user is a task that can only be achieved with a uniform vision and communication agreed upon by all stakeholders, ideally led by policymakers and solar thermal associations. This includes focused image and marketing campaigns highlighting solar thermal's merits, especially in contrast to PV and heat pumps.

Finally, current funding mechanisms need to be rethought towards their suitability and sustainability. Unsteady subsidies are more likely to disturb the market than support growing market penetration. A more promising mechanism is to curtail greenhouse gas emissions using a carbon tax.

IEA SHC Task 54 wishes to stress that increasing the worldwide development and deployment of solar thermal will only be achieved by an effective and harmonized combination of the abovementioned proposals for improvement.

# 4 Actions Needed

SHC Task 54 has identified the following challenges and means to strengthen the market uptake of solar thermal.

| **Monetary challenge** | **Action needed** |
|---|---|
| Upfront investment for the solar thermal system has to be paid back by the savings from the fuel used by the conventional heating systems. | Costs (per kWh) could be decreased by a combination of measures to the same order as for conventional gas-only heaters. Qualitative progress is needed. |
| The investment costs for the conventional heating system remain the same when the solar thermal system is simply added, leading to higher heating costs. | Lean distribution, new pricing models (e.g., guaranteed costs per flat rate incl. maintenance, contracting models).<br>Specialized collector installers with expertise in roof installation and piping to ease the installation for the conventional installer who does not feel comfortable on the roof.<br>Definition of the general Levelized Costs of Heat (LCoH) method for all potential contributors to the heat supply in buildings for the optimization of the optimal mix/combination of renewables. |
| No transparency of costs for the end-user (high margins in multiple distribution | |

4 For more information on the Levelized Cost of Heat (LCoH) calculation method as defined for solar thermal applications please see Task 54's Info Sheet A01 http://task54.iea-shc.org/Data/Sites/1/publications/A01-Info-Sheet--LCOH-for-Solar-Thermal-Applications.pdf

5 The calculation tool can be accessed via the official Task 54 homepage http://task54.iea-shc.org/lcoh-tool

| | |
|---|---|
| channels, maintenance costs not foreseeeable, no straightforward calculation tool, or visualization of costs over time). | |
| Competition by other renewable energy sources like surplus Photovoltaic Power used for heating or thermal storage | Technological innovations (e.g., low-cost mass production of solar thermal, stagnation safe designs, standardized piping, fittings, and frames for more compatibility of components).<br><br>Current funding mechanisms need to be rethought in terms of their suitability and sustainability (e.g., an increase of the conventional heating costs by introducing a carbon tax).<br><br>Decrease the cost/performance ratio and the LCoH by introducing technical improvements, as listed in the appendix. |
| **Non-monetary challenge** | **Actions needed** |
| Reluctance of installers, planners, heating companies to 'market' solar thermal because they still prefer the familiar easy-to-install conventional systems. | Worldwide awareness-raising campaigns.<br><br>Definition of a general approach to define life cycle inventories and conduct life cycle assessments.<br><br>Implementation of new standards for hybrid systems (heating systems using different energy sources). |
| Solar thermal technology lacks attractiveness and has a bad image (plumbing instead of electrical installation). | |
| Lacking awareness of solar thermal technology as a major future energy source. | |
| Insufficient training/education of all stakeholders from heating companies to planners, installers, and end-users. | |
| New approaches with specific benefits. | Solar thermal system designs produced specifically for sunbelt countries because simple and inexpensive solutions can reduce fossil fuel combustion easily. |

# 5 Appendix: Special technical and economic possibilities for cost reduction and supporting measures

1. Design & Development
   a. Drain back systems reduce the thermal stress on components of the solar thermal system.
   b. Multi-family house systems are more promising in the short run for reducing the fossil fuel need for heating because of the averaging effects with a larger number of users.
   c. System designs based on standardized components and hydraulic and mechanical interfaces simplify the installation, allowing solar thermal system installation to lower costs. In addition, the quality of the installations increases, leading to better performing systems.

2. Materials and Components
   a. Polymers are cheaper when mass production is possible.
   b. Standardized components reduce costs by an economy of scale and simplify the installation. Standardized components also reduce purchase costs and/or costs for handling and storage of the material/components.
   c. Temperature limitations allow the usage of less expensive materials and components.

3. Production
   a. Cost reduction in the production of conventional collectors can be achieved by a higher grade of standardization and, thus, a reduction in the number of different collector variations.
   b. Processing of polymeric collectors leads to a cost reduction by an economy of scales in mass production if the market is big enough.

4. Distribution
   a. Wholesale prices for end-users minimize the risk of extraordinary costs of unskilled installers.
   b. Solve the complexity of the distribution chain by employing installation experts who are used to do all installation tasks.
   c. Digitalization of distribution process.

5. Installation
   a. Easy to install systems (standardized solutions, plug and flow) reduce the possibility of failure and result in a higher acceptance of the technology by installers.
   b. Temperature limitation allows the usage of components made from cheaper

materials.

c. Subcontracting the installation to experts (especially for the solar collector array) is a promising, more efficient way to reduce efforts and errors. This results in a faster, error-free, and cheaper installation.

6. Operation and Maintenance
    a. A well and error-free installed solar thermal system can be operated longer without failure. This will decrease the maintenance costs. In addition, the increased lifetime always reduces the levelized cost of heat.
    b. Temperature limitation reduces the stress on the components and enables the application of less expensive materials. Also, the heat transfer fluid will last longer, significantly reducing maintenance costs.
    c. Predictive maintenance based on digital communication allows the optimization of the maintenance frequency and the identification of needed actions.

7. Planning and Energy Consulting
    a. Solar thermal must be a mandatory component of heating systems, which increases its share when the total heat needs are reduced by lowering the heat losses.

8. System Concepts
    a. The integration into multi-family house heat supply should become mandatory.
    b. The conventional heating system could be down-scaled (especially in multi-family houses) when an appreciable part of the heat supply is contributed by a solar system, thus resulting in lower $LCoH_{ov.}$
    c. PR campaigns should emphasize the use and evidence of solar thermal systems for domestic hot water preparation and heating.
    d. Marketing should promote the installation of solar heaters and solar combi-systems as a reasonable option for heat cost reduction in the future.
    e. “Framing Solar Thermal” differently and as easy to understand. Decrease the level of complexity by simplifying the system, the installation, and the operation.