SOLAR HEAT
FOR INDUSTRIAL PROCESSES

SHC ANNEX 33
SolarPACES ANNEX 4

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IEA Solar Heating and Cooling Programme TASK 33

Annex 33: SOLAR HEAT FOR INDUSTRIAL PROCESSES

1. Description of Technical Sector; Definitions

(a) Description of Technical Sector

The industrial sector accounts for approximately 30% of the energy consumption in the OECD countries. The major share of the energy which is needed in trade and industrial companies for production processes and for heating production halls, is below 250°C.

To be able to make use of the huge potential for solar heat in the industry and to open a new market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the industrial processes in a suitable way. Especially it is necessary to further develop the solar thermal components so that they fulfil the requirements stipulated.

(b) Definitions

The scope of the Task is on solar thermal technologies for converting the solar radiation into heat, (i.e., the subject which is covered by the Task starts with the solar radiation reaching the collector and ends with the hot air, water or steam transferred to the application.) In other words, the distribution system, the production process and/or the optimisation of the production process are not the main topics of the Task. However, influences on the production process and the distribution system arising from the solar character of the heat source will be studied in the framework of the Task.

Applications, systems and technologies which are included in the scope of this task are:

- All industrial processes where heat up to a temperature level of approx. 250°C is needed
- Space heating of production or other industry halls is addressed, but not space heating of dwellings.
- Solar thermal systems using air, water, low pressure steam or oil as a heat carrier, i.e. not limited to a certain heat transfer medium in the solar loop.
- All types of solar thermal collectors for an operating temperature level up to 250°C are addressed: uncovered collectors, flat-plate collectors, improved flat-plate collectors - for example hermetically sealed collectors with inert gas fillings, evacuated tube collectors with and without reflectors, CPC collectors, MaReCos (Maximum Reflector Collectors), parabolic trough collectors.

2. Collaboration with other Programmes

Whilst the Solar Heating and Cooling Programme is approaching the process heat sector from a range of lower temperatures and smaller plant sizes, the SolarPACES Programme has in the past, mainly focused on large scale, high temperature applications. Due to the complementary background and know-how of the participants of the SHC and the SolarPACES programme, significant synergies are expected from a collaboration.
Therefore it was agreed to co-operate with the SolarPaces Program on a “moderate level” according to the SHC Guidelines for Co-ordination with other Programs.

At this level, the Task work is jointly defined, that is, the SolarPACES ExCo provides input to the Task Concept Paper and the Task Definition Phase. Once the Task is defined, the SHC ExCo will manage the Task.
In the course of such collaboration, both ExCos may find that they have differing views on the definition of work. If the two ExCos agree to collaborate at this level, it is assumed that they will make every effort to resolve their differences. Such resolution implies that the SHC ExCo is willing to make changes in the Task Work Plan proposed by the SolarPACES ExCo. However, as ExCos are independent and sovereign bodies, it is understood that such decisions remain the sole responsibility of the SHC ExCo.

To minimise the additional effort for the Operating Agent, the information exchange with the SolarPACES ExCo will be mainly through a representative participating in the Task and nominated by the SolarPACES ExCo.

3. Objectives

The objective of this Task is to improve conditions for the market introduction of solar heating systems for industrial applications in order to promote a reduction of fossil energy consumption and thereby to develop an environmentally friendly way of industrial production.

The main focus of the Task will be to:

(a) Collect the resulting knowledge and experiences;

(b) Provide methods and tools to analyse a wide range of solar applications for industry;

(c) Help to co-ordinate research and development of solar thermal systems for industrial applications leading to improvements in both performance and costs;

(d) Ensure the reliability of new materials and components;

(e) Make sure that this knowledge is made available to those who can benefit from it;

(f) Spread the awareness that solar thermal can be an integral part of industrial processes;

(g) Demonstrate that systems providing solar heat for industrial applications are reliable and economical, as well as environmentally useful.

4. Means

(a) The objectives shall be achieved by the Participants in the following four Subtasks*:*

(1) Subtask A: Solar Process Heat Survey and Dissemination of Task Results

The objectives of this Subtask are:

a) To provide a comprehensive description of the potential and the state-of-the-art applications of solar heat for industrial process. This includes to evaluate completed research programs, to evaluate realised projects and to study ongoing developments in this field, as well as carrying out economical investigations.

b) To disseminate the knowledge to four main target groups involved: solar manufacturers, process engineers, installers and potential buyers (industry).

The Participants shall achieve these objectives by:

(a) Carrying out a potential study and investigating the most promising industrial sectors or solar thermal systems

(b) Documenting the state-of-the-art in the participating countries

(c) Documenting the projects realised and monitoring results

(d) Monitoring market developments

(e) Documenting the solar collector and system technology available and the system costs

(f) Carrying out economic analyses

(g) Strengthening collaboration with the solar industry during the Task and verifying that the industry gets valuable benefits and contributions from the Task throughout the work plan; and

(h) Adapting the presentation of the results of all subtasks to the four target audiences: solar manufacturers, process engineers, installers and potential buyers (industry).

(2) Subtask B: Investigation of industrial processes

The objective of this Subtask is to identify applications and the corresponding temperature levels of the processes suitable for solar energy.

The Participants shall achieve this objective by:

(a) Integrating of solar heat to the “PINCH-concept”

(b) Investigating of application potentials

(c) Analysing of production processes regarding the necessary minimum temperature levels

(d) Investigating, assessment and comparison of process parameters; regional and sector specific boundaries and socio-economic factors for Unit Operations and processes

(e) Investigating, assessment and documentation of energy efficiency for “useful processes”

(f) Investigating and documentation of alternative processes (e.g. physical separation processes instead of thermal separation processes)

(3) Subtask C: Collectors and Components

The objective of this Subtask is to develop, improve and optimise collectors, components and systems with a potential for integration in industrial processes with a temperature level up to 250°C.

The Participants shall achieve these objectives by:

(a) Developing new collectors, components and system designs for process heat applications in co-operation with the involved industry

(b) Advanced collector developments (for example double glazed flat plate collectors with anti-reflection coated glazing, hermetically sealed collectors with inert gas fillings, CPC collectors, parabolic trough collectors,...)

(c) Collector testing at temperatures of 100 -250°C, elaboration of recommendations for collector testing standards for the medium temperature level

(d) Investigating the material problems for medium temperature collectors up to 250°C operating temperature and system components

(e) Determining parameters for modelling collectors in simulation programs to reflect the realistic performance of medium temperature collectors in process heat systems

(f) Measurements on the thermal performance of all other components (heat exchangers, storage pipes, etc) of solar thermal systems operating at high temperatures. If possible, these measurements will be carried out in existing systems and in laboratory measurements in order to be able to realistically model medium temperature systems.

(g) Investigating the stagnation behaviour of large medium temperature collector fields. The influences and consequences on the collector loop fluids.

(h) Involving the solar industry in the analysis of all working fields through industry-dedicated workshops

(4) Subtask D: System Integration and Demonstration

The objective of this Subtask is to initiate pilot projects covering a broad variety of technologies in suitable applications representing a significant part of industrial process heat consumers (in terms of size, temperature levels, heat transfer media, load patterns, etc.). These pilot plants endeavour to become a "best practice" reference, encouraging other potential users to employ these technologies. Pre-feasibility studies will be performed in each participating country, to provide a basis for the identification of the most promising applications and to bring together partners for the design, funding and implementation of selected pilot projects. It is endeavoured to initiate at least one pilot project per participating country. The operation of these plants shall be monitored for a representative period to provide feedback on the design and operation concept as a basis for future development and improvements.

The Participants shall achieve this objective by the following major activities:

(a) Developing design guidelines for solar process heat integration in industrial energy supply systems

(b) Developing numerical simulation tools for fast feasibility assessment and system optimisation

(c) Carrying out case (feasibility) studies

(d) Organising roadshows and workshops targeted at selected industry sectors to congregate suitable partners and motivate the formation of consortia for the realisation of pilot plants

(e) Monitoring solar industrial process heat systems in operation

(b) Subtask Leaders

The Subtask Leader for each of the foregoing Subtasks will:

(1) Co-ordinate the work performed under that Subtask;

(2) Assist the Operating Agent in preparing the detailed program of work and budget;

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

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

Each Subtask Leader shall be a Participant which provides to the Subtask a high level of expertise and undertakes substantial research and development in the field of the Subtask. 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.

(c) Technical Advisory Committee

The Participants establish a Technical Advisory Committee consisting of the Subtask Leaders and the Operating Agent. The Technical Advisory Committee shall assist the Operating Agent in the co-ordination of the Task and advise the Operating Agent on the performance of the Task.

5. Results

The products of work performed in this Annex are designed for use by the solar industry (manufacturers, planners, engineers, technicians, installers) and for potential buyers and users of the solar heating systems (trade and industry, utilities).Results of the joint activity will include:

Subtask A:

(a) Potential study on solar heat for industrial processes in the participating countries and the most promising industrial sectors for solar thermal systems;

(b) Report on the state-of-the-art of the solar collector technology, system concepts and system costs in the participating countries; review of existing and projected solar process heat systems.

(c) A choice of interesting and promising designs to be further analysed by Subtask C and D, and for which a missing simulation component tool can be developed by Subtask C and D;

(d) Guidelines for the economic analysis of solar plants for industrial applications;

(e) Materials for dissemination of the Task results:

- An annual industry Newsletter to deliver new information (paper version, and an Internet version on the IEA SHC and the SolarPaces Program site);
- An information dossier
- A handbook on solar process heat. This handbook will be published either as a printed handbook, on a CD or on a web site.

(f) Proceedings of Task workshops on the status of solar heat for industrial processes.

Subtask B:

(a) Matrix of indicators that can be used to describe and classify industrial energy supply systems regarding the possibility to include solar thermal energy (temperature levels, temperature differences, load curves,…)

(b) Energy System - Analysis Tool based on the matrix of indicators. A methodology on how to practically analyse an industrial energy system in order to work out the relevant indicators

(c) Description of improvement methodologies for energy efficiency. Documentation of what alternatives to solar energy have to be regarded in order to avoid mislead investments in industrial energy systems.

(d) Process integration tool kit. Methodology on the best way to integrate solar energy into an industrial energy supply and recovery system.

(e) “Total cost analysis” methodology and tool kit

(f) Materials for dissemination in Subtask A and design in Subtask D

Subtask C:

(a) New performance and cost-improved collectors suitable for medium temperature solar process heat systems. The documentation of available and newly designed collectors for medium temperature solar process heat systems.

(b) Recommendations on the testing of medium temperature collectors and on the elaboration of standards for medium temperature collectors. Results from round robin collector test.

(c) Documentation on realistic component parameters needed for simulation calculations on medium temperature solar process heat systems.

(d) Recommendations on service life time test procedures for collector components of medium temperature collectors.

Subtask D:

(a) Design guidelines for solar industrial process heat systems

(b) TRNSYS model library for solar industrial process heat components

(c) Software tool for fast feasibility assessment

(d) A series of case study reports

(e) Detailed proposals for at least one pilot plant in each participating country

(f) Monitoring reports for each pilot plant

6. Time schedule

This Task will enter into force on November 1, 2003 and remain in force until October 31, 2007. Within the limits of the term of Agreement, this Annex may be extended by two or more Participants, acting in the Executive Committees, and shall thereafter apply only to those Participants.

7. Specific Obligations and Responsibilities of the Participants

In addition to the obligations enumerated in Article 10 of this Agreement

(a) Each Participant shall provide the Operating Agent with detailed reports on the results of the work carried out for each Subtask;

(b) Each Participant shall collect, assess and report to the Operating Agent data on solar heating systems for industrial applications in his country; and

(c) Each Participant shall participate in the editing and reviewing of draft reports of the Task and Subtasks.

8. Specific Obligations and Responsibilities of the Operating Agent

In addition to the obligations enumerated in Articles 7 and 10 of this Agreement, the Operating Agent shall:

(a) Prepare and distribute the results mentioned in paragraph 5 above;

(b) Prepare joint assessments of research, development and demonstration priorities for solar heating systems for industrial processes;

(c) At the request of the Executive Committee, organise workshops, seminars, conferences and other meetings;

(d) 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 Committees of the Solar Heating and Cooling Programme and the SolarPaces Programme;

(e) Propose and maintain a methodology and a format for the submission of information on solar heating systems for industrial processes which is collected by the Participants as described in paragraph 4 above;

(f) Provide semi-annually reports to the Executive Committees on the progress and the results of the work performed under the Program of Work;

(g) Provide to the Executive Committees, within six months after completion of all work under the Task, a final report for its approval and transmittal to the Agency;

(h) 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;

(i) Provide the Participants with the necessary guidelines for the work they carry out with minimum duplication;

(j) Perform such additional services and actions as may be decided by the Executive Committees, acting by unanimity; and

(k) Gather documents from Subtask Leaders, edit and distribute the output of the Task either as a printed handbook, on a CD-ROM or on a Web site.

9. Meetings

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

10. Funding

(a) Meetings

Each country will bear the costs of its own participation in the Task, including necessary travel costs. The cost of organising meetings will be borne by the host country.

(b) 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 which are specifically collaborative in nature and which 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 which exceeds the R&D work carried out in the framework of the national (or international) activity.

(c) Task-Sharing Requirements

Each Participant shall commit to the Task a minimum of 1 person -year per year of the Task. The Operating Agent shall commit a further minimum of 0.4 person-year per year over the period of four years of this Task.

11. Operating Agent

The Republic of Austria, acting through the Arbeitsgemeinschaft Erneuerbare Energie, Institute for Sustainable Technologies (AEE INTEC), is designated as Operating Agent.

12. Information and Intellectual Property

For purposes of this Annex, the following provisions shall prevail:

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

- 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;
- 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 which 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:

- To Participants in the Task:
  - On the most favourable terms and conditions for use by the participants in their own country; and
  - On favourable terms and conditions for the purpose of sub-licensing others for use in their own country.

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

- To the government of any Agency Member country and nationals designated by it, for use in such country in order to meet its energy needs.

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

13 Participants in this Task

The Contracting Parties which are Participants in this Task are the following:

Austria
Czech Republic
Germany
Portugal
Spain
(Other countries to be added when confirmed)

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