SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

TASK XX

SOLAR PROCESS HEAT

ANNEX DRAFT

OCTOBER 2019

Annex XX

Solar Process Heat

1. Definitions

(a) Description of Technical Sector

The industrial sector accounts for approximately 30% of the total energy consumption in the OECD countries. The major share of the energy that is needed in industrial companies, services and agriculture is used for heating and cooling of buildings and for production processes at temperatures from ambient up to approx. 400-500°C. This is a temperature range that can be addressed with solar thermal technologies at a high TRL.

To be able to make use of solar heat in industry and to support this market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the energy supply schemes in a suitable way.

(b) Definitions

The scope of the Task is on solar thermal technologies for converting solar radiation into heat and further the intelligent integration of the produced heat into industrial processes (i.e., the subject that is covered by the Task starts with the solar radiation reaching the collector and ends with the hot air, oil, water or steam being integrated into the application).
Applications, systems and technologies, that are included in the scope of this task, are:

- All processes in industry, commerce and agriculture that are thermally driven and operated in a temperature range from ambient temperature up to approx. 400-500 °C.

- 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 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), linear Fresnel collectors, parabolic trough collectors.

2. Purpose and Objectives

The goal of the proposed Task is to help solar technologies be (and also be recognized as) a reliable part of process heat supply systems. These systems are hybrid supply systems and will have to be integrated in the upcoming developments of the digitalization of industrial production systems and their energy demand. Instead of focusing on component development, we will look at the overall (solar) system at process temperatures from just above ambient temperature up to approx. 400°C-500°C. Open research questions are the standardization of integration schemes on process level and on supply level and the

combination with other efficient heat supply technologies. As a very important aspect, the experiences of numerous solar process heat markets throughout the world will be brought together to enable a market-oriented dissemination of existing and new knowledge.

3. Activities

(a) Main activities

The key objective of this new Task is to identify, verify, and promote the role of solar heating plants in combination with other heat supply technologies for process heat supply, such as fossil and non-fossil (biomass and biogas) fuel boilers, combined heat and power, heat pumps, or power-to-heat.

(b) Sub-activities

The activities will be performed in 5 subtasks:

Subtask A: Integrated energy systems

A.1 Selection and definition of reference applications and Industries

A.1.1 Holistic overview of world's most common industrial, commercial and agricultural heat sinks up to 400 °C.

A.1.2 Combination of selected heat sinks to derive representative industrial processes or applications

A.1.3 Collection and selection of industrial, commercial, and agricultural load profiles, both thermal and electrical

A.1.4 Definition of reference applications for different climatic conditions world-wide (to be used for other Subtask activities)

A.2 Integration concepts for solar process heat

A.2.1 Summarizing existing and development of new integration concepts for relevant heat sinks and/or applications identified within A.1

A.2.2 Investigation of required modifications of integration concepts when combining solar heating plants with other renewable or efficient heating technologies

A.2.3 Assessment of the impact of heat recovery and energy efficiency on integration concepts, achievable renewable fraction and overall energy consumption

A.3 System concepts for integrated renewable energy systems

A.3.1 Recommendations for tailor-made integrated energy systems for defined reference applications

A.3.2 Pre-dimensioning of solar heating plants and additional heating technologies (incl. storages) based on overall load profile and temperature level

A.3.3 Definition of specifications for simulation study within Subtask C

A.4 Dimensioning rules and recommendations for implementation (Roadmap)

A.4.1 Definition of key aspects of integrated energy systems such as hydraulic integration, control strategies and operation (What are the requirements of the different heat generating technologies)

A.4.2 Rules of thumb for dimensioning of the main components within integrated energy systems incl. solar heating plants

A.4.3 Roadmap for implementation (within reference applications) including low hanging fruits and considering the influence of disruptive changes within future process heat demand

Subtask B: Modularization

B.1: Modular system concepts for solar process heat applications

B.1.1: Identification of those integration schemes that are more usual in commercial SHIP applications

B.1.2: Proposal of modular system concepts

B.2: Standard components/packages for collectors and hydraulics (easy installation; easy dismantling)

B.2.1: Identification of components suitable for "normalization" in the solar field and hydraulic circuit

B.2.2: Definition of standard options for components suitable for "normalization"

B.3: Development of a modular and scalable interface unit for solar process heat applications

B.3.1: Identification and analysis of interfaces

B.3.2: Basic design of a modular and scalable interface

Subtask C: Simulation and design tools

C.1 Identification and evaluation of available simulation tools for SHIP

C.1.1 Classify, according application, technology and simulation strategy

C.1.2 Assess the capabilities for introducing optimization techniques and time-dependent energy strategies.

C.1.3 Assess tools for estimating the load demand profile.

C.1.4 Define comparative studies based on actual plants and identify the source of errors/differences observed in the different simulation tools

C.2 Simulation Tools for Solar Process Heat Systems

C.2.1 Summarize existing approaches and development of a new integrated methodology for relevant heat sinks and/or applications identified in subtasks A and standardized modules proposed in subtask B

C.2.2 Assessment of the impact of uncertainties on the yield assessment. Develop a checklist for reducing the uncertainties in simulations for pre-feasibility and feasibility evaluations.

C.2.3 Prepare guidelines for yield assessment of SHIP systems

C.3 Yield assessment of Solar Process Heat Systems

C.3.1 Assessment of monitoring strategies for Solar Thermal systems coupled to industrial processes. Analyze the options according to the size of the installation

C.3.2 Analyze the potential for using Machine Learning techniques for diagnosis and anomaly detection in SHIP plants.

C.3.3 Prepare guidelines for monitoring and assessing the performance of actual SHIP systems.

Subtask D: Standardization and Certification

D.1 Standardization Plan

D.1.1 Explore the relevant standardization and certification area

D.1.2 Analyze relevant standardization potential

D.1.3 Mapping of relevant standards

D.2 New standardization Work

D.2.1 Identify gaps

D.2.2 Proposal for new standardization work.

D.2.3 Establish links with on-going standardization committees in European level.

D.3 Develop standardization document

D.3.1 Feed into relevant technical committees.

D.3.2 Develop a standardization document according to CENCENELEC rules, specifically for SHIP: SHIP-CWA (CEN-CENELEC Workshop Agreement).

D.4 Proposal(s) for inclusion in Certification Scheme Rules

D.4.1 Explore the relevant certification schemes in European level.

D.4.2 Explore the relevant certification schemes in International level.

D.4.3 Establish links / open dialogue with committees, networks and organizations

D.4.4 Introduce relevant inputs based on the Task work and outcomes

Subtask E: Guideline to market

E1. Stimulating innovation

E.1.1 identifying the alignment of solar process heat related national research and funding programs, seeking synchronization with other worldwide programs;

E.1.2 promoting the acceleration of knowledge transfer to industry (end-user and multipliers) in the context of relevant initiatives;

E.1.3 mapping the available R&D infrastructures and disseminating potential R&D services to technology suppliers and/or end-users;

E.1.4 establishing communication structures for stakeholders (researcher/investor, supplier, industry, multipliers, relevant international organizations).

E2. Competitiveness indicators

E.2.1 to provide updated information on technology costs and cost reduction trends;

E.2.2 defining suitable energy cost evolution scenarios enabling a due perception of future heat production costs;

E.2.3 define and collect competitiveness indicators beyond cost alone (e.g. non-energy-benefits NEB or multi-benefit-approach);

E.2.4 a due quantification of the "hedging effect" of SHIP towards other energy sources;

E.2.5 the use of LCOH as benchmark for the comparison of innovative heating/cooling production systems;

E.2.6 updated information on best practice examples of successful installations and business models (e.g. www.ship-plants.info).

E3. Financing models

E.3.1 demonstrating that a "Payback driven" appraisal of SHIP is short sighted as it does not capture the NPV potential of these CAPEX driven investments;

E.3.2 gathering updated information and disseminating new trends on financing schemes and business models to SHIP, both in the scope of conventional solar-fossil systems and 100% RE hybrid energy supply systems;

E.3.3 developing suitable "PPA-like" scenarios demonstrating that SHIP based LCOH is competitive with other (conventional and/or renewable) energy sources;

E.3.4 pooling available SHIP financing possibilities among potential project promoters and/or end-users.

(c) Workshops and Seminars

Industry workshops will be held in conjunction with every second Task meeting. The workshops will be organised in the host country of the meeting and all relevant target groups will be invited.

(d) Participants and/or experts' meetings

Task meetings will be held twice a year with all participants. In between expert meetings will be held as web meetings if possible.

(e) Publications/Newsletters

The overall scope and objectives of the Task and the different Subtasks will be described on the Task Website.
A publicly available database of international solar process heat projects will be promoted.
In addition the task results will be published at conferences and webinars, in journals and magazines.

4. Expected Results/Deliverables

The deliverables, allocated to the 5 subtasks, will be:

Subtask A: Integrated energy systems

D.A1 Compilation of reference applications for integrated energy systems with solar heating plants incl. representative load profiles
D.A2 General integration concepts and achievable renewable fraction of integrated energy systems
D.A3 Dimensioning and integration guideline for integrated energy systems

Subtask B: Modularization

D.B1 Integration schemes and interfaces more commonly used in commercial SHIP applications
D.B2 System/component modularization for SHIP applications

Subtask C: Simulation and design tools

D.C1 Guidelines for yield Assessment, including a Checklist for a standardized yield assessment according to the project phase (pre-feasibility, feasibility, proposal, etc.)
D.C2 Guidelines for implementing simulation tools for assessing and monitoring the performance of SHIP systems

Subtask D: Standardization/Certification

D.D1 Standardization Plan
D.D2 Proposal for new standardization work
D.D3 Standardization document SHIP-CWA - CEN-CENELEC Workshop Agreement (CWA)
D.D4 Proposal(s) for inclusion in Certification Scheme Rules

Subtask E: Guideline to market

D.E1 Collection of available solar process heat related national and trans-national research and funding programs
D.E2 Update on technology costs, statistics and cost reduction trends, including suitable energy cost evolution perspectives and promoting the use of LCOH as benchmark for the comparison of innovative heating/cooling production systems
D.E3 New trends on financing schemes and business models to SHIP and collection of available SHIP financing possibilities

5. Rights and Obligations of Participants

In addition to the obligations enumerated in Article 4 of the implementing agreement:

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

(b) Each participating institution/company shall participate in the editing and reviewing of draft reports of the Task and Subtasks.

(c) *Meetings*
The cost of organising meetings will be borne by the host country but can be shared with the participants.

(d) *Level of effort*
Each country will bear the costs of its own participation in the Task, including necessary travel costs. The Participants agree on the following funding commitment:

Each Participant (country) will contribute to this Task a minimum of 0.5 person year per year of the Task, i.e. a total minimum of 2 person years.

Participation in the Task requires participation in at least one of the Subtasks.

The Operating Agent will contribute with a minimum of 0.1 person year per year to the Task (i.e., a total of 0.5 person years for his/her work as Operating Agent).

Participation may partly involve funding already allocated to a national (or international) activity that is substantially in agreement with the scope of work outlined in this Annex. 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 that are specifically collaborative in nature and that 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.

6. Management

(a) Switzerland, acting through the SPF Institute for Solar Technology at the HSR University of Applied Science Rapperswil, is designated as Operating Agent.

(b) The Operating Agent's rights, obligations and responsibilities in addition to those indicated in the main body of the implementing agreement and the organisation of the work under this Annex enumerated in Section 5 of this Agreement, the Operating Agent shall:

1) Prepare and distribute the results mentioned in paragraph 4 above
2) 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
3) Provide reports semi-annually to the Executive Committees on the progress and the results of the work performed under the Programme of Work

4) 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
5) In co-ordination with the Participants, use its best efforts to avoid duplication with activities of other related programmes and projects implemented by or under the auspices of the Agency or by other competent bodies
6) Provide the Participants with the necessary guidelines for the work they carry out with minimum duplication;

(c) The Subtask Leaders shall be Participants that provide to the Subtasks a high level of expertise and undertake 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.

A 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 Programme of Work
3) Direct technical workshops and provide the Operating Agent with written summaries of workshops results
4) Edit technical reports resulting from the Subtask and organise their publication.
5) Arrange meetings in between or in association with Experts meetings of the Task.

(d) Task 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.

(e) It is intended to organize expert / industry workshops every year, directly linked to Task meetings.

(f) The overall scope and objectives of the Task and the different Subtasks will be described on the Task Website.

7. Admission, Participation and Withdrawal of Participants

For purposes of this Annex the provisions of the implementing agreement shall apply.

8. Information and Intellectual Property

For purposes of this Annex the provisions of the implementing agreement shall apply.

9. Entry into Force, Term and Extension

This Annex shall enter into force on 1st January 2020 and shall remain in force for a period of 4 years/until 31st of December 2023.
At the conclusion of that period, this Annex can be extended by at least two Participants, acting in the Executive Committee, for a period to be determined at that time, provided that in no event shall the Annex continue beyond the current term, or actual termination, of the TCP.