SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 45

Large Systems

Large solar heating/cooling systems,
seasonal storages, heat pumps

Annex
November 7, 2011

Editor: JE Nielsen

1. Description of Technical Sector

The use of solar thermal energy in connection with district heating is far behind (relatively only one tenth of) the use of solar thermal in individual houses - even though it is in most cases much cheaper to supply solar energy centrally to a district-heating network, than to supply solar energy to individual houses.

Only a total of 40 systems in the MW size (>1 400 m² collectors) and very few large seasonal storages (>10 000 m^3 water equivalent) are installed worldwide.

The majority of the existing MW scale solar thermal systems (in the low/medium temperature range) are today used for district heating. But, MW scale systems for cooling and low/medium temperature process heating also exist.

Large solar systems with seasonal storage and heat pumps have already been treated in the IEA SHC:

- 1979-1988: Task VII: Central Solar Heating Plants with Seasonal Storage (CSHPSS) running from
- 1990-1994: “Large Systems Working Group” within Task 14
- 1995: Workshop on Large-Scale Solar Heating, 1995

Attempts in the ’90s to start a new task on the subject did not succeed. However, now - almost 20 years after the last task was completed - **things have changed**, and there is indeed a need for a comprehensive update.

The main change is **a dramatic improvement in performance and economy** of the collector part and of the seasonal storage building technology of these systems.

Comparing performance and costs from 1986 [1] till now shows this:

- Improvement in collector performance (flat plate, 70°C): 1.34
- Improvement in collector field costs (in 2010 $): 0.64

Gives:

- Improvement in performance/cost ratio for large collector fields: 2.08
  Taking also in consideration the ”improvement” in oil price
- ”Improvement” in oil price (in 2010 $): 2.65
  the total ”economical improvement factor” becomes:
- Improvement in total economy for large collector fields: 5.51

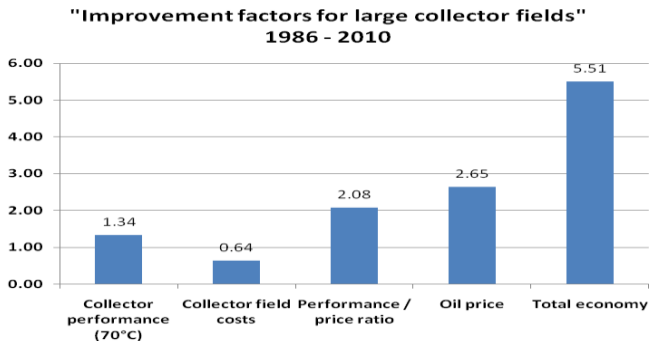

Figure 1. Improvement in performance, cost and overall economy for large-scale solar systems in the period 1986 to 2010.

On the storage side the improvements are not impressive e.g. when comparing prices in 1986 with now - for pit storages only a little reduction is seen (10 %) - see Appendix A.

However, in Germany a very good development for some storage types has been seen: Costs are reduced to below 50 % within the last 10 years.

On the heat pump side, major improvements with respect to the applicable temperature interval have been seen: Within the last few years the maximum delivery temperature has been increased from 60 to 90°C (very convenient for e.g. district heating systems).

From the final report of SHC Task 7, a future solar energy heat energy price of 50 $/MWh is reported. This price has now been achieved in Denmark (for simple systems without seasonal storages); but as the 2010 dollar is only 60 % of the 1990 dollar a price 40 % lower than foreseen has actually been achieved.

It should be noted that today's oil price of 80 $/bbl (raw oil) exactly matches the 50 $ per MWh.

The dramatic improvement in economy for the ground mounted collector field part of the system is expected to show up in a renewed interest for this kind of systems materialising in a large number of new systems within the next few years (especially if costs of storage will also be improved).

Building integrated collector fields did not show such dramatic cost improvement.

Comparing the concluding remarks from "1995 Workshop on Large Scale Solar Heating" [3]:

a) " The collector costs are still too high …"
b) "…the main difficulty to getting solar heating with seasonal storage on track lies in creating a storage design that is both reliable and has acceptable construction cost."

With today's situation it is seen that:

a) The situation has changed: Costs of field-mounted collectors are now feasible (however costs of roof/building integrated collectors are still rather high).
b) Situation did not change very much, still storage designs could/should improve with respect to the "reliability/cost" ratio.

It is important to be prepared for the foreseen very good market development - and it is a main aim of this task to supply the sector with guidelines and quality standards to assure good performing systems with a trouble less operation in a long life time.

Collaboration with IEA DHC IA and IEA ECES IA is being discussed.

2. Objectives and Scope

The main objective of this Task is to assist in a strong and sustainable market development of large solar district heating and cooling systems. The systems can include seasonal storages and/or heat pumps/chillers.

This objective will be achieved by optimising system configurations and components - using a systematic approach:

- at the system level: using the best relative sizes and combinations of solar thermal, heat pump, seasonal storage and others, control strategies - taking into account the local framework conditions
- at the component level: improve costs, performance and lifetime

The main focus is on the system level: How to match the actual system configuration to the actual needs and local conditions including the surrounding regional energy system (free electricity market). Or in other words: For the given conditions of load and energy prices, which system type and size to choose to have a competitive heat price and a large solar fraction.

It is important that the systems are installed and controlled/operated properly in order to perform well. To secure that, guidelines and standards have to be updated and developed and recognised performance guarantee procedures established.

To push the market development, a strong effort will be done in promoting the benefits of the technologies and results from the Task to the decisions makers in the sectors of district heating and cooling and process heating and cooling. The issue of financing the “upfront investment in 25 years of heat production” will be dealt with - and models for services of Energy Service Companies (ESCo’s) will be proposed and sought tried out.

The scope of the Task covers large-scale solar thermal systems – pre-heat systems as well as any combination with storages, heat pumps, CHP-units, boilers, etc. for the supply of block and district heating & cooling. Focus will be on district heating ond cooling applications.

Any type of solar collector is in principle possible:

- liquid based
- air based
- flat plate (glazed / un-glazed)
- evacuated tubes (direct / heat pipe)
- concentrating (tracking / stationary)

Concerning heat pumps the main focus will be on heat pumps driven by electricity. However during the course of the Task it might be become relevant to consider also thermally driven heat pumps.

Concerning thermal driven cooling machines (chillers) no restrictions in scope.

Concerning storages the main focus will be on seasonal storages.

3. Activities

The Participants shall share the coordinated work necessary to carry out this Task.

(a) Main activities

The objectives shall be achieved by the participants in the following Subtasks:

- Subtask A: Collectors and collector loop
- Subtask B: Storages
- Subtask C: Heat pumps / chillers
- Subtask D: Systems

The tasks of dissemination of results and market support are included in the Operating Agent's general task.

In the following the specific objectives, activities and deliverables of the subtasks are described in more detail.

Subtask A: Collectors and collector loop

The general objectives of Subtask A are to:

- Assure use of suitable components
- Assure proper and safe installation - including compatibility with district heating and cooling network
- Assure the performance of the collector field

The specific objectives of Subtask A are to:

- Improve use/accuracy of collector test results - pre-normative work
- Propose requirements for collector loop pipes (safety, durability, heat loss) - pre-normative work. Propose test methods for pipes accordingly
- Propose requirements for collector loop installation including precautions for safety and expansion. Propose check list for checking installation accordingly
- Develop and validate simulation model for the thermal behaviour of solar collector fields
- Check thermal performance of already installed solar collector fields
- Prepare guidelines for design, control and operation of solar collector fields
- Propose procedure for guaranteeing performance of collector field installation - incl. heat exchanger
- Propose procedure for checking guarantee of collector field installation incl. heat exchanger accordingly
- Improve cost /performance ratio for roof/building integrated collector fields
- Improve cost /performance ratio for ground mounted collector fields

The activities to reach these objectives are defined below.

A1: Improve use and accuracy of collector test results

A special problem for large collector fields has shown up:

- The test conditions used during collector tests are different from the operation conditions for the solar collectors in a solar collector field.

The volume flow rate through the collector, the collector tilt, the solar collector fluid and the wind velocity along the collector, the diffuse part of the radiation might be different during the collector test and the operation of the collector. The collector efficiency expression will therefore be different during collector operation than during the collector test. Further, the influence of changes of the mentioned conditions on the collector efficiency expression is different from collector type to collector type - for instance for flat plate collectors with one and with two covers. It is therefore proposed to investigate how the efficiency expression is influenced by the mentioned conditions for different solar collectors.

The results of these investigations can be used for corrections of test values to “real conditions” - and to improve test accuracy by restricting variability of test conditions

In this way a good basis for a more precise and fair comparison of different solar collectors can be established. The research will, if possible, be carried out in cooperation with participants of the IEA Solar Heating & Cooling Programme Task 43 project Solar Rating and Certification Procedure. Advanced Solar Thermal Testing and Characterization for Certification of Collectors and Systems.

A2: Requirements and test methods for collector loop pipes

Investigations on requirements and test methods on durability of pipes for solar collector loops will be carried out. Among other things, thermal expansion, corrosion and boiling behaviour with different solar collector fluids will be studied.

Consider EN 13941, EN 235, which changes are needed?

A3: Requirements to hydralic design of collectors and collector fields

Parallel theoretical and experimental investigations on the flow distribution for different rows of serial connected solar collectors will be carried out for differently designed solar collector fields with different piping systems and circulation pumps.

Includes:

- applicable hydraulic design of collectors
- flow distribution in parallel absorber pipes, collectors and collector groups
- uniform distribution of flow rates in overall collector area with less regulation valves
- pipe heat losses

Detailed simulation models to determine the thermal performance of solar collector fields will be developed and validated by means of measurements. The models will among other things include collector efficiency expressions for different collectors with different volume flow rates, for different collector tilts and for different solar collector fluids, heat loss from pipes, and shadows from one collector row to the next collector row. Solar collector fields consisting of different collector types will be considered. The models can be used to determine the suitability of differently designed solar collector fields and different operation strategies.

The thermal performance of existing solar collector fields will be compared to calculated thermal performances with the model.

Further, simulation models on the pressure drop for differently designed solar collector fields will be developed and validated by means of measurements.

Based on the above-mentioned investigations and on calculations with the model guidelines for design, control and operation of solar collector fields will be worked out.

Models will focus on flat plate collectors and temperatures below 100 °C - experience exchange with future task on industrial applications focusing on high temperature applications will be organised.

A4: Precautions for safety and expansion

"Thermal expansion and stagnation behaviour and measures to handle stagnation".

The solar collector loop design will also be investigated with focus on air escape, thermal expansion of solar collector fluid.

A5: Guaranteed performance of the collector loop

A procedure for how to guarantee and check the performance of collector field and heat exchanger will be elaborated and tried out on existing plants.

A6: Cost/performance improvement

Investigations with focus on reduction of the cost/performance ratio for building integrated as well as ground mounted solar collector fields inclusive the applied control and operation strategies will be carried out

Subtask B: Storages

The Subtask B will focus on large storages (> 1 000 m^3 water equivalent) in combination with solar heating and cooling systems using sensible storage materials.

It is anticipated that there is a high potential for optimisation of storage efficiency and economy in system integration.

The general objectives of Subtask B are to:

- Improve the economy of (seasonal) storage technologies
- Increase knowledge on durability, reliability and performance of (seasonal) storage technologies
- Demonstrate cost effective, reliable and efficient seasonal storage of thermal energy

The specific objectives of Subtask B are to:

- Evaluate existing storages
- Define requirements for efficient storages and “storage sub components” - structural loads, durability, tightness, insulation, stratification, high temperature capability, safety, etc.
- Define system requirements for efficient storages (temperature levels, hydraulics, control strategies etc)

- Identify the needs for technical improvements
- Define the quality measures - procedure for checking the performance of storages (heat loss, stratification, etc.)

- Design guidelines for cost-effective storages

The activities to reach these objectives are defined below.

B1: State of the art – Evaluation of existing projects

B1.1. Definition of selected pilot and research projects to be evaluated by national participants.

B1.2. Evaluation based on questionnaire

B1.3. Overview analyses of pilot projects and storage developments: main findings, constructions and materials to be recommended, problems found.

B1.4. Cost analyses of construction technologies and materials.

B1.5. Cost for operation and maintenance.

B1.6. System interaction.

B2: Technical improvements

Identification of necessary developments/improvements.

Collection of possible improvements, new concepts, materials, investigations …

If possible: investigations on identified technical improvements.

B3: Quality management

Definition of technical requirements and procedure(s) for checking the performance of storages (materials, thermal losses, stratification, etc.).

Definition of characteristic parameters for comparison of storages (equivalent storage volume, equivalent heat capacity, usability of stored thermal energy, etc.).

B4: Knowledge transfer/dissemination

Preparation of design guidelines for seasonal storages.

Review of design/simulation tools.

Database on seasonal storages: Gather data on all large seasonal thermal storages - present via web (cooperation with the IEA ECES IA).

Subtask C: Systems - configurations, operating strategies, financing issues

The general objectives of this subtask are to:

- Provide decision makers and planners with a good basis for choosing the right system configuration and size
- Give decision makers and planners confidence in system performance

The specific objectives are to:

- Provide an overview of system configurations suited for district heating and cooling
- See the large solar systems in the context of the surrounding regional/national energy system (competition with waste heat, integration in the free market for electricity, etc.)
- Provide a good basis for decision makers to decide on investment in large solar systems
- Provide state of the art of simulation tools and simulation models
- Provide general design requirements for DH networks
- Define parameters to identify suitable existing DH networks
- Provide models for ESCo services (contracting)
- Provide procedures for performance guarantee - and check
- Provide recommendations for monitoring and checking system output
- Define criteria to adapt solar systems to the DH networks (existing and new)
- Conduct sensitivity analysis of SDH systems, considering different parameters such as DH distribution temperature, solar fraction, storage size, load, economics
- Provide recommendations for operating strategies
- Provide design guidelines for “substations units” (units controlling the in- and output of heat for buildings with collectors fields on e.g., the roof)

The main activities are:

C1. Overview

C1.1. Overview of system categories (systematic categorisation of large solar systems with respect to applications, components, component types,

C1.2. Detailed description of (all) existing systems with (seasonal) storage and/or heat pump by each national representative

C1.3. Updated database for all large solar systems > 0.5 MW

C2. Analysis

C2.1. Sensitivity analysis of solar district heating systems, considering different parameters such as DH distribution temperature, solar fraction, storage size, load, economics

C2.2. National representatives demonstrate a large solar system fit into the surrounding regional/national energy system (competition with waste heat, integration in the free market for electricity, etc.)

C2.3. Tools for feasibility studies: overview on calculation tools providing strong and weak points and users’ categories

C2.4. Develop a dedicated pre-feasibility tool

C2.5. Written guidelines. Examples: Economy for realised systems

C2.6. Case studies; different application; different countries

C2.7. Guidelines for environmental assessment

C3. Models for ESCo services

C3.1. Financing models, financial risks, ownership, system maintenance

C3.2. Existing examples

C3.3. Case studies; different application; different countries

C4. Performance check/monitoring/surveillance

C4.1. Procedures for performance check

C4.2. Recommendation for monitoring and verification / surveillance of systems

C5. Guidelines for planning, installation, commissioning, operation

C5.1. Give inputs for Design Handbook

C5.2. Give inputs for handbook in subtask D for the overall installation, commissioning and operation of SOLAR DH

C6: Guidelines for connection of decentralised solar thermal systems

Give inputs for handbook for direct and indirect connection of decentralised solar thermal systems distributed in the district heating supply network and handling both solar production and user load (e.g. in building with a large collector field on the roof.

(b) Workshops and seminars

National experience exchange groups (participant to be chosen from each country)

Establish/participate in national experience exchange groups. The groups should meet e.g. twice a year and exchange experience from operation of systems and discuss new ideas. Experts could be invited for special issues. Participants could be:

- Plant operators
- Planners / consultants
- Suppliers
- Researchers

National workshops

Arrange workshops on thematic themes (heat pumps, thermal cooling; seasonal heat storage, collectors, etc.) (could be in cooperation with IEA HP IA and IEA ECES IA). Optionally organize national workshops in connection with the “experience exchange group meetings.”

International workshops

Task will hold 1 international workshop per year.

(c) Publications/newsletters

The target groups for Task information include:

- Utilities/heating companies/ESCos
- Planners
- Installers & Operators
- Technical Schools and Universities
- Producers of relevant components

Design handbook for large solar thermal systems
Write and publish design handbook for large solar thermal systems. (see proposal for contents below)

Lists of suppliers of systems, components and services
Make online lists of suppliers of components and services. Sorted country by country.

"Educational packages"
Make editable " educational packages" for universities/technical schools and associations.

Newsletters and Leaflets
Issue 1 - 2 newsletters/leaflets per year.

Presentations & papers
Give presentations at international conferences at least one per year.
Participate in meetings/events arranged by the target groups (e.g., associations of district heating and municipalities).

White paper
Prepare a "White paper" on policy position.

4. Expected Results/Deliverables

The products of work performed in this Task are designed for the utilities and heat companies, industry (manufacturers of components and systems), engineers and planners.

Subtask A - Deliverables

A-D1. Models for correction of collector efficiency parameters depending on 1) collector type, 2) flow rate, 3) tilt, and 4) fluid type

A-D2. If possible, proposal for an informal annex to be included in EN 12975 / ISO 9806-1 describing how to make the above mentioned corrections.

A-D3. Proposal for requirements and test methods for collector loop pipes (safety, durability, heat loss) - pre-normative work - to be proposed to the relevant ISO/CEN TC's

A-D4. Guidelines for requirements for collector loop installation including precautions for safety and expansion including check list for checking installation accordingly

A-D5. Detailed simulation models for solar collector fields

A-D6. Determination of optimum control and operation strategies for solar collector fields

A-D7. Procedure for guaranteeing performance of collector field installation - including how to check the guarantee - and including validation on existing fields

A-D8. Procedure for guaranteeing performance of solar loop heat exchanger - including how to check the guarantee - and including validation on existing fields

A-D9. Proposals for how to improve cost/performance ratio of building integrated collector fields and their installation

A-D10. Proposals for how to improve cost/performance ratio of ground mounted collector fields and their installation

A-D11. Input to Task web site

A-D12. Input to “Design Handbook”

A-D13. Subtask A Summary Report

Subtask B - Deliverables

B-D1. State of the art report with best practise examples (in the beginning of task)

B-D2. Design guidelines for seasonal storages

B-D3. Report on research requirements

B-D4. Database on large seasonal storages

B-D5. Input to Task web site

B-D6. Input to “Design Handbook”

B-D7. Subtask B Summary Report

Subtask C - Deliverables

C-D1. Overview of applications and system configurations

C-D2. Report on sensitivity analysis

C-D3. Updated database for all large systems > 0.5 MW

C-D4. Guidelines and tool(s) for feasibility studies

C-D5. Models and case studies for ESCo services

C-D6. Procedures for system performance guarantee - and check

C-D7. Recommendations for monitoring and surveillance

C-D8. Inputs for Design Handbook

C-D9. Input to Task web site

C-D10. Subtask D Summary Report

Task Deliverables

O-D1. Design Handbook for large solar thermal systems (OA + participants)

O-D2. Online databases with lists of suppliers of components and services. Sorted country by country

O-D3. Task website

O-D4. Material for education

O-D5. Workshops: 1 international workshop per year + 1 national workshop per participant

O-D6. Newsletters: 1 - 2 newsletters/leaflets per year

O-D7. Presentations at international conferences - 1 per year

O-D8. White paper/policy position

5. Rights and Obligations of Participants

(a) In addition to the obligations enumerated in Article 7 of this Agreement

1. Each Participant shall commit himself in actively working in the Task and provide Operating Agent with detailed reports on the results of the work carried out in each Subtask.

2. Each Participant shall collect, assess and report to the Operating Agent data on solar heat + heat pumps systems.

3. Each Participant shall participate in the editing and reviewing of draft reports of the Task and Subtasks

4. Each Participant shall participate in the editing and reviewing of the final design book of Task 45 “Large solar thermal systems”.

(b) Individual Financial Obligations.

Each country will bear the costs of its own participation in the Task, including reporting and necessary travel costs

(c) Task-Sharing Requirements.

The Participants agree on the following funding commitment: Each Participant (country) will contribute to this Task **a minimum of 0.4 person year per year of the Task**, i.e. a total of at least 1.2 person year over the period;

Participation in the Task requires participation in at least one of the Subtasks A, B, C, D.

The Operating Agent will contribute with **a minimum of 0.3 person year per year to the Task.**

Participation may partly involve funding already allocated to a national (or international) activity, which 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 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.

6. Management

(a) The Danish Energy Agency, acting through Jan Erik Nielsen, PlanEnergi is the Operating Agent.

(b) In addition to the obligations enumerated in Articles 4 and 7 of this Agreement, the Operating Agent shall:

(1) Prepare and distribute the results described above;

(2) Prepare joint assessments of research development and demonstration priorities for system using solar heat and heat pumps;

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

(4) Prepare the detailed Programme of Work for the Task in consultation with the Subtask Leaders and the Participants and submit the Programme of Work for approval to the Executive Committee;

(5) Provide, at least semi-annually, periodic reports to the Executive Committee on the progress and the results of the work performed under the Programme of Work;

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

(7) 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;

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

(9) Perform such additional services and actions as may be decided by the Executive Committee, acting by unanimity.

(c) Experts Meetings.

Experts meetings of the Task will be carried out 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. The cost of organising meetings will be borne by the host country.

7. Admissions, Participation and Withdrawal of Participants

(a) Publications.

In addition to the specific obligations, the Operating Agent will produce, promote and distribute the results of the Task. The Participants will support these activities by contributing respective papers and by dissemination activities financed by the individual Participants.

8. Information and Intellectual Property

(a) Executive Committee's Powers

The publication, distribution, handling, protection and ownership of information and intellectual property arising from this Task shall be determined by the Executive Committee, acting by unanimity, in conformity with the Agreement.

(b) Right to Publish

Subject only to copyright restrictions, the Participants shall have the right to publish all information provided to or arising from this Task, except proprietary information.

(c) Proprietary Information

The Participants and the Operating Agent shall take all necessary measures in accordance with this paragraph, the laws of their respective countries and international law to protect proprietary information provided to or arising from this Task. For the purposes of this Task, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example computer programs, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

Is not generally known or publicly available from other sources.

Has not previously been made available by the owner to others without obligation concerning its confidentiality.

Is not already in the possession of the recipient Participant without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information and of the Operating Agent for appraising proprietary information, to identify the information as such and to ensure that it is appropriately marked.

Arising Information

All information developed in connection with and during activities carried out under this Task (arising information) shall be provided to each Participant by the Operating Agent, subject only to the need to retain information concerning patentable inventions in confidence until appropriate action can be taken to protect such inventions.

For arising information regarding inventions the following rules shall apply:

(1) 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.

(2) 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 that disclose inventions that have not been appropriately protected by filing a patent application.

(3) The inventing Participant shall license proprietary information arising from the Task for non-exclusive use to participants in the Task:

(a) On the most favourable terms and conditions for use by the Participants in their own country.

(b) On favourable terms and conditions for the purpose of sub-licensing others for use in their own country.

(c) Subject to sub-paragraph (1) above, to each Participant in the Task for use in all countries, on reasonable terms and conditions.

(d) 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.

(d) Production of Relevant Information by Governments

The Operating Agent should encourage the governments of all Agency Participating Countries to make available or to identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task.

(e) Production of Available Information by Participants

Each Participant agrees to provide to a Subtask Leader or to the Operating Agent all previously existing information, and information developed independently of the Task, which is needed by a Subtask Leader or by the Operating Agent to carry out its functions under this Task and which is freely at the disposal of the Participant and the transmission of which is not subject to any contractual and/or legal limitations:

If no substantial cost is incurred by the Participant in making such information available, at no charge to the Task.

If substantial costs must be incurred by the Participant to make such information available, at such charges to the Task as shall be agreed between the Operating Agent and the Participant with the approval of the Executive Committee.

(f) Use of Confidential Information

If a Participant has access to confidential information which would be useful to a Subtask Leader or to the Operating Agent in conducting studies, assessments, analyses, or evaluations, such information may be communicated to a Subtask Leader or to the Operating Agent but shall not become part of the reports, handbooks, or other documentation, nor be communicated to the other Participants, except as may be agreed, between the Subtask Leader or the Operating Agent and the Participant.

(g) Reports on Work Performed under the Task

The Operating Agent shall, in accordance with section 6 above, provide reports of all work performed under the Task and the results thereof, including studies, assessments, analyses, evaluations and other documentation, but excluding proprietary information.

(h) Copyright

The Operating Agent may take appropriate measures to protect copyrightable material generated under this Task. Copyrights obtained shall be the property of the IEA for the benefit of the Participants provided, however, that the Participants may reproduce and distribute such material, but if it shall be published with a view to profit, permission should be obtained from the Executive Committee.

(i) Authors

Each Participant will, without prejudice to any rights of authors under its national laws, take necessary steps to provide the co-operation from its authors required to carry out the provisions of this paragraph. Each Participant will assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

9. Entry in Force, Term and Extension

This Annex shall enter into force 1 January 2011 and shall remain in force for a period of three years until 31 December 2013. 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 Implementing Agreement.