SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 41

Solar Energy and Architecture

Annex Plan

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TASK 41

Solar Energy and Architecture

1. Preamble

Solar energy can be utilized in buildings in several ways. Often we differentiate between two main ways to utilize solar energy. Either by letting the solar radiation transmit through windows to passively contribute to space heating and offer daylight that can reduce the electricity need for lighting. Or by using active solar systems on the building envelope to produce solar heat and electricity that can be used to reduce the building's need for non-renewable energy supply.

Passive solar utilisation is more or less always part of a building's energy balance. Passive solar gains can result in a reduced heating demand and a reduced lighting demand but also in excessive indoor temperatures and in increased cooling demand. Windows are used in most buildings and often well integrated in the building envelope. Shading devices are in many regions also frequently used even if there are regional differences both regarding the need and the tradition of using them.

Active solar systems are sometimes integrated in new buildings as well as put on existing buildings to produce hot water or electricity. The possibilities are many; solar thermal systems that contribute to domestic hot water heating and space heating and photovoltaics that produce electricity used either directly in the building or, when allowed, distributed into the common electricity grid. Also solar hybrid systems which produce both heat and electricity are available. While the technical development and energy performance improvements are always in progress, the actual use of these systems in buildings is not increasing as it could and should do.

Existing buildings account for over 40% of the world's total primary energy use and 24% of greenhouse gas emissions[1]. A combination of making buildings more energy-efficient and using a larger fraction of renewable energy is therefore a key issue to reduce the non-renewable energy use and greenhouse gas emissions. A large portion of the potential for energy efficiency in existing buildings and potential to utilize solar energy still remains unused.

It is clear that solar energy use can be an important part of the building design and the building's energy balance to a much higher extent than it is today. Cleverly used, active and passive solar energy can both contribute to the energy

[1] IEA *Promoting Energy Efficiency Investments – case studies in the residential sector.* ISBN 978-92-64-04214-8. Paris. 2008.

supply and to a higher quality of the architecture. Badly used, *passive* solar energy can increase the cooling and heating demands as well as cause discomfort. Wrongly used, *active* solar energy can make the buildings less robust and uglier and can lead to a higher cost without even supplying much energy.

Why are solar energy systems not more frequently used in buildings?
Despite all the available solar technologies and the opportunity to reduce the energy demand, solar energy systems are in most cases not used in buildings today. This has several causes:

1. Economical factors such as investment costs and maintenance costs.

2. Technical knowledge factors such as lack of knowledge among decision makers and architects, as well as a general reluctance to "new" technologies.

3. Architectural (aesthetic) factors: solar technologies for building use have an important impact on the building's architecture. Due to the large size of solar systems in relation to the scale of the building envelope, the architectural quality of their integration has a major impact on the final architectural quality of the building. In this respect the limit to the spread of solar technologies lies in the generally poor architectural quality of their integration into the building envelope.

Subsequently, the architectural factor has three main components:

3 a) Active technologies, solar thermal in particular, are characterized by a general lack of products conceived for building integration, caused by a lack of architectural knowledge of manufacturers.
3 b) The architects' knowledge in the possibilities offered by available technologies and available innovative products is generally insufficient.
3 c) A lack of simple tools that can quantify and illustrate (also architecturally) the influence of various solar applications, at an early design stage when there is still time for changes.

The present Task will focus on this third group of factors and sub factors, and is intended to support promoting the use of solar technologies as a complement to promotion policies focusing on subsidies and technical information spread.

The vision – and the opportunity – is to make architectural design a driving force for the use of solar energy.

Architectural quality
Looking at the many solar plants installed in the last generation two facts are clear: good architectural integrations do exist; they are extremely rare. Moreover, it is also a fact that public acceptance of solar energy to a high

degree depends on the quality of the architectural integration. Hence the justification for a common effort to improve the quality of architectural integration of solar technologies and the dissemination of related results.

Although subjective elements cannot be excluded in preferences on architecture styles and solutions, judgements on the quality of the architecture can certainly converge among skilled professionals and thereby constitute a valuable consensus for the future common work. It is therefore one of the main goals of this Task to deal in depth with the theme of solar architectural quality, in an international and co-operating way.

As recent works have shown, criteria can be defined and guidelines proposed for all the actors in the field; architects, collector and façade/roof manufacturers, clients and public bodies (municipalities, city planners). Through various interactions with all these actors, the results of this task should largely contribute to increase the architectural quality of the products and of the integrations.

Solar energy AND architecture
The title of this Task indicates that focus is on both high architectural quality and high energy performance. Thus, it would be counterproductive to show the use of solar applications in buildings where the energy performance is poor or even worse than without solar applications.

This title also indicates a new way of approaching the use of active solar energy in buildings that sees architects composing their architecture with solar components conceived as building elements.

2. Objectives and Scope

The main goals of the Task are to help achieving high quality architecture for buildings integrating solar energy systems, as well as improving the qualifications of the architects, their communications and interactions with engineers, manufactures and clients. Increased user acceptance of solar designs and technologies will accelerate the market penetration. The overall benefit will be an increased use of solar energy in buildings, thus reducing the non-renewable energy demand and greenhouse gas emissions.

To achieve these goals, work is needed in three main topics:

A. Architectural quality criteria; guidelines for architects by technology and application for new products development.
B. Tool development for early stage evaluations and balancing of various solar technologies integration.
C. Integration concepts and examples, and derived guidelines for architects.

The first objective is to define general architectural quality criteria and extract recommendations for solar components/systems, to support manufacturers in developing existing products as well as new products. Specific criteria for the architectural integration of different solar energy components/systems will be developed in cooperation between architects, manufacturers and other actors. New adapted products should result from this activity as well as appropriate ways to use them.

The second objective concerns methods and tools to be used by architects at an early design stage, which need to be developed or improved. An example of such a tool can be how to visualize the solar energy concepts to show e.g. clients. Other examples can be tools needed to quantify and clearly illustrate the solar energy contribution and help balance the use of different active and passive solar technologies on the building envelope.

The last objective is to provide good examples of architectural integration, in the form of both existing projects that can be analysed as well as proposals for new projects. Buildings, installations and products will be included. Case studies will be an important basis to gain experience regarding the level of successful building integration, achieved solar energy contribution and to identify barriers related to e.g. technical and economical aspects and attitudes. New demonstration buildings will be developed in connection with the Task work and followed at least for the first part of the design stage, to learn from and to test guidelines and tools.

Communication tools and guidelines with facts and arguments for architects to help convince their clients to include solar energy systems will be produced. Arguments and facts related to architectural value, energy performance and life cycle costs are essential. Here, the arguments and facts need to be tailored for different building types and owner/user structures. The results will also serve as a basis for teaching material that could be used in e.g. architecture schools.

To communicate the value of solar energy designs and technologies, the Task will carry out seminars, workshops and produce articles in e.g. architectural magazines.

Scope

The scope of the Task includes residential and non-residential buildings. Both new and existing buildings will be included, for the climatic zones represented by the participating countries. In this way the potential impact of the Task can be large. Already cost-effective systems can, with a successful architectural integration, accelerate the market penetration. But also technologies not yet fully cost-effective can benefit from the work to pave the way to successful integration and user/client acceptance, and make the coming market penetration smoother. The work will build upon past IEA Tasks and other research projects related to building integration of solar systems and development of sustainable buildings.

The work will be linked to national activities and will focus on individual buildings or groups of buildings with special focus on the building envelope. The work will be based on workshops with architects, manufacturers and other key actors. The workshops may be carried out nationally or regionally based on a common format developed within the Task. In addition, special workshops and seminars may be held in connection with a Task meeting; to let Task experts and representatives from local practitioners and manufacturers come together and discuss barriers and what can be done. Analysis of existing components, systems and buildings will help to develop innovative design solutions. Good examples will also be used to inspire and as help to convince the client.

3. Means

The Task is organized in three Subtasks, derived from the above described objectives and goals. The integration problems related to the different technologies (product development, method of integration) are treated in subtask A. The balance issues between the different types of solar gains, related to energy and cost impacts, are treated in subtask B. Finally the architectural integration issue is treated as a whole in subtask C, based on case studies.

The objectives shall be achieved by the Participants in the following Subtasks and activities:

1) Subtask A: Criteria for Architectural Integration

   This Subtask focuses on architectural integration of *active* solar energy products and systems since these are the least developed products for building envelope integration.

   The objectives of this Subtask are:

   - Improve the architectural integration quality and flexibility of active solar products and systems (integrability).
   - Bring together architects and product/system developers to understand each others needs. Develop criteria for products and systems, aiming at integrating solar energy systems in high quality architecture. Give recommendations to the industry.
   - Focus on products/systems that offer an important potential of increasing quality regarding architectural integration. Examples of products/systems are: solar thermal systems, PV systems and systems combining functions.
   - Educate/inform architects on integration characteristics for various technologies and on state of the art of innovative products.

The Participants shall achieve this objective by:

- Identifying and differentiating between the technologies already mature or needing new developments.
- Identifying the need for product development.
- Industry workshops with architects and manufacturers presentations, as a basis for discussion. Through the workshops and interviews, identify barriers and define key factors for successful component and system integration.
- Collaborating with architects, engineers and product developers to specify key issues and develop criteria for products and systems.
- Studying and documenting good examples of products and systems.

2) Subtask B: Methods and Tools

This Subtask is focused on methods and tools for architects to use in the early design stage. The use of the building envelope to achieve a good balance of both active and passive solar utilisation will be considered. The work includes tool development and the use of tools to produce material for the Communication Guidelines (Subtask C).

The objectives are:

- Define criteria for methods and tools to support architectural integration in the early design stage.
- Focus on tools that help give an overview and evaluate the energy and cost impacts of various *active and passive* solar options for the building envelope.
- Initiate the development/spread of design tools showing the visual impact of various solar options (elements libraries) and their influence on the energy balance of the building.
- Provide tools for Subtask C to support communication activities.
- Together with Subtask C, produce facts, illustrations and arguments to be included in the Communication Guidelines.

The Participants shall achieve this objective by:

- Studying available methods and tools: Organize workshops with presentations of available tools and from the architect's point of view discuss and document key features, what is already available and what could be improved. Identify if any lack of new types of tools.
- Improving methods and tools, test within the Task and if possible test in ongoing planning of demonstration buildings.

- Providing library elements (link Subtask A) to tool developers.
- Using tools to produce facts, illustrations and arguments for the Communication Guidelines.

3) Subtask C: Concepts, Case Studies and Guidelines

This Subtask is looking at concepts for architectural integration as well as case studies, with a whole building perspective. The Subtask also condenses the results into communication guidelines, with support from Subtask A and B.

The objectives of this Subtask are:

- Develop concepts and principles for high quality architectural integration of solar systems, based on analyzes of existing systems as well as proposals for future systems through national and later on international architectural colloquiums and workshops.
- Develop building concepts that utilize *active and passive* solar energy, achieving high quality architecture, sustainable solutions and high energy performance. The developed concepts should aim at reducing the energy demand in buildings and increasing the fraction of renewable energy use such as solar energy.
- Develop knowledge and strategies to promote and implement high quality architecture using solar energy.

The Participants shall achieve these objectives by:

- Collecting good examples of buildings using solar energy and sort into a set of typologies (link to IEA SHC Task 40).
- Analyzing such example buildings and documenting architectural quality, technologies and energy performance.
- Analyzing the performance of different concepts focusing on the effects of the solar system(s).
- Studying the potential for solar energy to cover the energy needed for buildings.
- Presenting the results in international seminars.
- Participating in the development of demonstration projects.

4. Results

The products of work performed in this Task are targeted to architects, manufacturers of components and systems, clients, building engineers, municipalities etc.

Results of the activities specific for the three Subtasks will consist of:

Subtask A Criteria for Architectural Integration:

(a) Document for product and system developers that describes important architectural design criteria for different categories of solar systems.

(b) Developed or new products/systems initiated by the Task (link to Subtask B; element libraries).

(c) Dissemination of new knowledge to e.g. practicing architects through seminars and workshops.

(d) Documents (articles, brochures) describing good examples of products and system integration in buildings.

Subtask B Methods and Tools:

(a) Improved or new methods and tools for architects for the early design stage. Tools supporting communication activities (link Subtask C).

(b) Provide element libraries that could be used in design tools showing the visual impact of various solar options.

(c) Convincing arguments and facts to be included in the Communication Guidelines (link Subtask C).

Subtask C Concepts, Case Studies and Guidelines:

(a) Typical concepts for building integration of solar energy systems.

(b) A study on the potential for solar energy to cover the energy needed for buildings. This includes different potentials for roof integration and façade integration in an urban context.

(c) Presentation of exemplary buildings including architectural design, systems, technologies, energy performance and costs.

(d) Present concepts, principles, potentials and exemplary buildings (a+b+c) in communication guidelines, in an IEA SHC web page, articles, architecture magazines, and at seminars for architects, engineers, component and system developers, clients, planners etc. The communication guidelines will include convincing arguments and facts with support from Subtask A and B.

(e) Basis for teaching material.

5. Time schedule

This Task shall start on May 1, 2009 and remain in force until April 30, 2012.

Within the limits of the term of the agreement this Annex may be extended by agreement of two or more participants acting in the Executive Committee and shall thereafter apply only to those participants.

6. Specific Obligations and Responsibilities of the Participants

(a) A Participant must undertake and complete all agreed activities and contribute to all or to a specific of the tasks outlined in Section 3 in a timely manner.

(b) Each Participant must actively participate in working meetings and other activities such as workshops.

(c) Attendance at Experts meetings of the Task will be mandatory. Experts meetings of the Task will be carried out at intervals of approximately six months. Experts meetings may be accompanied by national workshops dedicated to target audiences of the Task, mainly from the national industry of the host country of the Experts meeting.

(d) Each Participant shall provide timely, detailed reports on the results of their work carried out to the Subtask Leader and Operating Agent.

(e) Each Participant must contribute to one or more Task deliverables and shall participate in the editing and reviewing of draft reports and other outputs of the Task and Subtasks.

7. Specific Obligations and Responsibilities of the Operating Agent and Subtask Leaders

7.1 Operating Agent

(a) In addition to the obligations enumerated in Articles 4 and 5 of this Implementing Agreement, the Operating Agent shall:

(1) Be responsible for the overall management of the Task, including overall co-ordination and communications with the Executive Committee.

(2) 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.

(3) Provide semi-annually, periodic reports to the Executive Committee on the progress and the results of the work performed under the Programme of Work.

(4) Manage the preparation and distribution of the results described in Article 4 above.

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

(6) Provide to the Executive Committee, within six months after completion of all work under the Task, a final 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 and report with minimum duplication.

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

7.2 Subtask Leaders:

(a) A Subtask Leader shall be a Participant that provides to the Subtask a high level of expertise and undertakes substantial research related to the Subtask.

(b) In addition to the obligations enumerated in Articles 6 of this Annex, the Subtask Leaders shall:

(1) Assist the Operating Agent in preparing the detailed Programme of Work.

(2) Actively participate in the dissemination activities.

(3) Co-ordinate the work performed under that Subtask.

(4) Subtask leaders may arrange, direct and provide summarizes of Subtask meetings and workshops in between or in association with Task meeting.

(5) Provide the Operating Agent with timely written summaries of Subtask work and results.

(6) Edit technical reports resulting from the Subtask and organize their publication.

(7) Collaborate with the Operating Agent and other Subtasks and contribute to the preparation, production and distribution of the

results described in Article 4 above within the framework of the Task dissemination plan.

(c) 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 SHC Executive Committee upon the recommendation of the Operating Agent.

8. *Funding*

(a) Each participant will bear the *costs* of their participation in the Task, including travel costs. Task meetings will be held twice annually and hosted in turn by Participants. The cost of organising meetings will be borne by the host country.

(b) Participation in the Task requires active participation in at least one of the Subtasks A, B or C.

(c) Level of effort

The Participants agree on the following commitment:

(1) Each Participant (country) will contribute to this Task a minimum of 4 person months per year for the duration of the Task.

(2) Subtask Leaders will contribute a minimum of 4 person months per year for the duration of the Subtask.

(3) The Operating Agent will contribute a minimum of 6 person months per year to the Task.

(d) 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 Task. 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.

(e) The level of effort to be contributed by each country will be specified in a "Letter of National Participation" which is signed by the Operating Agent and the Executive Committee representative within 3 months from the start date of the Task.

9. Operating Agent

(a) Lund University (Sweden), acting through Maria Wall, is designated as Operating Agent.

10. 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:

(1) Is not generally known or publicly available from other sources.
(2) Has not previously been made available by the owner to others without obligation concerning its confidentiality.
(3) 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.

(d) 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 which 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.

(e) 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.

(f) 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:

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

(2) 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.

(g) 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.

(h) Reports on Work Performed under the Task

The Operating Agent shall, in accordance with paragraph 7 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.

(i) 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.

(j) 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.

11. Participants in this Task

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

Architecture et Climat, Université catholique de Louvain, for the Walloon Region of Belgium.
The Danish Energy Agency, Denmark
Royal Norwegian Ministry of Industry and Energy, Norway
Swedish Energy Agency, Sweden
The Office Fédéral de l'Economie Energétique, Switzerland

Others will join later on. Further information on participants will be provided in the Workplan.