Description of Case Stories

A Technical Report of IEA Solar Heating and Cooling

Task 23 – Subtask A

Case Stories

July 1999 / January 2001

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

Austria – Canada – Denmark – Finland – Germany – Japan – Korea – Netherlands
Norway – Spain – Sweden – Switzerland – United States

Description of Case Stories

Technical Report

IEA SHC Task 23: "Optimization of Solar Energy Use in Large Buildings"

Subtask A: "Case Stories"

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Abstract

In the framework of the IEA SHC Programme, a task regarding optimization of energy use was initiated: "Task 23, Optimization of Solar Energy Use in Large Buildings".

The Operating Agent of the Task is Professor Anne Grete Hestnes, Norway.

In a part of the Task, "Subtask A, Case Stories", different low energy solar buildings were investigated and documented.

The objective of Subtask A was to provide the knowledge needed in the development of the guidelines, methods and tools to be developed in the other subtasks in the task. This was done by evaluating and documenting a set of buildings designed using the "whole building approach". Both the particular processes used in the design of the buildings and the resulting building performance were evaluated.

This report documents the results of these studies. Twenty-one different solar buildings, comprising both offices, schools and conference and research centres, are presented. The buildings use a number of low energy and solar techniques, including daylighting, passive and active solar systems and photovoltaics.

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The Solar Heating & Cooling Implementing Agreement

Background

The International Energy Agency (IEA) was founded in November 1974 as an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD) to carry out a comprehensive program of energy cooperation among its 24 member countries. The European Commission also participates in the work of the IEA.

The IEA's policy goals of energy security, diversity within the energy sector, and environmental sustainability are addressed in part through a program of international collaboration in the research, development and demonstration of new energy technologies, under the framework of over 40 Implementing Agreements.

The Solar Heating and Cooling Implementing Agreement was one of the first collaborative R&D programs to be established within the IEA, and, since 1977, its participants have been conducting a variety of joint projects in active solar, passive solar and photovoltaic technologies, primarily for building applications. The overall Programme is monitored by an Executive Committee consisting of one representative from each of the 19 member countries and the European Commission.

The members are:

Australia	Japan
Austria	Mexico
Belgium	Netherlands
Canada	New Zealand
Denmark	Norway
European Commission	Spain
Germany	Sweden
Finland	Switzerland
France	United Kingdom
Italy	United States

Currents Tasks

A total of twenty-six Tasks (projects) have been undertaken since the beginning of the Solar Heating and Cooling Programme. The leadership and management of the individual Tasks are the responsibility of Operating Agents. The Tasks, which are presently active and their respective Operating Agents, are:

Task 19: Solar Air Systems – Switzerland
Task 20: Solar Energy in Building Renovation – Sweden
Task 21: Daylight in Buildings – Denmark
Task 22: Building Energy Analysis Tools – United States
Task 23: Optimization of Solar Energy Use in Large Buildings – Norway
Task 24: Solar Procurement – Sweden
Task 25: Solar Assisted Air-conditioning of Buildings – Germany
Task 26: Solar Combisystems – Austria

Description of Task 23

To significantly reduce the total energy use in large buildings, it is necessary to use several technologies, such as energy conservation, daylighting, passive solar, active solar, and photovoltaics, in combination. The designers of these buildings therefore need to find the optimum combinations of technologies for each specific case. This requires an integrated design approach, where the different low energy and solar technologies to be used are considered integral parts of the whole building.

The objective of Task 23 is to enable the designers to realise such integrated design processes and to carry out the necessary optimisation exercises, thereby ensuring the most appropriate use of solar energy in each building project. This will be done by providing the designers with a set of design tools. At the same time, the Task will ensure that the buildings designed using these tools promote sustainable development. This will be done by including criteria such as general resource use and local and global environmental impact in the analyses facilitated.

The work in the Task focuses primarily on commercial and institutional buildings, as these types of buildings all need more than one type of system. In particular, office buildings and educational buildings are addressed. The same issues are relevant for many other commercial and institutional buildings. However, some of these, such as for instance hospitals, require rather specialised design teams and would broaden the scope of the Task tremendously. They are therefore excluded from the Task in order to ensure concentration and focus in the work carried out.

The primary results of the work will be guidelines, methods, and tools for use by building designers in the early stages of design. The Task also includes demonstration buildings, as such buildings provide both an opportunity to test the design tools developed, and as they provide an effective way of demonstrating the integration of solar technologies in real buildings.

The Task began on June 1, 1997 and will continue for five years, until June 1, 2002. Twelve countries are participating: Austria, Canada, Denmark, Finland, Germany, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the USA.

In order to accomplish the objectives described above, the Participants are undertaking work in four subtask areas:

A: Case stories	Subtask Lead country: Denmark
B: Design process guidelines	Subtask Lead country: Switzerland
C: Methods and tools for trade-off analysis	Subtask Lead country: USA
D: Dissemination and demonstration	Subtask Lead country: Netherlands

Executive Summary

Objective

The main objective of Subtask A is to provide the knowledge needed in the development of guidelines, methods and tools, which will be developed in Subtasks B and C. This is done by evaluating and documenting a set of buildings designed using the “whole building approach”. This report presents the results of this activity by evaluating the particular processes used in the design of the buildings and the resulting building performance.

Selection of the buildings

The key selection criterions for the buildings were that the buildings are fairly typical, that they are reasonable in terms of cost, that there are both public and private buildings and both new and renovated cases, and different types of design and construction contracts represented.

The figure below shows the different technologies and other features which are used in the Case Stories. All buildings except 2 are new buildings. The two retrofit buildings are Bludenz, Austria and Danfoss, Denmark.

Case Story / **Technologies**	Münchendorf, AUS	Bludenz, AUS	Crestwood 8, CAN	Green on the Grand, CAN	Danfoss, DK	Brundtland Centre, DK	Arktikum, FIN	Maisema 2000, FIN	Gniebel, GER	WAT, GER	Tokio Gas, Japan	Yamanashi, Japan	Inzai Welfare, Japan	KIER, Korea	Bellevue, NL	Seterbråten, N	Maritime Centre, N	La Junta, E	OFS, CH	Landis & Gyr, CH	Durant, USA	Development Centre, GER	SurTec, GER	RWS, NL	Social Housing, E
Passive solar	X	X	X	X		X	X		X	X		X		X	X		X	X	X	X	X	X	X	X	X
Active solar	X					X				X		X		X	X			X	X					X	X
Daylight	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	
Photovoltaic						X				X		X		X										X	
Rainwater	X			X		X				X	X		X						X				X		
Sorting of waste	X	X	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X	X	X		
Materials	X	X	X	X		X	X	X		X	X	X			X	X	X	X	X	X	X		X	X	X
Heat pumps												X			X		X								
BMS / BUS		X	X	X	X	X	X				X	X	X		X	X	X		X	X				X	X
Glazed spaces	X	X				X			X				X	X	X		X		X	X		X	X	X	X
Efficient lighting	X	X		X	X	X				X					X	X	X	X		X		X	X	X	
Others	X			X			X		X		X	X	X			X			X			X	X		

Results

The design processes used in the design of the Case Story buildings have been documented. This includes documentation of the make-up of the design team, how the members of the design teams interacted, what problems they encountered, what information they needed and what design tools they used. These results are used as a basis for the development of appropriate design process guidelines in Subtask B.

Furthermore, the energy use patterns in the Case Story buildings have been documented. This establishes the different requirements in different climates and gives an indication of which technologies need to be considered in the development of tools for trade-off analysis in Subtask C.

Lessons learned

Lessons learned through the evaluation the different design processes:

- Co-operation between architects and engineers has to be very close from the beginning of the process in order to achieve good results.
- To attain good results it is necessary that the design team experiences a common responsibility and respects each other's expertise.
- It is necessary to be aware of differing interests of groups involved. Interests of client and users might not correspond. Therefore design guidelines have to consider different “settings”.
- It is crucial that the building techniques can be operated easily: the user has to be able to handle the technologies applied.
- New technologies can delay the design process because of problems concerning permission and warranties. It is therefore important to identify these innovative techniques and take them into account in the planning process.
- Commercial contractors and building owners tend to avoid risk and prefer to minimise financial risk by relying on methods and materials that are proven to be trouble-free. There is also a belief, that new products or methods are not cost-effective. This is due to the large financial commitment involved in commercial construction; design and construction problems are expensive to remedy.
- Validation of the concept by dynamic simulation is necessary for forecasting temperature processes, energy consumption for heating, ventilation, cooling, electricity and comfort level (thermal and visual).