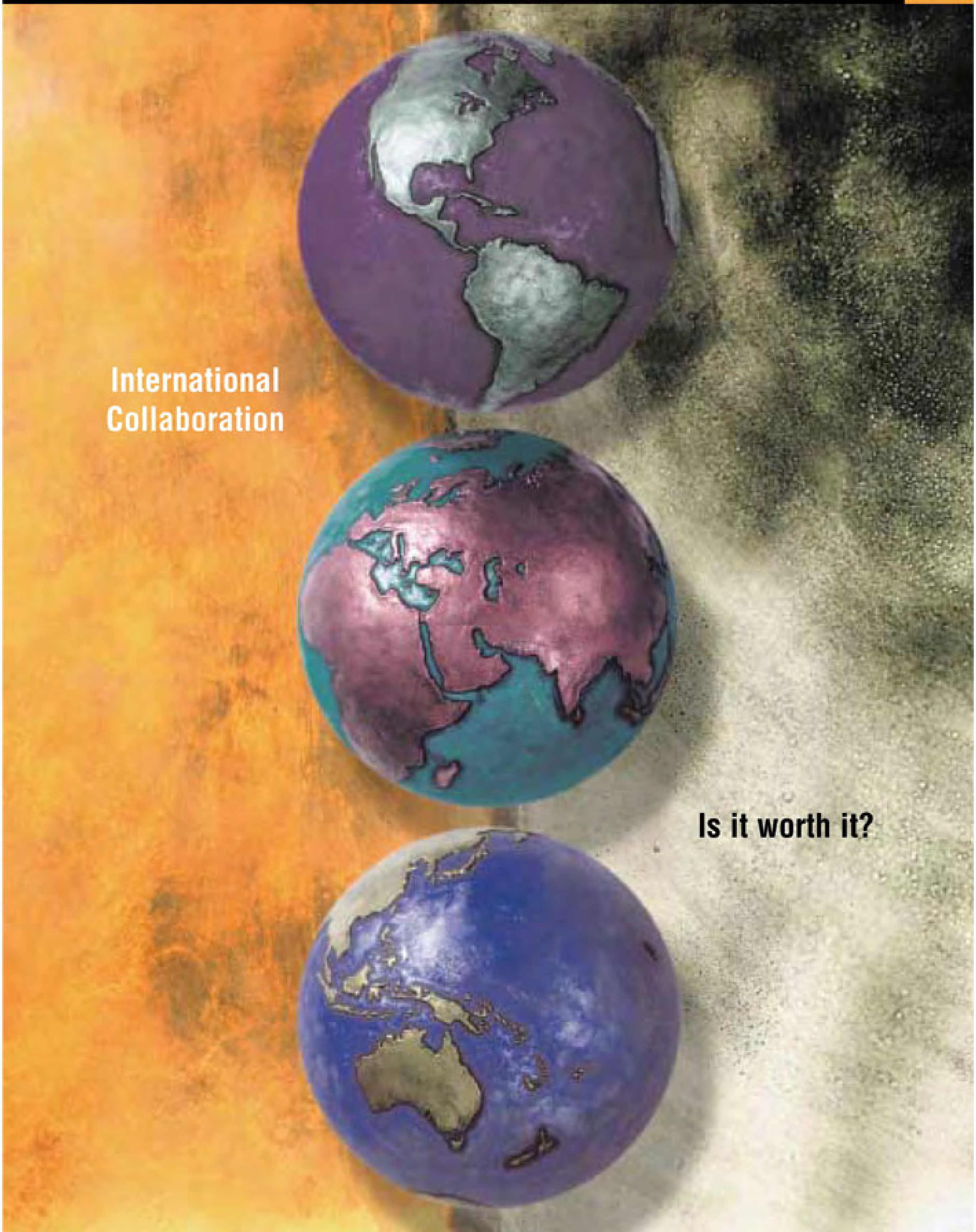
IEA SOLAR HEATING & COOLING PROGRAMME



2003 ANNUAL REPORT

IEA SOLAR HEATING & COOLING PROGRAMME 2003 ANNUAL REPORT

IEA Solar Heating & Cooling Programme

2003 Annual Report

Edited by
Pamela Murphy
Executive Secretary
IEA Solar Heating and Cooling Programme

Morse Associates, Inc.
1808 Corcoran Street, N.W.
Washington, DC 20009
USA

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The Solar Heating & Cooling Implementing Agreement

BACKGROUND

The International Energy Agency, based in Paris, was established as an intergovernmental organization in November, 1974 under the Agreement on an International Energy Program (IEP) after the oil shock of 1973/1974. The 26 Member countries of the IEA are committed to taking joint measures to meet oil supply emergencies. They also have agreed to share energy information, to co-ordinate their energy policies and to co-operate in the development of rational energy programmes.

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 20 member countries and the European Commission.

SHC Member Countries

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

CURRENT TASKS

A total of thirty-four 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 were active in 2003 and their respective Operating Agents are:

Task 22
Building Energy Analysis Tools
United States

Task 24
Solar Procurement
Sweden

Task 25
Solar Assisted Air Conditioning of Buildings
Germany

Task 26
Solar Combisystems
Austria

Task 27
Performance of Solar Facade Components
Germany

Task 28
Sustainable Solar Housing
Switzerland

Task 29
Solar Crop Drying
Canada

Task 31
Daylighting Buildings in the 21st Century
Australia

Task 32
Advanced Storage Concepts for Solar Buildings
Switzerland

Task 33
Solar Heat for Industrial Processes
Austria

Task 34/ECBCS Annex 43
Testing and Validation of Building Energy Simulation Tools
United States

Chairman's Report: Highlights of 2003

Mr. Michael Rantil
Executive Committee Chairman
Formas, Sweden

OVERVIEW

Another year has passed, and the Solar Heating and Cooling (SHC) Programme continued its work on accelerating the solar market through funding R&D of solar technologies and market-oriented projects. As a means to recognize the achievements being made in the field of solar energy at the international level, the SHC Programme awarded its first SHC SOLAR AWARD at a special ceremony at the ISES World Congress in Sweden. In addition, the Executive Committee of the SHC Programme hosted an industry brainstorming meeting to discuss what actions the SHC Programme could or should undertake to support industry in expanding the markets for solar heating, cooling, daylighting and solar buildings. Industry representatives from the European Solar Thermal Industry Federation (ESTIF) and the German Solar Association (BSI) participated in this discussion. The Committee also once again collected data on the solar thermal collector market in IEA countries, and initiated work in two new areas—PV/Thermal Systems and Solar Resource Management Based on Satellite Data.

In 2003, the SHC Programme worked to expand the solar market and to address design and technology issues facing solar energy. As a result of an SHC/industry brainstorming session, the Committee compiled and ranked a list of possible new areas of work, and agreed to hold another industry/trade association workshop in 2004. To support its market work, the Executive Committee published a report on the results of the collected data on the use of solar collectors in the Member countries. The report, Solar Thermal Collector Market in IEA Member Countries, is available on the SHC web site, iea-shc.org and an updated version of this report will be prepared in early 2004.

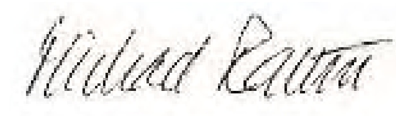
As for Task work, The Executive Committee approved one new Task and the Task Definition Phase for two other Tasks. The newly approved project is SHC Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools, which is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Programme.

The new work to begin in 2004 is PV/Thermal Systems, which is proposed to be a collaborative Task with the IEA Photovoltaic Power Systems Programme, and Solar Resource Management Based on Satellite Data, which is proposed to be a collaborative Task with the IEA Photovoltaic Power Systems Programme and the IEA SolarPACES Programme. The Executive Committee also approved the completion of three projects—SHC Task 22: Solar Building Energy Analysis Tools, SHC Task 24: Solar Procurement, and SHC Task 26: Solar Combisystems. It is with sadness that the Committee says farewell to Mr. Michael Holtz and Dr. Hans Westling, two of the three Operating Agents, as Mr. Werner Weiss of SHC Task 26 is the Operating Agent for the new SHC Task 33: Solar Heat for

Industrial Processes. In particular, the Committee would like to give Mr. Michael Holtz, the Operating Agent of SHC Task 22, a special goodbye. Mr. Holtz has been involved in Task work since the start of the SHC Programme over 25 years ago beginning with SHC Task 8: Passive and Hybrid Solar Low Energy Buildings and then SHC Task 12: Building Energy Analysis and Design Tools for Solar Applications

Participation in the Programme remains strong with 20 Member countries and the European Union actively participating in its work. This year, an observer from South Africa attended the June Executive Committee. In addition to South Africa, the Executive Committee has been in communication with the following countries that have been invited to join the Programme: Brazil, China, Czech Republic, Egypt, Greece, South Korea and Turkey.

With the approval of another 5-year extension of the SHC Programme by the CERT, the Committee has begun to prepare a new Strategic Plan. The process began in 2003 and will continue in 2004 with a final Plan completed by the end of the year. This process is providing the Committee the opportunity to assess the Programme's work and its impact on the national solar programs of the Member countries. It is my belief that this assessment will show that collaborative work is cost efficient and that we will find sound strategies that are appropriate for the new challenges we are facing.



Michael Rantil

Highlights of 2003

Notable achievements of the Programme's work during 2003 are presented below. The details of these and many other accomplishments are covered in the individual Task summaries later in this report.

Task 22: Building Energy Analysis Tools

This Task was completed in 2003, and SHC Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools, will continue work in this area. Experts this year focused on completing Task reports, which can be downloaded from the SHC Task 22 page on the SHC web site, iea-shc.org. Overall, the real benefit of the Task's accomplishments is the creation of a workable (enforceable) performance-based building energy efficiency code compliance method, which promotes/encourages the use of renewable energy technology to achieve the required minimum energy performance level. When innovative solar and energy efficiency technologies are not blocked from the marketplace, due to restrictive prescriptive energy codes and standards, these sustainable, renewable energy technologies will hopefully flourish in the marketplace.

Task 24: Solar Procurement

This Task was completed in 2003. Work this focused on finalizing projects. The main aim of this Task was to increase the use of solar water heating systems by encouraging coordinated large-scale purchasing. By focusing primarily on small domestic active solar water heating systems, but also larger commercial systems the experts reached their objectives—to reduce marketing, and distribution and hardware costs, and to improve system performance—and substantial cost and price reductions of 7-30% were reached.

Task 25: Solar Assisted Air Conditioning of Buildings

Twelve solar assisted cooling demonstration projects are in operation. And, detailed measurement data are available and were analyzed from about 8 systems. Based on the data, insights about overall energy balances as well as technical problems and shortcomings of systems were achieved and – in some cases – could be solved.

Task 26: Solar Combisystems

This Task was completed in 2003. The further development and optimisation of systems and their designs by Task 26 participants has resulted in innovative systems with better performance-cost ratings. And combined with the investigation of architectural integration of the collector arrays as well as the durability and reliability of solar combisystems, end users can have greater confidence in this technology's application.

Task 27: Performance of Solar Facade Components

Two methodologies were applied. The first was developed for environmental impact assessment and then successfully applied to "solar collectors" in one case study and to a "wooden frame window with a double glazed sealed unit" in a second case study. The second methodology for Failure Mode and Effect Analysis was used in three case studies: Double Glazing Unit/Insulated Glazing a Double Glazed Sealed Unit, Argon filled Low-e Coated Glazing, and Solar Collector. This is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Implementing Agreement.

Task 28/ECBCS Annex 38: Sustainable Solar Housing

Marketing success stories for sustainable housing projects, programs or products were documented and analyzed by a professional marketing consultant firm. The objective was to identify common threads suggesting effective marketing strategies within the framework of classical market approaches. This Subtask received substantial reinforcement from the Norwegian State Housing Bank, which is funding a publication on these results. This is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Implementing Agreement.

Task 29: Solar Crop Drying

The Coir Pith solar drying system in India continues to operate well and the operators appear to be satisfied. While waiting for the monitoring system to be installed, unconfirmed feedback suggests that the solar system supplied 60% of the heating during the dry season and 40% during the monsoon season. (Coir Pith is a powder found on the shells of coconuts, which after processing, is widely used as a fertilizer).

Task 31: Daylighting Buildings in the 21st Century

A report on a user behavior model called Lightswitch is being drafted. Lightswitch is a stochastic model that predicts how office occupants interact with manually and automatically controlled lighting and blind systems. The Lightswitch algorithm has been implemented into an online daylighting analysis tool that can be accessed via www.buildwiz.com. This tool has had 1000 users in the last six months and is being used as a teaching tool. The intention is to integrate this model into daylight analysis software packages developed in this Task.

Task 32: Advanced Storage Concepts for Solar Buildings

Task activities began in July 2003. One of the first activities that got underway was work on a state-of-the-art report on the heat/cold storage solutions for solar houses.

Task 33: Solar Heat for Industrial Processes

Task activities began in November 2003 with the main activity being the first experts meeting in Gleisdorf, Austria in December. A total of 22 participants from 7 countries attended the meeting. This is a collaborative Task with the IEA SolarPACES Implementing Agreement.

Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools

The Task began in September 2003, and the year's activities consisted primarily of recruiting participants, defining projects, and developing project plans. Based on the two Task Definition Workshops that were conducted, a Work Plan and Information Plan were finalized. This is a collaborative Task with the IEA Energy Conservation in Buildings and Community Systems Implementing Agreement.

NEW ACTIVITIES

PV/Thermal Systems

The objectives of this Task is to catalyse the development and market introduction of high quality and commercial competitive PV/Thermal Solar Systems and to increase general understanding and contribute to internationally accepted standards on performance, testing, monitoring and commercial characteristics of PV/Thermal Solar Systems in the building sector. The Task is a collaborative effort with the IEA Photovoltaic Power Systems Programme.

Solar Resource Management Based on Satellite Data

The objective of this Task is to exploit the emerging potential of satellite-based solar resource information techniques in response to the solar industry's expressed need for improved spatial and temporal coverage, worldwide standardization, better reliability and access and development of customized products. The first Task Definition Workshop will be held in February 2004 in Spain. It is to be is a collaborative effort with the IEA Photovoltaic Power Systems Agreement and the IEA SolarPACES Agreement.

MANAGEMENT ACTIONS

SHC Solar Award

The Programme will present an award at the ISES World Congress in Sweden in June 2003 to a person, organization or company that has presented outstanding leadership or achievements, with links to the IEA Solar Heating and Cooling Programme, in the field of solar energy at the international level within one or more of the following sectors: technical developments, successful market activities, or information.

Programme and Policy Actions

- The CERT approved a 5-year extension of the Implementing Agreement.
- The Committee approved the final management report of Task 22, Task 24 and Task 26.
- The Committee approved a new policy on Sponsor membership in the Implementing Agreement based on the guidance from the IEA.
- The Committee produced a new Programme slide show to celebrate its 25th anniversary.
- The Committee sent the SHC exhibit to the IEA Technology Fair in Paris, the ISES World Congress in Sweden and the CISBAT Conference in Switzerland.
- The Programme hosted a joint reception with the IEA PVPS Programme at the ISES World Congress in June 2003.
- Communication continued with the following countries that have already been invited to join the Implementing Agreement – Brazil, China, Cyprus, Egypt, Greece, Republic of South Korea, South Africa, and Turkey.

Executive Committee Meetings

2003 Meetings

The 53rd Executive Committee meeting was held in June 2002 in Potsdam, Germany. A full-day joint meeting was held with the Energy Conservation in Buildings and Community Systems prior to this meeting. The 54th Executive Committee meeting was held in November 2002 in Wellington, New Zealand.

2004 Meetings

The 2004 Executive Committee meetings will be held 3-5 May in Helsinki, Finland (with a joint meeting with the IEA Photovoltaic Power Systems Programme on the 3rd) and 15-17 November in Canada or Puerto Rica.

Internet Site

The Solar Heating and Cooling Programme's website continues to be updated and new pages added as needed. The site plays an increasingly important role in the dissemination of Programme and Task information. At this time, final documentation and reports have been added for SHC Task 22; Solar Building Energy Analysis Tools, SHC Task 24: Solar Procurement, and SHC Task 26: Solar Combisystems. The Executive Committee continues to encourage the posting of as many Programme and Task reports as possible to the web site. In 2004, the Webmaster will work to add PDF files of the highly requested reports from completed Tasks to the web site. The address for the site is www.iea-shc.org.

Future Workshops

The Programme will organize an Industry Forum in conjunction with the GleisdorfSOLAR conference on 9-11 September 2004 in Gleisdorf, Austria.

COORDINATION WITH OTHER IEA IMPLEMENTING AGREEMENTS AND NON-IEA ORGANIZATIONS

The IEA Energy Conservation in Buildings and Community Systems Programme is collaborating in three SHC Programme Tasks—SHC Task

27: Performance of Solar Facade Components, SHC Task 28/ECBCS Annex 38: Sustainable Solar Housing, and SHC Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools. A joint meeting was held June 2003 in Germany to facilitate the continued collaborative work between the Programmes.

The IEA Buildings Related Implementing Agreements (BRIA) is composed of the seven building-related IEA Implementing Agreements. The SHC Chairman continues to support the work of this group.

The IEA Photovoltaic Power Systems Programme is working with the SHC Programme in the development of two new Tasks on PV/Thermal Systems and Solar Resource Management Based on Satellite Data. A joint meeting will be held in May 2004 in Finland to facilitate the continued collaborative work between the Programmes.

The IEA Energy Storage Programme and SHC Programme continue to share information on relevant current Tasks, particularly on SHC Task 32: Advanced Storage Concepts for Solar Thermal Systems in Low Energy Buildings.

FEATURE ARTICLE

Every year the SHC Annual Report has included a feature article on some aspect of solar technologies for buildings. This year's article is somewhat different in that it does not focus on a particular technology, but is rather more introspective. The article answers the question, through specific illustrations, "Why International Collaboration for Solar Energy Work?"

ACKNOWLEDGMENTS

In closing, I would like to thank the Operating Agents, Working Group Leader, participating experts, Executive Committee Members and our Advisor, Fred Morse, for their work. I would especially like to thank our Executive Secretary, Pamela Murphy, for her help over the past year in preparation and reporting of the meetings and numerous Programme activities as well as helping to run this active IEA Programme.

International Collaboration – Is it worth it?

Pamela Murphy
Morse Associates Inc.
United States

SOLAR R&D

Facing leaner government budgets and approaching national Kyoto commitments, many countries are re-evaluating and re-prioritizing their international work. During this process, countries must determine if the benefits of international collaboration out weigh the costs, and if the results of the work meet national priorities.

The IEA's Solar Heating and Cooling Programme (SHC), an international programme comprised of 20 Member countries and the European Union, has held strong during the ebb and flow of national funding for the past 25 years. Governments have continued to support the SHC Programme because they have seen their investments in this international partnership payoff, and the international teams of experts consistently produce valuable results and products—beyond what one country could ever do on its own.

Solar technology is now at the stage where it must gain the confidence of the market and achieve economic competitiveness with other energy technologies. For this to occur, work is still needed in areas, such as:

- Improving current technologies,
- Making products more cost competitive,
- Continuing R&D on materials and processes that can improve building performance (e.g., electrochromic and thermochromic materials for controllable windows, phase change materials, energy storage materials, transparent insulation, etc.),
- Finding ways to better integrate and optimize solar components in energy efficient buildings, and
- Testing and certifying components and products.

Even with the most generous government incentives and funding, solar technologies will not be successful in the marketplace if consumers and investors do not believe that the technology works, and that it is safe and reliable. Therefore, international partnerships are increasing the role that industry plays to create a balance between government and industry support for solar.

The areas of work funded in 2003 by the IEA Solar Heating and Cooling Programme.

Task 22: Building Energy Analysis Tools

Task 24: Solar Procurement

Task 25: Solar Assisted Air Conditioning of Buildings

Task 26: Solar Combisystems

Task 27: Performance of Solar Facade Components

Task 28: Sustainable Solar Housing

Task 29: Solar Crop Drying

Task 31: Daylighting Buildings in the 21st Century

Task 32: Advanced Storage Concepts for Solar Buildings

Task 33: Solar Heat for Industrial Processes

Task 34/ECBCS Annex 43: Testing and Validation of Building Energy Simulation Tools

Countries and industries working together on solar heating and cooling projects yields both technical and governmental benefits, as illustrated by the SHC Programme's current work described below.

TECHNICAL BENEFITS

Serving As The Ultimate Test Procedure And Field-Test Arena

- IEA BESTEST (Building Energy Simulation Test and Diagnostic Method) focuses software tests on areas that are of a universal common interest. Having a number of countries participating in this work with different climates and building construction practices helped to find common areas of modeling, and to prioritize them according to test models of energy efficiency technologies. This input has helped to keep IEA BESTEST from straying into test areas that are not a priority to the building-energy simulation community. In addition, the international aspect of the field trials led to the development of a test specification that is easily understood by a wide variety of people conducting simulations.

- There has been collaborative parallel development of software test procedures for different aspects of models by various countries (e.g., building thermal fabric, unitary space cooling equipment, gas-fired furnaces, radiant heating and cooling, daylighting, economizers, etc) with minimal duplication of effort. Conducting field-tests of others' projects is more easily coordinated because of the SHC framework that was formulated during SHC Task 8, rigorously pursued in SHC Task 12/ECBCS , Annex 21, SHC Task 22, and now in SHC Task 34/ECBCS Annex 43.

- Field studies on the integration of daylighting and electric lighting systems are being conducted in buildings in various parts of the world. The goal of this work is to determine the impact of user response on energy savings. The amount of daylight, unlike the quantity of electric lighting, is not under the control of the designer as it varies in quantity and in distribution with the seasons and the weather. Countries working together are critical for this work as energy savings from the use of daylight will vary substantially depending on the climate conditions as well as the occupants' responses to visual and thermal comfort.

Sharing Technical Expertise Benefits All

- The main know-how on solar assisted air conditioning – at least in Europe – using desiccant cooling technology is in Central and Northern European countries, namely Germany and Sweden, while the need for summer air-conditioning is greater in warmer climates. Therefore, international collaboration creates a win-win-situation—industries with the know-how located in colder European countries are developing new markets and learning about the specific application conditions of their technology in warmer climates, such as Mediterranean countries. And, Mediterranean countries are establishing an environmentally friendly technology for building air-conditioning and helping to develop local markets for solar technologies.

Solar desiccant cooling demonstration unit with interactive poster (right) – a center of attraction at the German AirConTec, the major German trade fair for air conditioning and ventilation, which was connected with the Light & Building trade fair in Frankfurt, Germany.

Industry workshop at the Light & Building Trade Fair in Abu Dhabi.

- A new integrated adaptive lighting control technology was initially tested and monitored by 21 users in 14 office rooms at the Solar Energy and Building Physics Building (LESO-PB/EPFL) in Lausanne, Switzerland. Now the technology is to be tested and monitored in buildings in other SHC Task 31 countries to prove its effectiveness under various climatic conditions. The use of this adaptive controller will result in the development of revised software with existing control systems used in other countries and associated hardware such as motorized blinds to use with these adaptive controllers. It will benefit the electrical, controls and blind industries and professional designers as they will be able to produce more energy efficient and comfortable work environments throughout the world.

Combining Resources Benefits All

- International co-operation allowed more designs and ideas for solar combisystems (systems that provide both space and water heating) to be analyzed and reviewed than one country could ever cover. For over four years, 35 experts from nine European countries and the USA, and 16 solar industries worked together to further develop and optimize solar combisystems for detached single-family houses, groups of single-family houses and multi-family houses. As a result, standardized classification and evaluation processes, and design tools were developed for combisystems. Also, the further development and optimization of systems and their designs has lead to more innovative systems with better performance-cost ratings. It also allowed for aspects such as architectural integration of the collector arrays, durability, and reliability to be addressed.

- Twelve countries working together have collaborated on a variety of aspects confronting the performance of solar façade components—development of a window energy rating, definition of the needs of a general energy performance assessment methodology for solar facade components (e.g., solar shading devices, double envelope facades, transparent isolation materials, daylighting devices and window-wall interfaces), conducting performance testing of chromogenic glazing, and addressing the European Directive on the Energy Performance of Buildings.

- Countries are developing new design solutions for sustainable housing, but no single builder, or even national program could allocate the resources needed to match the extent of what has been accomplished in SHC Task 28:
  – Learning from the experiences from over 50 constructed housing projects systematically analyzed by a standard data collection process.
  – Exploring innovative strategies, which open up through the application of construction techniques, new components and configurations of systems not common or even known in one's own country.
  – Learning ways to achieve the same high performance by different means, be it conservation or extensive use of renewable energy with trends and sensitivities drawn from both computer modeling and analysis of monitoring results.
  – Learning how others market sustainable housing, products and ideas as illustrated in 20 success stories.
  – Testing the robustness of concepts by their performance in extreme climates (e.g., Sweden), difficult markets (Swiss home buyer demand for perfection) or constrained finances (low income housing in Scotland, Germany, and Austria).
  – Benchmarking the performance of solutions in multiple dimensions—costs, durability, environmental impact over the building life span, and user/market acceptance.

GOVERNMENTAL BENEFITS

Providing The Basis For Codes & Standards

- Communication continues with a number of CEN Technical Committees, including 89, 156, 229, which are addressing building energy calculation methods and developing building energy analysis tool test cases. Discussions were initiated on how CEN and SHC Task 22 can cooperate in the development and promulgation of test cases for evaluating building energy analysis tools. As a result of this, France (CSTB) has used BESTEST to test simulation tools used in conjunction with the development of CEN Standards.

- A liaison status was granted to SHC Task 26 with the European standards organization under CEN/TC 312 "Thermal solar systems and components" by Resolution 7/99. This decision was based on work done to classify solar combisystems based on their hydraulic scheme, and the development of test procedures. These aspects are of great practical relevance for industry, planners and installers.

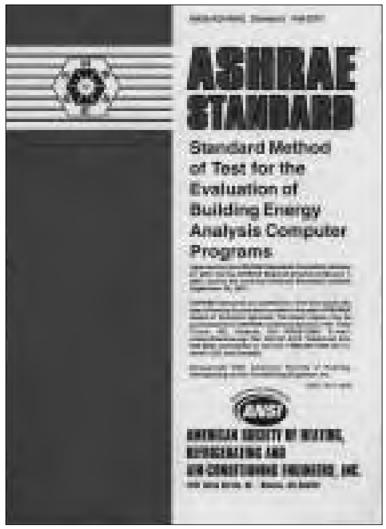
- National and international building energy standard making organizations are able to use the test cases developed in SHC Task 22 to create standard methods of tests for building energy analysis tools used for national building energy code compliance.

Developing Test Procedures

- Internationally acknowledged durability test procedures for chromogenic glazing and materials for solar collectors (reflectors, absorbers, glazing) were developed by countries working together in SHC Task 27.

- Test procedures for predicting the thermal performance of solar combisystems were designed and evaluated. The focus on simplifying testing resulted in the AC/DC test method and the Direct Characterization (DC) test method. In addition to the development of test methods, test facilities for solar combisystems were designed and built in five European countries.

- The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) published Standard 140-2001 in 2001. Standard 140 incorporates the IEA BESTEST suite of test cases developed under SHC Task 12/ECBCS Annex 21, which are primarily related to building thermal fabric heat transfer. During 2003, ASHRAE Standard 90.1, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, was revised to require use of Standard 140 for testing software used in building energy efficiency assessments. This is significant because it mandates formalized software evaluation using test procedures developed under SHC research activities.



The committee overseeing ASHRAE Standard 140, SSPC 140, has been given the status of a Standing Committee which means as new test cases become available from Task 22 and other sources they can be reviewed and integrated into a revised version of ASHRAE Standard 140. Recently SSPC 140 approved public review of proposed Addendum A to Standard 140 that includes the test cases of HVAC BESTEST Volume 1, which were developed under SHC Task 22 and are related to unitary space cooling mechanical equipment. Currently, SSPC 140 is responding to public review comments, and publication of Amendment A is expected during 2004.

Developing Design Tools

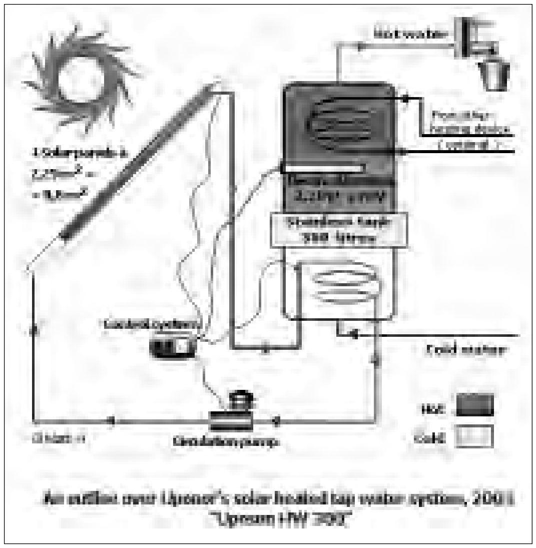
- In the area of combisystem characterisation, the scheme named FSC Procedure, introduced by the French participant, has turned out to become a major tool for solar combisystems. The FSC scheme has similarities with f-chart, the well-known design tool for solar water heaters. Data was used to characterise some 10 generic systems, and the characteristic functions obtained for each of them became the primary background information for the simple design tool "CombiSun" for architects and engineers. With this tool, solar combisystems can be easily compared and properly sized according to specific requirements from the practice.

Testing Software

- International collaboration on normes development is efficient for governments where policy attitudes are similar, and provides a means to avoid re-inventing the wheel and to share expertise. As a result, international collaboration in this area allows governments to be more efficient with their internal resources.

NATIONAL IMPACT

- Countries are adopting IEA's BESTEST procedures as a standard methods of test. In the Netherlands, TNO has developed their Energy Diagnosis Reference (EDR) based on BESTEST. TNO has developed the EDR to satisfy the European Performance Directive (EPD) of the European Union. The EPD emphasizes performance-based standards () and requires certification of software used to show compliance with energy performance standards. IEA BESTEST also has been referenced in codes and standards in Australia and New Zealand.



Uposun HW 300—Winner of the SHC Solar Procurement Competition in Sweden.

- The U.S. National Association of State Energy Officials has referenced the Home Energy Rating Systems (HERS) BESTEST for certification of home energy rating software. HERS BESTEST, which is conceptually based on the IEA BESTEST, was developed for testing software that is used specifically in conjunction with HERS. A number of other countries, such as The Netherlands, Belgium, Luxembourg, Australia and New Zealand are using BESTEST as a standard method of testing building energy analysis tools for their national energy codes or home energy rating software.

- Sweden held a solar procurement competition for Solar Domestic Hot Water (SDHW) systems as part of SHC Task 24. The goal of this competition was to develop a solar domestic hot water system that could replace the electric hot water systems that are used in many detached houses with electric heating in Sweden. Fourteen systems from Sweden, Germany, Denmark and Austria entered the competition. Uposun HW 300, a new system with a plastic collector from Uponor AB won the competition, and six systems received honorable mention. As a result of the competition, the average performance of marketable SDHW systems in Sweden improved, the price for SDHW systems in Sweden decreased approximately 20%, and a SDHW system testing facility was established.

- Failure mode and effect analysis (FMEA), which is widely used in other industrial sectors (e.g., car and airplane), was recently used by SHC Task 27 on solar components to anticipate critical damages. This project, lead by France, focused on methodological approaches for failure mode analysis of solar components. FMEAs have been performed for a Double Glazed Unit of a window in France and the United States, and for a specific design of a solar collector in France.

- Integrating solar components into the façade of a building is not a new concept, however, integrating the solar thermal collectors of a solar combisystem is. Façade collectors are suitable for new buildings and for the renovation of old buildings as well as for homes and larger buildings. By becoming part of a building's architecture, the options for their application improves as some architects and planners are opposed to collectors being tacked on the roof of a building as they detract from the building design.

Two Austrian solar engineering companies, as part of SHC Task 26, tested facades to evaluate the thermal behavior of the systems. One test façade was mounted on a two-family home. And the other test façade was mounted on a brick wall of an office building. The initial test results were positive.

- SHC Task 28 documents produced on sustainable solar housing have been adapted by the participants in Austria, Germany, and Switzerland to produce a German language sourcebook for planners. And the Task's final product—a design handbook—will be able to be produced in national languages and customized to local building cultures.

IS IT WORTH IT?

Is the investment of time, money and people worth it? Each country will continue to determine this for itself, but the impact that solar heating and cooling technology has on the world's energy supply will continue to depend on international collaboration.

TASK 22:

Building Energy Analysis Tools

Michael J. Holtz
Architectural Energy Corporation
Task 22 Operating Agent for the U.S. Department of Energy

Ron Judkoff
National Renewable Energy Laboratory
Task 34 Operating Agent for the U.S. Department of Energy

TASK DESCRIPTION

The overall goal of SHC Task 22 was to establish a sound technical basis for analyzing solar, low-energy buildings with available and emerging building energy analysis tools. This has been achieved by accomplishing the following objectives:

- Assess the accuracy of available building energy analysis tools in predicting the performance of widely used solar and low-energy concepts.
- Collect and document engineering models of widely used solar and low-energy concepts for use in the next generation building energy analysis tools.
- Assess and document the impact (value) of improved building energy analysis tools in analyzing solar, low-energy buildings, and widely disseminate research results to tool users, industry associations and government agencies.

Scope

SHC Task 22 investigated the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of solar and low-energy buildings. The scope of the Task is limited to whole-building energy analysis tools, including emerging modular type tools, and to widely used solar and low-energy design concepts. The primary audiences for the results of the Task are building energy analysis tool developers and national and international building energy standard making organizations.

However, tool users, such as architects, engineers, energy consultants, product manufacturers, and building owners and managers, are the ultimate beneficiaries of the research, and have been informed through targeted reports and articles.

Means

Participants carried out research in the framework of two Subtasks during the initial phase of the Task:

- Subtask A: Tool Evaluation
- Subtask B: Model Documentation

During a Task Extension Phase, the Participants focused on two new Subtasks:

- Subtask C: Comparative Evaluation
- Subtask D: Empirical Validation

Tool evaluation activities included analytical, comparative and empirical methods, with emphasis given to "blind" comparative evaluation using carefully designed test cases and "blind" empirical validation using measured data from test rooms or full-scale buildings. Documentation of engineering models used existing standard reporting formats and procedures. Final reports are on the SHC Programme Task 22 web site, www.iea-shc.org/task22/index.html.

Duration

The Task was initiated in January 1996, and with the approved 30-month extension, was completed in June 2003.

Participation

A total of eleven countries participated in the Task throughout its duration. They were:

Australia	France
Spain	UK
Canada	Germany
Sweden	USA
Finland	Netherlands
Switzerland	

TASK ACCOMPLISHMENTS

The objectives of SHC Task 22 have all been reached. A summary of Subtask research and codes & standards activities completed is presented below.

Codes and Standards Activities

A key audience for the research undertaken within this Task is national and international building energy standard making organizations. These organizations can use the test cases developed in Task 22 to create standard methods of tests for building energy analysis tools used for national building energy code compliance.

A significant achievement was the publication of American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 140-2001 in 2001. Standard 140 incorporates the IEA BESTEST suite of test cases developed under SHC Task 12 and ECBCS Annex 21, which are primarily related to building thermal fabric heat transfer. During 2003, ASHRAE Standard 90.1, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, was revised to require use of Standard 140 for testing software used in building energy efficiency assessments. This was important because it mandates formalized software evaluation using test procedures developed under IEA research activities.

The committee overseeing ASHRAE Standard 140, SSPC 140, has been given the status of a Standing Committee which means as new test cases become available from SHC Task 22 and other sources they can bereviewed and integrated into a revised version of ASHRAE Standard 140. Recently SSPC 140 approved public review of proposed Addendum A to Standard 140 that includes the test cases of HVAC BESTEST Volume 1, which were developed under SHC Task 22 and are related to unitary space cooling mechanical equipment. Currently, SSPC 140 is responding to public review comments, and publication of Amendment A is expected during 2004.

Other countries are adopting IEA's BESTEST procedures as standard methods of test. In the Netherlands, TNO has developed their Energy Diagnosis Reference (EDR) based on BESTEST. TNO has developed the EDR to satisfy the European Performance Directive (EPD) of the European Union. The EPD emphasizes performance-based standards (norms) and requires certification of software used to show compliance with energy performance standards. IEA BESTEST also has been referenced in codes and standards in Australia and New Zealand.

Regarding collaboration with ISO/CEN, communication continues with a number of CEN Technical Committees, including 89, 156, 229, which also are addressing building energy calculation methods and the development building energy analysis tool test cases. Discussions were initiated on how CEN and SHC Task 22 can cooperate in the development and promulgation of test cases for evaluating building energy analysis tools. As a result of this initiative, France (CSTB) has used BESTEST to test simulation tools used in conjunction with development of CEN Standards.

Subtask A: Tool Evaluation

This Subtask was concerned with assessing the accuracy of available building energy analysis tools in predicting the performance of widely used solar and low-energy concepts. Three tool evaluation methodologies were employed:

1) Analytical Tests
2) Comparative Tests
3) Empirical Validation Tests

This subtask ended in 2000. The related follow-on work that occurred in 2001 and 2002 is described in the subsections for Subtask C and Subtask D. Work accomplished for Subtask A on each of these tool evaluation efforts is summarized below.

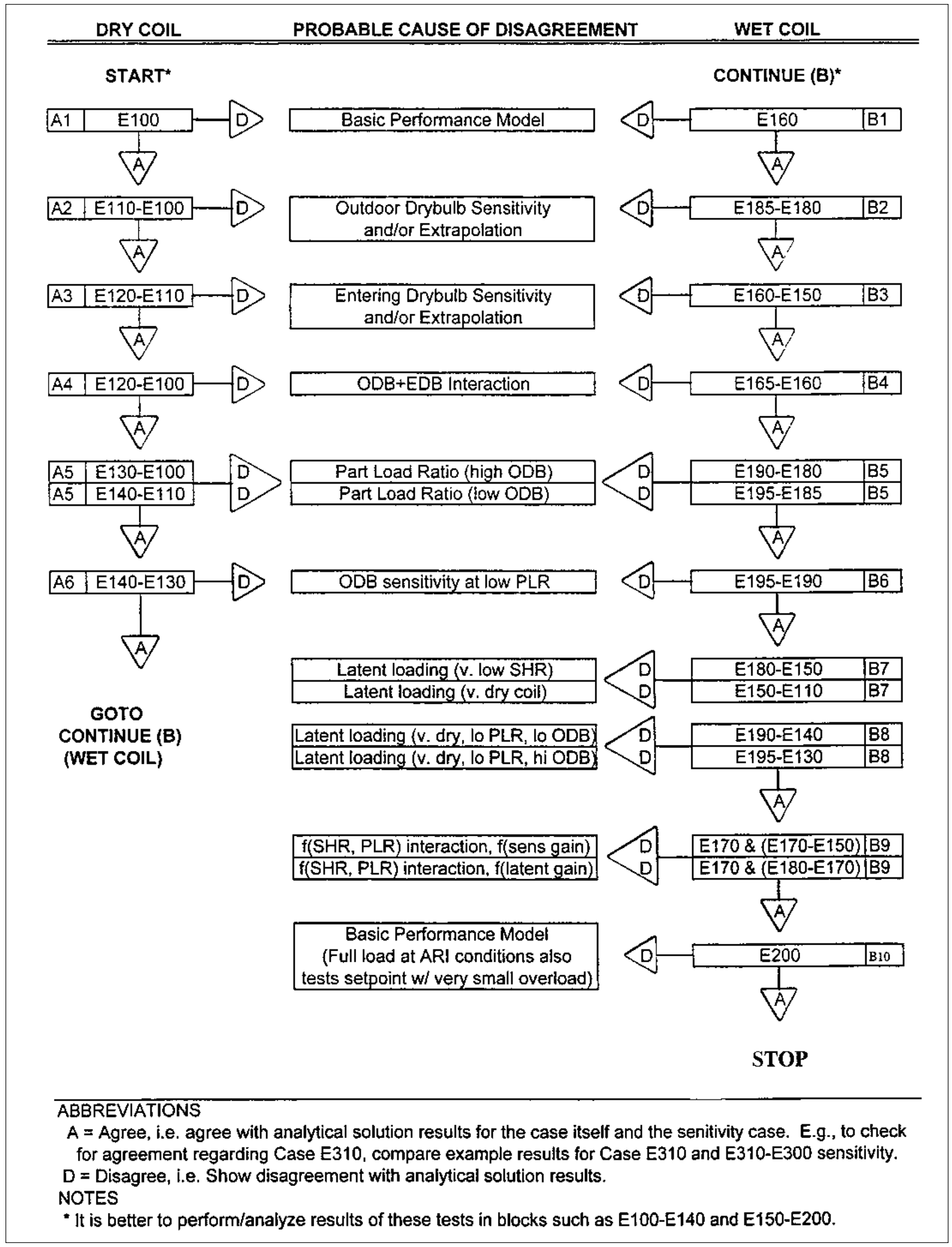


Figure 2: HVAC BESTEST Diagnostic Logic Flow Diagram – E100- E200, Steady-State Analytical Verification Test Cases

- **Analytical Tests:** All planned activities were completed. The Working Document, along with a questionnaire, a recommended implementation process, and a series of one-page summaries of use experience, was distributed to 40 leading building energy analysis tool authors throughout the world. The purpose was to inform code authors of the existing analytical tests, and to obtain their views and recommendations on the importance and value of analytical tests for tool evaluation/validation. This Working Document was used as a starting point for continued research by ASHRAE *(see Development of an Analytical Verification Test Suite for Whole Building Energy Simulation Programs – Building Fabric, by J. Spitler, S. Rees, and D. Xiao, Oklahoma State University, Oklahoma, US; published by ASHRAE, Atlanta, Georgia, US, 2001).*

- **Comparative Tests:** The HVAC BESTEST suite of test cases – series E100 - E200 – was completed and a final report prepared. A Diagnostic Logic Flow Diagram of the E100 - E200 series test cases is shown in Figure 2. Examples of the types of problems found when building energy analysis simulation tools are run through these tests are shown in Figure 3.

- **Empirical Validation Tests:** Iowa Energy Center: The final report on empirical validation exercises conducted at the Iowa Energy Center's Energy Resource Station (ERS) is on the SHC Program Task 22 web site. The report addresses three validation exercises based on experiments involving mechanical equipment conducted at the ERS:

1) Constant Air Volume with Terminal Reheat
2) Variable Air Volume with Terminal Reheat
3) Very Variable Air Volume with Terminal Reheat

A few conclusions from the ERS empirical validation exercise are as follows:

- The Energy Resource Station and the collected data represent an excellent source for empirical validation of building energy analysis tools for actual commercial buildings and equipment.

- The building energy analysis tools evaluated had good agreement

Software	Error Description	% Disagreement	Resolution
CASIS	No extrapolation of performance data	Possibly up to 10% power (E110, E100)	Manually fixed*
CASIS	Convergence Algorithm	E200 would not run (convergence problem)	Manually fixed*
CASIS	Fan heat added to coil load	4% sensible coil load (≤ 4% power f (SHR))	Fixed
CASIS	ID & OD fan power did not include COP f (PLR) degradation	2% power (mid PLR)	Fixed
CLIM2000	Verification of new model improvements	up to 50% COP for earlier model	Fixed
CLIM2000	Compressor/fan power does not include COP f(PLR) degradation	20% power (low PLR) 13% power (mid PLR)	Fixed
CLIM2000	Possible performance map extrapolation problem	10% power (E110, E100)	Revision in progress
DOE-2.1E (JJH ver < W54)	Minimum supply temperature coding error in early RESYS2 system	36% COP (base case)	Fixed
DOE-2.1E (JJH ver 133)	Coil/Zone load difference inconsistent with fan power for RESYS2 at low SHR.	5% sensible coil load (at low SHR)	Authors notified
DOE-2.1E (JJH ver 133)	COIL-BF-FT insensitivity	1% power (E185)	Authors notified
DOE-2.1E (JJH ver 133 & ESTSC ver 088)	Fan power does not include COP f(PLR) degradation (RESYS2 and PTAC)	2% power (mid PLR)	Authors notified
DOE-2.1E (ESTSC v 088)	Coil/Zone load difference inconsistent with fan power for PTAC at low SHR.	2% sensible coil load (at low SHR)	Authors notified
PROMETHEUS	Compressor COP f(PLR) calculated externally	20% power (low PLR) if no external calc	Authors plan to fix
TRNSYS-TUD (realistic ctrl)	Use of some single precision variables in the code.	45% power (low PLR) 14% power (mid PLR)	Fixed
TRNSYS-TUD (realistic ctrl)	Wrong data compiled for Coil Latent Load output.	4% power (E150) 3% lat. coil (E170)	Fixed

*Current results include non-automated version of the fix.

Figure 3: Examples of tool problems found through HVAC BESTEST, Volume 1, Cases E100-E200

with the measured data. Most of the building energy analysis simulations studied showed small disagreements, similar to the measurementuncertainty.

- The building energy analysis tools tested made accurate predictions of the mean values and showed good agreement with fast dynamics. These results should increase confidence in the use of simulation tools to model the types of HVAC systems used in the study.

- The comparison of measured data to the predictions from multiple simulation programs helped improve the models and the experiments. The use of multiple simulation tools is essential in evaluating the validity and accuracy of the measured data. Measurement errors were identified in the first round of the exercises. These errors were fixed for subsequent rounds.

- **Empirical Validation Tests, Electricité de France (EDF):** The final report on the ETNA and GENEC test room empirical validation exercises, prepared by France (EDF), was distributed to tool authors and researchers throughout the world and posted on the SHC Programme Task 22 web site. The report contains the final results of all Task Participants for the "blind" and "non-blind" empirical validation exercise, based on experiments involving building thermal fabric heat transfer using several test conditions in the ETNA and GENEC passive solar test facilities. The final report concludes that the data collected from the ETNA and GENEC test cells represents an excellent source of data for empirical validation of simulation tools, and that the test specification clearly described the test apparatus and the test data. In general, the tool predictions of energy and temperature are in close agreement with the measured test room data. However, in the study using the ETNA test cell there was a consistent difference between measured versus simulated overall average heat conduction that was later found to be caused by differences in thermal properties listed in the test specification versus as-built properties and/or unspecified thermal bridges in the test cell walls, floors and ceiling as constructed. This difference was identified using an innovative data analysis technique described below, and confirmed empirically in later experiments that thermally characterized the test cell heat loss coefficients of the ETNA test cell walls.

- **Parameter Estimation/Identification Technique:** A final report of this innovative building energy analysis tool validation method is on the SHC Programme Task 22 web site. The method involves two steps: 1) checking model validity, and 2) diagnosis.

Model validity is checked using residuals analysis, where the residuals are specific differences between measured and simulated results. Diagnosis is accomplished by identifying changes in model parameter values that are required for a significant model behavior improvement.

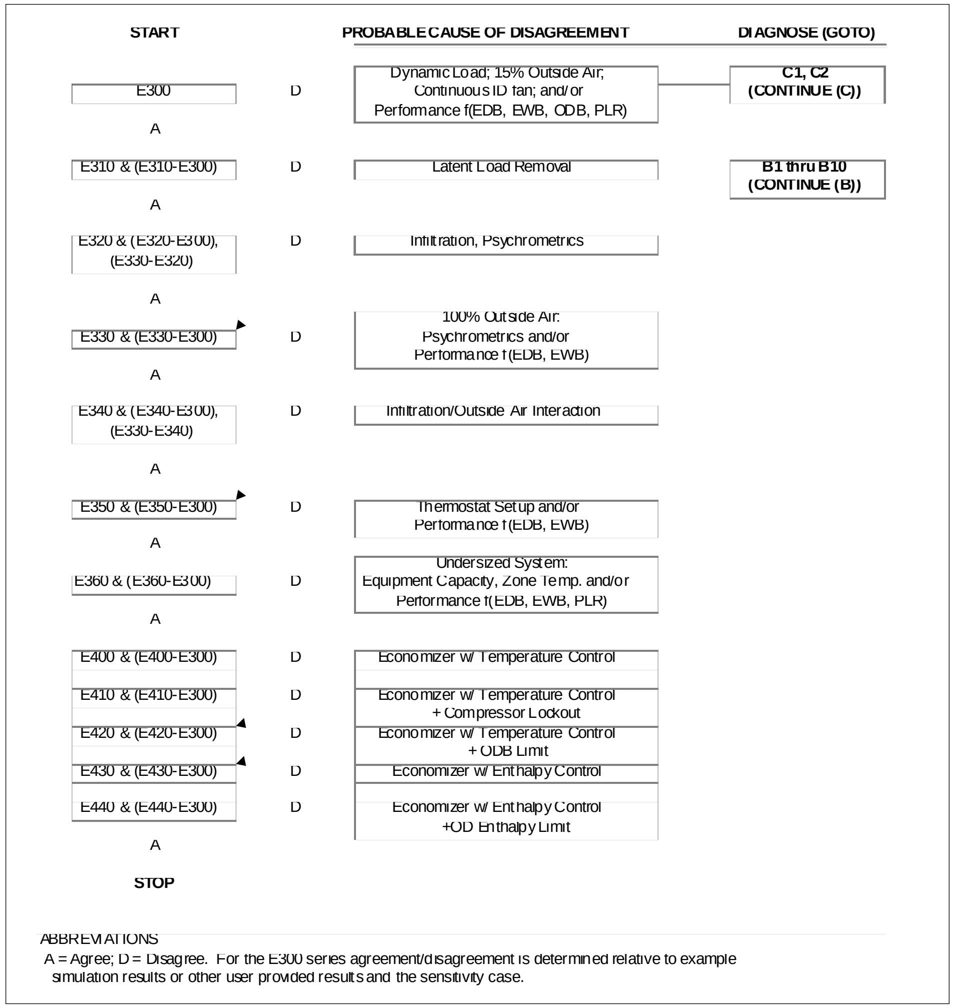


Figure 4: HVAC BESTEST Diagnostic Logic Flow Diagram – E300- E440, dynamic cases with outside air

The diagnostic approach required innovative application of rigorous mathematics to accomplish sensitivity analysis and calculation optimization needed to achieve a reasonable diagnosis. As noted above, this method was applied to EDF's empirical study using the ETNA test cells and uncovered an experimental deficiency indicating that specified thermal conductivity values were lower than the as-constructed values and/or that unspecified (and therefore not modeled) thermal bridges could exist. This analysis helped the researchers better understand the simulation tool results.

Subtask B: Model Documentation

This Subtask is concerned with the collection and documentation of existing engineering models, and the creation of a models library accessible by object-oriented (modular) simulation tool developers. Task Participants selected the Neutral Model Format (NMF) as the standard format for "hard" (computer-machine readable) model documentation.

A final report has been prepared which documents the forty plus engineering models specified in the Neutral Model Format, and is available on the SHC Programme Task 22 web site. Also, a web site has been created to allow code authors access to these models, http://home.swipnet.se/nmf.

Subtask C: Comparative Evaluation

This Subtask developed a number of comparative tests on basic energy modeling capabilities. Task Experts developed useable test case specifications and results sets for the following energy modeling topics:

- Radiant Floor Heating Systems (RADTEST)
- Gas-Fired Furnaces, extension to HVAC BESTEST
- Mechanical Cooling: HVAC BESTEST, Volume 2 – Cases E300-E545
- Ground Coupled Heat Transfer from Floor Slabs and Basements, extension to the original IEA BESTEST suite of test cases

The completed final reports for RADTEST and the Gas-Fired Furnaces extension to HVAC BESTEST are posted on the SHC Programme Task 22 web site. The final report for HVAC BESTEST, Volume 2 is expected to be available in 2004. During 2003, the test specification and initial results for Ground Coupled Heat Transfer from Floor Slabs and Basements was packaged as a working document; the ground coupling work is being continued as part of the new SHC Task 34/ECBCS Annex 43.

The gas-fired furnace HVAC BESTEST cases include eight Tier 1 analytical verification test cases that have "analytical/semi-analytical" solution results and three Tier 2 comparative test cases that do not have such solution results. Simulation tool results for the Tier 1 test cases showed good agreement versus the published solution results. For the Tier 2 cases, slightly more diversity exists among the simulation tool results. The test cases were successful in discovering errors or deficiencies in the simulation tools. For example, prior to performing the tests, the EnergyPlus simulation tool's furnace model did not have capability to simulate part load performance or account for parasitic electric power such as that used by a draft fan; the tool authors made corrections to improve the model.

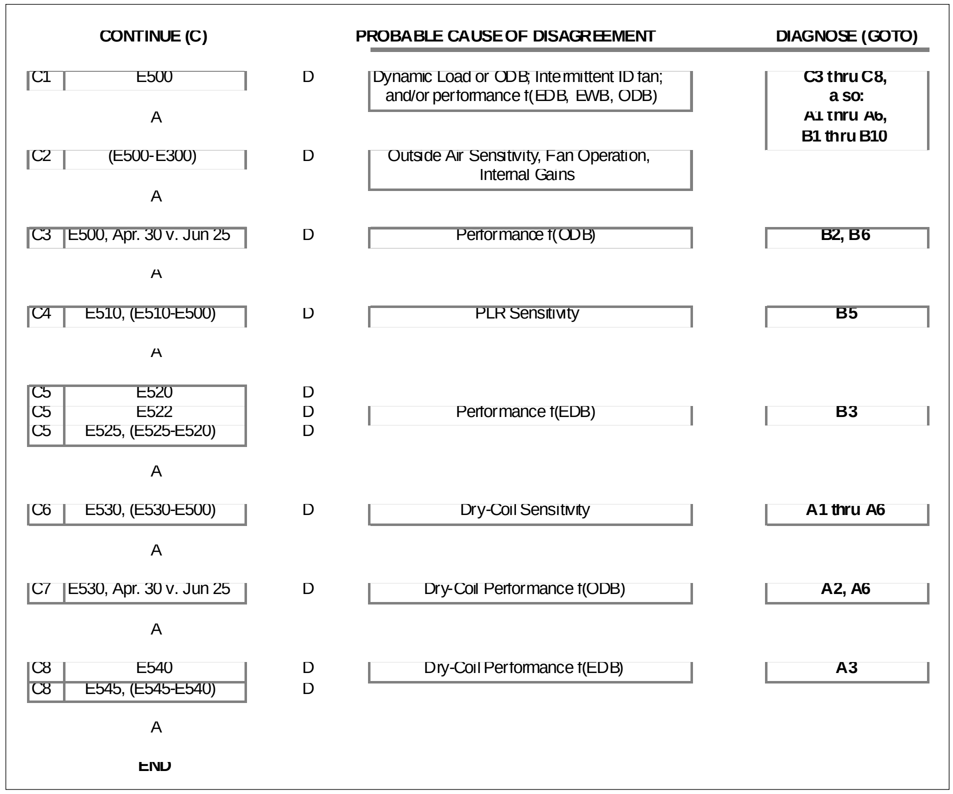


Figure 5: HVAC BESTEST Diagnostic Logic Flow Diagram – E500- E545, Dynamic Cases without Outside Air

The RADTEST final report documents a comparative diagnostic procedure for testing the ability of whole-building simulation programs to model the performance of radiant heating and cooling systems. For this purpose, RADTEST includes 13 test cases beginning with one of the original IEA BESTEST cases. Among the simulation tools that were tested, the different approaches to modeling radiant heating and cooling systems led to satisfying results. The simple approach of modeling with an active temperature layer to provide cooling or heating load to an active zone yields good agreement among the simulation tools.

HVAC BESTEST Volume 2 is a continuation of the Volume 1 steady-state analytically solvable cases for unitary space cooling equipment. Features of the Volume 2 test cases that are not present in Volume 1 include: hourly varying weather, internal gains and set point conditions, outside air mixing, infiltration, and various economizer control

Software	Error Description[a]	% Disagreement[a,b]	Resolution
CODYRUN	Inconsistent accounting of fan heat (main issue), and dry coil modeling in neural network performance mapping	14% compressor consumption 9% peak power (E300, E310)	Fixed
CODYRUN	Moisture balance calculation	1% comp. consumption(E360) 4-5% peak power(E360, E300-E320)	Fixed
CODYRUN	IDB does not float above set point when equipment is overloaded	14% comp. cons.(E320-E340) 1% comp. Cons. (other E3xx) 0-1% peak power (E300 series)	Fixed
CODYRUN	Thermal balance calculation, amalgamation of air infiltration and outside air mixing, and thermal capacitance input error	Up to 4% total consumption Up to 3% peak consumption	Fixed
CODYRUN	DF/PLR not properly accounted for in ID and OD fan consumptions.	8-18% ID and OD fan cons 1-3% total consumption(E500-E525)	Fixed
CODYRUN	Neural network performance calculation.	21% peak hour sensible coil load 1% total consumption(E360 only)	Fixed
CODYRUN	Balancing of zone air conditions and equipment performance parameters	36-53% peak latent coil load 2-6.5% peak consumption(E520, E522 only)	Fixed
DOE-2.1E-ESTSC	Misleading documentation for BF = f(PLR) curve, affects cases with continuous fan operation and typical range of PLRs	30-115% latent coil loads 7-22% total consumption (E300-E350, E400-E440)	Authors notified, Input fixed
DOE-2.1E-ESTSC	Hard-wired lower limit on EWB used with performance data	65-109% fan consumption 6-8% total consumption (low EDB E520, E540 only)	Fixed
DOE-2.1E-ESTSC	Single-pass HVAC calculation with 1-hour time step	20-50% peak latent coil load (E320-E340, E400). Peak humidity (E310, E350, E545)	No Change, Fixed in EnergyPlus
DOE-2.1E-ESTSC	Variation of zone humidity ratio in dry coil cases with constant set point and cooling on	10-25% daily humidity ratio (E530 specific day results)	No Change, Fixed in EnergyPlus
ENERGYPLUS	Documentation improvement for when performance data for ARI rating conditions not included	Possible fatal error[c]	Fixed
ENERGYPLUS	Latent cooling load calculation	Negligible	Fixed
ENERGYPLUS	System control during part loading	1-2% consumption[d] and total peak power (E300 series)	Fixed
ENERGYPLUS	Weather data interpolation with sub-hourly time steps	0-1% consumption[d] 0–2% total peak power (E300 series)	Fixed
ENERGYPLUS	Economizer compressor lockout allowed as input, but not implemented in the software	E410 gives same results as Case E400	Authors notified
ENERGYPLUS	Moisture balance	8-32% humidity ratio (E500-E525); negligible consumption	Fixed
HOT3000	Outside air not properly modeled	4% total consumption, 5% sens. coil, 9% lat. coil (E330 only)	Fixed
HOT3000	System performance parameters based on zone conditions from previous time step	3% peak consumption (E310, E520 only)	Authors notified

a Acronyms and abbreviations used in this column are described in the Nomenclature (Section 2.7).
b Specific cases or conditions relevant to the described disagreement(s) are included in parenthesis.
c Fatal error occurs if ARI-condition data point not used for curve fit normalization.
d Compressor + OD fan

Figure 6: Summary of Software Problems Found Using HVAC BESTEST, Volume 2, Cases E300-E545

schemes. Analytical solutions were not possible for the Volume 2 test cases. Diagnostic Logic Flow Diagrams of the HVAC BESTEST, Volume 2, Cases E300-E545 are shown in Figures 3 and 4. Examples of the types of problems found when building energy analysis simulation tools are run through these tests are shown in Figure 5.

Energy systems were tested at the Iowa Energy Resource Station Test Facility.

Subtask D: Empirical Validation

This Subtask is concerned with validating building energy analysis tool energy predictions with performance data from a highly controlled commercial test facility. The following energy systems were tested in the Iowa Energy Resource Station Test Facility, with the performance data used in the validation of participating building energy analysis tools:

- Daylighting/HVAC Interaction
- Economizer Control

The final report for Daylighting/ HVAC Interaction is on the SHC Programme Task 22 web site. Two daylighting tests using empirical test data were developed to evaluate the ability of whole-building energy analysis simulation programs to accurately model lighting, heating, and cooling energy consumption in a commercial building. The comparison of daylighting illuminance calculations by the simulation tools to measured light levels showed deficiencies in the models under conditions of excessive daylight. Results show that the models can predict lighting power within 15% of the measured values for a daylight-controlled space. Results from this work also show a reduction in cooling energy for the daylight-controlled spaces as compared to the non-daylight controlled spaces. A significant finding of this work showed that thermal stratification within a room affects the heating energy requirements to maintain the space temperature. Because many simulation tools do not account for spatial temperature variation within the conditioned zone, differences will occur between model predictions and actual energy usage. Regarding Economizer Control tests, all tests have been completed but the draft final report remains to be prepared. Publication of the draft final report is expected during 2004.

ACTIVITIES DURING 2003

As 2003 was the last year of the Task, the activities consisted of finalizing the products developed for Subtasks C and D, and of publishing and distributing them. These are included in the full final list of key publications and reports below. A public website has been developed (www.iea-shc.org/task22/index.html), and documents have been placed on that site and can be downloaded. Other activities included planning for a new Task that would continue work on software evaluation, which was approved as a joint Task with the Energy Conservation in Buildings and Community Systems Programme—SHC Task 34/ECBCS Annex 43.

Apart from that, work on bringing evaluation test procedures developed under IEA SHC research into codes and standards (norms) has continued and will be continuing beyond the time frame of the Task.

LINKS WITH INDUSTRY

Because of the nature of the Task—tool evaluation and emerging tool research—links with industry take a somewhat different form than other IEA SHC Programme Tasks. The primary audiences for SHC Task 22 research are building energy analysis tool authors and national and international building energy standard making organizations.

For tool authors, a number of links have been established. The Analytical Solutions Working Document was distributed for their use and comment, and was a starting point for continued analytical test verification research by ASHRAE. A number of prominent tool authors participated in the HVAC BESTEST and RADTEST comparative tests, and in the EDF and Iowa Energy

Resource Station empirical validation exercises.

The tool authors are formally documenting use of IEA tool testing procedures. For example, five papers by software developers related to tool evaluation test procedures created under SHC Task 22 were presented at the conference of the International Building Performance Simulation Association, September 2003 in Eindhoven, Netherlands. An additional paper describing one of the new test procedures developed under SHC Task 22 was also presented at the Eindhoven conference.

Abstracts for four papers by software developers related to software testing using SHC Task 22 work have been accepted for the Canadian ESim conference scheduled for June 2004 in Vancouver. Additional papers by software developers related to SHC Task 22 test procedures and earlier procedures developed under SHC Task 12/ECBCS Annex 21 have appeared regularly at ASHRAE meetings in the US. In this way the SHC Task 22 research is effectively linked to the needs and recommendations of the world's leading building energy analysis tool developers.

The results of SHC Task 22 research are used as prenormative information in the establishment of national and international building energy codes and standards. For example, the IEA BESTEST cases were used by ASHRAE to develop a standard method of test for evaluating building energy analysis programs as described above under "Task Accomplishments, Codes and Standards Activities". Also, the U.S. National Association of State Energy Officials has referenced HERS BESTEST for certification of home energy rating software. HERS BESTEST, which is conceptually based on IEA BESTEST, was developed for testing software that is used specifically in conjunction with Home Energy Rating Systems (HERS). A number of other countries, such as The Netherlands, Australia and New Zealand are using BESTEST as a standard method of testing building energy analysis tools for their national energy codes or home energy rating software.

Through these kinds of industry links, the participants of SHC Task 22 have ensured the valuable use of its research results.

MAIN REPORTS AND PUBLICATIONS

A Working Document of Subtask A.1 Analytical Tests.
P. Tuomaala, VTT Building Technology, Espoo, Finland. 1999.

Empirical Validation of EDF ETNA and GENEC Test Cell Models.
S. Moinard, Créteil University, France, and G. Guyon, Electricity of France, Moret sur Loing, France. 1999.

Models for Building Indoor Climate and Energy Simulation.
A. Bring, P. Sahlin, and M. Vuolle, Swedish Royal Institute of Technology, Stockholm, Sweden. 1999.

Simulation Model Network.
(SIMONE), web site of NMF engineering models, http://home.swipnet.se/nmf, BrisData, Stockholm, Sweden. 1999.

Empirical Validation of Iowa Energy Resource Station Building Energy Analysis Simulation Models.
J. Travesi, CIEMAT, Madrid, Spain, G. Maxwell, Iowa State University, Ames, Iowa, US, C. Klaassen, Iowa Energy Center, Ankeny, Iowa, US, and M. Holtz, Architectural Energy Corporation, Boulder, Colorado, US. 2001.

International Energy Agency Building Energy Simulation Test and Diagnostic Method for HVAC Equipment Models (HVAC BESTEST) Volume 1: Cases E100 – E200.
J. Neymark, J. Neymark & Associates, and R. Judkoff, National Renewable Energy Laboratory, Golden, Colorado, US. 2002.

Using Parameters Space Analysis Techniques for Diagnostic Purposes in the Framework of Empirical Model Validation.
E. Palomo Del Barrio, LEPT-ENSAM, Talence, France and G. Guyon, EDF, Moret sur Loing, France. 2002.

Radiant Heating and Cooling Test Cases (RADTEST).
M. Achermann and G. Zweifel, G.,Hochschule Technik + Architektur Luzern, Luzern, Switzerland. 2003.

Building Energy Simulation Test and Diagnostics Method for Heating, Ventilating and Air-Conditioning Equipment Models (HVAC-BESTEST): Fuel-Fired Furnace Test Suite.

J. Purdy and I. Beausoleil-Morrison, CANMET Energy Technology Centre, Natural Resources Canada, Ottawa, Canada. 2003.

Specifications, Experimental Data and Model Results for the Empirical Validation of Building Energy Analysis Tools for HVAC-Daylighting Interaction Tests.
G. Maxwell, P. Loutzenhiser, Iowa State University, Ames, Iowa and C. Klaassen, Energy Resource Station, Ankeny, Iowa, US. 2003.

International Energy Agency Building Energy Simulation Test and Diagnostic Method for Heating, Ventilating and Air-Conditioning Equipment Models (HVAC BESTEST): Cooling Equipment Test Cases E300-E545.
J. Neymark, J. Neymark & Associates, and R. Judkoff, National Renewable Energy Laboratory, Golden, Colorado, US. 2004 (expected).

Specifications, Experimental Data and Model Results for the Empirical Validation of Building Energy Analysis Tools for Economizer Control Tests.
G. Maxwell, P. Loutzenhiser, and C. Klaassen, Iowa State University and Energy Resource Station. 2004 (expected).

MEETINGS IN 2003

Fifteenth Experts Meeting
April 23
Delft, Netherlands
(held in conjunction with the Task Definition Workshop for SHC Task 34/ECBCS Annex43 on April 24-25)

TASK 22 NATIONAL CONTACT PERSONS

(Please note that these are contact details as of the end of Task 22, June 2003.)

Operating Agent

Michael J. Holtz
Architectural Energy Corporation
2540 Frontier Avenue, Suite 201
Boulder, Colorado 80301
United States

Australia

P.C. Thomas
Arup
Level 10
201 Kent Street
Sydney NSW 2000

Canada

Ian Beausoliel-Morrison
CANMET Energy Technology Centre
Natural Resources Canada
580 Booth Street, 13th Floor
Ottawa, Ontario K1A 0E4

Julia Purdy
CANMET Energy Technology Centre
Natural Resources Canada
580 Booth Street, 13th Floor
Ottawa, Ontario K1A 0E4

Finland

Pekka Tuomaala
VTT Building Technology
Energy Systems Research Group
P.O. Box 1804 (Lampomie henkuja 3, Espoo)
FIN-02044 VTT

Mika Vuolle
Helsinki University of Technology
Heating, Ventilating & Air Conditioning
Otakaari 4
Fin-02150 ESPOO

France

Joseph Ojalvo
Electricite de France, Department SEVE
Les Renardieres
Route de Sens, Ecuelles
77818 Moret-sur-Loing Cedex

Elena Palomo
LEPT-ENSAM
Esplanade des Arts et Metiers
33405 Talence Cedex

François Garde (observer)
LGI -- University of Reunion Island
IUT de Saint-Pierre
40 avenue de Saveto
97410 Saint Pierre

Thierry Mara (observer)
LGI -- University of Reunion Island
Faculté des Sciences of Technologies
15 Avenue René Cassion, BP 7151
97715 Ste. Clatilde

Germany

Clemens Felsmann and Gottfried Knabe
Technische Universität Dresden
Institut für Thermodynamik und Techn. Gebäudequsrüstung
Helmholtzstr. 14
01062 Dresden

Martin Behne
KLIMASYSTEMTECHNIK
Esdorn Jahn GmbH
Keplerstraße 8/70
10589 Berlin

Netherlands

Wim Maassen (observer)
TNO Building and Construction Research
Postbus 49
2600 AA Delft

Wim Plokker (observer)
TNO Building and Construction Research
Postbus 49
2600 AA Delft

Spain

Juan Travesi
Departamento De Energías Renovables, CIEMAT
Avda. Complutense, 22
28040 Madrid

Sweden

Per Sahlin and Alex Bring
EQUA Simulation AB
(formerly Bris Data AB)
P.O. Box 1376
172 27 Sundbyberg

Switzerland

Gerhard Zweifel, Matthias Achermann, Reto von Euw, and Sven Kropf
Hochschule Technik + Architektur Luzern
Abt. HLK
CH-6048 Horw

United Kingdom

David Bloomfield, Foroutan Parand, and Elizabeth Silver
Building Research Establishment
Bucknalls Lane
Garston
Watford Wd2 7 JR

United States

Ron Judkoff
National Renewable Energy
Laboratory
1617 Cole Boulevard
Golden, Colorado 80401

Joel Neymark
J. Neymark & Associates
2140 Ellis Street
Golden, Colorado 80401

Gregory Maxwell and Simon Winata
Mechanical Engineering Department
Iowa State University
2025 Black Engineering Building
Ames, Iowa 50011

Curtis J. Klaassen
IEC Energy Resource Station
DMACC, Building 23
2006 S. Ankeny Boulevard
Ankeny, Iowa 50021

Bill Beckman (observer)
Solar Energy Laboratory
1500 Engineering Drive
University of Wisconsin
Madison, Wisconsin 53706

TASK 24:

Solar Procurement

Hans Westling
Promandat AB
Operating Agent for Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

TASK DESCRIPTION

The main objective of SHC Task 24 was to create a sustainable, larger market for active solar water heating systems (mainly domestic systems).

This objective has been achieved through major cost and price reductions for all cost elements, including marketing and installation, as well as performance improvements and joint national and international purchasing.

Means

The work in Task 24 was divided into two Subtasks, each co-ordinated by a lead country:

- Subtask A: Procurement and Marketing (Lead Country: Netherlands)
- Subtask B: Creation of Tools (Lead Country: Denmark)

The objectives of Subtask A were:

- To raise interest in active solar thermal solutions.
- To form buyer groups to purchase state-of-the-art and innovative systems.

The objectives of Subtask B were:

- To collect, analyse and summarise experience.
- To create tools to facilitate the creation of buyer groups and the realisation of projects and procurements. These tools have been included in a manual: "Book of Tools."
- To define a process for prototype testing and evaluation, using existing methods.

Duration

The Task was initiated on April 1, 1998 and was completed on March 31, 2003.

Participation

A total of six countries participated in the Task – Belgium (joined in 2002), Canada, Denmark, Netherlands, Sweden and Switzerland.

TASK ACCOMPLISHMENTS

The aim of the cooperative procurement efforts of SHC Task 24 was to increase the use of solar water heating systems by encouraging coordinated large-scale purchasing. The objectives were to reduce marketing, distribution and hardware costs as well as to improve system performance. This Task also aimed to help organisations meet environmental commitments. The procurement efforts focused primarily on small domestic active solar water heating systems, but also included larger commercial systems. Substantial cost and price reductions of 7-30% were achieved through this work.

Subtask A: Procurement and Marketing

The main task of Subtask A was to create a larger and sustainable market for active solar water heating systems. This was done by creating buyer groups and raising general interest, mainly through projects carried out by these buyer groups. The extra challenge for SHC Task 24 compared to other procurement projects was that solar water heaters are not widely accepted products yet, unlike elevators, housing appliances and light bulbs, for example.

One of the biggest challenges for Subtask A proved to be the formation of buyer groups. Finding (representatives of) buyers willing to invest a lot of time and effort in buying and marketing a relative unknown product as a solar water heater was not easy. Within SHC Task 24 buyer groups were organised for projects aiming at the realisation of solar water heaters in new estates, existing houses and large systems.

A First Round of procurements with small national projects and a low degree of joint international collaboration took place. A Second Round was planned which was to have increased international collaboration and tendering. However, it was not possible to fulfil this objective of extended international activities within the timeframe of SHC Task 24.

SHC Task 24 aimed at initiating 10,000 solar systems. During the course of the Task, contracts for approximately 4,200 systems (recalculated to domestic systems) were signed, 3,785 of which were installed. Most of the systems were installed in the Netherlands, mainly because strategies for systematic market development had already been developed and tested in that country. In other countries, like Denmark, it appeared to be very difficult to realize systems, primarily due to external influences, such as the abolition of subsidies.

The main results of Subtask A can be summarised in the following accomplishments:

- Many buyer group approaches were developed.
- There has been a lot of synergy between the countries. Knowledge, experiences and tools have been shared.
- A cost reduction of 7-30% was achieved.
- The projects running will continue after the end of the Task and Task results will be used by others. For example, Task results will be used in the European Union project "Soltherm Europe Initiative."
- Future co-operation between the experts' organisations is also expected.

Subtask B: Creation of Tools

The main tasks of Subtask B were to collect, analyse and summarise experience, and to create tools to facilitate creation of buyer groups and realization of projects and procurements.

A brochure *"Large Scale Solar Purchasing – A Business Opportunity"* and a background report *"Opportunities for Large-Scale Purchase of Active Solar Systems"* were produced at the beginning of the Task with the purpose of attracting interest in the Task and giving background information on the market and technology of solar water heaters.

To facilitate the procurement process, within the Task and for future projects, a document was prepared to document the experiences of the Task and have in one place procurement information, guidelines, etc. This manual, "Book of Tools/Business Tools" is a web-based report and available on the SHC Task 24 web page on the SHC Programme web site, www.iea-shc.org . The "Book of Tools" consists of different sections. Some examples are:

- Procurement: Explanation of the procurement process and examples of successful procurement projects in other branches.
- Do's and Don'ts: Experience from SHC Task 24 projects and analyses of non-Task projects.
- Projects: Documentation of 21 cases or projects realised within or outside SHC Task 24.
- Business Tools: A number of useful documents for the procurement process or campaigns in general elaborated by SHC Task 24.
- Downloads and References: Comprehensive list of reference literature with links and downloads. This section also contains an archive of internal Task documents (minutes of meetings, status reports, etc.)

The main results of Subtask B can be summarised in the following accomplishments:

- SHC Task 24 website including the SHC Task 24 manual *"Book of Tools/Business Tools."*
- Brochure and background report (published at the beginning of the Task): *Large Scale Solar Purchasing – A Business Opportunity - Opportunities for Large-Scale Purchase of Active Solar Systems*
- Evaluation reports of the 1st Round of the Task.
- Six newsletters.

Task 24	Canada	Den-mark	Nether-lands	Switzer-land	Sweden	Belgium
Small systems	●	●	●		●	●
Medium sized systems			●		●	●
Company solar projects		●		●		
Internet buyer group	●			●	●	
Website	●	●				
Tender documents	●	●	●	●	●	●
Buyer tool	●	●	●	●	●	
Manual		●		●		
Training of installers			●	●		●

Figure 1. Areas of collaboration in SHC Task 24.

Extended International Collaboration
Many of the procurements have, to an increasing extent, been communicated to international media and to the European Commission's "Official Journal." It is the first time that countries have tried to spread their requests for proposals (RFPs) directly by using a website downloading mechanism for the full request for proposals, as was the case for the Swedish project, which other countries then replicated.

As part of the Swedish project, a number of different systems had the opportunity to be carefully tested. The test results and experience were communicated to the respective manufacturers as valuable material for further refinement of their systems.

IIn Figure 1 are examples of areas, where two or more Task 24 countries have initiated collaborative work for procurement documents or models for more efficient processes.

ACTIVITIES DURING 2003

As the Task ended in March 2003, the main activities consisted of finalizing ongoing work.

- The SHC Task 24 website was updated, in particular the "Business Tools" section. Tender and contract documents, case descriptions, campaign guidelines, spreadsheets and relevant reports, brochures and marketing material were uploaded as were all relevant Task internal documents (minutes of meeting, status reports, etc.). The Task 24 website is available on the SHC website www.iea-shc.org.

- The final report on the Swedish projects was translated into English ("Report on Activities in Sweden for the Period 1998-2002 in IEA SHC Task 24 Active Solar Procurement") and was uploaded to the website.

- The experience derived from the activities in SHC Task 24 was included in a Final Manage-ment Report at the end of the Task. It was drawn up by the Operating Agent in collaboration by the leaders of Subtask A and B and the other Task experts. The report is available on the website.

Apart from the above activities, Subtask A will be followed up and some projects will continue to run, for example in the EU project "Soltherm Europe Initiative."

LINKS WITH INDUSTRY

In the preparatory phase of SHC Task 24, industry was involved and contributed to the objectives and work plan of the Task. The contributions came from important manufacturers in the countries that started the Task and from the supplier organisation ASTIG (in 2003 it became ESTIF).

During the Task, the solar industry was involved in various ways. Some examples are given below.

- Parallel to the semi-annual experts meetings, industry workshops were organised. At these workshops, various buyer groups were presented and discussed, and discussions were organised on issues such as the aim and set-up of SHC Task 24 and how to deal with international tenders. The results of these discussions were used in the Task. Apart from the workshops, visits to solar factories and excursions to solar thermal projects were organised in close co-operation with national industries.

- The ASTIG and ESTIF supplier organisations were asked for comments on the standard tender documents produced during the Task. Comments from ASTIG were received and incorporated, but no reaction was received from ESTIF. In general, before every semi-annual experts meeting, there was a meeting with ASTIG/ESTIF and the Subtask A Leader.

- A charter for solar water heaters and a code of conduct for high quality installation of solar water heaters intended for installers were developed. The system quality charter was based mainly on the European quality standards for solar water heaters and was meant to fill in the gap until the "Solar Keymark" quality label was developed. The quality charter forms the basis for the tender documents developed within the framework of this Task.

- On a national level, there are many examples of collaboration with industry and manufacturers. The national experts of the participating countries also consulted with their national branch organisations before every meeting. Industry involvement was a standard agenda point at each experts meeting.

To sum up, it can be said that in practice industry was involved during the Task, both on a national and international level. The main achievements were to work together to realise uniform quality standards for both systems and installation work and to incorporate these standards in the system tenders of the various buyer groups. There also has been co-operation in new market development approaches, such as using the internet.

MAIN REPORTS AND PUBLICATIONS

Large Scale Solar Purchasing – A Business Opportunity.
A brochure produced in cooperation with IEA CADDET Renewable Energy Technologies Programme, 1998.

Opportunities for Large-scale Purchase of Active Solar Systems.
A report produced cooperation with CADDET Renewable Energy Technologies Programme, 1999.

Book of Tools /Business Tools.
Produced by Klaus Ellehauge as a web manual, available on the IEA SHC Programme website, www.iea-shc.org.

IEA Task 24 Active Solar Procurement - Evaluation after the 1st Round 1998-2001.
Special Evaluation Report compiled by Klaus Ellehauge, Task 24 Subtask B Leader, in collaboration with all Task Experts. May 2001.

Report on Activities in Sweden for the Period 1998-2002 in IEA SHC Task 24 Active Solar Procurement.
November 2003. Compiled by Hans Isaksson, December 2002. This report is also available in Swedish.

In addition to the publications mentioned above, conference papers, national brochures, leaflets and manuals have been produced during the years in the countries participating in SHC Task 24, which can be seen in appendices in the above documentation and minutes of SHC Task 24 Experts Meetings.

MEETINGS IN 2003

Eleventh Experts Meeting
March 20-21
Canada

TASK 24 NATIONAL CONTACT PERSONS

(Please note that these are contact details as of the end of Task 24, March 2003.)

Operating Agent

Hans Westling
Promandat AB
P.O. Box 24205
SE-104 51 Stockholm
Sweden

Belgium

Luc De Gheselle
3E nv.
Verenigingsstraat 39
B-1000 Brussels

Canada

Doug McClenahan
CANMET/Natural Resources Canada
580 Booth Street
Ottawa, Ontario K1A OE4

Michael Noble
EnerWorks
280 Cheapside Street
London, Ontario, N6A 2A2

Denmark

Klaus Ellehauge
Vestergade 48 H
DK-8000 Aarhus C

Torben Esbensen
Esbensen Consultants A/S
Mollegade 54
DK-6400 Sonderborg

Lotte Gramkow
Esbensen Consultants A/S
Mollegade 54
DK-6400 Sonderborg

Netherlands

Peter Out
Ecofys Research and Consultancy
P.O. Box 8408
NL-3503 RK Utrecht

Frank Zegers
Ecofys Research and Consultancy
P.O. Box 8408
NL-3503 RK Utrecht

Sweden

Hans Isaksson
K-Konsult Stockholm
P.O. Box 47044
SE-100 74 Stockholm

Switzerland

Markus Portmann
BMP Sanitär und Energie
Kirchrainweg 4
Postfach
CH-6011 Kriens

Christian Völlmin
SSES, Swiss Solar Energy Society
c/o Sopra Solarpraxis AG
Hombergstrasse 4
CH-4466 Ormalingen

TASK 25:

Solar Assisted Air Conditioning of Buildings

Hans-Martin Henning

Fraunhofer Institute for Solar Energy Systems ISE

Operating Agent for the German Federal Ministry of Economics and Labour (BMWA)

TASK DESCRIPTION

The main objective of SHC Task 25 is to improve conditions for the market introduction of solar assisted air conditioning systems in order to promote a reduction of primary energy consumption and electricity peak loads due to air conditioning of buildings. Therefore the project aims are:

- Definition of the performance criteria for solar assisted cooling systems considering energy, economy and environmental aspects,
- Identification and further development of promising solar assisted cooling technologies,
- Optimization of the integration of solar assisted cooling systems into the building and the HVAC system focusing on an optimized primary energy saving - cost performance, and
- Creation of design tools and design guidelines for planners and HVAC engineers.

The work in SHC Task 25 is carried out in the framework of four Subtasks.

Subtask A: Survey of Solar Assisted Cooling

The objective of Subtask A was to provide a picture of the state-of-the-art of solar assisted cooling. This includes the evaluation of projects realized in the past.

Subtask B: Design Tools and Simulation Programs

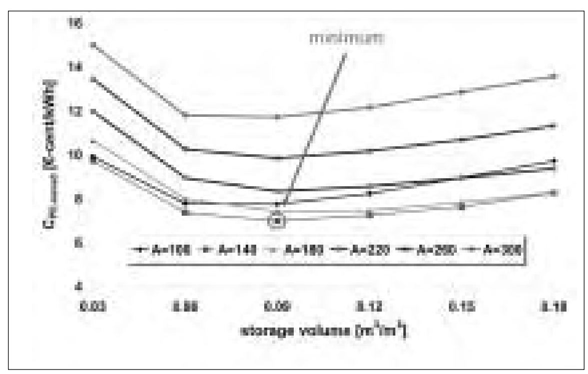
The objective of Subtask B is to develop design tools and detailed simulation models for system layout, system optimization and development of advanced control strategies of solar assisted air conditioning systems. The main result will be an easy-to-handle design tool for solar assisted cooling systems dedicated to planners, manufacturers of HVAC systems and building engineers.

Subtask C: Technology, Market Aspects and Environmental Benefits

The objectives of Subtask C are to provide an overview on the market availability of equipment suitable for solar assisted air conditioning and to support the development and market introduction of new and advanced systems. Design-guidelines for solar assisted air conditioning systems will be developed and target groups dealing with solar assisted air conditioning will be addressed at workshops and in brochures produced in national languages.

Subtask D: Solar Assisted Cooling Demonstration Projects

Several demonstration projects are



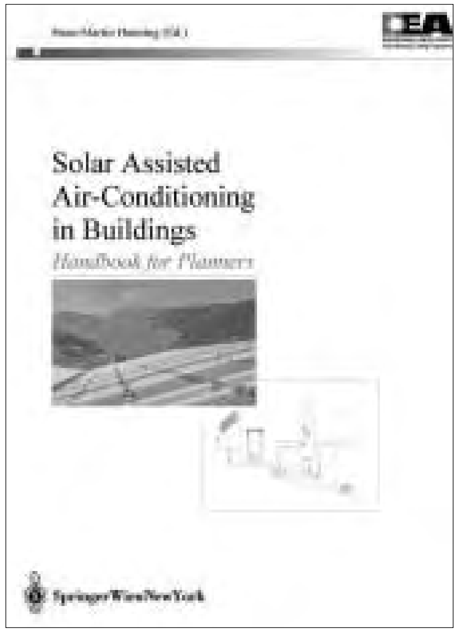
Example of a system design for solar assisted air conditioning of a hotel in Madrid, Spain that uses methods developed in SHC Task 25. This configuration of collector size and storage volume leads to a minimum in the cost of saved primary energy (expressed in _-cent per kWh of primary energy). This cost figure allows identification of the 'best' combined energy-cost performance.

carried out and evaluated in the framework of SHC Task 25. The objectives are to achieve practical experience with solar assisted cooling in real projects and to make data for the validation of the simulation tools available. The aim is to study the suitability of the design and control concepts and to achieve reliable results about the overall performance of solar assisted air conditioning in practice.

Duration

The Task was initiated in June 1999 and will be completed in November 2004.

Chamber for Trade & Commerce building in Freiburg, Germany. A desiccant cooling system (10200 m^3/h) with 100 m^2 of solar air heating collectors is used to air condition the seminar room on top of the building. The plant is being monitored under the framework of SHC Task 25, Subtask D.



ACTIVITIES DURING 2003

Important Task activities were:

- Finalization of a technical report on finished and ongoing R&D projects in the participating countries on new technologies (solar, cooling) which are useful for solar assisted air conditioning.
- Finalization of the handbook for planners, entitled *Solar Assisted Air-Conditioning in Buildings - A Handbook for Planners.*
- In several countries national workshops with professionals were carried out.
- The desiccant cooling demonstration model was shown at the Light & Building Trade Fair in Abu Dhabi in January 2003.
- The first detailed results from many of the Subtask D demonstration systems were obtained.

Subtask B: Design Tools and Simulation Programs

Work on mathematical models for all key components of solar assisted air conditioning systems has been completed; some component models are also available for TRNSYS (adsorption chiller, single-effect absorption chiller). A complete version of the WINDOWS design tool with user-friendly interface is available and being tested by Task participants. Reference load files for 21 combinations of buildings (hotel, office, seminar room) and climates are available.

Subtask C: Technology, Market Aspects and Environmental Benefits

The handbook for planners, which is a major result of Subtask C, was finished. The study on completed and ongoing national R&D work on new components was finished. New work was started on the creation of a tool for decision-making ("decision-tree") in an early phase of a project. Also a multi-coloured brochure about solar assisted air conditioning is in preparation which will be produced in several national languages.

Subtask D: Solar assisted cooling demonstration projects

Twelve demonstration projects are part of Task 25. All systems are in operation. From about 8 systems detailed measurement data were analyzed and are available. Insights

Solar collector of the world's largest solar assisted cooling system in Greece at the Sarantis cosmetics factory (2700 m^2 collector area).

on the overall energy balances as well as technical problems and shortcomings of systems were achieved, and in some cases could be solved.

WORK PLANNED FOR 2004

Subtask A has been completed. Work in Subtasks B and C will be finished in May 2004. This includes several dissemination activities, such as participation at international conferences and trade-fairs on air-conditioning, production and distribution of the brochure and workshops with professionals in national languages. The design tool will be ready for providing it to users. Subtask D will continue until November 2004. Monitoring of the systems will continue during summer 2004 and all results (energy balances, operation experiences and problems, lessons learned) will be documented in a technical report.

REPORTS PUBLISHED IN 2003

Solar Assisted Air-Conditioning in Buildings - A Handbook for Planners. Springer Vienna, New York, 2003 (ISBN 3-211-00647-8).

Ongoing Research Relevant for Solar Assisted Air Conditioning of Buildings. Technical Report (available on the SHC Task 25 web page at www.iea-shc.org).

REPORTS PLANNED FOR 2004

Technical Report about the Subtask D projects.

Multi-colour brochure on solar assisted air conditioning for professionals in national languages.

MEETINGS IN 2003

Eighth Expert Meeting
April 3-4
Palermo, Italy

Ninth Expert Meeting
October 13-14
Barcelona, Spain

MEETINGS PLANNED FOR 2004

Tenth Expert Meeting
April 19-20
Lisbon, Portugal
(including participation at CLIMAMED Conference in Lisbon on April 16-17)

Eleventh Experts Meeting
To be determined

TASK 25 NATIONAL CONTACT PERSONS

Operating Agent
Hans-Martin Henning
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 5
D-79100 Freiburg
Germany

Austria
Michael Neuhäuser
(leader Subtask C)
Arsenal Research
Faradaygasse 3, Objekt 210
1030 Vienna

Wolfgang Streicher
Technical University Graz
Inffeldgasse 25
A-8010 Graz

France
Jean-Yves Quinette
(Leader Subtask D)
Tecsol
105, rue Alfred Kastler - Tecnosud - B.P. 434,
F-66004 Perpignan

Germany
Uwe Franzke (Leader Subtask B)
Institut für Luft- und Kältetechnik
Bertolt-Brecht-Allee 20
D-01309 Dresden

Greece
Constantinos A. Balaras
Group Energy Conservation
IERSD, National Observatory of Athens
Metaxa & Vas. Pavlou
R 15236 Palea Penteli

Israel
Gershon Grossman
Technion Haifa
Haifa 32000

Italy
Federico Butera
Politecnico di Milano
via Bonardi, 3
20133 Milano

Japan
Hideharu Yanagi
Mayekawa MFG.Co., LTD.,
2000, Tatsuzawa Moriya-Machi, Kitasoma-Gun
Ibaraki-Pref. 302-0118

Mexico
Wilfrido Rivera
Universidad Nacional Autonoma de Mexico
Apdo. Postal #34 Temixco 62580
Morelos

Netherlands
Daniel Maron
TNO Building & Construction Research
Schoemakerstraat 97, P.O. Box 49
2600 AA Delft

Portugal
João Farinha Mendes
DER / INETI, Edificio G
Estrada do Paco do Lumiar, 22
1649-038 Lisboa

Spain
Jordi Cadafalch
Universitat Politècnica de Catalunya
C/ Colom, 11
E-08222 Terrassa (Barcelona)

TASK 26:

Solar Combisystems

Werner Weiss
AEE, Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Operating Agent for the Austrian Ministry of Transport, Innovation and Technology

TASK DESCRIPTION

Solar heating systems for combined domestic hot water preparation and space heating, so called solar combisystems are increasing their market share in several countries. Much is already known about solar domestic hot water systems, but solar combisystems are more complex and have interaction with extra subsystems. These interactions profoundly affect the overall performance of the solar part of the system.

The general complexity of solar combisystems has led to a large number of widely differing system designs, many only very recently introduced onto the market. After the first introduction of combisystems during 1975-1985, when the design of non-standard and complex systems by engineers was the rule, a new period began in 1990. At this time, solar companies that were interested in selling less complex and cheaper systems began to take over from the engineers and design combisystems. However, the current designs were the result mainly of field experiences and have not yet been carefully optimized. As a result, there was substantial potential for cost reduction, performance improvement and increase in reliability, areas SHC Task 26 would begin to address.

Scope and Main Activities

SHC Task 26 reviewed, analyzed, tested, and compared, optimized and improved designs and solutions of solar combisystems for:

Solar Combisystem with facade-integrated collector array in Germany.
(Source: Wagner & Co, Germany)

- detached single-family houses,
- groups of single-family houses, and
- multi-family houses or equivalent in load with their own heating installations.

The Task did address solar district heating systems, systems with seasonal storage and central solar heating plants with seasonal storage.

To accomplish the objectives of the Task, the Participants carried out research and devel-opment in the framework of the following three Subtasks:

- Subtask A: Solar Combisystems Survey and Dissemination of Task Results (Lead Country: Switzerland)
- Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components (Lead Country: The Nether-lands)
- Subtask C: Optimization of Combisystems for the Market (Lead Country: Austria)

Besides 37 experts from 10 countries, 16 companies from almost all the participating countries took part in the work. Their contributions made the results of the Task more relevant to the solar heating industry in general.

Duration

The Task was initiated on December 1, 1998 and completed on December 31, 2002.

Participation

A total of eight countries have participated in the Task throughout its duration. These were:

Austria	Netherlands
Denmark	Sweden
France	Switzerland
Germany	USA

Two other countries, Finland and Norway participated, but not throughout the whole duration. Finland participated from December 1998 to December 2001. Norway joined the Task in October 1999 and participated until December 2002.

All participating countries have been very active and have participated in the work in all the Subtasks. Between 26 and 30 experts attended each meeting, with very little exchange of persons from meeting to meeting, ensuring good continuation in the work. The experts comprised both researchers from universities and research institutions, and engineers from private companies.

TASK ACCOMPLISHMENTS

Subtask A: Solar Combisystems Survey and Dissemination of Task Results

On one hand, Subtask A was a service subtask for the other two subtasks, especially in the first and the last year of SHC Task 26 operation. Parameters and reference conditions were defined, which then were used for the system performance simulation in Subtask C and as a background for the development of test methods by Subtask B. As planned, Subtask A produced and published—after one year of intensive co-operative work—an overview of the solar combisystems on the market in the participating countries. This color booklet became the main reference for all subsequent work in the Task. At the same time, this booklet was a good 'flag' attracting the attention of architects, engineers, industry and public offices to the ongoing Task work.

The second main activity of Subtask A was the co-ordination and editing of the design handbook for solar combisystems, was published by James & James. This handbook contains all of the main results of SHC Task 26, and includes important chapters directly related to specific Subtask A activities.

There were also more specific activities of Subtask A. At the beginning, criteria were defined for the analysis of solar combisystems, resulting in a classification of solar combisystems based on their hydraulic scheme—this was pre-normative work with results passed to the Technical Committee CEN/TC 312 in charge of European standards for solar heating systems—and in a number of considerations over durability and reliability of solar combisystems. These aspects are of great practical relevance for industry, planners and installers. Subtask A focused particularly on the stagnation behaviour of solar collectors, collector arrays and solar combisystems. New results have been obtained, which are significant advances from the point of view of durability and reliability of solar heating systems with a large collector area leading to considerable excess heat in summer time. Design rules have been defined for collectors, collector arrays and collector loops. One different way to address this issue is to move to drainback technology for the collector loop. With growing collector areas, architectural integration of collector arrays into roofs and facades becomes increasingly important for a large market penetration of the technology. This topic was addressed by Subtask A, with significant advances as well. Finally, in co-operation with the Operating Agent, Subtask A organised seven well-attended Industry Workshops in conjunction with the regular Expert's Meetings.

In summary, all of the objectives of the Subtask A work plan were achieved, some of them even to a larger extent than originally expected.

Subtask B: Development of performance test methods and numerical models for combisystems and their components

In Subtask B, a major step was taken in the development of tools for characterisation, comparison and assessment of prototypes and products. Test procedures for revealing the thermal performance of test procedures were designed and evaluated. Attention towards the simplification of testing resulted in the AC/DC test method and the Direct Characterisation (DC) test method, both having a 6-day core phase and making assumptions for the heat distribution system. The DC test procedure does not even require a numerical model to reveal the annual system performance. Another test method, the 12-day Concise Cycle Test (CCT) method, also takes into account the control of the heat distribution system. The already available CTSS (Component Testing - System Simulation) method acted as reference. Every method has specific characteristics with respect to accuracy, reproducibility and possibility for extrapolation of test results for other operational conditions and system sizes.

Parallel to the development of test methods, test facilities for solar combisystems were designed and built. Test facilities are available now and will be ready soon in five European countries. Tests have been restricted to comparison testing with CTSS, but soon DC and CCT tests will be carried out. Construction of test facilities required more effort than planned. That is why, in the time frame of SHC Task 26, reproducibility testing of one system in different laboratories could not be carried out. Participants discussed whether or not to introduce one or more of the simpler solar combisystem test methods as work item to CEN, the European standards organisation. It was decided to wait until more validation experience and more support from industry is available.

The comfort aspect of solar combisystems was accounted for through the development of a simple hot water comfort test method. Three combisystem heat stores were tested successfully using this procedure. Apart from model development for the test method design, choice and development of numerical models took place in Subtask C.

Subtask C: Optimisation of Combisystems for the Market

In Subtask C, nine systems were modelled in detail. This is two systems less than proposed in the revised work plan from March 2001, but a change was needed due to less manpower available and the financial situation of some participants. One of the conclusions of this subtask is that it is very difficult and time consuming to find common reference conditions for the different solar combisystems and compute the results in order to deliver comparable results, as also was found in Subtask B. In addition, the simulation models used for parts of the combisystems had to be deeply analyzed in order to know how to use them to achieve results close to reality. Each participant will distribute the system simulation models separately in order to prevent proprietary information from being disseminated. Nevertheless, the detailed system reports provide a good overview and show which parameters have high and which have low significance for the fractional savings. The main parameters seem to be collector area, azimuth and slope, storage volume, control strategy and settings, and hydraulics.

The optimisation of systems is, of course, a multi-dimensional effort and therefore again complicated. First results show, that optimised systems that take into account minimum store volumes for the auxiliary heater, prevent water from being mixed to lower temperatures (second thermodynamic law), operate the collector at low temperature and use as few pumps as possible, show similar good performance. These conclusions will be drawn in the report on the comparison of the systems.

ACTIVITIES DURING 2003

Activities were focused on editing the book, *Solar Heating Systems for Houses – A Design Handbook for Solar Combisystems.*

LINKS WITH INDUSTRY

Sixteen companies from almost all the participating countries are taking part in SHC Task 26. The Industry Workshops, which were jointly organized by Subtask A and the Task's Operating Agent, received positive responses from industry. Between 11 and 50 industry representatives attended each workshop.

LINKS WITH CEN TC 312

A liaison status has been granted to

Solar combisystem with 22.7 m² façade-integrated collector in Austria

SHC Task 26 with CEN/TC 312 "Thermal solar systems and components," by Resolution 7/99. CMC (CEN Management Center) has recorded as interface between the CEN/TC 312 and SHC Task 26.

The Subtask A Leader, J.-M. Suter, attended the November 2001 CEN/TC 312 meeting in Athens, Greece. At this meeting the liaison officer reported on the progress of SHC Task 26 work, especially on: (1) the classification of combisystems developed within Subtask A and published 2000 in the coloured booklet 'Overview of Solar Combisystems.', and (2) The development of test procedures within Subtask B. CEN/TC 312 acknowledged the extensive information and passed the following resolution #2.

The possible work item for CEN on test procedures for solar combisystems was discussed. It was agreed to start this work after validation of the proposed test methods and when more practical experience with testing is available. Still open is which test methods the work item should contain, probably CTSS and DC but maybe more.

KEY REPORTS AND PUBLICATIONS

The main results of SHC Task 26 are a design handbook, several technical reports, design tools and proceedings from six industry workshops, many of which can be downloaded from the Task page on the web site of the SHC Programme, www.iea-shc.org

Solar Heating Systems for Houses – A Design Handbook for Solar Combisystems.

This book summarises all the results of SHC Task 26. The focus is on heat demand of buildings, different system designs and built examples, building-related aspects like space requirements of the systems and architectural integration of collector arrays, performance as well as durability and reliability of solar combisystems, and last but not least, dimensioning and testing of solar combisystems. Published by James and James (Science Publishers).

CombiSun Design Tool

In the area of combisystem characterisation, the scheme named FSC Procedure, introduced by the French participant, has turned up to become a major powerful tool for solar combisystems. The FSC scheme has similarities with f-chart, the well-known design tool for solar water heaters. Data from Subtask C has been used to characterise some 10 generic systems. The characteristic functions obtained for each of them are the main background information for a simple design tool–called CombiSun–for architects and engineers. With this tool, solar combisystems can be compared and properly sized according to specific requirements from the practice.

Technical Reports

The technical reports document specific results and findings of SHC Task 26 and provide details and background information on the topic presented. The following technical reports are available on the SHC Programme web site:

- Comparison of solar combisystems, architectural and reliability/durability aspects
- Performance test of solar combisystems
- Optimization of solar combisystems

Meetings

Proceedings of Industry Workshops

Oslo, Norway, April 8, 2002
Rapperswil, Switzerland, October 10, 2001
Delft, the Netherlands, April 2, 2001
Espoo, Finland, October 9, 2000
Borlänge, Sweden, April 3, 2000
Stuttgart, Germany, October 4, 1999

TASK 26 NATIONAL CONTACT PERSONS

Operating Agent
Werner Weiss
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf
Austria

Austria
Irene Bergmann and Robert Hausner
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf

Wolfgang Streicher and
Richard Heimrath
Technical University of Graz
Institut für Wärmetechnik
Inffeldgasse 25
A-8010 Graz

Denmark
Simon Furbo, Louise Jivan Shah
and Elsa Andersen
Solar Energy Center Denmark
Technical University of Denmark
Department of Buildings and Energy
Building 118
DK-2800 Lyngby

Klaus Ellehauge and
Line Louise Overgaard
Solar Energy Center Denmark
Teknologisk Institut
DK-8000 Aarhus C

Finland
Petri Konttinen
Helsinki University of Technology
Advanced Energy Systems
P.O. Box 2200
FIN-02015 HUT

France
Thomas Letz
ASDER
BP 45
299, rue du Granier
F-73230 Saint Alban-Leysse

Philippe Papillon
Clipsol-Recherche
Z.I.
F-73100 Trevignin

Rodolphe Morlot
CSTB
Energie, Environment Interieur et Automatisimes
Route des Lucioles
Boite postale 209
F-06904 Sophia Antipolis Cedex

Germany
Harald Drück and
Henner Kerskes
Stuttgart University
ITW
Pfaffenwaldring 6
D-70550 Stuttgart

Klaus Vajen and
Ulrike Jordan
Kassel University
Dpt. of Mech. Engineering
Solar and System Technology
D-34109 Kassel

Netherlands
Huib Visser
TNO
Building and Construction Research
Division Building & Systems
P.O. Box 49
NL-2600 AA Delft
Visiting address:
Schoemakerstraat 97
NL-2628 VK Delft

Norway
Michaela Meir, Markus Peter and
Bjørnar Sandnes
University of Oslo
Department of Physics
P.O.BOX 1048, Blindern
N-0316 Oslo

Sweden
Peter Kovacs
SP-Swedish National Testing & Research
Institute
Box 857
S-501 Boras

Chris Bales and
Klaus Lorenz
Högskolan Dalarna
Solar Energy Research Center -
SERC EKOS
S-78188 BorÄnge

Bengt Perers and
Stefan Larsson
Vattenfall Utveckling AB
The Swedish National Power Board
P.O. Box 1046
S-61129 Nyköping

Switzerland
Jean-C. Hadorn
Swiss Research Program
CH-1035 Bournens

Jean-Marc Suter
Suter Consulting
Postfach 130
CH-3000 Bern 16

Ueli Frei, Peter Vogelsanger and
Beat Menzi
SPF-HSR
Postfach 1475
CH-8640 Rapperswil

Philippe Dind, Olivier Renoult,
Jacques Bony and Thierry Pittet
School of Engineering (EIVD)
Route de Cheseaux 1
CH-1400 YVERDON-LES-BAINS

United States
William A. Beckman
University of Wisconsin
Solar Energy Lab
1500 Engineering Drive
Madison, Wisconsin 53706

TASK 26 INDUSTRY PARTICIPANTS

Austria
Christian Holter
SOLID
Herrgottwiesgasse 188
A- 8055 Graz

Martin Bergmayr
Solarteam GmbH
Jörgmayrstraße 12
A-4111 Walding

Peter Prasser
Sonnenkraft GmbH
Resselstrasse 9
A-9065 Ebental

Denmark
Emanuel Brender
Batec A/S
Danmarksvej 8
DK 4681 Herfolge

Finland
Janne Jokinen
Fortum Advanced Energy Systems
P.O. Box 100
FIN-00048 Fortum

France
Philippe Papillon
Clipsol
Zone Industrielle
F-73100 Trevignin

Germany
Thomas Krause and Dagmar Jaehnig
SOLVIS- Solarsysteme GmbH
Marienberger Straße 1
D-38122 Braunschweig

Andreas Siegemund
Consolar Energiespeicher- und
Regelungssysteme GmbH
Dreieichstrasse 48
D-60594 Frankfurt

Norway
John Rekstad
SolarNor AS
Erling Skjalgssons gate 19 B
N-0267 Oslo

Sweden
Bo Ronnkvist
Borö-Pannan AB
Bangardsuagen 1
S-95231 Kalix

Switzerland
M.C. Jobin
AGENA
Le Grand Pré
CH-1510 MOUDON

Fritz Schuppisser
SOLTOP Schuppisser AG
St. Gallerstrasse 7
CH-8353 ELGG

Josef Jenni
Jenni Energietechnik AG
Lochbachstrasse 22
CH-3414 Oberburg

Netherlands
Erwin Janssen
ATAG Verwarming B.V.
P.O. Box 105
NL-7130 AC Lichtenvoorde

Edwin van den Tillaart
Daalderop B.V.
P.O. Box 7
NL-4000 AA Tiel

Paul Kratz
Zonne-Energie Nederland
De Run 5421
NL-5504 DG Veldhoven

TASK 27:

Performance of Solar Facade Components

Michael Köhl
Frauhofer Institute for Solar Energy Systems
Operating Agent for the Forschungszentrum Jülich

TASK DESCRIPTION

The objectives of this Task are to determine the solar visual and thermal performance of materials and components, such as advanced glazing, for use in more energy efficient, comfortable, sustainable buildings, on the basis of an application oriented energy performance assessment methodology; and to promote increased confidence in the use of these products by developing and applying appropriate methods for assessment of durability, reliability and environmental impact.

Scope

The work is focusing on solar facade materials and components selected from the following:

- Coated glass products
- Edge sealed glazings, windows and solar façade elements
- Dynamic glazing (i.e., electrochromic, gasochromic and thermochromic devices, thermotropic and other dispersed media)
- Antireflective glazing
- Light diffusing glazing
- Vacuum glazing
- Transparent insulation materials
- Daylighting products
- Solar protection devices (e.g., blinds)
- PV windows
- Solar collector materials, including polymeric glazing, facade absorbers and reflectors.

Means

The work in Task 27 is carried out in the framework of three subtasks:

- Subtask A: Performance (Lead Country: Netherlands)
- Subtask B: Durability (Lead Country: Sweden)
- Subtask C: Sustainability (Lead Country: France)

Main Deliverables

Subtask A: Performance

- A further developed coherent energy performance assessment methodology to enable comparison and selection of different products and to provide guidance for their assembly and integration into building envelope elements.

- A structured data base of components and façade elements to present data in a consistent and harmonised form, suitable for product comparison and selection and for simulation of performance in specific applications.

- Recommended calculation and test methods for solar and thermal performance parameters in support of international standards development.

Subtask B: Durability

- A validated methodology for durability assessment of advanced solar building materials.

- An estimation of the service lifetime based on degradation of performance for selected materials tested.

- Recommended standard test procedures for service life testing of selected materials and components.

Subtask C: Sustainability

- A review of international knowl-

View of the test box for outdoor exposure and meteorological instruments at CSTB in France.

edge base, tools, actions and requirements related to glazing, windows and solar components.

- An overview of the FMEA tool capabilities, adaptation to the field of glazing, windows and solar components, and guidelines for using it in the assessment of possible shortening/reduction of the service life.

Duration
The Task was initiated in January 2000. Subtask C was completed in December 2003. Subtasks A was extended until end of 2004 and Subtask B will continue until end of 2005.

ACTIVITIES DURING 2003
Overall, good progress was achieved on the main issues of performance, durability and sustainability.

Subtask A: Performance
The extended report on performance indicators and terminology was completed. More emphasis was put on fenestration rating tools as a result of a respective workshop during the April Experts meeting. A work plan for the extension was prepared that includes a general energy performance assessment methodology and performance testing of solar control devices and daylight redirecting devices. A final report will be available the beginning of 2004. Results of modelling the performance of buildings equipped with switchable glazing were compared. This work will be extended for another year.

Subtask B: Durability
The general methodology for durability assessment has been defined and disseminated through articles and conference papers. The adaptation of durability assessment methodology to specific chromogenic requirements was carried

Outdoor-weathering of reflector and absorber samples in Freiburg, Germany.

out. Two different samples (electrochromic and gasochromic) were exposed to natural weathering in Grenoble (France) and Freiburg (Germany) for comparison with accelerated testing.
Activities in durability testing of switchable glazings were finished, despite not having reached all goals due to funding problems. A final report will be prepared the beginning of 2004, which will include recommendations for test procedures.

Candidate materials for durability and reliability assessment of static solar materials are investigated in the framework of the following case studies:

- Anti-reflective and polymeric glazing materials
- Reflectors
- Solar facade absorbers

Initial risk analysis was performed, and samples are being exposed on outdoor test facilities at different locations with monitoring of the relevant optical properties and climatic data.

The first round of accelerated screening tests is nearly completed for all the case studies. This work in durability testing needs more time because the comparison of the degradation after the accelerated tests with the degradation in real operation is necessary for the development of the life time tests. In addition, some of the samples are very durable and need more time for outdoor exposure for enabling a reliable detection of the degradation phenomena.

Subtask C: Sustainability
A first attempt of data processing was completed for examples performed on reference products. The methodology report (nominal service life prediction and anticipation of premature termination), application to an example as well as the terminology report and the state of the art report were completed.

Methodology for environmental impact assessment was developed and exemplarily applied to "solar collectors" in one case study and to a "wooden frame window with a double glazed sealed unit" in a second case study.

Methodology for Failure Mode and Effect Analysis was used within three case studies:

- Double Glazing Unit / Insulated Glazing a Double Glazed Sealed Unit
- Argon filled Low-e Coated Glazing (Major contributions from Aspen Research, USA)
- Solar Collector

Two of three case studies were finished. The case study on argon filled low-e coated glazing will be finished in 2004 and serve as a starting point for a project on service life prediction tools for complete systems.

WORK PLANNED FOR 2004

Subtask A: Performance

Some experts will concentrate on the issue of simplified tools for cooling and ventilation plus lighting issues, as the transparent simple methodologies close to EN 13790/EN832 are favored by building authorities. This is important because the countries of the European Union have to implement nationally the Energy Performance Directive for Buildings. The experimental work will be focused on solar shading and daylight devices.

Subtask B: Durability

The extension of the work for the next two years will focus on durability tests static solar materials and the joint case study on service life prediction tools for complete systems.

This work is aimed at adopting and comparing existing tools for service life prediction of selected systems with the purpose of improving existing durability test methods for qualification of the systems. It will be conducted in parallel with the other sub-projects concerning window/wall interfaces, insulating glass units and chromogenics.

The first objective is to integrate a materials oriented approach to service life prediction with a system oriented approach for the selected systems of solar collectors. The analysis starts with a Failure Modes and Effect Analysis, FMEA, of the complete system. Then, by making use of the methodology for initial risk analysis, IFMA, on each material and materials combinations, the risk associated with each degradation mechanism of materials or materials combinations is estimated. In the risk assessment, the expected service life associated with each failure mechanism identified is also estimated. Based on this analysis the critical factors determining the long-term performance and service life of the solar collector are possible to rank.

The second objective is then to critically review the existing qualification test standards for the selected systems with respect to durability assessment. Are the proposed test methods and qualification criteria in agreement with the risk assessment made? Are test methods missing or can some test methods be excluded from the existing qualification standards? Can some system tests be replaced by materials or materials combination tests?

The third objective is to make use of existing data on service life on materials, components and complete solar collectors for data fusion to estimate reliability versus service time relationship for each kind of system type studied. To estimate the service life of the systems also the so-called factor method described in ISO 15686-1 will be critically reviewed and its limitations for estimating service life clarified.

Work will focus on:

- FMEA analysis of selected systems for study.
- Adoption of the initial failure mode analysis (IFMA) of the B1 methodology to identify and estimate the risks associated with the most critical degradation mechanisms and failure modes of the complete systems selected for study.
- Analysis and critical review of existing qualification test standards for the selected systems.
- Assessment of a service life prediction by applying the data fusion tool to all existing data on service life duration for each selected system.
- Adoption of the factor method for service life prediction of the selected systems.
- Recommendations for future work on qualification test standards on the selected systems.

A series of case studies are planned. They are:

- Window/wall interface
- IG-Units
- Solar Collectors
- Chromogenic glazings (if the manufacturers would be interested)

LINKS WITH INDUSTRY

Nine companies from five countries are participating in SHC Task 27. Through these industry links, the participants of SHC Task 27 can ensure the valuable use of its research results. See the list of SHC Task 27 national contact persons for further details.

MEETINGS 2003

Seventh Experts Meeting
April 1-4, 2003
Lisbon/Portugal
With a workshop with local industry and research institutes.

Eighth Experts Meeting
October 6-9, 2003
Freiburg/Germany
With a workshop with local industry and research institutes.

MEETINGS PLANNED FOR 2004

Ninth Experts Meeting
May 16-19, 2004
Lund/Sweden

Tenth Experts Meeting
October, 2004
Rosenheim/Germany
In conjunction with the "Rosenheimer Fenstertage"

TASK 27 NATIONAL CONTACT PERSONS

Operating Agent
Michael Köhl
Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg
Germany

Belgium
Magali Bodart
Université Catholique de Louvain
Architecture et Climat
Place du Levant 1
1348 Louvain-la-Neuve

Canada
Hakim Elmahdy
National Research Council of Canada
Institute Research in Construction
Montreal Road
M-24, Ottawa, Ontario K1A OR6

Denmark
Svend Svendsen
Technical University of Denmark
Department of Civil Engineering
Building 118
2800 Lyngby

Karsten Duer
VELUX A/S
Maskinvej 4
2860 Soborg

Finland
Ismo Heimonen
VTT Building and Transport
Building Physics and Indoor Climate
P.O. Box 1804
02044 VTT

France
Jean-Luc Chevalier
CSTB Centre Scientifique et Technique du Batiment
24, Rue Joseph-Fourier
38400 Saint-Martin d'Heres

Denis Covalet
EDF - Electricité de France Division Recherche et Dévelopment
Site des Renardieres
77818 Moret-sur-Loing

Xavier Fanton
Saint-Gobain Recherche
B.P. 135
93303 Aubervilliers

Richard Mitanchey
ENTPE
Le Laboratoire des Sciences de l´Habitat
de l´Ecole des Travaux Publics de l´Etat
Vaulx-en-Velin

Germany
Michael Freinberger
ift. Rosenheim
Theodor-Gietl -Straße 7-9
83026 Rosenheim

Joachim Göttsche
FH Aachen
Solar-Institut Jülich
Abteilung Solares Bauen
Heinrich-Mussmann-Str. 5
52428 Juelich

Werner Platzer
Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg

Helen Rose Wilson
Interpane E & BmbH c/o Fraunhofer ISE
Heidenhofstr. 2
79110 Freiburg

Dirk Joedicke
FLABEG GmbH & Co. KG
Glaserstr. 1
93437 Furth i. Wald

Italy
Maurizio Cellura
DEAF - Università di Palermo
Viale delle Scienze
Palermo
90128

Michele Zinzi
ENEA
Via Anguillarese 301
00060 S.Maria Di Galeria, Roma

Netherlands
Dick van Dijk
TNO Building and Construction Research
Department of Sustainable Energy and Buildings
P.O. Box 49
2600 AA Delft

Norway
Ida Bryn
Erichsen & Horgen A/S
P.O. Box 4464 Torshov
0403 Oslo

Portugal
Maria João Carvalho
Instituto de Technologias Energeticas (INETI)
Estrada do Paço do Lumiar 22
1649-038 Lisboa

Sweden

Bo Carlsson
SP Swedish National Testing and Research Institute
Materials Technology Section for Polymers
Box 857
50115 Boras

Björn Karlsson
Vattenfall Utveckling AB
Solar Energy
814 26 Älvkarleby

Arne Roos
University Uppsala
The Angstrom Laboratorium
Box 534
75121 Uppsala

Switzerland

Stefan Brunold
Institut für Solartechnik SPF
Hochschule Rapperswil HSR
Oberseestrasse 10
8640 Rapperswil

Hans Simmler
EMPA Eidgenössische Materialprüfungs- und Forschungsanstalt
Überlandstr. 129
8600 Dübendorf

United States

Dragan Curcija
University of Massachusetts
Center for Energy Efficiency and Renewable Energy
Engineering Lab Building
160 Govenors Dr.
Amherst, MA 01003-2210

James Fairman
Aspen Research Coorp.
1700 Buerkle Road
White Bear Lake, MN 55110

Gary Jorgensen, Roland Pitts
NREL
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393

Mike Rubin
Lawrence Berkeley National Laboratory University of California
MS 2 - 300
1 Cyclotron Road
Berkeley, CA 94720

TASK 28 / ECBS ANNEX 38:

Sustainable Solar Housing

S. Robert Hastings
Architecture, Energy and Environment GmbH
Operating Agent for the Swiss Federal Office of Energy

TASK DESCRIPTION

The goal of this Task is to help participating countries achieve significant market penetration of sustainable solar housing by the year 2010, by providing home builders, institutional real estate investors and banks with:

- A **Task web site** illustrating built projects, exemplary in design, living quality, low energy demand and environmental impact.
- Documentation sets of *Exemplary Sustainable Solar Housing* as a basis for local language publications to communicate the experience from built projects and motivate planers to develop marketable designs.
- A handbook: *Marketable Sustainable Solar Housing*: with guidelines, graphs and tables derived from building monitoring, lab testing and computer modeling.
- **Demonstration buildings** with press kits for articles and brochures in local languages to increase the multiplication effect beyond the local region.
- **Workshops** after the Task conclusion presenting the results of the Task.

Participation

Sharing the work of the Task this period are experts from 16 countries:

Austria	Italy
Australia	Japan
Belgium	Netherlands
Brazil	New Zealand
Canada	Norway
Czech Republic	Sweden
Finland	Switzerland
Germany	UK/Scotland

Duration

The Task was initiated in April 2000 and is planned for completion in April 2005.

ACTIVITIES DURING 2003

During the year 2003 the emphasis was on producing material for precisely defined publications to be completed by the end of the Task. The goals of this work are to communicate results from research on market strategies for builders, give design advice to planners, inspire building clients with demonstration buildings, and offer insight from detailed data analysis for energy consultants. The topics of energy and ecology over the building lifetime are well covered, and economics and costs are to be more adequately addressed. A working group is examining the important topic of sustainable housing in hot climates. Following is a sample of activities and results by Subtask and working groups.

Subtask A: Market-Assessment and Communication

Marketing success stories for sustainable housing projects, programs or products were documented and analyzed by a professional marketing consultant firm. The objective was to identify common threads suggesting effective marketing strategies within the framework of classical market approaches. An example is a SWOT analysis (strengths, weaknesses, opportunities and threats). The Subtask received substantial reinforcement from the Norwegian State Housing Bank, which is backing the publication of Subtask A results. Work in 2003 for this publication

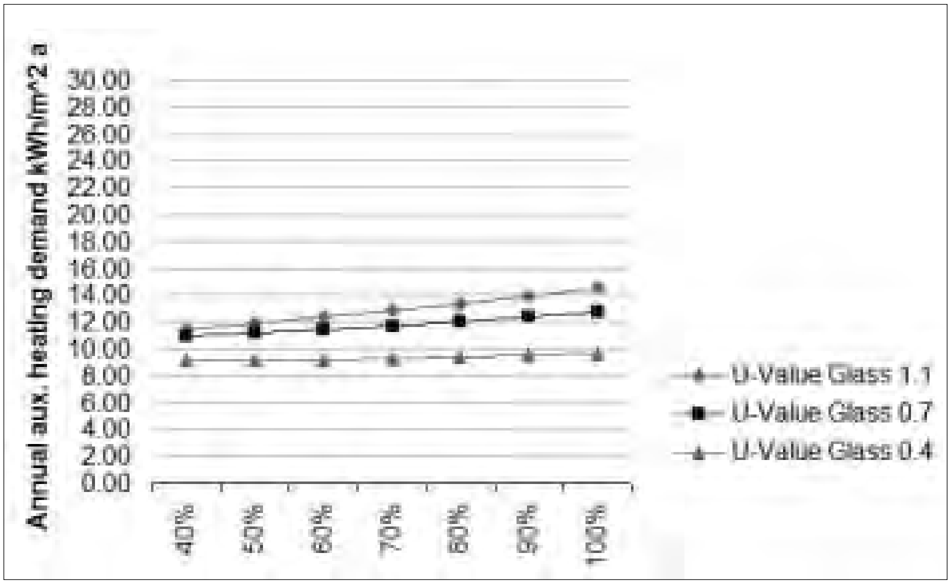


Figure 1a. Auxiliary heating for a middle apartment as a function of glass to facade area and glass type in Zurich. (Source: L. Junghans, AEU Gmbh, Switzerland)

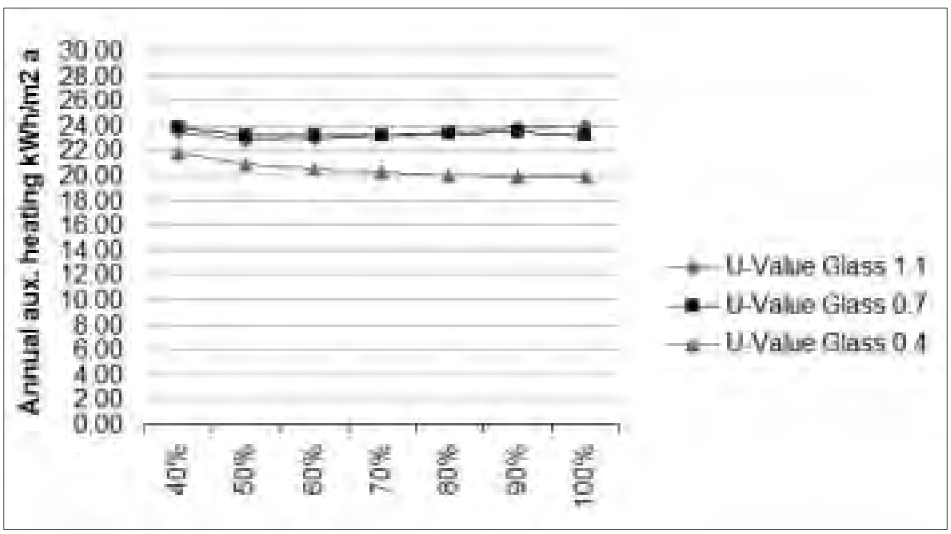


Figure 1b. Auxiliary heating for a top corner apartment as a function of glass to facade area and glass type in Zurich. (Source: L. Junghans, AEU Gmbh, Switzerland)

included:

- Documentation of 20 marketing success stories of which 13 were selected for detailed analysis by SEGEL, a professional marketing consultant in Norway
- Completion of seven sustainable housing market audits by national participants
- Evaluation of seven marketing strategies by the firm Dutch firm, MoBius Consult

Subtask B: Design and Analysis

Work in 2003 consisted of researching and documenting technologies for high performance housing. Combinations of technologies were also investigated. Technology solution sets (TSS) were defined to achieve strategy 1: minimizing losses or 2: maximizing use of renewable energy.

Through computer modeling the sensitivity of key design parameters for the strategies were quantified for many combinations of the three Task 28/38 house types and three climates. An example of results from the modeling work is the usability of passive solar gains through windows depending on the heat losses through the building envelope. For example, a middle apartment, with neighboring apartments to the sides, above and below, has minimal heat losses. Accordingly, heat produced by the occupants and the use of appliances cover the heat losses through late autumn and again starting early in spring. Auxiliary heating is only required during mid-winter when the days are short and the sun is weak. As a result, a middle apartment profits little from passive solar gains and increasing the proportion of window to facade increases the auxiliary heating needed. This is seen in Figure 1a. In the best case, namely, where a very low U-value glass is used, auxiliary heating is insensitive to the window to facade proportion. By contrast, a top corner apartment with exposure on four surfaces has a longer heating season and can profit much more from passive solar gains, as can be seen in Figure 1b. By analogy, a single family detached house or end unit row house also can profit more from passive solar gains than a middle row house.

Subtask C: Demonstration

Subtask C focused on producing

brochures presenting demonstration housing projects in the planning or recently completed stages. Anne Lien of the Netherlands prepared a template for text content and graphics along with a document defining what projects qualify as a SHC Task 28/ECBCS Annex 38 Demo. The energy performance must be less than half current building standard performance. Currently 10 demonstration projects are on the IEA SHC web site for Task 28 under "results." Brochures have been completed for the following demonstration projects:

- Passive housing in Vienna, Austria
- Demonstration houses in Hannover-Kronsberg, Germany (Berthold Kaufmann)
- Demonstration house in Kassel, Germany Berthold Kaufmann)
- ISIS demonstration housing project in Freiburg, Germany (Christel Russ)
- Kanagawa Zero energy house, Japan1 (Motoya Hayashi)
- Kankyokobo Sunny Eco-House, Japan1 (Motoya Hayashi)
- Prefabricated house with PV, Japan (Motoya Hayashi)
- Demonstration house in Monte Carasso, Switzerland (Daniel Pahud)

Subtask D: Monitoring and Evaluation

Data sets from monitored and built housing projects, exemplary for their extreme low energy use, were analyzed and missing data was collected. Work on the technical report: "Design Insights from the Analysis of 50 Sustainable Solar houses" has begun. And, these data sets provided the basis for a book produced for German-speaking countries, which is expected to be available in January 2004.

LCA Working Group

The Life Cycle Analysis group completed the first draft of a working document presenting results on the sustainability of selected demonstration projects. The Task is using the definition of sustainability from the 1987 Brundtland Commission Report Our Common Future: "Maintaining the environmental, social and economic system in such a way as to meet the need of the present generation without compromising the ability of future generations to meet their needs."

The working document of the Subtask reviews analysis methods used by the group, describes the underlying principles and limitations. The methods are then used to evaluate selected cases. A final chapter deals with life cycle analysis of various technical solutions for sustainable solar housing. The first case study "The Solar Housing Estate Gelsenkrichen" illustrates two important facts:

- As the heating energy consumption is dramatically reduced as a result of extreme insulation and air tightness, the proportion of energy consumed in the building process increases and also needs careful consideration.
- The energy consumed during construction and then demolition varies greatly among house types as a result of materials and constructions selected.

It is interesting to compare the cumulative energy demand over a 50 year building life time to the operational energy demand. In these houses, about 25 kWh/m_a are used for construction, maintenance and decommissioning over their assumed lifespan. This amount is considerable compared to the primary energy demand for heating purposes of

Figure 2a. Demonstration project in Gelsenkirchen, Germany. *Source: C. Petersdorff, ECOFYS, Germany*

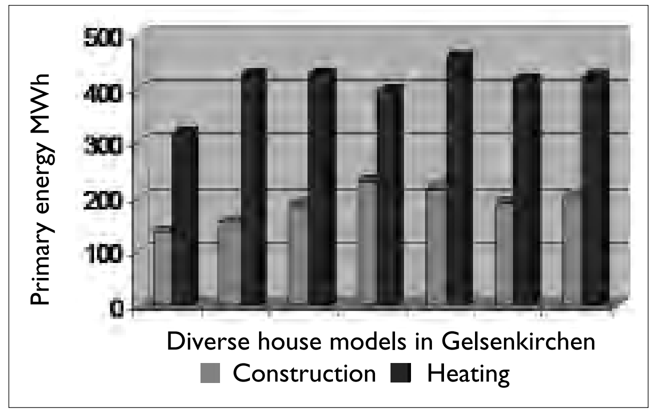


Figure 2b. Cumulative energy demand over the house lifetime vs. heating energy over the same period.
Source: C. Petersdorff, ECOFYS, Germany

Figure 3. A plus energy demonstration house in Austria.
Source: Uwe und Karin Kroiß, Kirchberg-Thening, Austria

approximately 45 kWh/m_a during the same time.

Regarding the energy for construction it is notable that the houses in light construction results in significantly lower energy use compared to the masonry houses (20%). One major factor is the presence or absence of a basement, due to the large amount of embodied energy in reinforced concrete. The difference, in the case of light frame construction above grade, is an increase of 22% of the life cycle energy when a basement is included.

Hot Climates Working Group
A mini-workshop was held in conjunction with the November expert meeting with the following presentations, which will subsequently be part of a publication on sustainable housing in hot climates:

1. *"Solar Sustainable Housing in Malaysia" Keynote* (P. Woods, Malaysia)
2. *"Lifecycle-thinking for Sustainable Housing in Warm Climates, A Case Study"* (R. Hyde, Australia)
3. *"Case studies of high performance houses in Warm climates"* (Nobuyuki Sunag, Japan)
4. *"Misawa House Case study"* (Motoya Hayashi, Japan)
5. *"Case Studies from Iran"* (V. Ghobadian, Iran)
6. *"Simulation Method for Solution Set Analysis"* (Kenichi Hasegawa, Japan)

WORK PLANNED FOR 2004

Subtask A: Task Communication and Market Analysis
Additional success stories will be analyzed, strategies to more effectively market sustainable solar housing identified based on the analysis and results published in the document sponsored by the Norwegian State Housing Bank.

Subtask B: Design and Analysis
Computer analysis of technology solution sets (combinations of technologies optimized by housing type and climate) will be completed, graphs produced and design guidelines extracted from the trends evident in the results. A full draft of the design handbook, including basic principles, strategies with technical solution sets and descriptions of the technologies will be completed.

Subtask C: Demonstration
Additional demonstration projects will be documented in SHC Task 28/ECBCS Annex 38 brochures in the form of PDF files available on Task 28 page of the SHC web site, iea-shc.org. It is interesting to see that some projects produce more energy than they consume, thanks to very energy saving construction and the integration of large PV systems. Figure 3 illustrates one such "energy plus house."

Subtask D: Monitoring & Testing
In the first half of 2004, data sets from 42 projects will be analyzed and a technical report for energy consultants prepared. Trends, insights for planning, and critical indicators of performance will be reported.

LCA Working Group
In 2004, the working group will evaluate three or more demonstration projects and examine the ecological impact of a sample of technologies solution sets selected from Subtask B. Results will be reported in a working document, with conclusions integrated in the Design Handbook.

Hot Climates Working Group
A publication will be drafted reporting on exemplary built projects in the participating countries and examining technologies that use renewable energy to provide comfort. Climates represented are taken from Australia, Brazil, Italy, Iran, Japan and Malaysia and therefore cover both hot and humid climates as well as hot and dry climates.

LINKS WITH INDUSTRY

Many Task experts represent specific industries, for example, Arise Technologies (Canada), ABB and the State Housing Bank (Norway), and Coldwell Banker (USA). In addition, many experts are from private energy consulting firms that work with designers, and are therefore in direct contact with the design profession.

REPORTS PUBLISHED IN 2003

A Comparison of Energy Regulations in 12 Countries Based on IEA 28/38 Reference Buildings.
Smeds, J., Wall, M. & Hastings, R., Working Document.

Demonstration Buildings - Designs, Monitoring and Evaluation.
Voss, K., Working Document.

Energy Targets for Simulations of Typical Solutions for High Performance Housing.
Wall, M. & Hastings, R., Working Document.

REPORTS PLANNED FOR 2004

Design Insights from the Analysis of 50. Sustainable Solar Houses.
C. Russ, Technical Report.

Wohnbauten mit geringem Energieverbrauch - 12 Gebäude: Planung, Umsetzung und Realität (Housing with Minimal Energy Use - 12 Buildings: Planning, Application and Reality).
C. Hofmann, R. Hastings & K. Voss, Muller Publishing, Heidelberg (Germany) ISBN 3-87907-356-2, January 2004.

Creating the Environment Brief.
R. Hyde, et. al. Planned for commercial publication in mid-2004.

Additional brochures on demonstration projects from Austria, Germany, Norway, Sweden, Switzerland and the UK will be published on the IEA SHC web site throughout the year.

MEETINGS IN 2003

Subtask: B Workshop
January 26-27
Siegen, Germany

LCA Workshop
January 28
Cologn, Germany

7th Expert Meeting
April 7-9
Prague, Czech Republic

LCA Workshop
September 22
Zurich, Switzerland

Subtask B Workshop
October 6-7
Wallisellen, Switzerland

8th Expert Meeting
November 4-6
Fraser Island, Australia

MEETINGS PLANNED FOR 2004

Subtask B Workshop
January 29-30
Wallisellen, Switzerland

LCA Working Group
January 29-30
Wallisellen, Switzerland

9th Experts Meeting
April 26-28
Norway

10th Experts Meeting
October
Scotland

SHC TASK 28/ECBCS ANNEX 38 CONTACT PERSONS

Operating Agent
Robert Hastings
(Subtask B Co-Leader)
Architektur, Energie & Umwelt GmbH
Kirchstrasse 1
CH-8304 Wallisellen, Switzerland

Austria
Gerhard Faninger
IFF
University of Klagenfurt
Sterneckstrasse 15
A-9020 Klagenfurt

Australia
Richard Hyde
(Hot Climates Working Group Leader)
Department of Architecture
The University of Queensland
St. Lucia
AUS-4072 Brisbane

Belgium
Andre DeHerde
Architecture et Climat
Univ. Catholique de Louvain
Place du Levant 1
B-1348 Louvain-la-Neuve

Brazil
Marcia Ribeiro
Fed. Univ. of Minas Gerais
Rua Inconfidentes 355/J001
BR-Belo Horizonte, MG CEP-30140-120

Canada
Pat Cusack
Arise Technologies Corp.
321 Shoemaker St.
CDN-Kitchener, Ontario, N2E 3B3

Czech Republic
Miroslav Safarik
ZECM Envir. Institute
Kodanska 10
CR-10010 Praha 10

Germany
Christel Russ (Subtask D Leader)
Fraunhofer ISE
Inst. for Solar Energy System
Heidenhofstr. 2
D-79110 Freiburg

Finland
Jyri Nieminen
VTT Building & Transport
Building Physics
P.O. Box 1803
FIN-02044 VTT

Italy
Francesca Sartogo
PRAU
Via Costabella, 34/36
I-00197 Roma

Japan
Motoya Hayashi
Miyagigakuin Womens' College
9-1-1 Sakuragacka Aobaku
J-981-8557 Sendai

Norway
Anne Gunnarshaug Lien (Subtask C Leader)
Enova SF
Innherredsv. 7A
N-7014 Trondheim

Netherlands
Peter Erdtsieck (Subtask A Leader)
MoBius consult bv.
Diederichslaan 2
NL-3971 PC Driebergen - Rijsenburg

New Zealand
Albrecht Stoecklein
Building Research Assoc.
Private Bag 50908
NZ-Porirua

Sweden
Maria Wall
(Subtask B Co-Leader)
Dept.of Constr.& Arch.
Lund University
P.O. Box 118
SE-221 00 Lund

Scotland
Gökay Deveci
Faculty of Design & Technology
Robert Gordon University
Garthdee Rd.
UK-Aberdeen, Scotland

United States
Guy Holt
Coldwell Banker
6317 NE Antioch Rd.
USA-64119 Kansas City MO

TASK 29:

Solar Crop Drying

Doug Lorriman
Namirrol Ltd.
Operating Agent for Natural Resources Canada

TASK DESCRIPTION

One of the most promising applications for active solar heating worldwide is the drying of agricultural products. In a recent study, the potential amount of energy that could be displaced using solar in this market was estimated to be between 300 PJ and 900 PJ annually, primarily in displacing fuel-fired dryers for crops that are dried at temperatures less than 50°C. The use of solar energy for these markets is largely undeveloped. Wood and conventional fossil fuels are used extensively at present. In many countries, more expensive diesel and propane fuels are replacing wood. Three key barriers to increased use of solar crop drying are the lack of awareness of the cost-effectiveness of solar drying systems, the lack of good technical information and the lack of good local practical experience.

The objective of the Task is to address the three barriers above by providing technical and commercial information and experience gained from the design, construction and operation of full-scale, commercially viable solar drying systems for a variety of crops and a number of geographical regions where solar is expected to have the greatest potential. Crop grower and processor industry associations will be key partners in dissemination of the results.

Duration

The Task was initiated in January 2000 and is planned for completion in June 2005. This includes an extension to allow for monitoring a number of the delayed projects.

ACTIVITIES DURING 2003

Panama – Coffee Drying

The solar system was ready for the late 2002 harvest, however, the harvest was much smaller than anticipated and some operational problems were encountered. The project was further hampered by the sad passing of one of the key members of the client team.

Regarding the harvest, this drying facility was constructed in connection with an initiative of Café Duran to introduce coffee growing to an economically depressed lowland region of Panama. As such, there were many unknowns, none of which were related to the solar drying system.

Operational problems with the solar system centred around the lack of familiarity with the control and monitoring system on the part of the plant personnel. An example is that the monitoring computer had been turned off and it appeared that the computer had been used for other office functions. A visit by one of the Task participants during January identified these problems. Minor equipment problems were corrected and plans were put in place to resolve the operational issues.

Another problem is that the system operators tend not to trust automation and are manually overriding the operation of the variable speed fan. We are currently addressing ways to gain their confidence.

Data which was collected prior to the shutdown of the drying system after the harvest indicates that the solar system supplied between 20% and 30% of the total drying energy and operated at approximately 20% efficiency during the months of January and February.

Post harvest, we have continued to collect weather data from the monitoring system which is useful not only in gaining a better understanding of the microclimate around the plant and the solar panels but also serves to confirm the continuing operation of the some of the sensors and the monitoring computer.

We have heard from the client that although they expect the 2003/4 harvest to be better than last year's, they do not expect that the harvest will allow the plant to run at full capacity. Apparently they have experienced problems with the crop irrigation system and also have not had the degree of pollination required for full yield. It is important to recognize that this plantation was started from scratch in an area of Panama where coffee growing has not been tried before. It is not surprising that there are learning experiences all round.

Costa Rica – Coffee Drying

Early in the year an agreement to install a solar system on an existing coffee drying facility was reached with the cooperative Coopeldos in the western mountains of Costa Rica.

There has been good progress at this installation. The solar panels were installed in September and the duct work was essentially complete

A solar system was installed on an existing coffee drying facility in the western mountains of Costa Rica. The system is expected to be commissioned in time for this year's harvest season.

at the time of writing. It is expected that the monitoring system will be installed by the end of the year and the system commissioned in time to operate for a good part of this year's harvest season.

India – Coir Pith Drying

The solar system continues to operate well and the operators appear to be satisfied. The monitoring system at the Task site has not yet been installed. We are waiting for the second Task project in India to be completed so that both monitoring systems can be installed in one trip. Unconfirmed feedback suggests that the solar system on this project supplied 60% of the heating during the dry season and 40% during the monsoon season.

Preliminary discussions have been held with other operations nearby regarding the installation of additional solar drying systems. These discussions are being led by the Solarwall® representative in India. Coir Pith is a powder found on the shells of coconuts, which after processing, is widely used as a fertilizer.

India – Cardamon Drying

For various commercial reasons, a different site was chosen for the project over the one which was initially proposed. A verbal agreement was reached to install a solar system on a MAS Industries plant near Vandanmedu. Negotiations with the owners have been ongoing and numerous design changes for both the system and the building are being considered. Material for the solar panels is already in stock in India and can be shipped to the site on short notice.

An additional benefit for this new site is the owner's affiliation with the Indian Spice Board who has agreed to provide some funding assistance for the project. Also, the participation of the Spice Board should enhance the visibility of the project and improve the possibility for follow-on installations.

Project	Status
Panama – Coffee Drying	System monitoring continued
Costa Rica – Coffee Drying	Solar system installation completed System commissioned Monitoring system installed System monitored
India – Coir Pith Drying	Monitoring system installed System monitored
India – Cardamon Drying	Solar system installed System commissioned Monitoring system installed System monitored
China – Jujube Drying	Facility construction completed System commissioned Monitoring system installed System monitored
China – Biomass Drying	Facility completed Solar system installed Monitoring system installed System monitored
Zimbabwe – Tobacco Drying	System report completed

China – Biomass Drying

This project in Lianghe, China, is proposed for a facility where fuel briquettes are manufactured by combining coal and straw. Initially, the project did not involve mechanical drying, however, the owners are now intending to include a drying chamber and boiler. Input from Task 29 has included both the design and installation of the solar air heating system and the design of the mechanical drying system.

During the year, construction on the building has continued and the material for the solar system has been shipped to the site. However, this project has not been completed as planned primarily due to financial issues on the part of the client. The main problem seems to be that the organization responsible for the plant is being converted to a private company and the financing of this entity going forward is not clear. We have been told that the privatization process should be completed soon but a definitive schedule is not available. Once these matters have been resolved, then the financial issues related to the project funding can be dealt with. Our latest information suggests that the construction can resume soon after the privatization but this has not been confirmed.

In the meantime, the Task team has provided revised duct design to allow for certain site conditions and improved operation.

China – Jujube Drying

The project started the year positively. Progress was achieved in the construction of a small pilot unit, which is now operating. However, economic problems continue to plague the main project and we are working to help resolve these. The walls of the new drying facility have been completed for some time with the solar roof remaining to be finished. Materials for the solar panels are on site.

The system at a jube drying facility in China was built to test feasibility while funding was secured for a full production facility. It is intended that operating data from this pilot will be used to help design a large scale plant.

The Task team has attempted to identify sources of government assistance but have not yet found the appropriate channel. Furthermore, obtaining correct and consistent information from the client continues to be a challenge and we are working at a number of levels in attempts to improve this.

Pending a final decision on the Cardamom project, we will likely abandon the large system for this Task but may monitor the smaller pilot project.

Zimbabwe – Tobacco Drying

There have been some changes in the original Dutch participation team and the project has been assumed by Egbert Gramsbergen of Gramsbergen Solar. There have also been some changes at the Tobacco Research Board (TRC) in Zimbabwe which resulted in a long period of no communication. Progress is further complicated by the political situation which affects all matters in that country.

We are hoping that the situation will improve and that the TRC has kept the equipment in operating condition. If this is the case, we hope that further communication will provide more complete feedback on the project. At the very least, we expect to report on the early system experience.

United States – Various Projects

The USA projects are not officially part of the Task but we do intend to include reference to them in our final report. These projects include:

- Walnut drying in California
- Prune drying in California
- Grain drying in New York
- Wool drying in New York
- Chicken manure drying in New York

ACTIVITIES PLANNED FOR 2004

The following activities are expected to be completed in 2004:

LINKS WITH INDUSTRY

The Task continues to maintain excellent links with industry as summarized below:

- The owners of the Panamanian coffee processing plant have indicated an interest in building a second facility which will use only dry chaff and solar as the energy sources. If this is successful, it could show the way for other coffee producers in the area to reduce or eliminate their dependence on wood or fossil energy fuels. In the short term, however, the owner's priority is improving the harvest.

- The completion of the system in Costa Rica should further demonstrate the feasibility for using solar crop drying systems in the region. The Canadian supplier of the solar panels has now engaged a representative in Costa Rica to help further commercialize the product in the Central American region.

- A major international coffee industry conference is held each year in Costa Rica. Preliminary discussions have been held to highlight the Panama and Costa Rica SHC Task 29 projects at this conference.

- The owners of the briquette factory in China have expressed an interest in the manufacture and marketing of Solarwall® products in that country but this initiative was not advanced in 2003. It is possible that the privatization of the company may enhance the chances of success but it is still too early to tell.

- The support of the India Spice Board has been obtained in connection with the proposed cardamom project. It is hoped that upon successful completion of this project, the Spice Board will help to promote the technology to other sites.

REPORTS PUBLISHED IN 2003

No official reports were published in 2003.

REPORTS PLANNED FOR 2004

The Task plans to publish another newsletter in 2004 to provide updated information on the active projects.

MEETINGS IN 2003

There were no task expert meetings held in 2003. It is a policy of the Task to hold meetings in countries where there are active projects. The two remaining countries are India and China but it was decided that it would be more productive to hold these meetings when the projects are completed and operating.

The Canadian team which is responsible for most of the projects did meet regularly throughout the year.

MEETINGS PLANNED FOR 2004

As discussed above, the Task experts do hope to meet in India and China in 2004 but the timing will be determined by the progress of the projects.

TASK 29 NATIONAL CONTACT PERSONS

Operating Agent
Doug Lorriman
Namirrol Ltd.
38 Morden Neilson Way
Georgetown, ON L7G 5Y8

Canada
Doug McClenahan
Alternative Energy Division
CANMET
Natural Resources Canada
580 Booth St.
Ottawa, ON K1A 0E4

John Hollick
Conserval Engineering Ltd.
200 Wildcat Road
Downsview, ON M3J 2N5

Netherlands
Egbert Gramsbergen
Gramsbergen Solar
Tus 7
5507 MG Veldhoven

United States
Peter Lowenthal
Solar Energy Industries Association
1616 H Street N.W., 8th Floor
Washington, DC 20006-4999

TASK 31:

Daylighting Buildings in the 21st Century

Nancy Ruck
University of Sydney
Operating Agent for Standards Australia International

TASK DESCRIPTION

SHC Task 31 seeks to make daylighting the typical and preferred design solution for lighting buildings in the 21st century. The intent is to integrate human response with the application of daylighting systems, shading and electric light control strategies and to ensure the transfer of the Task's results to building design professionals, building owners, and manufacturers.

The Task is focusing on commercial buildings, both new and existing, including office, retail and institutional buildings, such as schools. Institutions from 14 countries in Europe, North America, Asia, Australia and New Zealand are now collaborating in the SHC Task 31 work programme. Emphasis is on communication with building owners, professional designers and industry by including industry in the work programme, and holding round table discussions at each experts meeting.

To carry out the work programme there are four main Subtasks each with 4-5 project areas:

- Subtask A: User Perspectives and Requirements,(Lead country Canada);
- Subtask B: Integration and Optimisation of Daylighting Systems (Lead Country USA),
- Subtask C: Daylighting Design Tools (Lead Country: Germany)
- Subtask D: Daylight Performance Tracking Network and Design Support (Lead Country: France)

Duration

SHC Task 31 was initiated in September 2001 and will be completed in September 2005.

ACTIVITIES DURING 2003

A summary of Subtask research activities is presented below:

Subtask A: User Perspectives and Requirements

Data are now being collected in a number of laboratory and field studies (see Table 1). The project on the application of assessment methods has now been combined with a Subtask B project on laboratory and field studies for greater coordination of research and application.

The studies include user surveys on occupant reactions to daylighting, shading and electric lighting control strategies. Many projects are now using luminance mapping cameras for documenting the luminous environment. The inclusion of webcams (time lapse monitoring) is also being considered. In some of the buildings monitoring has been completed and the data is now being analysed. These include the ENTPE building research programme on manual and automatic blinds in France and the monitoring of adaptive controls in the LESO building in Switzerland. A new project from the Danish Building and Urban Research Institute (DBUR) on integrated solar shading, daylighting and electric lighting has now commenced. The intent is to develop a design decision tool and simulation algorithms for shading and control systems. An EU funded project Ecco-Build has also commenced with the aim of developing a new generation of control devices for solar shading systems, electric lighting and HVAC systems. An outcome will be the simultaneous optimisation of building energy consumption and visual and thermal comfort. A large mock-up facility of the New York Times Headquarters Building is being built in New York to test integrated automated shading and dimming control systems. The performance of two shading and control systems are to be investigated.

Laboratory and Field Studies in Project AB1

A brief description of the laboratory and field studies is as follows:

- The SWIFT (Switchable Façade Technologies)-PhilipsLighting, Eindhoven, Netherlands. User acceptance/preference study to determine user-friendly control strategies for switchable glazings Project has been completed. Report being drafted.
- The Productive Office 2005, HUT, Finland. Survey of lighting demand in offices/laboratory measurements and user survey –a draft report has been written
- ISE New Building, Freiburg, Germany: Post occupancy evaluation of an energy-efficient commercial building. The offices have a semi automated motorized external split blinds and manually controlled ambient electric lighting with individual task lamps. The data collection has been completed and the analysis ongoing. First results on switching probabilities have been drafted. There was no visual comfort survey.
- LESO Building, Lausanne, Switzerland. User acceptance and

Table 1: Progress of Field Studies (✓=task complete, ip=in progress, tc=testing completed)

Project Details		Description		Progress						
Name	Location	IEA Task 31 Contact	Type	Measurements	User Surveys	Planning	Exp.Setup	Data	Analysis	Report
SWIFT	Eindhoven, NL	Ariadne Tenner	lab	✓	✓	✓	✓	✓	✓	
Productive Office 2005	Espoo, Finland	Jorma Lethovaara	lab		✓	✓	✓	✓	✓	Draft report
ISE New Building	Freiburg, Germany	Sebastian Herkel, Fraunhofer ISE	field	✓		✓	✓	✓	ip	
LESO Building	Lausanne, Switzerland	Antoine Guillemin, LESO	field	✓	✓	✓	✓	✓(9)	Ip	
ENTPE field study 1	Lyon, France	Yannick Sutter, ENTPE	field	✓		✓	✓	✓(8)	✓	
ENTPE field study 2	Lyon, France	Yannick Sutter, ENTPE	field	✓		✓	✓	✓(8)	✓	
NRC Daylighting Lab	Ottawa, Canada	Christoph Reinhart	lab	✓	✓	✓				
LBNL Daylighting Lab	Berkeley, USA	Steve Selkowitz, LBNL	lab			✓	✓	✓(1)		
Assessment of lighting controls in schools	Turin, Italy	Anna Pellegrino,	field			Ip				
International Solar Research Centre	Berlin, Germany	Alexander Rosemann TUB	field	✓	✓	Ip				
DBUR test facilities	Horsholm, Denmark	Jens Christoffersen, DBUR	lab	✓	✓	✓				
Ecco Build Project	Switzerland, Germany, Denmark		lab	✓	✓	✓				
Times Headquarters Building	New York, USA	Steve Selkowitz LBNL	field	✓	✓					
T Building, Deakin University, Geelong	Australia	Mark Luther Deakin	field	✓	✓	✓				

energy performance of manual and automated integrated lighting and blind control. The data collection has been completed and data analysis ongoing. There are user comfort and visualisation studies

- ENTPE field study 1, Lyon, France: Occupant use and acceptance of motorized Venetian blinds with a remote, Data collection completed. Report to be drafted.
- ENTPE field study 2, Lyon, France: Occupant use and acceptance of purely manually controlled Venetian blinds. Data collection completed. Report to be drafted
- National Research Council, Canada (NRC) Daylighting Laboratory: User acceptance of automatic lighting controls, energy benefits; durability of motorised blinds. Differences in occupant alertness with clear and diffuse glazing. This project is in the planning stage.
- Politechnico di Torino, Italy. Assessment of lighting controls in schools In planning stage
- LBNL -Test Facility, Berkeley, USA: Studies of electrochromic glazings-energy savings and user acceptance-Calibration completed and testing commenced.
- International Solar Research Centre, Berlin, Germany - Development of auto adaptive controls for shading with a user survey. In planning stage.
- DBUR, Denmark. Integrated control of solar shading, daylight and electric lighting. –Developing a design decision tool, implementing simulation algorithms for shading and control systems, testing a new integrated lighting and shading control device. Now testing
- Ecco Build Project To develop a new generation of control devices for solar shading systems, glare control systems, electric lighting and HVAC systems for the simultaneous optimisation of building energy consumption and comfort. In planning stage
- Times Headquarters Building, New York, USA: To test and integrate automated shading and dimming control system, lighting energy measurements, luminance and illuminance data as well as occupant studies will be included. A full scale model is now being planned and constructed.
- T Building, Deakin Campus, Australia Testing integrated daylighting and electric lighting control systems re energy and visual optimisation for a low energy building. Measurements are underway.

A report on a user behaviour model called Lightswitch is being drafted as an IEA Report. Lightswitch is a stochastic model that predicts how office occupants interact with manually and automatically controlled lighting and blind systems. The Lightswitch algorithm has been implemented into an online daylighting analysis tool that can be accessed via www.buildwiz.com. This tool has had 1000 users in the last six months and is being used as a teaching tool. Future development will be with BCHydro and a coupling with LEED is planned. The model is currently being integrated into the dynamic thermal simulation program ESP-R. It is intended that the model be integrated into daylight analysis software packages in Subtask C. Surveys on architects needs, the use of daylight simulation tools and a guide on the use of algorithms in software are also being planned in Subtask A

The adaptive controller was monitored at the LESO building in Lausanne, Switzerland.

Subtask B: Integration and Optimisation of Daylighting Systems

Progress has been made in the coordination of field and test room studies with Subtask A. Several of the field tests initiated in Subtask B involve both energy measurements and human factors studies. The Subtask B web site address is http://gaia.lbl.gov/iea31,

The roadmap is being further developed. Subtask B continues to explore electronic means to handle the complexity of the design process. The roadmap is to be explicitly related to a decision-making process in design; and to tool use, construction, and calibration operations. A tool has been developed at Deakin University to include video clips of key actors commenting on their role in the design process.

There has been considerable progress in the testing of adaptive controls to take into account user response to integrated lighting and shading controls. The AdControl experiment in the LESO's research office building in Lausanne, Switzerland has been completed. This project was designed to explore how auto adaptive controls can improve either energy savings or occupant satisfaction or both. The experiment has been found successful in meeting user preferences and maintaining energy savings derived from smart controls. A comparison of three situations (manual controller, smart non-adaptive controller, smart adaptive controller) showed that the adaptation to user's preferences, while not impairing the energy savings, allowed a significant increase of acceptation by the users (from 75 % to 95 %). The focus is now on which algorithms are most effective in various control systems.

The project on lighting controls also has a web site: http://iea31.epfl.ch. The content of this website includes technical reports (i.e., the first draft of the "Control System Design Guide"), descriptions of projects from which information can be found on advanced control systems (including a list of published papers, theses, internal reports, and web link). __Projects currently documented are AdControl (EPFL); Athelio (TUB), Ecco-Build (EPFL), and Edificio (EPFL) where clicking on each reference will obtain the pdf document on the paper.

Subtask C: Daylighting Design Tools

A final working document on user expectations of design tools has been completed. The following work has been carried out in the countries associated with Subtask C.

- Switzerland. In the project on algorithms and plug-ins, the digital based goniophotometer has been validated with a virtual test set-up based on a forward tracing algorithm (Tracepro). A special technique to record the specular component of systems has also been developed and tested. Data sets for a wide variety of systems have been recorded and will be included in future activities of the Subtask.

- Germany. Additional validation work on the numerical goniophotometer based on the commercial forward ray-tracer OptiCad has been carried out including standard glazing, prismatic elements and laser cut panels. As a standard, a full directional hemispherical transmittance and BTDF dataset for a serraglaze sample is to be carried out. This will be measured in the EPFL goniophotometer and additionally be calculated with the EPFL and IBP numerical goniophotometers. A draft report on goniophotometry is to be compiled that will contain information on existing real goniophotometers, numerical goniophotometers, performance criteria, validation results, descriptions of available datasets, and the system-database.

- USA. At LBNL the DELight program is basically finished and a simple user interface has been set-up. From this documentation, a prototype internet representation for the online tool catalogue for Subtask C will be developed.

- Japan. At Kyushu University, validation work on the "All Sky Model" has been completed and a Radiance description now exists. A report will be compiled and new work started regarding application of the "CIE standard general sky" in practical daylighting design. This is linked to CIE-TC3-37 "Guide for the application of the CIE general sky."

- France. A CIE TC 3.33 paper (Fawaz Maamari) has defined a number of different test cases. This document is to be turned into an official IEA Task 31 report.

Validations according to the defined test cases have been performed for

A full scale model of the Times Headquarters Building in New York City, USA is planned and constructed. It will be used to test and integrate automated shading and dimming control system, lighting energy measurements, luminance and illuminance data as well as occupant studies.

the lighting tools Lightscape, Dialux, and Radiance and for Inspirer and Genelux. The results are available on the Task 31 web page. This on-line site will be used as a future validation and benchmark site. he web site and will provide other related information including the validation report of IEA Task 21.

Subtask D: Performance Tracking Network and Design Support Groups

The public section of the web server structure can be accessed at: www.iea-shc.org/task31. It includes information on performance of solutions, and examples of solutions, validation data sets, PowerPoint presentations, and a web catalogue of tools. The internal web site www.iea-shc.org/task31/members contains literature examples and a literature survey is being carried out on productivity by ENTPE, France. A standard format for the entry of noteworthy buildings is being planned.

Material for support groups now includes a list of presentations by Marc Fontoynont of France in 2002-2003, including:

- "Optimal selection of shading devices," French Federation of Shading Device Manufacturers, Workshop, Paris,
- "Daylighting monitoring and efficient lighting," Training of Professional Engineers and Architects, Aix en Provence, France,
- "Indoor transparency and secondary daylighting in office buildings" ARCHINOV Seminar, Association for Innovation in Architecture, Paris,
- "Potential for standardization in the field of daylighting", Conseil National Francais de l'Eclairage, Paris,
- "Performance of daylight guidance Systems", Conference presentation,
- "Characterization of glazings for daylighting applications", CEKAL Workshop, Glazing Certification Association, Batimat Building Fair, Paris, and
- "Windows as lighting sources: optimisation of shading techniques". National Federation of Indoor Architects (FNSAI), Batimat Building Fair, Paris.

Technical Visits

A technical visit was made to the National Museum in Wellington and the daylit gallery was subsequently monitored for illuminance levels with an aural questionnaire carried out with participants. The results are to be compared with the measurements from the National Gallery of Canada. These were recorded at the last experts meeting in Ottawa, Canada. A technical visit was also made to the Energie Ouest Suisse (EOS) building in Lausanne, Switzerland. The EOS building has 160m of aluminium light shelves on one façade. A visit was also made to the LESO Building on the EPFL campus which features anidolic systems, automatic blind controls and electrochromic glazing and to the LESO lighting laboratories. Participants' subjective impressions of the daylit environments in these buildings was recorded. A report is being prepared.

CISBAT Conference, Lausanne, Switzerland

300 persons attended the CISBAT Conference. SHC Task 31 participants who presented daylighting papers included Marilyne Andersen and Jean-Louis Scartezzini (Specular component in a BTDF Assessment based on Digital Imaging); Jan De Boer (Incorporation of Numerical

Goniophotometry into Daylighting Design); Fawaz Maamari et al (Reliable Datasets for Lighting Programs Validation), Christoph Reinhart et al (Lightswitch: A Model for Manual Control of Lighting and Blinds); Stephen Selkowitz (Perspectives on Advanced Facades with Dynamic Glazings and Integrated Lighting Controls); Mark Luther et al (Case Studies in the Development towards a Daylighting Roadmap); and Antoine Guillemin and Nicolas morel (Experimental Assessment of Three Automatic Building Controllers). It is intended to provide further papers for a special issue of the publication Energy and Buildings on daylighting in the near future.

WORK PLANNED FOR 2004

Subtask A:

- An internal website for Subtask A.
- A report on the Lightswitch model.
- A measurement protocol for lab and field studies.
- A report form for field studies.
- A report on an overview of visual assessment methods.
- A multi-year test plan for test rooms and buildings.

Subtask B:

- Benchmarks for the performance of conventional buildings to be determined from a number of countries so that benefits from daylighted buildings can be claimed.
- A generic roadmap for the design process to be further developed.
- Further case studies to be examined as reality checks on the road map format
- A tool to display the effects of changing specific parameters, preferably by adapting an existing tool.
- Exploration on improved control systems and a more detailed R & D plan
- A master list of projects developed with Subtask A in which either human factors or controls or both will be studied.

Subtask C:

- Working document on survey on daylighting software.
- Report on the All Sky Model validation and implementation into Radiance.
- Measurement of serraglaze sample and the generation of datasets based on the numerical goniophotometer.
- Report on goniophotometry.
- 1st draft of operational on-line catalogue.
- Continuous testing of softwares and integration in validation internet site.

Subtask D:

- Further relevant papers to be included in web site.
- Further noteworthy buildings to be included in the database, including the National Gallery of Ottawa, Canada.
- PowerPoint presentations are to be created for the different professions and industries.
- The infrastructure of country/regional support groups to be set up.

LINKS WITH INDUSTRY

Further links with industry have been established particularly with control industries and architects to encourage the uptake of adaptive controllers in buildings. Round table discussions with building owners and professional designers have established further links and will be continued.

REPORTS PLANNED FOR 2004

- Report on manual lighting control model
- Document on roadmap
- Document on data display and visualization formats for reporting test results
- Document on test protocol for field studies
- Document on test plan for test rooms and buildings
- Survey questionnaire on architects' needs
- Draft working document on plug-in interface specification
- Numerical photogoniometer performance rating specification
- PowerPoint presentations for architects and industry
- Reports on noteworthy buildings for database

MEETINGS IN 2003

Fourth Experts Meeting
April 14-17, 2003
Wellington, New Zealand

Fifth Experts Meeting
October 7-11, 2003
Lausanne, Switzerland

MEETINGS PLANNED FOR 2004

Sixth Experts Meeting
March 22-26, 2004
Tokyo, Japan

Seventh Experts Meeting
Date to be determined
Italy

TASK 31 NATIONAL CONTACT PERSONS

Operating Agent
Nancy Ruck
University of Sydney
Sydney NSW 2006
Australia

Australia
Stephen Coyne
Centre for Medical, Health
Environment Physics
School of Physics & Chemical
Sciences
Queensland University of Technology
GPO Box 2434
Brisbane, 4001

Phillip Greenup
Ove Arup and Partners
Sydney
E-mail: Phillip.Greenup@arup.com

Mark Luther
Built Environment Research Group
Deakin University
Geelong, Victoria

Belgium
Magali Bodart
Université Catholique de Louvain
Architecture et Climat
Place de Levant 1
1348 Louvain-la-Neuve

Arnaud Deneyer
Belgian Building Research Institute
arnaud.deneyer@bbri.be

Canada
Guy Newsham
National Research Council
Indoor Environment Research
Program
1500 Chemin Montreal Road (M-
24)
Ottawa, Ontario K1A OR6

Christoph Reinhart
National Research Council,
Canada Institute for Research in
Construction
1500 Chemin Montreal Road
Ottawa, Ontario KIA OR6

Denmark
Kjeld Johnsen and Jens
Christoffersen
Danish Building and Urban Research
Energy and Indoor Climate Division
Postboks 119
DK-2970 Hørsholm

Finland
Liisa Halonen
Helsinki University of Technology
Otakaari 5 A
02150 Espoo

Jorma Lethovaara
Helsinki University of Technology
Lighting Laboratory
PO Box 3000
FIN-02015 HUT

France
Marc Fontoynont, Fawaz Maamari,
ENTPE/DGCB
Rue Maurice Audin
69518 Vaulx-en-Velin, Cedex
Laurent Escaffre and Christophe
Marty Ingelux
E-mail:
escaffre.ingelux@espace-arco.com
E-mail:
marty.ingelux@espace-carco.com

Germany
Jan de Boer and Hans Erhorn
Fraunhofer-Institut für Bauphysik
Nobelstrasse 12
70569 Stuttgart

Italy
Valentina Serra
Politecnico di Torino
Viale Mattioli 39
10125 Torino

Anna Pedllegrino
Dipartimento di Energetica-
Facolta di Architettura-
Politecnico di Torino
Viale Mattioli 39
10125 Torino

Japan
Koga, Yasuko
Dept. of Architecture And Urban
Design
Kyushu University
E-mail: koga@arch.Kyushu-u.ac.jp

New Zealand
Kit Cuttle
University of Auckland
Private Bag 92019
Auckland

Michael Donn and Werner
Osterhaus
Victoria University of Wellington
Centre for Building Performance
P.O. Box 600
Wellington 1

Norway
Barbara Matusiak
Norwegian University of Science and
Technologyh
Faculty of Architecture, Planning and
Fine Arts
7034 Trondheim

Switzerland
Nicolas Morel, Jean-Louis Scartezzini, Antoine Guillemin, Marilyne Andersen
Solar Energy & Building Physics Lab.
École Polytechnique Fédérale de Lausanne
1015 Lausanne

Sweden
Helena Bülow-Hübe
Lund University
Division of Energy and Building Design
Department of Construction and Architecture
P.O. Box 118
S-221 00 Lund

Nils Svendenius
Lund University
Department of Atomic Spectroscopy
Sölvegatan 14
S-223 62 Lund
Lars R Bylund
PELK Design Group
Drottningsgatan 71 C
SE-11136 Stockholm

United Kingdom
John Mardaljevic
Institute of Energy & Sustainable Development
Leicester
UK LE7 9SU

United States
William Carroll
Lawrence Berkeley National Laboratory
Mailstop 90 - 3026
Berkeley, CA 94720

Steve Selkowitz
Lawrence Berkeley National Laboratory
Building 90-Room 3111
Berkeley, CA 94720

TASK 32:

Advanced Storage Concepts for Solar Buildings

Jean-Christophe Hadorn
BASE Consultants SA
Operating Agent for the Swiss Federal Office of Energy

TASK DESCRIPTION

The main goal of this Task is to investigate new or advanced solutions for storing heat in systems providing heating or cooling for low energy buildings.

The first objective is to contribute to the development of advanced storage solutions in thermal solar systems for buildings that lead to high solar fraction up to 100% in a typical 45N latitude climate. The second objective is to propose advanced storage solutions for other heating or cooling technologies than solar, for example systems based on current compression and absorption heat pumps or new heat pumps based on the storage material itself.

The ambition of the Task is not to develop new storage systems independent of a system application. The focus is on the integration of advanced storage concepts in a thermal system for low energy housing. This provides both a framework and a goal to develop new technologies.

The Subtasks are:

- Subtask A: Evaluation and Dissemination (Subtask Leader to be confirmed, contingent upon funding)
- Subtask B: Chemical and Sorption (Subtask Leader to be confirmed, contingent upon funding)
- Subtask C: Phase Change Materials (Austria is the Subtask Leader)
- Subtask D: Water (Subtask Leader to be confirmed, contingent upon funding)

Duration

The Task was initiated in July 2003 and will be completed in December 2006.

ACTIVITIES DURING 2003

The Task work was not split into Subtasks during this first year in order to achieve a common understanding of all projects in the Task, independent of the technologies thy follow (water, PCM, sorption or chemicals)

Activities during the year included:

- Work began on a state-of-the-art report on the heat/cold storage solutions for solar houses.
- Methodological aspects were discussed for the future evaluation of projects (should LCA be taken into account, which criteria are the most relevant).
- The basic criteria to be considered for the evaluation of systems were discussed and proposed: Energy performance; Availability; Environment; Integration; Economics.
- Reference conditions for the common SHC Task 32 reference system were discussed and first ideas were evaluated. Cooling load and the way to undertake the performance of a system that does both heating and cooling was discussed.
- Chemical storage concepts were studied and found to be more an assisted heat pump concept than a true storage solution. However, these concepts can achieve a high solar fraction when solar is available, but they need another heat source in wintertime.

- A web site was designed and will be online in 2004. It will include a summary of the Task, Task news and Task documents.
- Experts decided, regarding the goal of a high solar fraction, that targeting more than 50% solar is an objective that the solar market would like to achieve, and not necessarily 100% now.

WORKED PLANNED FOR 2004

Activities planned include:

- Preparing a State-of-the-Art report.
- Selecting evaluation criteria.
- Defining reference conditions.
- Describing projects in each storage technology on a common basis.

REPORTS PLANNED FOR 2004

State-of-the-Art Report on the Heat/Cold Storage Solutions for Solar Houses

Report on Reference conditions

Report on the projects to be considered in Task 32 evaluation

MEETINGS IN 2003

First Experts Meeting
July 10-11
Lausanne, Switzerland

Second Experts Meeting
December 9-11
Petten, Netherlands

MEETINGS PLANNED FOR 2004

Third Experts Meeting
June 8-10 (tentative)
Arvika, Sweden

Fourth Experts Meeting
December 1-3
Graz,, Austria

TASK 32 NATIONAL CONTACT PERSONS

Operating Agent
Jean-Christophe Hadorn
BASE Consultants SA
51 Chemin du Devin
CH-1012 Lausanne
Switzerland

Austria
Prof. Wolfgang Streicher
Institute of Thermal Engineering
Graz University of Technology
Inffeldgasse 25, 8010 Graz, Austria

Waldemar Wagner
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
A-8200 Gleisdorf, Feldgasse 19

Denmark
Simon Furbo
Solar Energy Center Denmark
Technical University of Denmark
Department of Buildings and Energy
Build. 118
DK-2800 Lyngby

Finland (observer)
Dr. Ari Lampinen
Jyväskylä University

France
Thomas Letz
ASDER
299 rue du Granier BP 45
F-73232 ST ALBAN LEYSSE Cedex

Germany
Harald Drueck
Institut fuer Thermodynamik und Waermetechnik (ITW)
Pfaffenwaldring 6
D-70550 Stuttgart

Hans-Martin Henning
Thermal Systems and Components
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
D - 79110 Freiburg

Norway (observer)
Jacob Stang
SINTEF Energy Research AS
N-74XX Trondheim

Spain (observer)
Luisa F. Cabeza (Mrs.)
Escola Universitària Politècnica
Universitat de Lleida
Jaume II, 69
SP - 25001 Lleida

Sweden
Chris Bales
Lecturer and Researcher in Environmental Engineering (Energy)
Högskolan Dalarna
Solar Energy Research Center SERC
Dept. of Mathematics, Natural Sciences and Technology
S-78188 Borlänge

Switzerland
Stéphane Citherlet
HESSO-EIVD-LESBAT
CP
CH - 1401 Yverdon-les-Bains

Peter Vogelsanger
SPF Hochschule für Technik Rapperswil
Oberseestr. 10
CH-8640 Rapperswil

Netherlands (observer)
Jacob van Berkel
Entry technology
Spoorbaanweg 15
3911 CA Rhenen
NL - KvK Utrecht 30142996

Klaas Visscher
Energy research Centre of the Netherlands (ECN)
P.O. box 1
NL - 1755 ZG Petten

TASK 33:

Solar Heat for Industrial Processes

Werner Weiss
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Operating Agent for the Austrian Ministry of Transport, Innovation and Technology

TASK DESCRIPTION

Around 60 million square meters of solar thermal collectors were installed by the year 2000 in the OECD countries. Until now, the widespread use of solar thermal plants has focused almost exclusively on swimming pools, domestic hot water preparation and space heating in the residential sector.

The use of solar energy in commercial and industrial companies is currently insignificant compared to the use in swimming pools and the household sector. Most solar applications for industrial processes have been used on a relatively small scale and are mostly experimental in nature. Only Just a few large systems are in use worldwide. However, if one compares the energy consumption of the industrial, transportation, household and service sectors in OECD countries, the industrial sector has the highest energy consumption at approximately 30%, followed closely by the the transportation and household sectors.

The major share of the energy, which is needed in commercial and industrial companies for production processes and for heating production halls, is below 250°C. The low temperature level (< 80°C) complies with the temperature level that can easily be reached using solar thermal collectors already on the market. The principles of operation of the components and systems apply directly to industrial process heat applications. The unique features of these applications lie oin the scale on which they are used, system configurations, controls needed to meet industrial requirements, and the integration of the solar energy supply system with the auxiliary energy source and the industrial process. For applications where temperatures up to 250°C are needed, the experiences are rather limited and suitable components and systems are missing. Therefore, for these applications the development of high performance solar collectors and system components is needed.

To be able to make use of the huge potential for solar heat in the industry and to open a new market sector for the solar thermal industry, SHC Task 33 is going to carry out potential studies, it will investigate the most promising applications and industrial sectors for solar heat, and it will optimize, develop and test solar collectors for medium temperature applications (up to approximately 250°C). The development of integral solutions for solar thermal energy applications for given industrial processes (based on the "PINCH-concept") is also one of the main topics of this Task. In additions, the development of design tools (based on TRNSYS simulations) and a software tool for fast feasibility assessment, economic analyses as well as the design and the erection of pilot plants in co-operation with the industry are planned.

Scope of the Task

The scope of the Task is on solar thermal technologies for converting the solar radiation into heat, (i.e., starting with the solar radiation reaching the collector and ending with the hot air, water or steam

This production hall in Bludesch, Austria uses a flat plate collector (87 m²) for space heating. The operating temperature is 20 - 80°C. *Source: AEE INTEC, Austria*

transferred to the application.) The distribution system, the production process and/or the optimization of the production process are not the main topics of the Task. However, influences on the production process and the distribution system arising from the solar character of the heat source will be studied in the framework of the Task.

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

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

To accomplish the objectives of the Task, the Participants are carrying out research and devel-opment in the framework of the following four Subtasks:

- Subtask A: Solar Process Heat Survey and Dissemination of Task Results (Lead Country: Spain)
- Subtask B: Investigation of Industrial Energy Systems (Lead Country: Austria)
- Subtask C: Collectors and Components (Lead Country: Germany)
- Subtask D: System Integration and Demonstration (Lead Country: Germany)

Collaboration with other IEA Programmes

Due to the complementary background and know-how of the participants of the SHC and the SolarPACES Programmes, significant synergies were expected from collaboration. Therefore, it was agreed to co-operate with the SolarPACES Program on a "moderate level" according to the SHC "Guidelines for Co-ordination with other Programs."

Duration

The Task was initiated on November 1, 2003 and will be completed on October 31, 2007.

ACTIVITIES DURING 19992003

Since SHC Task 33 started its activities in November 2003, the main activity in 2003 was to organize and carry out the first Experts Meeting, which was held in Gleisdorf, Austria from 4 – 6 December. In total, 22 participants from 7 countries attended the meeting.

WORK PLANNED FOR 2004

A summary of the work planned in the four subtasks is presented below. Subtask A: Solar Process Heat Survey and Dissemination of Task Results

Potential Studies

Available data on industrial heat demand will be analyzed with respect to the potential application of solar thermal energy, classified by temperature ranges, industrial sectors and processes. For this, unified criteria will be used in order to compare the data, bringing together the experience from previous and ongoing projects in this field (Austrian project PROMISE, EU-Projects POSHIP and PROCESOL). Available data on industrial heat demand will be collected for each of the represented countries. Data for other selected countries not represented in the Task—but with high solar radiation and a high potential for solar industrial heat application—will be collected from data bases, such as of the IEA (World Energy Outlook) and other international organizations.

Documentation and Analysis of Case Studies
Case studies found in literature or carried out by participants regarding the integration of solar heat into production processes will be documented and analyzed.

Review of Systems and Applications in all Participating Countries
In order to get as much information as possible from projects carried out in the past an overview on realized and projected systems will be conducted. For this survey a form will be developed which makes the projects comparable and reflects the main performance criteria in the energetic and economic area. In asAs far as this is available, monitoring results on solar process heat plants will be collected and analyzed.

In order to organize the available information, materials such as questionnaires and lists of projects available from other projects (POSHIP, IEA-Task 25) will be updated and adapted.

Review of Solar Collector and System Technology Available on the Market
A review of the national solar market will be given by each participant in order to collect and distribute the information about the available solar collectors and solar system technology available. This information will be maintained and updated throughout the period of the Task.

Organization of Two Industry Workshops
Workshops targeted at industries not directly involved in the Task and atto other potential users of the Task results. The "industry workshops" will be organized in conjunction with the Task meetings in Brussels and Mexico.

Publication of the First Newsletter
The newsletter will present SHC Task 33 work and results. The intended audience is the solar industry. The newsletter will be produced in English and then translated into national languages, and it will posted on the Task web site and sent it is going to be send to the industry via e-mail.

Subtask B: Investigation of industrial energy systems

Identification of energy-relevant characteristics
Characteristics, parameters, indicators of energy supply processes will be identified so that they can then be documented, classified and assessed. Industrial processes are usually supplied by a heating system with steam, thermo-oils or hot water, and powered by the incineration of fossil fuels. Most energy supply systems operate at varying temperatures and loads during the day, the week and the year. Characteristics of load curves of industrial production processes with the potential to use solar heat will be documented and analyzed regarding peak hours and stop times and compared with supply loads of solar thermal systems.

Identification of Typical Temperature Differences
Identification of the second law losses in industrial energy supply systems in order to get information about necessary levels of heat supply in selected industrial sectors.

In classical energy supply systems, high levels of temperature in the supply system (steam, hot water) lead to smaller and cheaper equipment for heat distribution (small volumes) and heat transfer (high fT), without increasing energy costs. This results in rather high "second law losses" that should not be accepted with solar heated production. As solar energy is used, higher temperatures become more expensive and larger equipment with smaller temperature differences becomes more economical. On the other hand, few industries will be ready to replace their existing heat delivery system as a whole and solar heat has to be supplied at the temperature level of the existing steam or hot water system.

Expansion of Existing Heat Integration Models
Expand models, such as PINCH-technology, to solar energy and/or expansion of design tools for solar heating systems to industrial processes. The minimum energy demand of a production system and the maximum potential for heat recovery can be found through heat integration models like the PINCH-theory. This theory will be adapted

to the temperature and load curves of solar thermal systems in order to find the optimal integration for a time-dependent user.

Subtask C: Collectors and Components

Medium Temperature Collector Developments

Some of the available collectors are suitable for application in systems with medium operating temperatures. But there also are development possibilities to improve collectors so that they can be operated at medium temperatures. New collector developments and improvements are necessary to achieve a better cost/performance ratio as is presently achieved for medium temperature systems. The collectors to be investigated may be, for example, double glazed flat plate collectors with anti-reflection coated glazing, hermetically sealed collectors with inert gas fillings, CPC collectors, MaReCos (Maximum Reflector Collectors), vacuum tube collectors with and without reflectors, and parabolic trough collectors. In these activities, investigations on materials suitable for medium temperature collectors will play an important role.

The aim is to achieve improvements with respect to the thermal performance and, even more so, with respect to collector costs for the medium temperature range from 80°C - 250°C.

Medium Temperature Collector Testing

There is a broad range of experience in collector testing for operating temperatures below 100°C. Most of the testing laboratories carry out the tests with water as the fluid and up to a maximum temperature of 100°C. Therefore, only very few test results are available for higher operating temperatures. In simulation programs, an extrapolation of the collector performance determined at low temperature measurements (up to 100°C) is made to describe the collector performance at higher temperatures. Definitively, these extrapolations often have a high uncertainty. This results in system design calculations with uncertain component dimensioning results. The is present situation surely is undoubtedly a major big obstacle in designing medium temperature process heat systems with the needed accuracy for successful pilot systems. Therefore, the testing of suitable collectors at medium temperatures and the exchange of the experiences amongst of different testing laboratories is very important.

It is suggested to carry out a round-robin test on a medium temperature collector with efficiency measurements at 160°C or higher. The results will be discussed with respect to improving the testing procedures in the ISO 9806 and EN12975 standards. A cComparison of outdoor and indoor measurements (using solar simulators) will be carried out.

Test and Qualification Standards for medium temperature collectors up to 250°C

An important task for the wide spread commercial application of solar collectors in industrial processes will be the development of some Test and Qualification Standards that allow the assessment of such different technologies as flat plate collectors (stationary, using global radiation) and parabolic troughs (tracking, using direct radiation) with a view to their respective suitability for a particular application (in terms of the degree of compliance with specific requirements). Whilst comprehensive standards and procedures already exist for the non- or low-concentrating collectors, the methods used for concentrating systems are not yet described in standards. The envisioned aim of some kind of "unified" standard would be a major added value for rom the co-operation between the SHC, and SolarPACES Programmes, relieving potential customers and manufacturers alike of much doubt and uncertainty. Due to the inherent differences of the technologies to be characterized, this will be a challenging task. The aim is to contribute to a unified standard for medium temperature collectors.

Subtask D: System Integration and Demonstration

Design Guidelines

Development of a structured design approach that provides guidance with respect to the criteria and sequence of decisions during the system design process. The result will be a kind of roadmap, leading from the analysis of the intended application (with methods developed in Subtask B) and evaluation of different technological solutions (e.g., direct coupling of a solar system to a particular process versus integration of solar heat into the overall "conventional" energy system, heat storage or fossil back-up, etc.) to the definition of basic system design parameters (e.g., size and temperature level of the solar contribution) and the selection of appropriate components.

LINKS WITH INDUSTRY

The Task defines two levels of participation for the solar industry:

■ Level 1

An industrial y participant at this level should expect to participate in an annual workshop organized by SHC Task 33 and to receive at least once during the Task duration a visit from of a Task participant, and to answer technical and marketing questions on solar heat for industrial applications (this activity is part of the system survey and the dissemination activity of Subtask A).

■ Level 2

An industrial y participant at this level should expect Level 1 commitment and to participate in all Task meetings and to bring information and feedback from the market. Level 2 participation should be seen in close connection with the main participant of the country of origin of the industry.

REPORTS PLANNED FOR 2004

Potential studies on solar heat for industrial processes in the participating countries and the most promising industrial sectors for solar thermal systems;

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

First industry Newsletter

MEETINGS IN 2003

First Experts Meeting
December 4 – 6
Gleisdorf, Austria

MEETINGS PLANNED FOR 2004

Second Experts Meeting
March 29 – 30
Brussels, Belgium

Third Experts Meeting
October 4 – 5 or 10 - 12
Mexico

TASK 33 NATIONAL CONTACTS

Operating Agent
Werner Weiss
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf
Austria

Austria
Dagmar Jähnig and Thomas Müller
AEE INTEC
Arbeitsgemeinschaft ERNEUERBARE ENERGIE
Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf

Hans Schnitzer and Christoph Brunner
Joanneaum Research
Elisabethstrasse 16/1
A-8010 Graz

Gernot Gwehenberger
Technical University of Graz
RNS
Inffeldgasse 25c
A-8010 Graz

Australia
Wes Stein
Lucas Heights Science & Technology Centre
New IllawarraRd, Lucas Heights
NSW, PMB 7
Bangor NSW 2234

Czech Republic
Bohumil Horák
VSB- Technical Universtity of Ostrava
17. listopadu 15
CZ 70833 Ostrava-Poruba

Eva Kudrnova
Technology Centre AS CR
Rozvojova 135
165 02 Prague 6

Germany
Klaus Vajen and Elimar Frank
Kassel University
Department of Mechanical Engineering
Solar and System Technology
D-34109 Kassel

Andreas Häberle
PSE GmbH
Christaweg 40
D-79114 Freiburg

Klaus Henneke
DLR
Institut für Technische
Thermodynamik
D-51170 Köln

Matthias Rommel
Fraunhofer ISE
Heidenhofstrasse 2
D-79110 Freiburg

Mexico
Claudio Estrada
CIE-UNAM
Privada Xochicalco, S/N, Col. Centro
Cuernavaca, Mor., Mexico

Portugal
Maria Joao Carvalho
INETI
Edificio H, Estrada do Paço do
Lumiar, 22
1649-038 Lisboa

Spain
Esther Rojas Bravo
CIEMAT-PSA
Avda. Complutense, 22, Edificio 42
28040 Madrid

Eduardo Zarza
CIEMAT-PSA
P.Box 22, Tabernas
04200-Almería

Hans Schweiger
AIGUASOL Engineering
Palau 4, 2o 2°
08 002 Barcelona

Sweden
Peter Kovacs and Henrik Quicklund
SP-Swedish National Testing & Research Institute
Industrig. 4
Box 857
S-501 Boras

Svante Nordlander
Högskolan Dalarna
Solar Energy Research Center - SERC
EKOS
S-78188 Borƒnge

Björn Karlsson
Vattenfall Utveckling AB
The Swedish National Power Board
P.O. Box 1046
S-61129 Nyköping

TASK 33 INDUSTRY PARTICIPANTS

Austria

Christian Holter
SOLID
Herrgottwiesgasse 188
A- 8055 Graz

Gerald Jungreithmayr
Solution GmbH
Neue Landstraße 70/1
A-4655 Vorchdorf

Germany

Markus Peter
dp2 - Energienutzung mit Verstand
Michelsweg 29
D- 59494 Soest

Georg Brakmann
Fichtner Solar GmbH
Sarweystrasse 3
D-70191 Stuttgart

Israel

Alain Dahan
SOLEL Solar Systems
3 Hac'shara st., Bosch Industry Zone
Beit-Shemesh 99107

TASK 34/ECBCS ANNEX 43

Testing and Validation of Building Energy Simulation Tools

Ron Judkoff
National Renewable Energy Laboratory
Operating Agent for the U.S. Department of Energy

TASK DESCRIPTION

The goal of this Task is to undertake pre-normative research to develop a comprehensive and integrated suite of building energy analysis tool tests involving analytical, comparative, and empirical methods. These methods will provide for quality assurance of software, and some of the methods will be enacted by codes and standards bodies to certify software used for showing compliance with building energy standards. This goal will be pursued by accomplishing the following objectives:

- Create and make widely available a comprehensive and integrated suite of IEA Building Energy Simulation Test (BESTEST) cases for evaluating, diagnosing, and correcting building energy simulation software. Tests will address modeling of the building thermal fabric and building mechanical equipment systems in the context of innovative low-energy buildings.
- Maintain and expand as appropriate analytical solutions for building energy analysis tool evaluation.
- Create and make widely available high quality empirical validation data sets, including detailed and unambiguous documentation of the input data required for validating software, for a selected number of representative design conditions.

Scope

This Task will investigate the availability and accuracy of building energy analysis tools and engineering models to evaluate the performance of innovative low-energy buildings. Innovative low-energy buildings attempt to be highly energy efficient through use of innovative energy-efficiency technologies or a combination of innovative energy efficiency and solar energy technologies. To be useful in a practical sense such tools must also be capable of modeling conventional buildings. The scope of the Task is limited to building energy simulation tools, including emerging modular type tools, and to widely used innovative low-energy design concepts. Activities will include development of analytical, comparative and empirical methods for evaluating, diagnosing, and correcting errors in building energy simulation software. The audience for the results of the Task/Annex is building energy simulation tool developers, and codes and standards (normes) organizations that need methods for certifying software. However, tool users, such as architects, engineers, energy consultants, product manufacturers, and building owners and managers, are the ultimate beneficiaries of the research, and will be informed through targeted reports and articles.

Means

At this time a number of projects have been defined. These will be assigned to specific subtasks pending the outcome of discussions among the SHC and ECBCS executive committees. For the purpose of this preliminary work plan, it is useful to define the terms "comparative tests" and "empirical validation." In comparative testing, a BESTEST-type comparative/diagnostic evaluation test procedure is written and software programs are compared to each other. Advantages of comparative tests include ease of testing many parameters, and that simple building descriptions may be used; the major disadvantage is lack of any truth standard in comparisons for cases where analytical solutions are not possible. In empirical validation, software is compared with carefully obtained experimental data. The advantage of empirical tests is that true validation of the models may be accomplished within the uncertainty of the experimental data; disadvantages are that gathering high quality experimental data is expensive and time consuming, making it difficult to test the individual effects of many parameters.

Proposed comparative tests include:

- BESTEST ground-coupled heat transfer with respect to floor slab and basement constructions
- BESTEST multi-zone heat transfer, shading, and air-flow
- Radiant heating and cooling
- HVAC BESTEST heat pumps

Within the comparative test cases, analytical verification tests for evaluating basic heat transfer and mathematic processes in building energy analysis tools will be included where possible.

Proposed empirical validation tests include:

- Shading/daylighting/load interaction
- Radiant heating and cooling
- Systems, components, and controls
- Buildings with double-skin facades.

When a number of building energy simulation programs are tested against the same empirical data set, comparative tests are also possible. Such comparative tests can help identify deficiencies in the empirical experiment if they exist, or broad-based deficiencies in the current modeling state of the art.

Duration

The Task was initiated in September 2003, and will be completed in December 2006.

Participation

A total of twelve countries have participated in the two planning workshops conducted during 2003 for this Task. They are:

Australia	Czech Reublic
Japan	Switzerland
Belgium	France
Netherlands	United Kingdom
Canada	Germany
Sweden	United States

ACTIVITIES DURING 2003

A summary of Subtask research and codes & standards activities completed is presented below.

Codes and Standards Activities

A key audience for the research undertaken within this Task is national and international building energy standard making organizations. These organizations can use the test cases developed in SHC Task 22 to create standard methods of tests for building energy analysis tools used for national building energy code compliance.

ASHRAE Standard 140-2001 incorporates the IEA BESTEST suite of test cases developed under IEA SHC Task 12 and ECBCS Annex 21, which are primarily related to building thermal fabric heat transfer. During 2003, ASHRAE Standard 90.1, which is used for regulating energy efficiency in commercial and non-low-rise residential buildings, was revised to require use of Standard 140 for testing software used in building energy efficiency assessments. This was important because it mandates software evaluation using test procedures developed under IEA research activities.

SSPC 140 is the cognizant committee for ASHRAE Standard 140. During 2003 SSPC 140 approved public review of proposed Addendum A to Standard 140 that includes the test cases of HVAC BESTEST Volume 1, which were developed under IEA SHC Task 22 and are related to unitary space cooling mechanical equipment. Currently, SSPC 140 is responding to public review comments, and publication of Amendment A is expected in the near future.

The Netherlands (TNO) has developed their Energy Diagnosis Reference (EDR) based on BESTEST. TNO has developed the EDR to satisfy the European Performance Directive (EPD) of the European Union. The EPD emphasizes performance-based standards and requires certification of software used to show compliance with energy performance standards (normes).

Elsewhere, IEA BESTEST has been referenced in codes and standards in Australia and New Zealand. France (CSTB) has used BESTEST to test simulation tools used in conjunction with development of CEN Standards.

Communication continues with a number of CEN Technical Committees, including 89, 156, 229, which are also addressing building energy calculation methods and the development building energy analysis tool test cases. Discussions were continued on how CEN and SHC Task 22 can cooperate in the development and promulgation of test cases for evaluating building energy analysis tools.

Projects

This year was dedicated to planning and task formation. Activities during 2003 consisted of recruiting participants, defining projects, and developing project plans. Based on the two task definition workshops that were conducted, a Work Plan (including Information Plan) was developed by the Operating Agent. The Work Plan was approved by the SHC Executive Committee in November 2003.

WORK PLANNED FOR 2004

Ground Coupled Floor Slab and Basement Comparative Tests

(Leader: US/NREL)

Develop BESTEST-GC User's Manual for ground-coupled heat transfer test cases. Conduct field trials of user's manual using hourly (or sub-hourly) building energy simulation software programs. Perform iterations of field trials for both user's manual and simulation software improvements. Test sequence will include:

- Steady state 3D analytical solution for rectangular slab.
- Harmonic 3D analytical solution for rectangular slab and basement.
- Basic heat ground heat transfer tests that cannot be solved analytically
- Solar interaction with building mass and the ground using internal gains as solar surrogate.

Multi-Zone Heat Transfer Comparative Tests

(Leaders: US/NREL, Japan, Switzerland)

- Review of the exploratory work by Timo Kalema conducted in IEA SHC Task 12 / ECBCS Annex 21.
- Write a test specification usable by hourly (or sub-hourly) detailed building energy simulation programs. The specification will start with very simple typical office multi-zone configurations. Later, more complex cases that include air-flows between zones may be used to compare results from zonal models, network models, coarse CFD, and full CFD models to each other.
- Conduct field trials using the test specification with several hourly (or sub-hourly) building energy simulation software programs, some of which may be linked to zonal, network, coarse CFD, or full CFD models.
- Use the results from the simulations to improve the test specifications and the simulation programs. Conduct two iterations of this process during 2004; additional iterations are expected over the course of the project.

Shading/Daylighting/Load Interaction Empirical Tests

(Leaders: Switzerland, US/Iowa)

Conduct series of EMPA test cell experiments

- "Steady-state" heat losses/determination of total thermal loss coefficient H
- Transient test cell response (time constant)
- Glazing only
- Glazing with external shading screen (textile)
- Glazing with internal shading screen (textile)
- Glazing with external venetian blinds (painted aluminum slats)
- Glazing with internal mini-blinds
- Window (Glazing with frame)
- ERS experiments: Window with/without mini-blinds/external shading device

Year 1

- Winter Tests
  - Internal shading with screens (A) and muslin fabric (B)
  - Dimmable lighting controls in both sets of test rooms.

- Spring/Summer Tests
  - Internal shading with screens (A) and muslin fabric (B)
  - South room's external shading with fins and overhang.
  - Dimmable lighting controls in both sets of test rooms.

Comparative and Empirical Tests

(Leader: Switzerland)

- Finish project planning
- Literature review
- Create revised test specification for EMPA-3D / HTAL-room
- 3D-modelling
- Simulations with 1D/2D-models

Heat Pump Comparative Tests

(Leader: Canada)

- Determine if there is interest in expanding HVAC BESTEST cases to cover heat pumps
- Perform literature review regarding existing work on validation and testing of heat pump models
- If there is enough interest, then submit a detailed project plan for development of a test specification to the Operating Agent, and begin work

Systems, Components, and Controls Empirical Tests

(Leader: Germany/TUD)

Goal of 2004 activities is to refine project plan, and begin work.

- Determine which tests already exist. Literature review ‡ overview, catalog
- Send information to potential participants and get feedback.
- Extend/update existing tests; define new tests

Double-Facade Empirical Tests

(Leader: Germany/Fraunhofer Institute)

Goal of 2004 activities is to develop a project plan, and begin work.

Virtual Centre Proposal

(Leader: Switzerland)

- Develop a proposal to create an entity dedicated to the coordination of building simulation software development activities including validation and testing
- Present the proposal to ECBCS and SHC Executive Committees

Other

Continue work outside the scope of this task related to bringing evaluation test procedures developed under IEA research into codes and standards (normes).

LINKS WITH INDUSTRY

The primary audiences for the IEA tool evaluation research are building energy analysis tool authors and national and international building energy standard (norme) making organizations. For tool authors, a number of links have been established. Activities of previous related Task 22 research effectively are linked to the needs and recommendations of the world's leading building energy analysis tool developers. This link continues in Task 34/43. For example, 5 papers by software developers related to use of tool evaluation test procedures created under Task 22 were presented at the conference of the International Building Performance Simulation Association, September 2003 in Eindhoven, Netherlands. Abstracts for four papers by software developers related to Task 22 work have been accepted for the Canadian ESim conference scheduled for June 2004 in Vancouver. Additional papers by software developers related to use of Task 22 test procedures have appeared regularly at ASHRAE meetings in the US.

The results of IEA tool evaluation research are used as prenormative information in the establishment of national and international building energy codes and standards, as discussed above under codes and standards activities. The IEA BESTEST cases were used by ASHRAE to develop a standard method of test for evaluating building energy analysis programs. Also, the U.S. National Association of State Energy Officials has referenced HERS BESTEST for certification of home energy rating software. HERS BESTEST, which is conceptually based on IEA BESTEST, was developed for use specifically in detached-residential applications. A number of other countries, such as the Netherlands, Australia and New Zealand are using BESTEST as a standard method of testing building energy analysis tools for their national energy codes or home energy rating software.

REPORTS PUBLISHED IN 2003

As 2003 was a year for Task formation and development of project plans, only the following reports related to task formation were developed.

Building Energy Analysis Tool Test Methods, Task 34/43 Concept Paper. November 2002.

Testing and Validation of Building Energy Simulation Tools, Task 34/43 Annex Document. 20 May 2003. To be updated during 2004.

REPORTS PLANNED FOR 2004

As this is the first full year for project work, no final reports are planned. Draft reports covering the following topics are expected:

- Revised ground coupled heat transfer test specification and results
- Multi-zone heat transfer comparative test specification and results
- Shading/Daylighting/Load

Interaction: test procedures, test cell specifications, empirical data sets, and simulation results

- Radiant Heating and Cooling: literature review documentation, comparative test specification, simulation results, and empirical test project plan
- Project plans and test specifications for: heat pump comparative tests; systems, components and controls empirical tests; and double-façade empirical tests
- Virtual Centre Proposal

MEETINGS IN 2003

First Task Definition Workshop
April 24-25, 2003
Delft, Netherlands

First Experts Meeting/Second Task Definition Workshop
September 29-30, 2003
Duebendorf, Switzerland

MEETINGS PLANNED FOR 2004

Second Experts Meeting
April 5-7, 2004
Munich, Germany

Third Experts Meeting
Autumn 2004
Dates and location to be determined.

TASK 34/ECBCS ANNEX 43 NATIONAL CONTACT PERSONS

Operating Agent
Ron Judkoff
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401

Australia
P.C. Thomas
Arup
Level 10
201 Kent Street
Sydney NSW 2000

Belgium
Jean Lebrun
University of Liege

Canada
Julia Purdy
CANMET Energy Technology Centre
Natural Resources Canada
580 Booth Street, 13th Floor
Ottawa, Ontario K1A 0E4

Czech Republic
Miroslav Jicha, Pavel Charvat
BRNO University of Technology
Dept. of Thermodynamics and Environmental Engineering
Technicka 2
61669 BRNO

Milos Lain
CTU Prague
Dept. of Environmental Engineering
Technicka 4
16607 Prague 6

Irena Plockova
Czech Energy Agency
Ministry of Industry and Trade
NA Frantisku 32
Prague 1
11000 CZECH REPUBLIC

France
Joseph Ojalvo
Electricite de France, Department SEVE
Les Renardieres
Route de Sens, Ecuelles
77818 Moret-sur-Loing Cedex

Jean-Robert Millet
CSTB
BP02
F77421 Marne la Vallee, Cedex2

Germany
Clemens Felsmann
Technische Universität Dresden
Institut für Thermodynamik und Techn. Gebäudequsrüstung
Helmholtzstr. 14
01062 Dresden

Hans Erhorn
Fraunhofer Institute
Stuttgart

Japan
Yasuo Utsumi
Department of Architecture
Miyagi National College of Technology
Natori, Miyagi, 981-1239

Teruaki Mitamura
Yokohama National University

Netherlands
Wim Maassen, Wim Plokker, Aad Wijsman (observers)
TNO Building and Construction Research
Van Mourik Broekmanweg 6
Postbus 49
2600 AA Delft

Sweden
Hasse Kvist, Harris Poirazis
EBD, LTH
Lund University
P.O. Box 118
SE-221 00 Lund

Switzerland
Gerhard Zweifel
Hochschule Technik + Architektur Luzern
Abt. HLK
CH-6048 Horw

Heinrich Manz, Thomas Frank
EMPA
Laboratory for Applied Physics in Buildings
Uberlandstr. 129
CH-8600 Duebendorf

Viktor Dorer, Markus Koschenz, Andreas Weber
EMPA
Energy Systems/Building Equipment Lab
Uberlandstr. 129
CH-8600 Duebendorf

Mark Zimmermann
EMPA
Centre for Energy and Sustainability in Buildings
Uberlandstr. 129
CH-8600 Duebendorf

Pierre Hollmuller
Universite de Geneve
Centre universitaire d'etude des problemses de l'energie
Route de Drize 7
Ch – 1227 Carouge – Geneve

United Kingdom

Donald Alexander
Welsh School of Architecture
Cardiff University
Cardiff, Wales

Paul Strachan
ESRU, Dept. of Mechanical Eng
University of Strathclyde
Glasgow G1 1XJ, Scotland

United States

Joel Neymark
J. Neymark & Associates
2140 Ellis Street
Golden, Colorado 80401

Gregory Maxwell
Mechanical Engineering Department
Iowa State University
2025 Black Engineering Building
Ames, Iowa 50011

Peter Loutzenhiser
Mechanical Engineering Department
Iowa State University
0095E Black Engineering Building
Ames, Iowa 50014

Curtis J. Klaassen
IEC Energy Resource Station
DMACC, Building 23
2006 S. Ankeny Boulevard
Ankeny, Iowa 50021

IEA Solar Heating and Cooling Address List

EXECUTIVE COMMITTEE MEMBERS

AUSTRALIA
Colin Blair
Standards Australia International
GPO Box 5420
Sydney NSW 2001
Tel: +61/2/8206 6735
Fax: +61/2/8206 6015
e-mail: Colin.Blair@standards.com.au

Alternate
Mr. Ken Guthrie
Sustainable Energy Authority Victoria
215 Spring Street
Melbourne
Victoria 3000
Tel: +61/3/9655 3266
Fax: +61/3/9655 3255
e-mail: ken.Guthrie@seav.vic.gov.au

AUSTRIA
Prof. Gerhard Faninger
c/o Universität Klagenfurt, IFF
Sterneckstraße 15
A-9020 Klagenfurt
Tel: +43/463/2700 6125
Fax: +43/463/2700 6199
e-mail: gerhard.faninger@uni-klu.ac.at

BELGIUM
Prof. André De Herde
Architecture et Climat
Université Catholique de Louvain
Place du Levant, 1
B-1348 Louvain-la-Neuve
Tel: +32/10/47 21 42 or
+32/10/47 22 23
Fax: +32/10/47 21 50
e-mail: deherde@arch.ucl.ac.be

CANADA
Mr. Doug McClenahan
CANMET - Natural Resources Canada
580 Booth Street
Ottawa, Ontario K1A 0E4
Tel: +1/613/996 6078
Fax: +1/613/996 9416
e-mail: dmcclena@nrcan.gc.ca

DENMARK
Mr. Jens Windeleff
Danish Energy Authority
Amaliegade 44
DK-1256 Copenhagen K
Tel: +45/33/92 68 18
Fax: +45/33/11 47 43
e-mail: jew@ens.dk

Alternate
Mr. Poul E. Kristensen
IEN Consultants, Energy
Hasselvej 30
2830 Virum
Tel: +45/45/855 092
Fax: +45/45/8 55 092
e-mail: poulerik@adr.dk

EUROPEAN COMMISSION
Mr. Pietro Menna
Commission of the European Union (DG TREN)
Rue de la Loi 200
B-1049 Brussels, BELGIUM
Tel: +32/2/295 1445
Fax: +32/2/299 3694
e-mail:pietro.menna@cec.eu.int

FINLAND
Prof. Peter D. Lund
Helsinki University of Technology
Department of Engineering Physics and Mathematics
Rakentajanaukio 2 C
P.O. Box 2200

FIN-02015 HUT (Espoo)
Tel: +358/9/451 3197 or
+358/9/451 3198
Fax: +358/9/451 3195
e-mail: peter.lund@hut.fi

Alternate
Mr. Jerri Laine
TEKES
P.O. Box 69
FIN-00101 Helsinki
Tel: +358/105 215874
Fax: +358/9/694 9196
e-mail. jerri.laine@tekes.fi

FRANCE
Mr. Yves Boileau
French Agency for the Environment and Energy Management (ADEME)
500 Route des Lucioles -
Sophia Antipolis
F-06565 Valbonne Cedex
Tel: +33/4/93 95 79 11
Fax: +33/4/93 95 79 87
e-mail: yves.boileau@ademe.fr

GERMANY
Dr. Volkmar Lottner
Forschungszentrum Jülich - PTJ
D-52425 Jülich
Tel: +49/2461/61 48 79
Fax: +49/2461/61 31 31
e-mail: v.lottner@FZ-Juelich.de

ITALY
Dr. Paolo Zampetti
Division of Systems for Energy Conservation
ENEA
Via Anguillarese 301
I-00060 S. Maria di Galeria (Rome)
Tel: +39/6/3048 3414
Fax: +39/6/3048 6504
e-mail: zampetti@casaccia.enea.it

MEXICO
Dr. Isaac Pilatowsky
Centro de Investigacion en Energia
Universidad Nacional Autonoma de Mexico
Apartado Postal #34
62580 Temixco, Morelos
Tel: +52/73/25 00 52 or
+52/5/62 29 733
Fax: +52/73/25 00 18 or
+52/5/62 29 742
e-mail: ipf@mazatl.cie.unam.mx

Alternate
Dr. Wilfrido Rivera Gomez-Franco
same address as above
Tel: +52/73/25 00 44
Fax: +52/73/25 00 18
e-mail: wrgf@mazatl.cie.unam.mx

NETHERLANDS
Mr. Lex Bosselaar
NOVEM
P.O. Box 8242
3503 RE Utrecht
(Street address: Catharijnesingel 59)
Tel: +31/30/239 34 95
Fax: +31/30/231 64 91
e-mail: L.Bosselaar@novem.nl

NEW ZEALAND
Mr. Michael Donn
School of Architecture
Victoria University of Wellington
P.O. Box 600
Wellington 1
Tel: +64/4/463 6221
Fax: +64/4/463 6204
e-mail: michael.donn@vuw.ac.nz

NORWAY
Mr. Fritjof Salvesen
KanEnergi AS
Hoffsveien 13
0275 Oslo
Tel: +47/2206 5773
Fax: +47/2206 5769
e-mail: fritjof.salvesen@kanenergi.no

PORTUGAL
Mr. Joao A. Farinha Mendes
INETI – Edificio G
Departamento de Energias Renovaveis
Estrada do Paco do Lumiar, 22
1649-038 Lisboa
Tel: +351/21/7127186
Fax: +351/21/7127195
e-mail: farinha.mendes@ineti.pt

SPAIN
Mrs. María-Luisa Delgado-Medina
(Vice Chair)
Head of Renewable Energy Dept. CIEMAT
Avda. Complutense, 22
Edificio 42
28040 Madrid
Tel: +34/91/346 60 50
Fax: +34/91/346 60 37
e-mail: luisa.delgado@ciemat.es

SWEDEN
Mr. Michael Rantil
(Chairman)
Formas - The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
Box 1206, SE-111 82 Stockholm
Tel: +46/8/775 40 67
Fax: +46/8/775 40 10
e-mail: michael.rantil@formas.se

SWITZERLAND
Mr. Urs Wolfer
Federal Office of Energy
CH-3003 Bern
Tel: +41/31/322 56 39
Fax: +41/31/323 25 00
e-mail: urs.wolfer@bfe.admin.ch

UNITED KINGDOM
Prof. David Strong
Managing Director –
Energy Division BRE
Bucknalls Lane
Garston, Watford
Herts WD2 7JR
Tel: +44/1923/664237
Fax: +44/1923/664087
e-mail: strongd@bre.co.uk

UNITED STATES
Mr. Drury Crawley
U.S. Department of Energy
(Vice Chair)
Energy Efficiency and Renewable Energy
EE-2J, Building Technlogies Program
1000 Independence Ave. S.W.
Washington, D.C. 20585-0121
Tel: +1/202/586 2344
Fax: +1/202/586 4617
e-mail:Drury.Crawley@ee.doe.gov

OPERATING AGENTS

Task 22
Mr. Michael J. Holtz
Architectural Energy Corporation
2540 Frontier Avenue, Suite 201
Boulder, Colorado 80301 USA
Tel: +1/303/444 4149
Fax: +1/303/444 4304
e-mail: mholtz@archenergy.com

Task 24
Dr. Hans Westling
Promandat AB
Box 24205
S-104 51 Stockholm, SWEDEN
Tel: +46/8/667 80 20
Fax: +46/8/660 54 82
e-mail: hans.westling@promandat.se

Task 25
Dr. Hans-Martin Henning
Fraunhofer Institute for Solar Energy Systems
Heidenhofstr. 2
D-79110 Freiburg, GERMANY
Tel: +49/761/45885134
Fax: +49/761/45889000
e-mail: hans-martin.henning
@ise.fraunhofer.de

Task 26
Mr. Werner Weiss
AEE INTEC
Feldgasse 19
A-8200 Gleisdorf, AUSTRIA
Tel: +43/3112/5886 17
Fax: +43/3112/5886 18
e-mail: w.weiss@aee.at

Task 27
Mr. Michael Köhl
Fraunhofer Institute for Solar Energy Sytems
Heidenhofstr. 2
D-79 110 Freiburg, GERMANY
Tel: +49/761/4016682
Fax: +49/761/4016681
e-mail: michael.koehl
@ise.fraunhofer.de

Task 28
Mr. Robert Hastings
Architecture, Energy & Environment GmbH
Kirchstrasse 1
CH 8304 Wallisellen,
SWITZERLAND
Tel: +41/1/883 1717 or 16
Fax: +41/1/883 1713
e-mail: robert.hastings@aeu.ch

Task 29
Mr. Doug Lorriman
Namirrol Ltd.
38 Morden Neilson Way
Georgetown, ON
CANADA L7G 5Y8
Tel: +1/905/873 3149
Fax: +1/905/873 2735
e-mail: dlorriman@cogeco.ca

Task 31
Dr. Nancy Ruck
79 Amaroo Drive
Smiths Lake, NSW 2428
AUSTRALIA
Tel: + 61/2/65 544 073
Fax: +61/2/65 544 073
e-mail: ncr1@austarnet.com.au

Task 32
Mr. Jean-Christophe Hadorn
BASE CONSULTANTS SA
51 Chemin du Devin
CH-1012 Lausanne
SWITZERLAND
Tel: + 41/21/651 42 82
Fax: +41/21/651 42 83
e-mail:
jchadorn@baseconsultants.com

Task 33
Mr. Werner Weiss
AEE INTEC
Feldgasse 19
A-8200 Gleisdorf, AUSTRIA
Tel: +43/3112/5886 17
Fax: +43/3112/5886 18
e-mail: w.weiss@aee.at

SHC Task 34/ECBCS ANNEX 43
Ron Judkoff
Director,
Buildings & Thermal Systems Center
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
USA
Tel: +1/303/384 7520
Fax: +1/303/384 7540
e-mail: ron_judkoff@nrel.gov

Proposed Solar Resource Management
David S. Renné, PhD
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
USA
Tel: +1/303/384 7408
Fax: +1/303/384 7411
e-mail: david_renne@nrel.gov

Proposed PV-Thermal Solar Systems Task
Henrik Sørensen
Esbensen Consulting Engineers Ltd.
Vesterbrogade 124 B
Case for Task
DK-1620 Copenhagen V, DENMARK
Tel: +45/33/26 73 04
Fax: +45/33/26 73 01
e-mail: h.soerensen@esbensen.dk

EXECUTIVE SECRETARY
Ms. Pamela Murphy
Morse Associates, Inc.
9131 S. Lake Shore Dr.
Cedar, Michigan 49621, USA
Tel: +1/231/228 7016
Fax: +1/231/228 7016
e-mail: pmurphy@MorseAssociatesInc.com

ADVISOR
Dr. Frederick H. Morse
Morse Associates, Inc.
1808 Corcoran Street, N.W.
Washington, D.C. 20009, USA
Tel: +1/202/483 2393
Fax: +1/202/265 2248
e-mail: fredmorse@MorseAssociatesInc.com

IEA SECRETARIAT LIAISON
Mr. Peter Tulej
International Energy Agency
9 rue de la Fédération
75739 Paris Cedex 15, FRANCE
Tel: +33/1/4057
Fax: +33/1/4057 6759
e-mail: peter.tulej@iea.org

SHC INTERNET SITE
http://iea-shc.org

http://iea-shc.org

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

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