IEA Solar Heating & Cooling Programme

2000 Annual Report

Edited by
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The Solar Heating & Cooling Implementing Agreement

BACKGROUND

The International Energy Agency (IEA) was founded in November 1974 as an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD) to carry out a comprehensive program of energy cooperation among its 25 Member countries. The European Commission also participates in the work of the IEA.

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

The Solar Heating and Cooling (SHC) 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 twenty-nine 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 2000 and their respective Operating Agents are:

Task 22
Building Energy Analysis Tools
United States

Task 23
Optimization of Solar Energy Use in Large Buildings
Norway

Task 24
Solar Procurement
Sweden

Task 25
Solar Assisted Air Conditioning of Buildings
Germany

Task 26
Solar Combisystems
Austria

Task 27
Performance of Solar Facade Components
Germany

Task 28
Sustainable Solar Housing
Switzerland

Task 29
Solar Crop Drying
Canada

Chairman's Report: Highlights of 2000

Mr. Lex Bosselaar
Executive Committee Chairman
NOVEM, b.v., The Netherlands

OVERVIEW

Last year public interest in renewable energy continued to grow due to higher oil prices and an increasing awareness of the effects of climate change. These trends also raised political interest, and as a result, the Energy Ministers of the International Energy Agency requested extended plans for energy security and the G8 asked for plans to increase renewable energy use in developing countries. In addition, the IEA Renewable Energy Working Party continued its market acceleration initiative for renewables in collaboration with the IEA Secretariat in Paris. The Solar Heating and Cooling (SHC) Programme has responded to these initiatives and supported them by providing input on the solar energy aspects as well as initiating new work to address many of the technical and market issues concerning solar energy.

In 2000, the Executive Committee of the SHC Programme initiated a variety of solar activities from workshops to new Tasks. This year, three Tasks were started—Task 27, *Performance of Solar Facade Components*, Task 28, *Sustainable Solar Housing* and Task 29, *Solar Crop Drying*—bringing the total of current Tasks to eight. And, two Tasks were completed—Task 19, *Solar Air Systems* and Task 21, *Daylight in Buildings*. In addition to the current Tasks, two new Tasks are in the definition phase—Task 30, *Solar City* and Task 31, *Daylighting Buildings in the 21st Century*. The new daylighting work will build upon the results of the Programme's recently completed daylighting work, Task 21.

This year, the Executive Committee also began arrangements for two workshops to be held in 2001— a Legionnaires' workshop on the health aspects of solar water heating and an Advanced Solar Energy Storage System workshop.

Participation in the Programme continues to be strong with 20 Member countries and the European Union actively participating in its work. This year Portugal signed the Implementing Agreement and is participating in Task 25, *Solar Assisted Air Conditioning of Buildings*. The Executive Committee also extended invitations to Argentina, Egypt and Ireland to join the Programme. Other countries previously invited to join the Programme are Brazil, China, Cyprus, the Czech Republic, Greece, India, Israel, Peoples Republic of Korea, Slovenia and South Africa.

With the dedicated participation of Programme members, I look forward to the continued growth of the Programme and the demonstration of the tremendous potential of solar heating and cooling technologies.

HIGHLIGHTS OF THE TASKS AND WORKING GROUPS

Notable achievements of the Programme's work during 2000 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

A report on the empirical validation exercises conducted at the Iowa

Energy Center's Energy Resource Station (ERS), in the United States was produced. This report addresses three validation exercises 1) constant air volume with terminal reheat, 2) variable air volume with terminal reheat, and 3) very variable air volume with terminal reheat. The data collected from these exercises are an excellent source for empirical validation of building energy analysis tools for commercial buildings and equipment.

Task 23: Optimization of Solar Energy Use in Large Buildings
An electronic, multidimensional information space called the "navigator" is being developed to guide the user through the design process. This tool provides an extensive list of issues to consider during the design process, with their related problems, reasons, impacts, and recommended solutions.

Task 24: Solar Procurement
A first round of solar water heater procurements have been held in Canada, Denmark, the Netherlands and Sweden. Each country has experienced successful results and has plans for a second round of procurements. For example, a campaign launched by a Dutch bank has sold and installed approximately 100 systems in the Netherlands.

Task 25: Solar Assisted Air Conditioning of Buildings
As part of Task work on design tools and simulation programs, several mathematical models for key components of solar assisted air conditioning systems have been developed. The components covered include solar systems (collector, storage tank, backup gas heater), water chillers (adsorption chiller), and air handling units (humidifiers, heat exchangers, regeneration wheel, desiccant wheel).

Task 26: Solar Combisystems
Generic combisystems were analysed and a new classification scheme developed based on physical criteria. This new classification will be used in future work of the European Standardization Committee's CEN/TC312 Thermal Solar Systems and Components and the International Standardization Committee's ISO/TC180 Solar Energy.

Task 27: Performance of Solar Facade Components
This Task began in January 2000. Work has included developing a generic durability assessment methodology and conducting a survey on performance assessment regarding terminology, international standards and calculation tools.

Task 28: Sustainable Solar Housing
This Task began in April 2000. To begin work, the participants developed a strategy to examine the national market situations and began exploring how the product "sustainable solar houses" should be adjusted to specific markets. Sources tapped include already published literature complimented by interviews with builders, bankers, current occupants and prospective house buyers.

Task 29: Solar Crop Drying
This Task began in January 2000. During the year, participants identified potential projects and conducted feasibility studies for coffee drying projects in Brazil, Costa Rica, Guatemala, Mexico and Panama; a rice drying project in Viet Nam; and a tobacco drying project in Zimbabwe.

Working Group on Advanced Solar Low-Energy Dwellings
The Working Group has collected and analyzed monitoring results of buildings from Task 13, *Advanced Solar Low Energy Buildings*. The participants compared, predicted and measured performances, taking the climate and actual weather conditions into account, and analyzed the reasons for any deviations. The results will be published in 2001.

NEW ACTIVITIES

Task 30: Solar City
This Task is in the Task Definition Phase. It was started in cooperation with the International Solar Energy Society (ISES) and the IEA Energy Conservation in Buildings and Community Systems Programme. Currently, experts from these organizations are in the process of structuring the new work. The objective of this Task is to increase the understanding and application of solar technologies in cities. The overall goal of this effort is to reduce emissions in the targeted cities.

Task 31: Daylighting Buildings in the 21st Century
This Task is in the Task Definition Phase. The objective of this Task is to make daylighting the preferred design solution for lighting buildings by integrating human response with the application of integrated day-

lighting systems and control strategies. The intent is to provide benchmarks, performance metrics and tools to effectively design and optimize daylighting solutions.

Working Group on PV/Thermal Systems
The objectives of this Working Group are to exchange information, to prepare a "road map" by identifying the necessary international steps needed to develop various markets for PV/Thermal systems, and to advise the IEA on further work in this field. The Working Group is a collaborative effort with the IEA Photovoltaic Power Systems Programme.

Working Group on Solar Gain
The Executive Committee agreed to form this Working Group to collect and analyze passive solar data. A proposed Work Plan will be prepared for the June 2001 Executive Committee meeting.

MANAGEMENT ACTIONS
Programme and Policy Actions
The Executive Committee approved a new procedure for identifying and approving new work the Programme undertakes. The revised process will be added to the Policy & Procedures Handbook.

The Executive Committee agreed to invite Argentina, Egypt and Ireland to join the Implementing Agreement. Communication continued with the countries that have already been invited to join—Brazil, China, Cyprus, Czech Republic, Greece, India, Israel, Peoples Republic of Korea, Slovenia and South Africa.

The Software Policy Committee continued to work on strengthening and ensuring that the policy is adhered to as new Tasks develop software.

Executive Committee Meetings
The 47th Executive Committee meeting was held in June 2000 in Copenhagen, Denmark. The 48th Executive Committee meeting was held in November 2000 in Cuernavaca, Mexico.

Internet Site
The Solar Heating and Cooling Programme's web site 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. The address for the site is <http://www.iea-shc.org>.

Future Workshops
In 2000, the Executive Committee agreed to organize several workshops in 2001.

Legionnaires' Workshop
This workshop is planned for early 2001. The goal of this workshop is to exchange information on the perceived risks of this disease in solar water heaters.

Advanced Solar Energy Storage System Workshop
This workshop is planned for the middle of 2001. The objective is to explore the short- and long-term options for high density, high efficiency thermal energy storage for low energy solar houses. The intended audience is applied scientists, consultants and manufacturers in the fields of solar thermal system design and advanced thermal energy storage.

COORDINATION WITH OTHER IEA IMPLEMENTING WORKING PARTIES/AGREEMENTS AND NON-IEA ORGANIZATIONS
The Renewable Energy Working Party (REWP) increased its activities that are coordinated between the renewable energy Implementing Agreements. The SHC Programme presented its long-term R&D needs at a REWP workshop and provided input to the market acceleration initiative for renewables.

The SHC Programme participates in the Sustainable Buildings Task Force of the End Use Working Party because sustainable building is a key element of the SHC Strategic Plan.

The IEA Energy Conservation in Buildings and Community Systems Programme is collaborating in two SHC Programme Tasks—*Performance of Solar Facade Components* and *Sustainable Solar Housing.* A joint Executive Committee meeting is planned for June 2001 to facilitate the continued collaborative work between the Programmes.

The IEA Photovoltaic Power Systems Programme is working with the SHC Programme to organize the PV/Thermal Systems Working Group as well as keeping the SHC Programme abreast of activities in the PVPS Task on PV in the Built Environment.

The IEA Heat Pump Programme expressed interest in SHC Task 25, *Solar Assisted Air Conditioning of*

Building, and is considering collaborating in this work.

The International Solar Energy Society continues to collaborate with the SHC Programme on the new Solar City Task.

PUBLICATIONS

The following IEA Solar Heating and Cooling reports and related publications were printed in 2000 and are not listed elsewhere in this annual report.

Solar Energy Activities in IEA Countries—1999.
A summary of national solar building technology activities in the Member countries of the IEA Solar Heating and Cooling Programme. The report costs USD 30 and can be ordered from the SHC Executive Secretary.

The Power of Solar: Integrating Solar Energy into Today's Buildings.
A color brochure highlighting the activities and accomplishments of the IEA Solar Heating and Cooling Programme. The brochure is free and can be ordered from the SHC Executive Secretary.

FEATURE ARTICLE

Each year our annual report includes a feature article on some aspect of solar technologies for buildings. This year's article is on solar cities, which is a new area of work for this Programme. Thanks to Prof. Peter Droege of the University of Sydney, Australia for preparing an overview of this timely topic.

ACKNOWLEDGMENTS

In closing, I would like to thank the Operating Agents, Working Group Leader, 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.

This first year of the new millennium demonstrated that there is keen interest and steady growth in the solar design and technologies market. I hope, and expect, that these actions will stimulate all the involved parties to increase their efforts to make this a real solar millennium.

Solar Energy for the World's Cities:

Visions, Targets, and Tasks

Peter Droege
University of Sydney
Australia

Two daunting challenges confront the world's cities—fossil fuel depletion and man-made climate change. Many agree that if these challenges are not swiftly and effectively met that the impact will deeply affect all industrial and mega-city systems, hitting hardest the fast-growing, major urban agglomerations in the developing world.

Understanding the import role solar energy and other renewables need to play if these challenges are to be overcome, the Solar Heating and Cooling (SHC) Programme has initiated new work that focuses on the systematic introduction of solar and other renewable energy technologies in cities. This new Task, *Solar City*, will seek to carry the important work conducted in other recent SHC Tasks one step further by integrating solar and other renewable energy systems in entire buildings.

Despite significant hurdles, energy issues have begun to take center stage in an increasing number of cities around the world. The leaders of these pioneering communities realize that because of the significance of cities in national economies and their dependence on relatively short-term fossil fuel, the speed and magnitude in which renewable energy strategies are introduced will be of crucial importance to their future. As socially, politically, economically and culturally important places, cities face increasingly intense local action to improve the local environment and to combat global warming. Business, industry, and government are being challenged to respond and deliver solutions. It is here where a growing number of new urban actions and development initiatives are being readied to link local agendas and national frameworks to international challenges and resources.

Major Urban Energy Issues

Many of today's cities function on a global scale. Modern globalization, in the general sense of a complex set of global economic, communication and cultural changes, is very much driven by the use of fossil fuels.

Global supply lines are required for securing oil, coal and natural gas from the limited number of highly productive fields in production. And, the mining, shipping and processing of the raw material and its worldwide distribution has necessitated a vast logistical network, military management, security arrangements and diplomatic agendas. The result is a rapidly growing system that is fed by tenuous supplies lines that are distant, even global. As a consequence, formerly productive, but now suburbanized or relatively impoverished rural and semi-rural regions surround an increasing number of local urban areas. These new 'globalization hinterlands,' which were the former supply regions, are losing their population to the rising, brightly lit and comfortably powered urban centers.

It is appropriate to refer to contemporary urban areas as fossil cities when considering their dependence on inexpensive power for all urban infrastructure—building construction, lighting, air conditioning, computing and telecommunications, and transportation systems. As a conse-

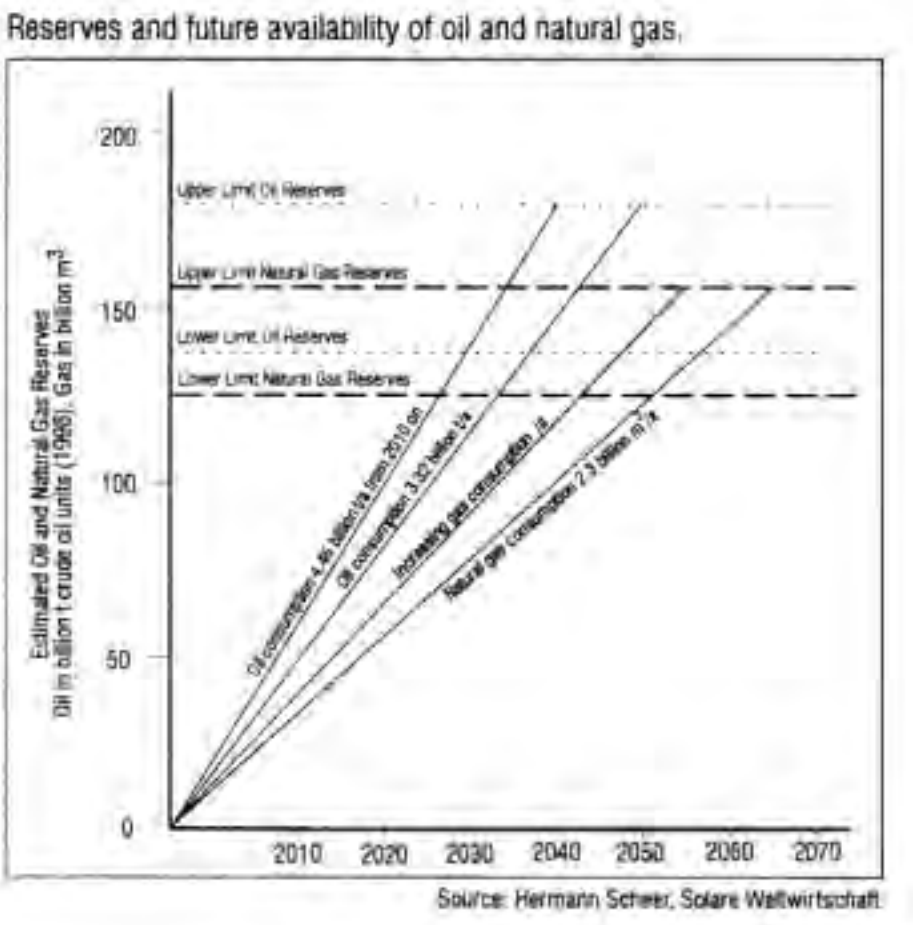


Figure 1. The prospects of fossil fuel depletion under a range of scenarios.

quence, globalized urban systems are inherently more vulnerable to a serious decline of global fossil fuel supplies than those that rely more on their local and regional resources.

Fossil fuel use has increased five-fold over the past half century, from 1.7 billion tons of oil equivalent in 1950 to 8 billion tons in 1999, and provides 85% of the world's commercial energy. The majority of this energy is used either within cities or for transport to and from cities.

Most fuel sources are due to expire within this century and much of this reality will become globally pervasive within the next 30-50 years (see Figure 1). Even conservative industry and national and international governmental sources estimate that oil will expire by 2050 (depletion of the more easily accessible supply sources is likely to occur in 20-30 years). According to rising use scenarios, natural gas is likely to evaporate in 2040; coal, is expected to expire well before 2100 (provided no large scale efforts of energy fuel substitution is pursued to stretch its deposits); and uranium is expected to be depleted by the mid-2030s (given that significant growth rates in uranium use are not anticipated due to the risks involved and a waning willingness among many governments to pursue nuclear fission further).

At the same time, global climate change is perhaps the most long-term and devastating effect of the massive and rapid worldwide burning of much of the global Carbon Age heritage (the organic carbon stores, deposited and sequestered, for example, in coal sediment layers over the past 330 million years). As primary energy consumers, cities and other urban systems are the largest single sources of CO_2 equivalent greenhouse gas emissions. And as massive urban growth is being fueled by a fossil-fed economy, it will be difficult to retrofit them to a renewables-based, zero-emissions behavior.

The protocol resulting from the 1997 Kyoto United Nations Framework Convention on Climate Change has most industrialized nations agreeing to a 5% cut of carbon-dioxide-equivalent emissions by 2010, although it is widely agreed that a 60% cut is required to actually halt global warming. A proposed global target, based in international development equity principles, of 3.3 tons of carbon dioxide-equivalent emissions per person per year (based on the customary 1990 figures) is also being proposed as a total sustainability measure to reflect the actual oceanic and forest sink capacity of the earth. The United States produces nearly 26 tons, while India still lies well below this level, at 1.8 tons (see Figure 2). The large imbalance between nations– the world average lies at 7 tons–has led to a sizable and complex global

carbon market, heralded by some as an effective mechanism to achieve overall reductions and equity, and decried by others as a pollution licensing scheme for the rich.

To achieve large-scale savings in fossil energy consumption and greenhouse gas emissions a systematic integration of renewable energy products, systems and processes is needed in cities. However, many industrialized countries are looking to energy efficiency and conservation measures, and expect most savings to come from lowering electricity consumption in residential and commercial buildings and altering transportation and land-use patterns.

In the long run, efficiency and conservation measures will only have a limited capacity to reduce fossil fuel use and combat global warming due to the growing fuel requirements, particularly in developing countries. If renewable energy technologies are to supplement and/or replace current energy sources then their continued advancement is needed as many of the prevailing urban energy agendas are aimed either at efficiency or at isolated, but highly visible, renewable energy technology installations.

What is needed are sustainable and comprehensive actions—and cities are increasingly regarded as important actors in this process.
In the built environment, there are two types of actions that are being taken to address energy issues. The first is regulation- or incentive-driven industry reform, which primarily

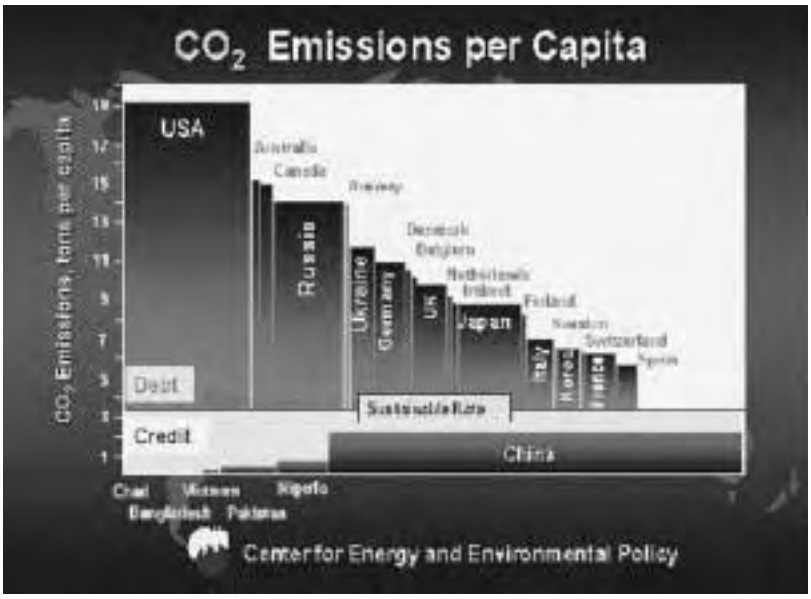


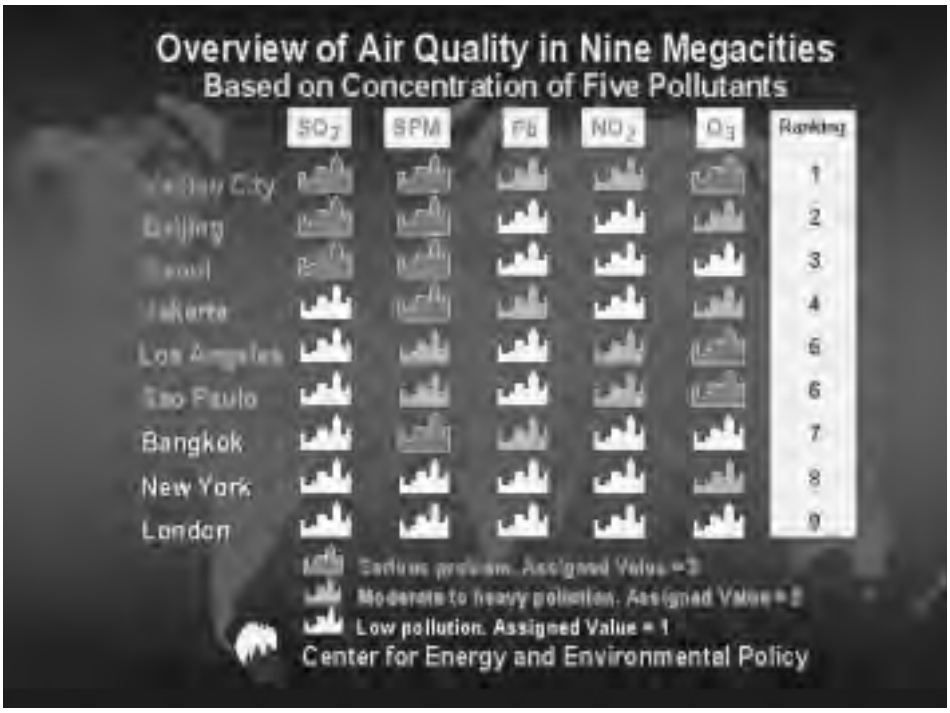
Figure 2. International CO_2 emissions debit and credit budgets relative to a globally sustainable per-capita emissions level of 3.3 tons per year.

focuses on passive energy design, conservation and efficiency. The other is mandates, which seek to drive more advanced forms of technological and design innovation to fundamentally transform the way built structures are made. Some countries, most notable being Germany, are pursuing a mandated solar energy pricing policy aimed at jump-starting a new generation of buildings. In this vision, the zero-emissions house that functions without a fossil energy supply, once the exclusive domain of eccentrics and university research laboratories, would become a reality for a majority of people.

Another area that needs to be addressed is how to reduce the large amount of energy that is embodied in the building materials themselves, the services contributing to their making, and the energy implications of the very form and design of neighborhoods and cities.

Indeed, the energy use in cities is made up of more than the buildings and the infrastructures that service these. It is the sum total of all the goods and services measurably consumed in a given location.

New ways of re-knitting central cities with their regional economies and related spatial structures are already being pursued by a number of communities. These are based on age-old principles of rural/urban support economies that boost the primary sectors of agriculture and forestry. Cities around the world are beginning to make concrete links between their renewable energy needs and potential regional resources capable of meeting their needs. This movement is also beginning to help spawn new indigenous manufacturing and advanced industry sectors in renewable energy production, supply and services.
Cities can become net renewable energy producers. This idea requires



Air pollution levels in cities.

a rethinking of urban/regional alliances as well as the adoption of increasingly firm industry promotion practices. The Australian city of Melbourne, for example, is in the process of investing in renewable energy producers with the dual aim to reduce its fossil fuel dependency and to promote the development of more advanced industries in solar and wind as well as in educational and research programs and service-based industries that one day will be capable of competing nationally as well as internationally.

In a technologically advanced renewable economy, energy supplies would no longer depend on large, centralized supply models but unfold in more diverse manners. For example, traditional appliance and facility users could become net energy generators by using solar or zero-emission systems in buildings and renewable-source based hydrogen fuel cells in vehicles. The long-range energy management paradigm is grid-free, self-sufficient and renewable for consumer appliances, households, neighborhoods and even city-regions.

All this is of enormous importance to cities. *Ubiquitous energy management* is introduced here as the notion that in a renewable-energy based economy a myriad of small and medium-scale energy service providers replaces the system of large-scale centralized ones. This system can operate both at the high end and low end of technological sophistication. High-end technology would blend information and telecommunication technologies with energy production and consumption modes residing everywhere, from personal apparel and equipment to cars and facilities. At the lower end of the scale are distributed, low-cost and low-maintenance small hydropower and solar systems that can access global information networks for use in small, remote communities.

Solar City: A Blueprint for Integrated Urban Planning

A search is underway for new models capable of unifying local governments' sector concerns, technology imperatives, energy markets and global agendas. A good example of a current attempt to support cities' quest for a sustainable energy future is the new SHC Solar City Task. This new Task represents a new generation of SHC Programme research and development work by linking solar energy techniques to other renewable energy technologies not only in a coherent spatial and social context, but also within a finite and community-wide timeline. The Task will work with a number of cities to nurture a Solar City network and support local action by augmenting existing efforts.

By not duplicating, but enhancing existing and related national and local urban development programs and networks, the Solar City Task will build on a growing momentum worldwide by adding valuable intelligence, focus and an unequivocal implementation mission. Interest in this Task includes cities and national partners in Africa, Asia, Australia, Europe and North America. The participant areas range from entire city regions to individual new town settlement programs.

The aim of the Solar City Task is to work collaboratively across locally

relevant institutional contexts. It focuses on the energy supply and technology, but does so as part of a total town planning and design strategy that also includes institutional arrangements. It promotes a community-wide rural and urban energy and emissions accounting system as well as performance targets that are linked to urban development and reform initiatives. Finally, it advocates land use strategies that are based on a consideration of urban/rural linkages and values land use and transport investment choices according to their potential contribution to long-range energy and resource self-sufficiency.

The Solar City concept is structured into three thematic areas of inquiry and two general investigation tasks to operate across these. They are to be advanced simultaneously, within nationally defined agendas. These are: sustainable-energy focused urban planning strategies; targets, baseline studies and scenario development; and urban energy technology, industry and business development. The two general investigation tasks focus on best practice cases and on learning in action. The three areas of general inquiry are briefly described below.

Solar City strategies
The aim of this activity is to advance research and development in the general planning and organizational systems of local government, with a view towards the improvement of the aims and processes of government in conducting long-term sustainable energy development strategies.

While each participating city is to produce a Solar City strategy that identifies incremental targets en route to an absolute goals well as processes and actors, it is the role of the Task to develop more powerful urban agendas and mechanisms that make the individual city's experience relevant to others in the country as well as worldwide. To be addressed are issues of strategy, planning tools, organizational arrangements, legislation and standards, incentive structures, public information and exemplary municipal practice.


Solar City Task's trademark image, the sun over our cities. Source: www.solarcity.org

By introducing new and improved ways of adopting solar and other renewable energy technologies, the Task will to contribute to integrated climate-stable practices that are relevant to the building and property development industry, land-use planning and infrastructure development.

Targets, baseline studies and development scenarios
The objective of this activity is to compare and evaluate established approaches, and to seek their enhancement. The means deployed will be absolute, yet appropriate climate-stable carbon dioxide-equivalent emissions targets aiming at 2050 as the absolute per-capita performance horizon. They will be introduced in ways that can be quantified and translated into short-term milestones. Another objective is to understand the related, fundamental performance of each Solar City in terms of a range of key indicators such as greenhouse gas emissions, renewable and non-renewable energy use, household consumption patterns, and transportation distribution.

Planning applications of energy and emissions accounting methods include backcasting, based on a twenty-year old principle. The aim is to develop town development growth trajectories while maintaining sustainable CO_2 emissions and fossil fuel use rate goals for 2050, then 'backcast' growth milestones for emissions in order to determine workable reduction rates for each milestone period. Scenarios of anticipated emissions reduction rates are important for the determination of alternative sustainable development strategies. One scenario approach is being prepared to model the local economy using a physical model of the regional economy and then vary it to agree with the milestones.

Urban renewable energy technology, systems and industry development
The objective of this activity is to assess the current, emerging and potentially competing technologies, in terms of their relative effectiveness in achieving emissions and fossil fuel use reductions. Also important is to consider the institutionally appropriate settings, prospects for community acceptance, commercialization, employment, social amenity and export development. This will help to inform financial and policy strategies, which are likely to boost the viability of renewable energy businesses.

The technology categories to be included are renewable fuels used directly for industrial use and transportation, such as ethanol; bulk electricity generation, as in biomass, wind and hydropower generation; and consumer applications such as remote area power supplies, domestic, commercial and industrial photovoltaics, and solar hot water systems. While each participating community will pursue its own programs and technologies based on local conditions and institutional arrangements, it will be important to understand what trade-offs apply when embarking on one path over another. For example, it may be critical to know which strategy constitutes the least-cost approach to the agreed target level of energy self-sufficiency and emissions mitigation, while cost refers to economic as well as non-economic resources.

General investigation program in best practice
The objective of this activity is to make accessible and to apply useful lessons from current and recent related initiatives. This objective will be achieved by studying successful practices in integrated urban energy planning, management and specific projects. The activities include the identification of scope and criteria for evaluation; information gathering and documentation; study and evaluation; analysis and description; case study development; and communication and dissemination. The scope will encompass technologies, management practices and growth strategies. At least three categories of case studies will be differentiated: comparable towns, urban precincts and settlement projects. Also to be included are development policies and programs.

General investigation program in learning from action
The objective of this activity is to monitor, analyze and provide feedback on the experiences of the participating cities. This will help to develop a shared understanding of the barriers to as well as the dynamics and impacts of community, institutional, industrial and technological changes, with a view towards the planned and targeted greenhouse gas reductions, in solar and other renewable energy sources on an urban and regional scale. This activity will not only be useful to the participants, but of value in the application of lessons and methods learned across the national urban system.

For a full description of the Solar Heating and Cooling Task 30, Solar City, visit the web site at http://www.solarcity.org.

TASK 22:

Building Energy Analysis Tools

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

TASK DESCRIPTION

The overall goal of Task 22 is to establish a sound technical basis for analyzing solar, low-energy buildings with available and emerging building energy analysis tools. This goal will be pursued 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.

Task 22 will investigate 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. To accomplish the stated goal and objectives, the Participants will carry out research in the framework of two Subtasks:

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

Tool evaluation activities will include 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 will use existing standard reporting formats and procedures. The impact of improved building energy analysis tools will be assessed from a building owner perspective.

The audience for the results of the Task is building energy analysis tool developers. 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.

Duration

The Task was initiated in January 1996 and, with a recently approved 24-month extension, is planned for completion in December 2002.

ACTIVITIES DURING 2000

A summary of Subtask research activities completed during 2000 is presented below.

Subtask A: Tool Evaluation

This Subtask is 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 are being employed:

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

Work accomplished during 2000 on each of these tool evaluation efforts is summarized below.

■ Analytical Tests: All planned activities have been 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 is 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.

■ Comparative Tests: The HVAC BESTEST suite of test cases – series E100 - E200 – has been completed and the final report prepared by the Task Experts and

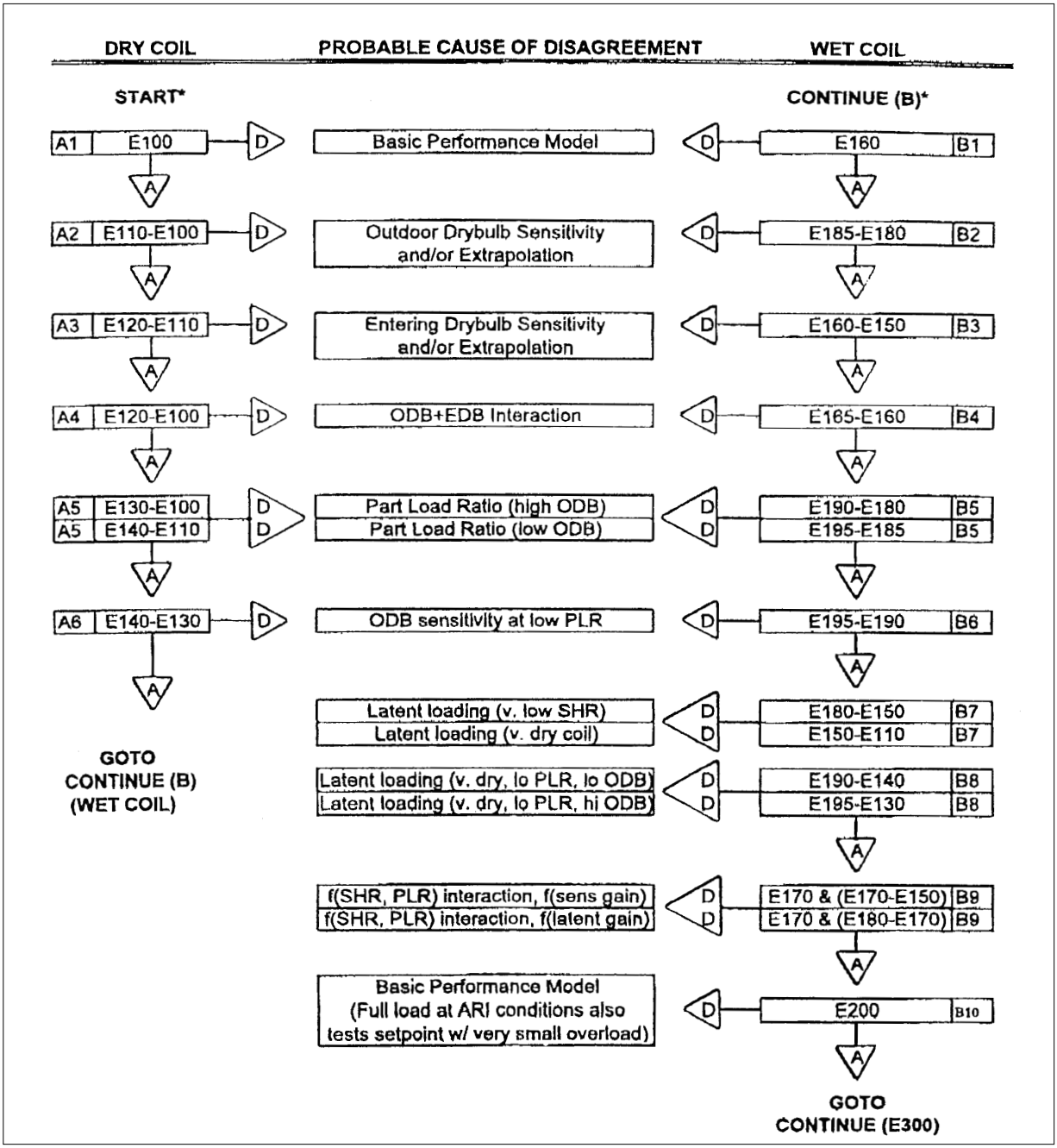


Figure 1: HVAC BESTEST Diagnostic Logic Flow Diagram – E100- E200 Test Cases

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% COPfor 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 2: Examples of Tool Problems found through HVAC BESTEST

approved by the Executive Committee. A Diagnostic Logic Flow Diagram of the E100 - E200 series test cases is shown in Figure 1.

Examples of the types of problems found when building energy analysis simulation tools are run through these tests are shown in Figure 2.

- Empirical Validation Tests: The final report on empirical validation exercises conducted at the Iowa Energy Center's Energy Resource Station (ERS) has been prepared by the Task experts and distributed to the Executive Committee for approval. The report addresses three validation exercises based on experiments 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 with the measured data. Most of the building energy analysis simulations studied showed small disagreements, similar to the measurement uncertainty.
- 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.

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. Also, a web site has been created to allow code authors access to these models – http://home.swipnet.se/nmf.

WORK PLANNED FOR 2001

A summary of planned activities for the Task Extension phase is presented below:

- Comparative Tests: Create specifications for a new suite of comparative (BESTEST) test cases addressing cooling systems, gas-fired furnaces and multi-zone space configurations.

Complete a first round of analyses on two of these three test case topics.

- Empirical Validation: Conduct experiments at the ERS to create data sets for empirical validation of simulation tools. Three sets of tests will be undertaken – heat recovery, economizer control, and daylighting - HVAC interaction. Specifications will also be developed which describe all test conditions.

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 audience for Task 22 research is building energy analysis tool authors. A secondary audience is building energy codes and standards writing organizations. For tool authors, a number of links have been established. The Analytical Solutions Working Document has been distributed for their use and comment, and a number of tool authors are participating in the HVAC BESTEST and ERS tool evaluation exercises. These activities keep Task 22 research effectively linked to the needs and recommendations of the world's leading building energy analysis tool developers.

The results of Task 22 research are used as prenormative information in the establishment of national building energy codes and standards. For example, the BESTEST cases are being developed by ASHRAE into a standard for energy standard compliance tool certification (ASHRAE SPC 140). Also, the U.S. National Association of State Energy Officials has referenced IEA BESTEST for certification of home energy rating software. A number of other countries are considering BESTEST as a standard method of testing building energy analysis tools for their national energy codes, such as CEN in the European Community.

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

REPORTS PUBLISHED IN 2000

International Energy Agency Building Energy Simulation Test and Diagnostic Method for HVAC Equipment Models (HVAC BESTEST) Volume 1: Cases E100 – E200.
National Renewable Energy Laboratory, November 2000.

Empirical Validation of Iowa Energy Resource Station Models.
CIEMAT and Iowa State University, October 2000.

Models for Building Indoor Climate and Energy Simulation.
Swedish Royal Institute of Technology, December 1999.

REPORTS PLANNED FOR 2001

BESTEST specifications for comparative tests of cooling equipment (series E300 – E520 test cases), residential gas-fired heating equipment, and multi-zone load tests.

ERS data sets and test specifications for three empirical validation exercises—daylighting—HVAC interaction, economizer control, and heat recovery.

Parameter Estimation/Identification Technique for Modeling Error Diagnostics, GISE/ENPC, France.

MEETINGS IN 2000

Ninth Experts Meeting
March 20-23
Madrid, Spain

Tenth Experts Meeting
September 7-8
Boulder, Colorado

MEETINGS PLANNED FOR 2001

Eleventh Experts Meeting
March 8-9
Lucerne, Switzerland

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TASK 23:

Optimization of Solar Energy Use In Large Buildings

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TASK DESCRIPTION

The main objectives of Task 23 are to ensure the most appropriate use of solar energy in each specific building- project for the purpose of optimizing the use of solar energy and to promote an increased use of solar energy in the building sector.

This is achieved by enabling the building designers to carry out trade-off analyses between the need for and potential use of energy con-servation, daylighting, passive solar, active solar, and photo-voltaic tech-nologies in systematic design processes.

In addition, the objective of the Task is to ensure that the buildings promote sustainable development. This is done by including considerations of other resource use and of local and global environmental impact in the trade-off analyses to be carried out.

Scope

The work primarily focuses on commercial and institution-al buildings, as these types of buildings clearly need several types of systems. In particular, office buildings and educational buildings are addressed. The same issues are relevant for many ---other commercial and institutional buildings. However, some of these, such as for -instance hospitals, require rather specialized design teams and would broaden the scope of the Task tremendously. They are therefore excluded from the Task in order to ensure concentration and focus in the work carried out.

Means

The work in the Task is divided in four Subtasks:

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

Subtask A provides the knowledge base to be used in the development of guidelines, methods, and tools in Subtasks B and C, while Subtask D ensures that the results of the work are disseminated to the appropriate audiences.

Duration

The Task was initiated in June 1997 and will be completed in June 2002.

ACTIVITIES DURING 2000

Subtask A: Case Stories

The main objective of Subtask A is to provide the knowledge needed in the development of the guidelines, methods, and tools that are being developed in Subtasks B and C. This is done by evaluating and documenting a set of buildings designed using the "whole building approach." Both the particular processes used in the design of the buildings and the resulting building performances are evaluated.

An article based on the technical report on case stories of the buildings was published in several jour-

nals, and a brochure based on the same was distributed. A second volume of this report is being produced. Two case stories for this report have been completed; these describe building projects from Germany and the Netherlands. Three more, from Canada, Germany, and Spain, are being prepared, and the intention is to distribute the working document by the end of 2000.

In addition, the working document identifying and discussing the criteria used in the design of the case story buildings was revised. It now includes a matrix indicating the relative importance given to the various criteria during the design process. This document will be distributed at the end of 2000.

Subtask B: Design Process Guidelines

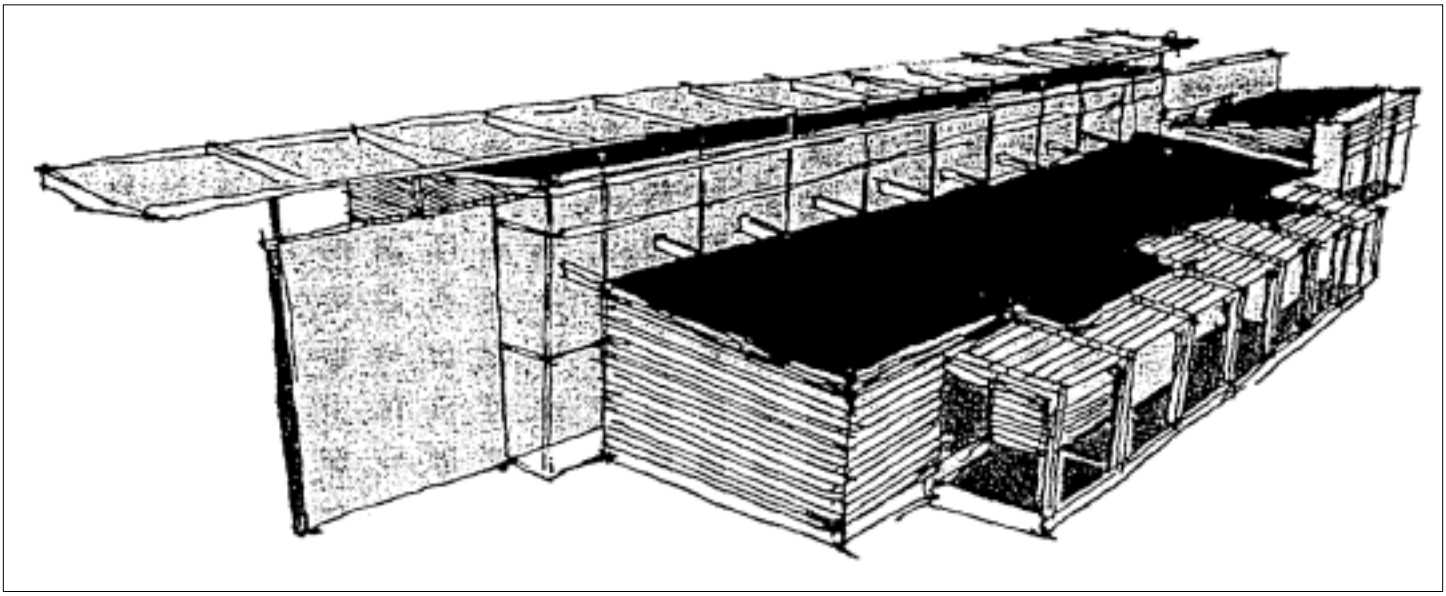
The main objective of Subtask B is to develop design process guidelines suitable for the early stages of design, as the integrated design approach is particularly important in these stages. The guidelines deal both with the make up of and the interaction between members of the design team, with the information required by the team, and with the ways of designing the building as a system, where the different low energy and solar technologies to be used are integral parts of the whole.

The Subtask B work on what is now called the "navigator" (formerly the "navigation space") has made good progress. This is an electronic, multi-dimensional information space that can serve as a guide through the design process, providing information about what issues to consider at what time, etc. The information included is based on studies conducted by the group on existing guidelines, traditional design processes, the design processes used in the design of the case story buildings, and the survey of what tools are needed and/or used in these processes. The first version was reviewed by the group and revised based on the comments received.

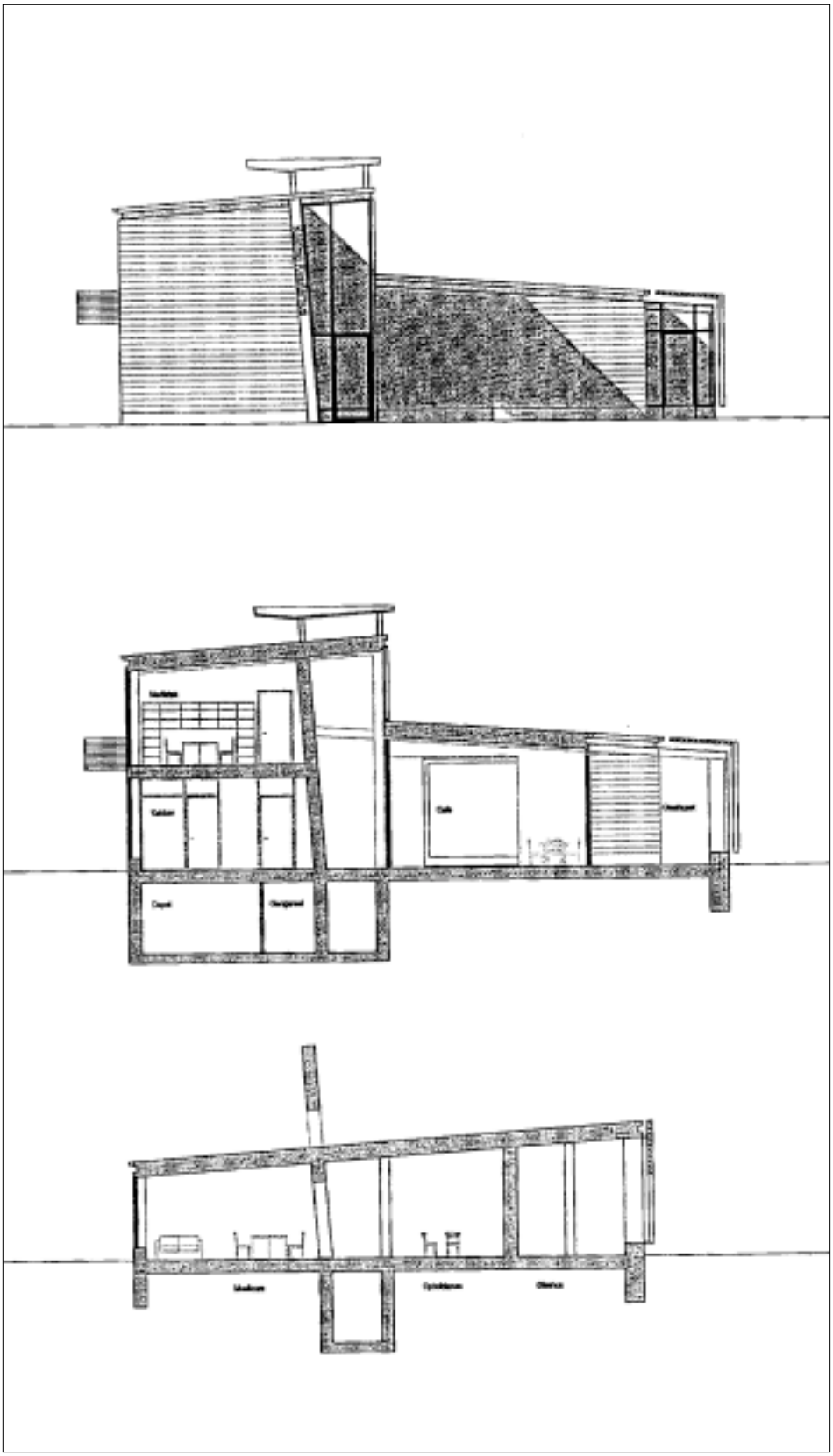
Included in the "navigator" is an extensive list of issues to consider during the design process, with related problems, reasons, impacts, and recommended solutions. This list also is used as the basis for a simpler list/set of key issues to be included in the short (paper) version of the Task 23 design process guideline. This will be a document intended for wider distribution than the "navigator" itself, describing the need for an integrated design process and the key, more universal issues that need to be considered during such a process.

Subtask C: Methods and Tools for Trade-off Analysis

The main objective of Subtask C is to develop methods and tools to be used by the designers when doing trade-off analyses between different low energy and solar technologies. As designers, builders, and owners



Sketch of the first Task 23 demonstration project: Kvarterhuset, the community center in Kolding, Denmark.



Section views of Kvarterhuset.

optimize against a large number of criteria, such as energy use, comfort, cost, aesthetics, environmental impact, etc., it is assumed that there is a need for both a computer-based tool that can optimize against a relatively limited set of criteria and a more complex, multi-criteria decision making method that will enable the designers to do more general and, therefore, less detailed optimizations.

An important part of this work is the development of the multi criteria decision-making (MCDM) method. The first version of the method was tested in local/national workshops on real design problems. It is now revised to allow the design team to select criteria and sub-criteria, to allow for non-linear scales, to eliminate the use of a reference building, and to invert the star diagram (bigger is now better). The new version is being tested by the teams designing the Task 23 demonstration buildings.

The computer tool, MCDM 23, which includes the worksheet used in the MCDM method and presents the results as star diagrams, is also being further developed. The intention is to have a beta version in March 2001 and the finished version by the end of 2001.

Work on adapting Energy-10 to be used as a Task 23 tool is continuing. And, work on Sketch, the input routine for drawing buildings directly on screen, is well under way and will be completed in early 2001. The PV module has been completed and is now being distributed. In con-

junction with the discussions of computer tools in Subtask C at the last Experts Meeting, Drury Crawley from the U.S. Department of Energy gave a comprehensive overview of work on tool development in the USA.

Subtask D: Dissemination and Demonstration
The main objective of Subtask D is to disseminate the results of the work in the Task work to the building community. The Task 23 "package" of products will consist of the following:

- Integrated Design Process Guideline (the "short" version)
- Navigator (the "long" version)
- MCDM (the method)
- MCDM-23 (the tool)
- Design workshop blueprint
- Design competition guideline
- Case story booklet(s)
- Case story reports
- Demonstration project descriptions

The first case story booklet, "*Examples of Integrated Design*," was printed. The first Task 23 demonstration project is the winning entry in a competition for Kvarterhuset, a community center in Kolding, Denmark. The design team has begun working and will use the Task 23 tools. Austria may be the next demonstration project to begin as the Austrian experts entry they intended to use for this Task won the competition it was entered in.

General
Task 23 information material (case story brochure, first case story report, and booklet) was distributed at the Sustainable Building Conference in Maastricht, the Netherlands. In addition, the work of Subtasks B and C were presented at several conferences and at the IEA SHC Whole Building Design Tools workshop in the Netherlands.

WORK PLANNED FOR 2001
As 2001 is the next to last year of the Task, the main activities will include the further development and testing of the design process guidelines and the MCDM method and the production of presentation material for these tools, as well as intensified work on demonstration buildings and dissemination activities.

Subtask A: Case Stories
The working document on the criteria used in the design of the case story buildings will be completed, and the second volume of the case stories report will be completed and distributed.

Subtask B: Design Process Guidelines
The design process guideline/"navigator" will be further developed and a complete draft of the short version of the guideline will be prepared.

Subtask C: Methods and Tools for Trade-off Analysis
The Task 23 multi criteria decision-making method will be further tested and used, a first draft of the booklet presenting the MCDM method and MCDM-23 (the tool) will be prepared, and a beta version of MCDM-23 will be produced. Work on making Energy-10 a useful Task 23 tool will continue.

Subtask D: Dissemination and Demonstration
Work on the demonstration building projects will continue, and detailed plans for such projects will be presented.

A "blueprint" for the initial design phase workshops will be developed and tested, attempts at testing the MCDM method in competition programming will be made, and a public Task 23 web site will be established.

REPORTS PUBLISHED IN 2000
A Multi-Criteria Decision-Making Method for Solar Building Design.
Andresen, I., PhD-thesis 2000:23, Department of building technology, NTNU, Trondheim, Norway, 2000.

Multi-Criteria Solar Design Method,
Andresen, I. Proceedings of the European Solar Conference, EuroSun 2000, Copenhagen, Denmark, 2000.

Multi-Criteria Decision-Making in Green Building Design.
Andresen, I., Proceedings of the International Conference Sustainable Building 2000, Maastricht, the Netherlands, 2000.

Multi-Criteria Decision Making Process for Buildings.
Balcomb, D. J., A. Curtner, I. Andresen, A.G. Hestnes, Proceedings of the PLEA Conference (Passive Solar and Low Energy Architecture), Cambridge, England, 2000.

The Bigger View: Optimizing Solar Energy Use in Large Buildings.
Henriksen, C. et al., Renewable Energy World, Volume 3, Number 3, pages 118-128, 2000 and Sun at Work in Europe Volume 15, Number 1, pages 10-13, 2000.

Building Integration of Solar Energy Systems.
Hestnes, A.G., Solar Energy Volume 67, Numbers 4-6, pages181-189, 1999 (printed 2000).

Good Examples of Integrated Solar Design.
Van Cruchten, G. (editor). This report is available from Damen Consultants, Arnhem, The Netherlands.

MEETINGS IN 2000
Sixth Experts Meeting
March 8-10
Saariselkä, Finland

Seventh Experts Meeting
September 14-16
United States

MEETINGS PLANNED FOR 2001
Eighth Experts Meeting
March 14-16
Lund, Sweden

Ninth Experts Meeting
November 12-13
Stuttgart, Germany

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TASK 24:

Solar Procurement

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TASK DESCRIPTION

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

This objective will be 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.

Subtasks

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

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

The objectives of Subtask A are:

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

The procurement activities will consist of two rounds: the first with smaller projects and a low degree of joint international collaboration, and the second with larger projects and a higher degree of collaboration.

The objectives of Subtask B are:

- 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 will be included in a manual: "Book of Tools"
- To define a process for prototype testing and evaluation, using existing methods

Participation

Five countries take part in the Task – Canada, Denmark, Netherlands, Sweden and Switzerland.

Duration

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

ACTIVITIES DURING 2000

- During the year, there was intensive work on the *First Round of Procurements*, consisting of smaller, national procurements. It has included the identification of buyers, forming of national buyer groups, drawing up of specifications and competition documents, and, in some of the countries, launching procurements and competitions.

- After the completion of Phase I tendering in *Canada*, three manufacturers were selected to supply the solar systems, and 17 systems were installed in two communities. The tendering of Phase II was jointly launched in two communities by an NGO and a utility in the autumn. They plan to install 20 and 30 systems, respectively. After evaluation of the tenders, it is expected that the systems will be installed during the spring of 2001.

- A solar campaign was launched by two utilities in *Denmark*. The tender documents were sent out in March, and after evaluation of the tenders submitted, a supplier was selected. Up to the end of the autumn, the campaign has sold 15 systems (of which 8 larger 12 m^2 systems). During the year, contacts also were established with several companies and organisations as potential buyer groups.

- Several solar campaigns for systems in existing dwellings as well as in new housing developments and large renovations have been running in *the Netherlands* during the year. In one of the campaigns, launched at the end of 1999 by a Dutch bank, about 100 systems are being sold/installed. Another of the campaigns was launched by a Dutch company owned by 40 installers, offering solar sales and installation service on a national scale. A survey project also was started together with the umbrella organisation of all housing associations in the Netherlands and its counterparts in nine other European countries. Work also is occurring for medium-sized systems through a buyer group of 59 Dutch organisations. This initiative is expected to include more than 100 projects (with a total of about 20,000 m^2) that are to be realised during the coming years.

- Two buyer groups were established in *Sweden*—one for small solar-heated domestic hot water systems (5-10,000 m^2) and the other for solar collectors in larger systems (10,000 m^2). The competition for the small systems was launched in March and a procurement for the larger systems in April. A large number of entries were received for both. Several prototypes were tested with good results and evaluated. The intention is to sign framework contracts in early 2001. Intensive work has been going on in Sweden for raising the general interest in solar systems using brochures, promotional meetings and TV presentations.

- Much of the work in *Switzerland* during the year was concentrated on preparations for and carrying out of a referendum, in which one important question was: Will the Swiss population support renewable energy by paying a minor sum for non renewables? 55% of the votes were against this. Contacts were established with different electricity works with the intention of forming buyer groups and starting projects. Experience has been gained from some municipal initiatives, such as in Zurich, Basel and Zug.

- Information material, brochures and articles were produced and published in all the participating countries. Papers were presented at different solar conferences. Different sources for financing information activities were investigated. Unfortunately, the applications to the European Commission ALTENER Programme and the 5th Framework Programme were rejected.

- A proposal for an "IEA SHC Award of Excellence" which could further increase the interest in Task 24 activities and could be used for the Second Round of Procurements as a prestigious recognition for good performance continues to be developed for consideration by the SHC Executive Committee.

WORK PLANNED FOR 2001

- The evaluation of the First Round of the Task 24 Procurements will be finalised and the Second Round of procurements will be planned for a start in the autumn of 2001.

- In *Canada*, it is expected that several communities will participate in the Phase III tendering, and up to 50 systems will be installed in each community. A market transformation study will be undertaken. A market survey, new performance and system specifications and the value of peak saving electric load with solar water heating will be included in this activity.

- Additional deliveries will take place in *Denmark* following the tender by the utilities in two Danish regions. Contacts initiated in 2000 with the Danish Association of Plumbers will be continued. The intention is to establish collaboration and the goal is to install 30-40 systems per installer per year. Further contacts will also be developed with, among others, the Danish environment offices, house-building associations and "green" municipalities in order to establish long-

term relations.

- The ongoing solar campaigns in *the Netherlands* will continue. Based on the Dutch survey project, buyer groups of housing associations will be established, national tenders will be launched in early 2001 and international tendering will take place during the Second Round of Task 24 later in the year. In the initiative for medium-sized solar systems in the Netherlands, co-operative international actions within Task 24 will be taken.

- Deliveries of the small SDWH systems are expected to start in *Sweden* in early 2001 and will comprise 1,000-2,000 systems. An extended subsidy programme for solar systems is planned for 2001. For the larger systems, additional efforts will take place in order to increase the acquired amount of solar surface area.

- The *Swiss* Solar Energy Society is planning an internet-based project with a "virtual" buyer group. It is aimed at house owners and the call for tender will be in accordance with the Task 24 guidelines. A local project team will be formed, consisting of, among others, PR specialists, computer experts, suppliers, contractors and Swiss Task 24 representatives. A project for solar roofs in a town in Switzerland is planned to be launched. The project concerns hot water for single-family houses and for multifamily houses with less than 10 apartments. The intention is to have turnkey installations at a fixed price, professional management and to use only certified components.

- Information activities will continue in all the participating countries. The Task 24 newsletter will be updated and published on the Task 24 home page (www.ieatask24.org) and presentations will be made at different solar conferences.

- Contacts with interested organisations will continue in Austria, Belgium, Finland, France and United States. Further contacts will be taken with the supplier organisations ASTIG and ESIF.

REPORTS PUBLISHED IN 2000

The first edition of the Task 24 report *"Book of Tools"*—produced on the web—with the majority of the original content in the section *"Business Tools."* The report is available from the Task home page (www.ieatask24.org).

Tender documents have been drawn up for each different national tender and have been exchanged between the participating countries.

REPORTS PLANNED FOR 2001

Example Tender Packages for solar heating systems for single-family houses and for collector subsystems for large solar heating systems. The intention is to publish these documents on the home page to facilitate tendering procedure and contribute to more efficient purchasing of solar systems.

Business Tools (or "Book of Tools" on the web site) will be upgraded in 2001.

MEETINGS IN 2000

Fifth Experts Meeting
February 28 - March 1
Canada

Sixth Experts Meeting
October 2-4
Switzerland

MEETINGS PLANNED FOR 2001

Seventh Experts Meeting
March 21-23
Sweden

Eighth Experts Meeting
September (2-3 days during the period 17-28 September)
Netherlands

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TASK 25:

Solar Assisted Air Conditioning of Buildings

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TASK DESCRIPTION

The main objective of 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. The project will aim to:

- Define the performance criteria of solar assisted cooling systems considering energy, economy and environmental aspects.
- Identify and further develop promising solar assisted cooling technologies.
- Optimize the integration of solar assisted cooling systems into the building and the HVAC system focusing on an optimized primary energy saving - cost performance.
- Create design tools and design guidelines for planners and HVAC engineers.

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

Subtask A: Survey of Solar Assisted Cooling

The objective of Subtask A is 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. 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.

Subtask D: Solar Assisted Cooling Demonstration Projects

Several demonstration projects will be carried out and evaluated in the framework of 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. 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 May 2004.

ACTIVITIES DURING 2000

A summary of Subtask research activities carried out during 2000 is presented below.

Subtask A: Survey of Solar Assisted Cooling

A survey of existing solar assisted air conditioning systems was conducted

and information on about 25 installations was compiled. A database was prepared for this purpose. The production of reports about national R&D activities on solar assisted air conditioning in the participating countries is an ongoing activity.

Subtask B: Design Tools and Simulation Programs
Mathematical models for some key components of solar assisted air conditioning systems was developed, such as solar system components (collector, storage tank, backup gas heater), water chillers (adsorption chiller) and components of the air handling unit (humidifiers, heat exchangers, regeneration wheel, desiccant wheel). A draft version of the WINDOWS-surface of the design tool was produced. Task participants decided that three typical loads (hotel, office, lecture room) and 6 climatic regions (Tropical, Mediterranean/Coastal, Mediterranean/Inland, Central European/South, Central European/Moderate and Central European/North) will be available in the design tool as predefined data files.

Subtask C: Technology, Market Aspects and Environmental Benefits
A survey of market available equipment for solar assisted air conditioning was started. The survey aims to achieve a market overview about absorption chillers, adsorption chillers and desiccant wheels. Other components will be described in a general way. A survey about finished and ongoing national R&D work on new components has been started as well. The aim is to identify promising new approaches that are feasible for solar assisted A/C systems. A draft form to measure overall performance related to energy, economy and environmental issues was produced. This form will be included into the design tool (Subtask B) to provide an easy method for comparing different system options.

42 m² of solar collectors supply a desiccant cooling system in Lisbon/Portugal, which provides air conditioning for 11 office rooms. A monitoring of this system will be carried out in Subtask D.

Subtask D: Solar assisted cooling demonstration projects
Two levels of monitoring were defined for demonstration systems: global monitoring with less effort is based on daily energy balances and detailed monitoring requiring more effort is based one-minute-averages of all important parameters. While the first level allows the assessment of overall system performance, the second level allows for the study of the performance of single components. At present about 15 demonstration systems in 10 countries will be investigated (about 10 new plants and 5 existing systems).

WORK PLANNED FOR 2001
A summary of Subtask research activities planned for 2001 is presented below.

Subtask A: Survey of Solar Assisted Cooling
Completion of the final report of Subtask A is planned for March 2001.

Subtask B: Design Tools and Simulation Programs
A first executable version of the design tool will be available in early next year. Predefined load files as well as meteorological data sets will be implemented in the design tool. Component models of absorption chillers as well as vapour compression chillers will be developed and implemented.

Subtask C: Technology, Market Aspects and Environmental Benefits
Definition of predefined loads will be carried out and respective load files for the different climatic zones will be produced. The survey of market available equipment will be continued and draft chapters of the hand-

book will be produced. The survey of new developments of low temperature heat driven cooling equipment and solar collector developments feasible for solar assisted A/C will be continued. A technical report on this topic is scheduled for completion the end of 2001.

Subtask D: Solar Assisted Cooling Demonstration Projects
Commissioning of first demonstration plants will take place in 2001 and monitoring will begin.

REPORTS PUBLISHED IN 2000
No official reports were published in 2000.

REPORTS PLANNED FOR 2000
Survey of Solar Assisted Cooling and Air Conditioning Projects (Subtask A).

Technical Report on New Developments (Subtask C).

MEETINGS IN 2000
Second Experts Meeting
January 27-28
Delft, Netherlands

Third Experts Meeting
September 21-22
Cuernavaca, Mexico

MEETINGS PLANNED FOR 2001
Fourth Experts Meeting
January 29-30
Sophia Antipolis, France

Fifth Experts Meeting
September 27-28
Lisbon, Portugal

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TASK 26:

Solar Combisystems

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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 recently introduced into the market. After the first period of combisystems (1975-1985), during which engineers developed non-standardized designs and complex systems, a new period began in 1990. Now systems are designed primarily by solar companies that are interested in selling simpler and cheaper systems. However, current designs are based mainly on field experiences and so have not yet been carefully optimized. There is substantial potential for cost reduction, performance improvement and increased reliability, all of which need to be scientifically addressed.

Scope and Main Activities

Task 26 is reviewing, analyzing, testing, comparing, optimizing and improving designs and solutions of solar combisystems for:

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

This Task does not refer to solar district heating systems or systems with seasonal storage or central solar heating plants with seasonal storage.

To accomplish the objectives of the Task, the Participants are carrying out research and development 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 Netherlands)
- Subtask C: Optimization of Combisystems for the Market
  (Lead Country: Austria)

Besides 32 experts from 10 countries, 16 companies from almost all the participating countries are taking part in the work. Their contributions will make the results of the Task more relevant to the solar heating industry.

Duration

The Task was initiated in December 1998 and will be completed in December 2002.

ACTIVITIES DURING 2000

A summary of Subtask research activities during 2000 is presented below.

Subtask A: Solar Combisystems Survey and Dissemination of Task Results

The emphasis to date has been on preparing an overview of combisystems, defining reference conditions for simulation runs and performance reports, and developing criteria for ranking and making inter-comparisons of the systems.

Overview of Combisystems

For one and a half year this has been a major activity. First a review form was drafted in 1998, before the Task official began, then the participants completed. The information was analysed by the Subtask A leader and compiled into the coloured booklet "Solar Combisystems in Austria, Denmark, Finland, France, Germany, Sweden, Switzerland, the Netherlands and the USA". This illustrated booklet presents relevant existing solar combisystems. It is targeted at industry (architects, engineers, HVAC companies). Following an introduction on solar combisystems and their features and potential market, the booklet covers 21 generic systems on the market in the nine participating countries. A generic system from Norway, which joined Task 26 in May 2000, is being considered for inclusion in the review.

To date, all the generic systems have been analysed and a new classification scheme developed based on physical criteria (strategy used for stratification enhancement in the storage tank(s); strategy used for the auxiliary heat management). This classification will serve as a contribution to future work of the European standardization committee CEN/TC312 "Thermal Solar Systems and Components" as well as of the international standardization committee ISO/TC180 "Solar Energy."

The production of the booklet was financially supported by nine industry participants (Batec A/S (Denmark), Borö-Pannan AB (Sweden), Clipsol (France), Consolar Energiespeicher- und Regelungssysteme GmbH (Germany), Fortum New Technology Business (Finland), SOLID (Austria), SOLTOP Schuppisser AG (Switzerland), SOLVIS- Solarsysteme GmbH (Germany), Sonnenkraft GmbH (Austria) as well as from two government offices from the Netherlands and Switzerland. The booklet was published in time for the EuroSun Conference in Copenhagen, June 2000. This report has been distributed to industry sponsors, national contact persons and participants at the EuroSun Conference. An internet version is available on the web site of the IEA Solar Heating and Cooling Programme (www.iea-shc.org).

Definition of Reference Conditions for Simulation Runs and Performance Reports

This work was completed in 1999 and the results were passed on to Subtask C. Subtask C enhanced them and added the technical details needed for simulation runs and performance reports.

Criteria for the Ranking and Inter-Comparison of Combisystems

The difficult challenge for Subtask A is the development and practical application of a set of ranking and inter-comparison criteria on an objective basis. The potential success of an optimised system on the market also substantially depends on its end-user price and reliability/durability, which is more difficult to assess for all the systems and to compare from system to system.

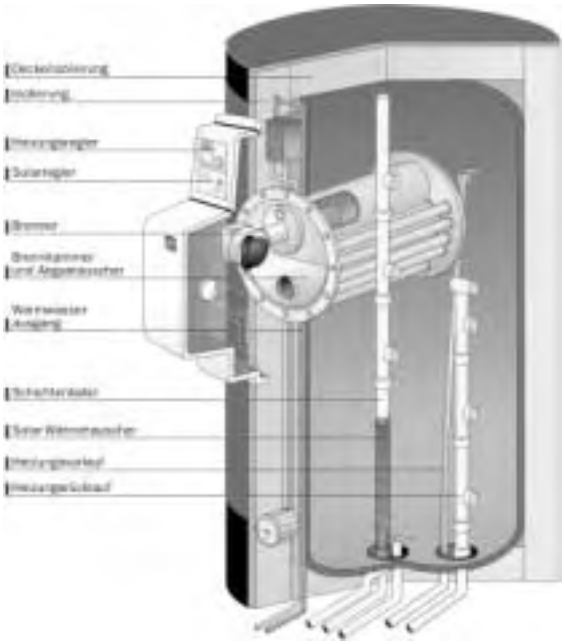
The collector area on this building in Gleisdorf, Austria is part of a solar combisystem which provides 70 % of the annual space heating and hot water demand for six terraced houses and an office building.

Quantitative comparisons shall include both price and performance considerations. After extensive discussions within the Task, two types of diagram were agreed upon:

1) An efficiency diagram with the fractional energy savings plotted as a function of the main dimensioning parameter (the ratio of the yearly solar radiation incident on the collector array to the yearly heat consumption for space heating and domestic hot water); in such a diagram, secondary parameters will be used to draw family of curves

2) A cost performance diagram with the annual energy savings plotted as a function of the additional investment cost related to solar.

Sets of diagrams according to this



Solmax 3d: Advanced storage for solar combisystems with an integrated gas burner. Source: SOLVIS, Germany

dual concept shall allow the identification of trends related to the system type, design and dimensioning.

Also a number of qualitative ranking and inter-comparison criteria, among them several reliability/durability criteria, are being discussed in Subtask A. An internal working document on the ranking and inter-comparison criteria developed and the first system comparisons will be prepared in 2001.

Industry Newsletter

The first issue of the annual industry newsletter was prepared. It has been translated in the national languages of the participating countries, with regional cooperation between countries speaking the same language. The first issue presents Task 26, the current status and the industry workshops that have been organized in conjunction with each Experts Meeting (workshop proceedings are available on the Task web site).

Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components

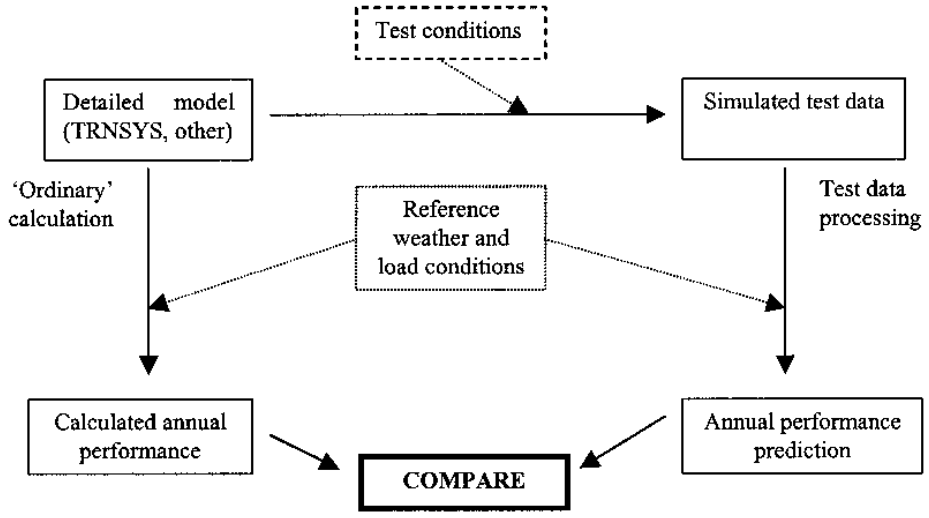
The test method development for solar combisystems includes both thermal and hot water performance. Model development supports the testing of the definition of procedures, the evaluation of tests in Subtask B and the optimization of solar combisystems in Subtask C.

Test Method Development for Thermal Performance Characterization

Test procedure development has moved into the direction of the simple AC/DC method rather than further development of the more complex CTSS method, however, development of the latter has not stopped. Wishes from the industry for an inexpensive test method lead the way in this respect.

Development of the AC/DC method should reveal as much information as possible for the least cost possible. Currently, the thermal performance test is thought to (1) indicate the well functioning of the system and aspects for improvement and (2) reveal an annual performance prediction with sufficient accuracy.

Requirements on the test procedures for solar combisystems were listed and a first draft of the AC/DC test procedure produced based on investigations of simulated data. The basis for investigation of test conditions can be read from the figure below. Given a certain system and specific test conditions, test data are generated using a detailed simulation program, like TRNSYS. These simulated test data are processed using the procedures and tools matching the AC/DC test method. This reveals an



annual performance prediction. The performance figure is compared with the thermal performance calculated by the detailed model. Deviation between both figures is a measure for the accuracy of the test method, hence, the soundness of test conditions.

The aim of investigating test conditions is to find the test sequence yielding accurate performance figures. The first goal for the investigation of test conditions for the AC/DC test method is the delivery of annual performance prediction with sufficient accuracy. For the time being, the goal for accuracy of this figure is set at 10% to compare the performance of different solar combisystems in the same climate and load. At a later stage, investigation of test conditions should also include extrapolation of annual performance for different climates and loads as well as for slightly different system sizes. For these extrapolations inaccuracy is expected to be larger.

Test rigs for AC/DC testing are being built in Sweden and Switzerland and will be built in Germany and the Netherlands. Special attention is being paid to the solar collector emulator.

A first version of the hot water performance test also is available. The test is simple and inexpensive. It provides a performance figure that is easy to understand: the amount of hot water (with specific quality) available. The figure gives a rating of the heat store without auxiliary power as this power can be changed in some cases. The test has successfully been tried out on two combisystem stores.

Model development
Most model developments have been carried out in combination with Subtask C. Developments consisted of preparation of specific subroutines for the TRNSYS package. So-called types were put together for the solar collector (coupling with CEN standardisation has been made in this respect), multi-port heat stores, heat stores with integrated burner and a specific floor heating system. Whole systems also have been modelled following the overview in the Booklet from Subtask A.

Solar combisystems in Sweden are frequently connected to biomass boilers for back-up.

Subtask C: Optimization of Combisystems for the Market
Reference conditions for simulation runs have been defined and approved by the participants. Eleven of the 19 system designs chosen by Subtask A will be optimized.

Optimization Procedure
The following optimization procedure will be used:

- Model the system in TRNSYS using present manufacturers data.
- Perform a sensitivity analysis with all parameters defined at the Helsinki meeting (Zurich climate, 4 buildings).
- Define critical parameters.
- Optimize systems with critical parameters (by hand or automatically with e.g. GenOpt) using the target functions defined at the Copenhagen meeting and the investment costs of the components.
- Perform a sensitivity analysis with all parameters with an optimized system in order to check non-sensitive parameters and find overall optimum.

In addition DREAM SYSTEMS for combisystems will be defined in the final phase of the Subtask.

WORK PLANNED FOR 2001
A summary of planned activities for each of the Subtasks is presented below.

Subtask A: Solar Combisystems Survey and Dissemination of Task Results
The activities planned in this Subtask for 2001 are the following:

- Comparison and ranking of solar combisystems: practical application of the principles developed in 1999-2000, including results

from the Subtask C optimization of systems as well as reliability/durability considerations.
- Organisation of two industry workshops. The industry workshops will be held in conjunction with the Task 26 meetings in the Netherlands and Austria.
- Production of the 2001 issue of the Industry Newsletter.
- First outline of the design handbook and preparation of data, in interaction with Subtasks B and C.

Subtask B: Development of Performance Test Methods and Numerical Models for Combisystems and their Components

The activities in Subtask B in 2001 are the following:

- Further investigation of the test conditions for the AC/DC test method using simulated test data. Test sequences will be simulated for solar combisystems with external auxiliary heater and load side heat exchanger for domestic hot water and with a direct burner. At a later stage, there will be attention for specific Scandinavian systems with different auxiliary heating for winter and summer conditions as well as for poorly designed systems. Furthermore, sspecial attention will be paid to extrapolation of annual performance for different climates and loads as well as for slightly different system sizes.
- Design and building or finishing test rigs for AC/DC testing. Special attention will be paid on design of the solar collector emulator.
- Further development of the hot water performance test, also by way of real testing.
- Start of real solar combisystems testing according to the AC/DC test method and compare the outcome with CTSS test results.

Subtask C: Optimization of Combisystems for the Market

The activities in Subtask C in 2001 are the following:

- Modeling of chosen combisystems based on the survey produced by subtask A and simulation within their respective boundary conditions and validation against measured data if available;
- Sensitivity analysis for various parameters including control strategies, and optimization with respect to all reference conditions, parameters and target functions chosen by Subtasks A and C that can be modeled with the available tools;

LINKS WITH INDUSTRY

Sixteen companies from almost all participating countries are taking part in Task 26. The industry workshops jointly organised by Subtask A and the Task's Operating Agent have received a positive response from industry, especially from industry in the country hosting the Experts Meeting. Between 11 and 24 industry representatives attend the workshops.

LINKS WITH CEN TC 312

Liaison status has been granted to Task 26 with CEN/TC 312 "Thermal Solar Systems and Components" by Resolution 7/99. The duration of this liaison is three years and will be reviewed accordingly on 2002-10-27.

CEN/TC 312 has been informed on the State-of-the-Art in Task 26 with respect to test procedure development and definition of reference conditions for meteorological, space heating and domestic hot water loads.

REPORTS PUBLISHED IN 2000

Solar Combisystems in Austria, Denmark, Finland, France, Germany, Sweden, Switzerland, the Netherlands and the USA.

This report can be ordered from the national contact persons or downloaded from the Task 26 home page on the SHC web site.

First Industry Newsletter

Proceedings of Borlänge and Espoo Industry Workshops

REPORTS PLANNED FOR 2001

Second Industry Newsletter

Proceedings of 2nd Industry Workshops

MEETINGS IN 2000

Second Experts Meeting
April 11-14
Taastrup, Denmark

Third Experts Meeting
October 3-6
Stuttgart, Germany

MEETINGS PLANNED FOR 2001

Fourth Experts Meeting
April 2-5
Borlange, Sweden

Fifth Experts Meeting
October 8 - 11
Espoo, Finland

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TASK 27:

Performance of Solar Facade Components

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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 will focus 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:

- 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:

- 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:

- A review of international knowledge 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 and is planned for completion in December 2003.

ACTIVITIES DURING 2000
Subtask A: Performance
The development of a generic energy performance assessment methodology started with the compilation of survey results on terminology, international standards and calculation tools.

A sample selection and distribution scheme for Chromogenic Glazings were prepared. The first samples were distributed by Flabeg to two Task 27 participants (CSTB and ISE) and two partners in the European SWIFT project (Oxford Brookes University and the National Institute of Chemistry, Slovenia), who are prepared to provide input into Task 27, subject to permission by Flabeg. Gasochromic samples were also distributed. The United States Task participant contacted several U.S. manufacturers about supplying electrochromic samples. In addition, a list of detailed properties that are to be measured was prepared.

Candidates for the performance measurements of solar building components and integrated assemblies were identified and will be investigated in the framework of the following case studies:

- Solar control devices (in particular lamella type of shading) and their integration
- Double envelope systems
- TI-facades
- Daylight redirecting systems
- High performance glazing/window/wall assemblies

Subtask B: Durability
A draft of a general durability assessment methodology, based on contributions from SP, SPF, ISE and CSTB, was completed. This methodology will serve as a guide for developing material specific durability test procedures which are needed for solar facade components. In the final phase of Task 27 work, the general methodology will be revised to take advantage of the experiences gained.

An initial risk analysis was performed defining, from an end-user point of view, the durability and reliability of switchable materials and devices (chromogenics). The areas assessed were the critical functional properties, potential failure modes, and critical factors of environmental stress.

Results from survey research were compiled on 1) test standards and 2) availability of durability testing facilities (accelerated and outdoor) appropriate for chromogenic exposure testing.
Work is continuing, in collaboration with Subtask A, to define the quantitative measures of the critical performance characteristics associated with various chromogenic materials and their dependence on switching stimulus. Also, a list of chromogenic glazing characteristics critical to performance assessment was made to serve as a guide when selecting quantities to be monitored during or in association with outdoor exposure.

Subtask C: Sustainability
The goals of the environmental performance assessment have been validated and are as follows:

- To reach a common level of knowledge in terms of terminology and categories of tools.
- To perform a survey of national approaches (needs and priorities, tools used, work completed or in progress on glazing, windows and solar devices)
- To agree on appropriate methodologies to assess the environmental performance of our products, as well as target and communication formats.
- To perform application exercises on a glazing, a window, and a solar collector following four steps: 1) agree on priorities, system limits and criteria, 2) collect data, 3) conduct the procedure, and 4) communicate the results.

The windows and glazing unit systems to be assessed for durability and reliability were selected. The following will be tested using accelerated indoor testing, long-term monitoring (outdoor tests), comparison with accelerated aging and risk analysis:

- Edged sealed glazing units (large samples)
- Breathing glazing units and TIM-elements
- Insulated frames
- Assembling of window and wall/roof (complete windows)

WORK PLANNED FOR 2001

Subtask A: Performance
A draft of a mega-matrix of products, properties, standards and problem areas will be prepared. Harmonization of component formats and product data will be completed. Work will begin on defining reference buildings to be used for performance calculations. Energy assessment calculations for switchable glazings will be performed using the selected reference building. Five participants have already modified and used different building energy simulation programs to cater to their switchable glazings.

The chromogenic glazings market potential review will be a central part of the work besides the performance definition report. And, data from the performance measurements of solar building components and integrated assemblies will be collected.

Subtask B: Durability
A validation study on how useful the general methodology would be for the assessment of durability and service life of sealant materials and polymeric glazing materials of PVC, PS, and PC will be conducted. Also, an initial risk analysis on polymeric glazing materials will be performed.

Participants who plan to conduct outdoor testing of chromogenic samples include ISE, CSTB, and EDF. Outdoor exposure testing of chromogenic devices is extremely important both to compliment accelerated exposure testing and to validate real-world operation and performance. Detailed procedures for outdoor testing including mounting of test samples, switching program and monitoring of climatic data have been prepared and testing will begin in 2001.

Work started on identifying microclimatic data needed for accelerated life testing (e.g., frequency distribution for pane temperatures, total annual incident energy per m2 in UV and solar range).

The test samples of anti-reflective and polymeric glazing materials were distributed for studies were sol-gel coated glass (Uppsala University, Pilkington/Flabeg) and etched glass of Sunarc, Duroglas. Solar control films of polymer sheet and films of PC will be exposed for outdoor testing at least six test sites: Denmark (DTU), France (CSTB), Germany (ISE), Italy (ENEA), Sweden (SP), Switzerland (SPF). Optiwhite will be used as reference material. The glazing materials will be exposed to the outdoors in mini-solar collector boxes developed using the guidelines prepared by the SHC Working Group, Materials in Solar Thermal Collectors.

As the first step in durability assessment, an initial risk analysis of potential failure modes of studied materials will be performed to identify the most critical damage/degradation mechanisms, suitable degradation indicators and most critical degradation factors. For this analysis the general methodology will be used as well as any durability data already collected by the sample manufacturers. Based on the results of the initial risk analysis, a proposal for screening testing will be prepared and an accelerated test will be performed by four laboratories—France (CSTB), Germany (ISE), Sweden (SP), and Switzerland (SPF).
The following reflector samples will be distributed for studies: aluminium foil protected by clear coat (Vattenfall, Sweden)' Solar Brite, CEN reflector, Sol-gel coated aluminium (CIEMAT), and SOLEL. Pure polished aluminium will be used as the reference material.

Outdoor testing will begin in February 2001 at four test sites: Germany (ISE), Italy (ENEA), Sweden (SP), and Switzerland (SPF). An initial risk analysis of potential failure modes and the program for screening testing will be set up like for glazings.

The case study on solar facade absorbers is being performed in close cooperation with the EU-Joule project "Solar Building Facades." The objectives of this project are to develop 1) coatings for facade absorbers, 2) procedures for durability testing, and 3) facade elements and their building integration as well as performance testing. The EU-Joule project is already performing outdoor exposure tests on selected materials and Task 27 will make use of the results. In addition, the EU-

Joule will provide data on the materials from the accelerated screening tests as well as carry out complementary studies on the degradation mechanisms and perform additional accelerated aging tests.

Subtask C: Sustainability
The following products have been chosen for an environmental impact assessment: a wooden frame window and a façade absorber. Data will be collected in each country from all available sources (industry, literature, data bases, etc.).

After reaching a common level of knowledge in terms of concept and terminology on Service Life Prediction (SLP) and Failure Mode and Effects Analysis (FMEA), and agreement on appropriate methodologies to predict service life and its possible premature terminations, application exercises on a several products will be conducted

After assessing the durability and reliability of windows and glazing units and installing them for long-term monitoring, the work will focus on evaluation and investigation of critical conditions and design parameters for:

- Edged sealed glazing units (large samples)
- Breathing glazing units and TIM-elements
- Insulated frames
- Assembling of window and wall/roof (complete windows)

LINKS WITH INDUSTRY
Nine companies from seven countries are participating in Task 27. Through these industry links, the participants of Task 27 can ensure the valuable use of its research results. See the list of Task 27 National Contact Persons for further details.

MEETINGS IN 2000
First Experts Meeting
May 15-17
Grenoble, France

Second Experts Meeting
October 9-12
Scheveningen, Netherlands

MEETINGS PLANNED FOR 2001
Third Experts Meeting
April, 27-30
Berkeley, California, United States

Fourth Experts Meeting
October, 8-11
Rome, Italy

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TASK 28:

Sustainable Solar Housing

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TASK DESCRIPTION

This Task is being performed in collaboration with the IEA Energy Conservation in Buildings and Community Systems Programme. The goal of Task 28 is to help achieve significant penetration of sustainable solar housing in the markets of participating countries starting in the year 2005 by providing home builders and institutional real estate investors with:

- A web site: Model Solar Sustainable Housing illustrating built projects which are exemplary in design, living quality, energy use and environmental impact.
- A book: Marketable Sustainable Solar Housing: Plans, Details and Performance which describes and analyzes recently built housing to help planers learn from built experience.
- A handbook: Marketable Sustainable Solar Housing: A Design Handbook 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 Task results.

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

- Subtask A: Market-Assessment and Communication (Lead countries: Netherlands and Norway)
- Subtask B: Design and Analysis (Lead countries: Sweden and Switzerland)
- Subtask C: Demonstration (Lead country: Australia)
- Subtask D: Monitoring and Evaluation (Lead country: Germany)

Duration

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

ACTIVITIES DURING 2000

The Task officially began with the first expert meeting on April 3-5 in Lugano, Switzerland with 30 experts from 14 countries in attendance (Australia, Austria, Belgium, Canada, Switzerland, Germany, Finland, Norway, Netherlands, Sweden, and observers from Brazil, Denmark, Italy and the United Kingdom). A wealth of national projects closely related to or directly linked to Task 28 provided a good basis for the start.

Subtask A: Market-Assessment and Communication

Task Communication

A Task website has been created (http://www.iea-shc.org/task28/index.htm). A Task brochure was prepared and will be printed in 2001. It will be available from the Task 28 Secretariat.

Market Assessment

What are the prerequisites from a "consumer" point of view to achieve "marketable housing for a better environment?" What will be expected from housing in the next 5-10 years? What installations and equipment will become standard? What

Passivhaus Wolfurt, Oberfeld, Austria

price is acceptable for sustainable houses? What qualities of architecture, materials, comfort, user friendliness etc. will be in demand? The challenge for this Subtask is to assure that buildings and concepts the Task investigates and promotes are adapted to the marketplace. The experts developed a strategy to examine the national market situations and began exploring how the product "solar sustainable house" should be adjusted to the specific markets. Sources tapped include published literature complimented by interviews by the experts with builders, bankers, current occupants and prospective house buyers.

Subtask B: Design and Analysis
A handbook for planers is the focus of activities in this Subtask. An outline for the handbook was presented, with the main headings: Introduction, General principles, Advice by climate region, Advice by building type, Specific technologies, and Typical Solution Sets (TSS).

Work began to quantify energy, ecological and economic advice for the handbook by:

- Defining reference geometries for an apartment building, row house and single family detached house; internal gain profiles and regional climates. Constructions are being derived from national building codes.
- Analyzing the reference buildings to provide a basis of comparison for the high performance housing. A secondary result will be a comparison of how progressive national building regulations are.
- Identifying Typical Solution Sets (TSS) to achieve the high performance buildings. Combinations of technologies and design will be analyzed to provide solutions optimized by region and building type.

Subtask C: Demonstration
A process was defined to establish what qualifies as a solar sustainable house design in a given environment. Work began in the following areas:

- Conduct environmental performance assessments for a number of Subtask D buildings that have been monitored in order to provide quantified criteria. This will be completed in 2001.
- Based on these assessments, performance targets will be established for designing the demonstration buildings to be constructed between 2002-2003.
- These criteria will serve in planning the monitoring program for the demonstration projects.

Subtask D: Monitoring and Evaluation
Existing very low energy housing is the platform from which we can learn much for the planning of new projects. Two approaches are being pursued:

- Statistical analysis of design parameters correlated to performance to extract key indicators for a successful project.
- Documentation of experiences from built projects including photographs, drawings and insights from interviews with the designers, consultants, clients and occupants.

The Subtask now has an impressive inventory of projects built according to these very low energy standards including single-family detached houses, row houses and apartment buildings as well as whole communities of up to 100 houses. Projects have been presented from Sweden (1 project), Austria (8 projects), Switzerland (7 projects), Finland (1 project), Germany (12 projects) and the Netherlands (11 projects).

Cooling Working Group
This group's challenge for the first year was to show the importance of addressing sustainability in a social and cultural context in diverse climates as Task 28 represents a wide range of climates. The climates can be grouped as follows:

- Heating dominated (i.e., middle and northern Europe)
- Heating & cooling (i.e., Australia, Canada and Italy.)
- Cooling (i.e., Australia and Brazil)

An interesting example of a project being pursued by a Task expert is the development of a prototype housing module for mass production to help meet the current deficit of 5.5 million housing units in Brazil. The government plans to build 400,000 housing units with 60,000 units in Mines Gears. The project objective is to create a sustainable housing unit of 60 m^2, costing only \$100/m^2. Sustainability goals, such as using indigenous construction materials, gravity-flow solar DHW systems, and photovoltaic systems for remote sites, while improving comfort through passive cooling and ventilation. Constructing these units according to current practice (i.e., with electrically heated shower heads) would increase electric power demand by 6 GW. The utilities are strong advocates of this project.

First Experts Meeting in Lugano, Switzerland

WORK PLANNED FOR 2001

Subtask A: Market Assessment and Communication

The Task web site will be expanded to include examples of building projects. The Task brochure will be printed and distributed. Task experts will evaluate current literature of professional associations and interview target groups. Following are sample groups and questions:

- Builders:
  - What qualities/user benefits should solar sustainable housing have and what are the barriers to market growth?
  - Which technical questions would builders like clarified that could lead to an improved housing product?
- Occupants of existing sustainable solar housing projects:
  - Which qualities were important when buying the house?
  - After living in the house, which qualities are appreciated? Should be improved?
- Prospective house owners:
  - Which groups are willing to invest more in a healthy, sustainable, energy efficient house?

Subtask B: Design and Analysis

Chapters on the technology sets for the handbook will be drafted based on results from related national research activities. Unanswered important issues will be identified and the first set of computer runs completed to provide quantitative advice for planers regarding energy issues unique to such high performance housing. Ecological issues related to the technology solution sets will be assessed using checklist procedures.

Subtask C: Demonstration Projects

Performance targets and example design briefs will be drafted to help in the selection and planning of demonstration housing projects. Results from Subtask D will be evaluated to establish the targets. Demonstration projects already in the planning stage will be reviewed in special sessions at the expert meetings. Finally, ideas will be shared among the experts on how to initiate demonstration projects.

Subtask D: Monitoring and Evaluation

Key indicators and correlation parameters identified in the year 2000 will be extracted from the data of the built projects. An initial statistical analysis will be carried out to determine within which ranges performance varies according to the applied criteria. Lessons learned will be documented. The purpose of this documentation is to promote high performance housing and to give planers and builders insights as to what performs well. As with the Handbook, energy, ecology and economy are to be the key aspects. The material developed will serve as

the basis for the planned book on the built projects.

Cooling Working Group
Exemplary sustainable housing from hot humid climates in Australia and southern Europe will be examined. Typical solution sets for hot humid climates will be identified and literature reviewed with regard to design advice. An outline will be written for a proposed cooling chapter in the Handbook. The prototype sustainable housing project in Brazil will be further developed and additional projects will be searched for.

LINKS WITH INDUSTRY
The principle link with industry is via Task experts who represent specific industries. Industries involved in the Task include: an innovative Canadian construction firm, a Swiss manufacturer of prefabricated sustainable housing, two professional associations for passive house design, a major manufacturer of HVAC equipment, and the Norwegian State Housing Bank.

REPORTS PUBLISHED IN 2000
No official reports were published in 2000.

REPORTS PLANNED FOR 2001
Draft of *Marketable Sustainable Solar Housing: Plans, Details and Performance*

MEETINGS IN 2000
First Experts Meeting
April 3-5
Lugano, Switzerland

Second Experts Meeting
October 4-7
Helsinki, Finland

Subtask Leaders Meeting
December 11-13
Wallisellen, Switzerland

MEETINGS PLANNED FOR 2001
Third Experts Meeting
May 2-4
The Netherlands

Fourth Experts Meeting
September 24-26
Italy

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TASK 29:

Solar Crop Drying

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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 wood is being replaced by more expensive diesel and propane fuels. 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 December 2002.

ACTIVITIES DURING 2000

During the year Task 29 participants identified potential projects and conducted feasibility studies for the following:

2000 Feasibility Studies

Location/Country	Crop	Task 29 Project Lead
Panama	Coffee	Canada
Mexico	Coffee	Canada
Guatemala	Coffee	Canada
Brazil	Coffee	Canada
Costa Rica	Coffee	Canada
Viet Nam	Rice	Canada
Zimbabwe	Tobacco	The Netherlands

A coffee beneficio in Mexico. The roof is especially adaptive to the installation of solar panels.

In addition, the Canadian team identified potential sites in Viet Nam. The Austrian team worked with the tobacco industry and is searching for a potential coffee drying application in Uganda.

WORK PLANNED FOR 2001

The following feasibility studies are expected to be completed in 2001:

2001 Feasibility Studies

Location/Country	Crop	Task 29 Project Lead
China	Bio Fuel	Canada
China	Jujubes	Canada
Columbia	Coffee	Canada
India	Tea	Canada
India	Spice	Canada
Uganda	Coffee	Austria

From the projects noted above, the following are scheduled to be designed, constructed and operating in 2001:

Projects to Operate in 2001

Location	Crop
Panama	Coffee
Mexico	Coffee
Columbia	Coffee
China	Biofuel
China	Jujubes
Viet Nam	Rice
India	Tea
India	Spice
Zimbabwe	Tobacco

LINKS WITH INDUSTRY

Task 29 has established excellent industry links on two fronts, suppliers and users. The Canadian team includes representatives from the manufacturer of Solarwall® solar panels, which are being adapted for use in solar crop drying. The Dutch team includes a representative from Zen Solar, a producer of solar systems, who has an interest in establishing a joint venture in Zimbabwe for the production of their systems. The United States is represented by an official of the Solar Energy Industries Association and the Austrian participant is employed by Arbeitsgemeinschaft Erneuerbare Energie (AEE), an independent association to promote the practical utilization of renewable forms of energy.

On the user side, Task participants are working directly with growers and processors in order to encourage them to install pilot systems. In Panama, for example, the Canadian team is negotiating with the largest coffee processor in the country for one of the projects. In China, our team is dealing directly with the operators of drying facilities. In Zimbabwe, the Dutch participants are working with the Zimbabwean Tobacco Association and will be installing a Task project at their research center. At the Task meeting in Mexico earlier this year, approximately 25 representatives of the local coffee growers and beneficio owners attended a half-day workshop to exchange information.

A coal-fired jujube dryer in China

A tobacco-drying barn at the Zimbabwean Tobacco Association Research Station.

REPORTS PUBLISHED IN 2000
No official reports were published in 2000.

REPORTS PLANNED FOR 2001
The Task plans to widely distribute three newsletters in 2001.

MEETINGS IN 2000
First Experts Meeting
March 21 – 23
Jalapa, Mexico

Second Experts Meeting
October 30 – November 1
Veldhoven, The Netherlands

MEETINGS PLANNED FOR 2001
The meetings have yet to be confirmed. Plans are as follows:

Third Experts Meeting
March/April
India

Fourth Experts Meeting
October/November
China

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