INTERNATIONAL ENERGY AGENCY

The SolarPACES Implementing Agreement
Mid Term Report for the Period
January 2002 to June 2004

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Background:

Attached is the Mid Term Report of the SolarPACES Implementing Agreement. At the 60th meeting of the IEA SolarPACES Executive Committee in Cuernavaca, Mexico, held 8-9 May 2001, the ExCo unanimously took the following decision:

"The ExCo has unanimously approved the extension of the SolarPACES Implementing Agreement for another five years until December 31st, 2006, and gives the ExSec the mandate to proceed with the formal steps required by IEA in this respect."

The current SolarPACES end-of-term is 31 December 2006 but the CERT approved the extension of the SolarPACES IA with a condition of providing a mid-term progress report in 2004.

The SolarPACES Implementing Agreement submits this Report to the REWP for review, and recommendation to the CERT for an extension of the Term of the Agreement.

1 Introduction

This summary report on the activities of IEA SolarPACES for the period January 2002 to June 2004 is produced for the Renewable Energy Working Party (REWP) and the Committee on Energy Research and Technology (CERT) of the International Energy Agency (IEA).

At the 60th meeting of the IEA SolarPACES Executive Committee (ExCo) held in Cuernavaca, Mexico, on May 8th and 9th, 2001, it was unanimously agreed to extend the Implementing Agreement to December 31st, 2006. At the same time, the Chairman and Secretary were given the mandate to seek IEA Headquarters approval of this extension. The approval process involves a recommendation from the REWP and approval of the CERT.

The current SolarPACES end-of-term is 31 December 2006 but the CERT approved the extension of the SolarPACES IA with a condition of providing a mid-term progress report in 2004.

2 Objectives, Strategy and Scope

2.1 Objectives of Strategic Planning

The Strategic Plan for IEA SolarPACES was published in 1997 following formal approval at the 50th Executive Committee meeting. It is also available at the IEA SolarPACES website: www.solarpaces.org.

The objectives of the IEA SolarPACES Strategic Plan expand the role of this Implementing Agreement from one that has been focused largely on technology development to one addressing the full range of activities necessary to overcome barriers to large-scale adoption of concentrating solar technology. Prime objectives of the Strategic Plan are to:

1. Support **TECHNOLOGY** development
2. Support **MARKET** development
3. Expand **AWARENESS** of the technology

It thereby considers the impact of increased use of concentrating solar power (CSP) technologies on predicted global climate change, the increased interest shown by non-member and developing countries to participate in IEA SolarPACES, the changing information needs of the developing CSP industry, revision of the REWP strategy, and increased access to the Internet.

In 2002, SolarPACES joined forces with UNEP, the Global Environmental Facility (GEF) and the Solar Thermal Industry Associations of Europe and U.S.A., to develop the Concentrated Solar Power (CSP) Global Market Initiative (GMI) in order to facilitate and expedite the building of 5,000 MWe of CSP worldwide over the next ten years. This initiative represents the world's largest, coordinated action in history for the deployment of solar electricity.

2.2 IEA SolarPACES Vision, Mission and Strategy

These are detailed in the IEA SolarPACES Strategic Plan. The vision and mission statements for IEA SolarPACES focus on overcoming the technical, non-technical, institutional, and financial barriers to the deployment of CSP technologies.

IEA SolarPACES *VISION*	To make by 2010 a significant contribution with concentrating solar power (CSP) technologies to the delivery of clean, sustainable energy services in the world's sun belt.
IEA SolarPACES *MISSION*	To facilitate, co-ordinate and maintain concentrating solar technology research, development and demonstration through international co-operation and information exchange, leading to the deployment and commercialization of sustainable, reliable, efficient and cost-competitive concentrating solar power technologies.
IEA SolarPACES *STRATEGY*	To assist the participating countries in expanding the use of economical, reliable and efficient concentrating solar technologies in a manner which is linked to and consistent with the REWP strategy and goals.

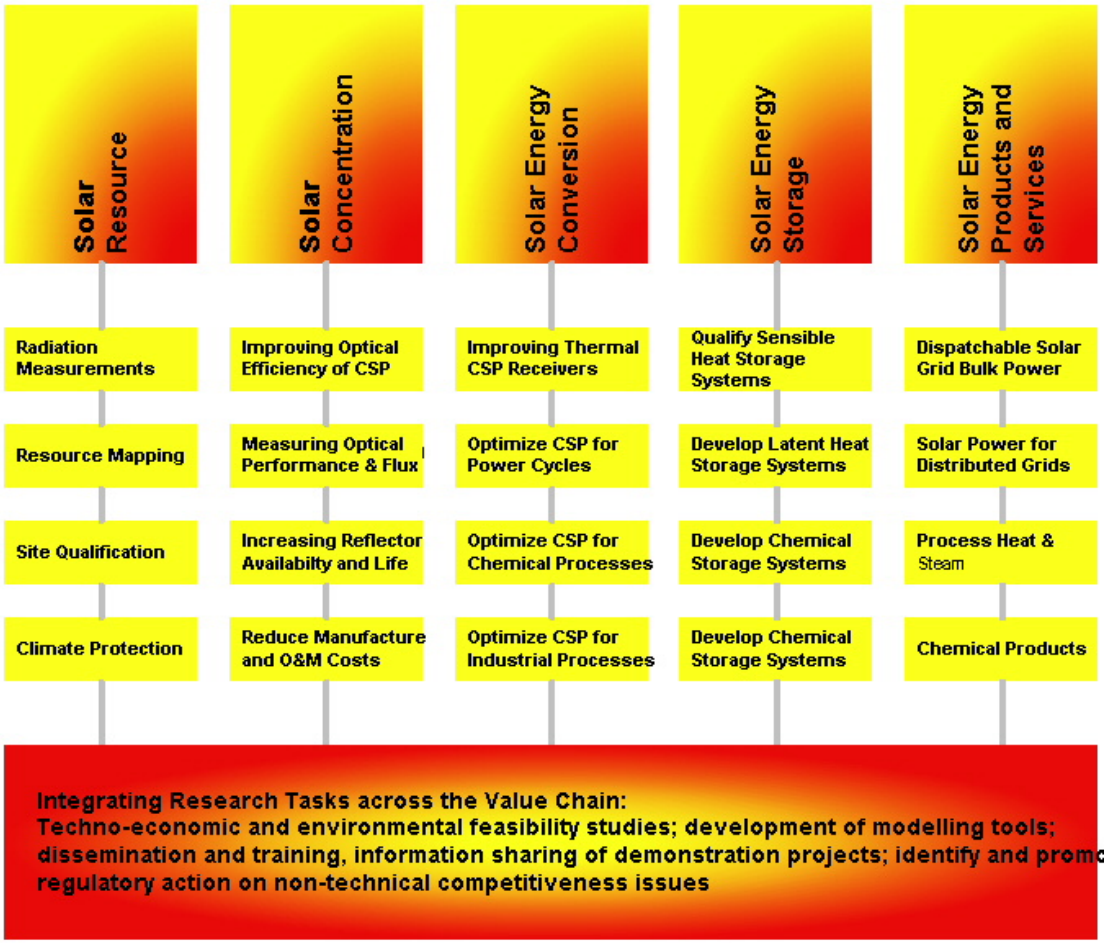

Figure 1 Scope of CSP research, development and demonstration work

2.3 Scope of IEA SolarPACES

The scope of IEA SolarPACES is co-operative research, development, demonstrations and exchanges of information and technical personnel, regarding solar power and chemical energy systems. The scope of thematic subjects undertaken is shown in Figure 1, structured according to the solar concentration and conversion process.

3 Participation of Countries, R&D Institutions, Utilities and Industry

Figure 2: New Energy Algeria (NEAL) was mandated by the Algerian Government to become signator to the IEA SolarPACES Implementing Agreement on 13 January 2003 at the IEA HQ in Paris. From left to right: Richard Sellers (IEA Head Renewable Energy Unit), Hanns-Joachim Neef (IEA Head Energy Technology Collaboration Division), Michael Geyer (IEA-SolarPACES Executive Secretary), William C.Ramsey (IEA Executive Director), M. Chakib Khelil (Algerian Minister for Energy and Mines), Tewfik Hasni, (President Director General of New Energy Algeria NEAL).

Algerian Minister of Energy and Mining and former OPEC President, Chakib Khelil and Ambassador William C. Ramsay, Acting Executive Director of the International Energy Agency (IEA), met on January 13th, 2003, at the IEA in Paris to attend a ceremony marking the accession of NEAL (New Energy Algeria) to the IEA Implementing Agreement on Solar Power and Chemical Energy Systems, SolarPACES. Algeria is the second OPEC member country to join an IEA Implementing Agreement and the first in the field of renewable energy. As part of its commitment to expanding its electricity generating capacity, Algeria aims to increase the share of solar power in electricity generation to five percent by 2010. It is keen to establish a partnership with the European Union to supply electricity from Algerian solar powered generating plants. Plans are underway for two undersea transmission cables with capacity of 1.2GW each to carry electricity from Algeria to Spain and Italy.

As of June 2004, thirteen countries or organizations, designated by their governments, participate in IEA SolarPACES:

Country	Represented by	Govt.	R&D Institute	Industry	Electric Utility
ALG	New Energy Algeria			X	
AUS	Utility Consortium				X
BRA	CEPEL		X		
EGYPT	NREA	X			
EC	DG-RESEARCH DG-TREN	X			
FRA	CNRS		X		
GER	DLR		X		
ISR	WIS		X		
MEX	IEE				X
RSA	ESKOM				X
SPA	CIEMAT		X		
SWI	PSI		X		
USA	Industry Consortium			X	

Table 1 Countries and organizations participating in SolarPACES

The SolarPACES Implementing Agreement has attracted the ***Non-IEA Member countries*** Algeria, Brazil, Egypt, Israel, Mexico, and South Africa, which possess excellent solar resources for the application of solar concentrating technologies. Thanks to the participation of these sun-belt countries, the CSP technology development will be much better focussed to their market needs, local CSP expertise will be built up, joint R&D projects can be initiated, and the feasibility of utility-scale projects can be investigated. Task Participation is shown in Table 2.

SolarPACES Task	ALG	AUS	BRA	EC	EGY	F	D	IL	MEX	RSA	E	CH	USA
I. CSP Systems	x	x	x	x	x	x	x	x	x	x	x		(X)
II. Solar Chemistry		x	x	x		x	x	x			x	(X)	x
III Technology and Advanced Applications	x	x	x	x		x	(X)	x	x	x	x	x	x
III SHIP Solar Heat for Industrial Processes					x		(X)		x		x		

Table 2 Task Participation

Cooperation with industry is a key element in the SolarPACES cooperation. Over a fourth of the contracting governments designated industrial or utility partners as SolarPACES participants--i.e., Algeria (project developer), Australia (utility association), Mexico (utility), South Africa (utility) and US (industry). Those countries that have nominated industry or utilities as the contracting party are represented in the ExCo by industry and utility representatives. Furthermore, the ExCo has invited to most of its meetings special guests from industry, utilities, financial institutions and regulatory bodies. Details are given in the SolarPACES Annual Reports. This has been intensified by introducing a special "Host Country Day" to the ExCo meetings, where energy policy makers, utilities and industry are invited to report and discuss on the host country's perspectives for CSP projects.

Industry and utility partners are actively participating in the Tasks and their technical meetings and seminars, as reported in detail in the SolarPACES Annual Reports. Since the announcement of renewable electricity incentive programs in the European Union,

industry and utility participation in the task meetings has increased sharply. At the last task meetings, over a dozen private firms were represented. At the biannual Symposia, about a third of the 150-200 participants come from industry and utilities.

Industry actively participates in SolarPACES Tasks and other activities as partners. Task I, which focuses on CSP systems and is most closely related to market and near-term demonstration projects, is the most prominent example. Industry is responsible for over 50% of the information sharing projects.

The CSP Global Market Initiative has been jointly developed with the European Solar Thermal Industry Association (ESTIA) and the Solar Energy Industry Association (SEIA) of U.S.A. .

The nature of the CSP technologies with their large concentrator fields, receivers and storage systems implies an intensive collaboration with industry in all stages of development, from initial conceptual engineering, to prototype development, and to large-scale demonstration. The CSP cost reduction strategy builds on progress by R&D and mass manufacturing by industry.

Potential for increased participation: Additional countries, that are not SolarPACES members yet, have become interested in CSP. Among them are:

- Italy, where a 110Mio Euro research, development and demonstration program has been launched in 2000
- India, where the state of Rajasthan is preparing the RFP for a combined cycle plant with integrated CSP in Mathania
- Morocco, where the national utility ONE is currently preparing the RFP for a combined cycle plant with integrated CSP in Ain Beni Mathar

Other countries with high solar insolation and power needs include Namibia and Chile.

With the approval of the new IEA Framework For International Energy Technology Co-Operation, that allows participation of sponsors from industry in Implementing Agreements further industrial participation is expected.

4 The Work Programme and Nature of Work

SolarPACES member (contracting party) activities are carried out through cooperative research, technological development and demonstration, and exchange of information and technical personnel. As the nature of electric power technologies would imply, the parties involved comprise governments, public research institutions, industrial suppliers, electric utilities, and international financing entities. They all cooperate by means of information ex-change, formal and informal initiation of joint or national activities – task-shared as well as cost-shared – and also by sharing the costs of mutually agreed activities. In the period under review, the work within IEA SolarPACES was structured in the four main Tasks with a number of Subtasks shown in Figure 3. Their detailed objectives, budgets, time frames and results have been described in detail in the SolarPACES Annual Reports submitted to the IEA Secretariate and the REWP.

The collaboration which earlier was focused on Research, Development and Demonstration is now increasingly also emphasizing Deployment worldwide on a large scale.

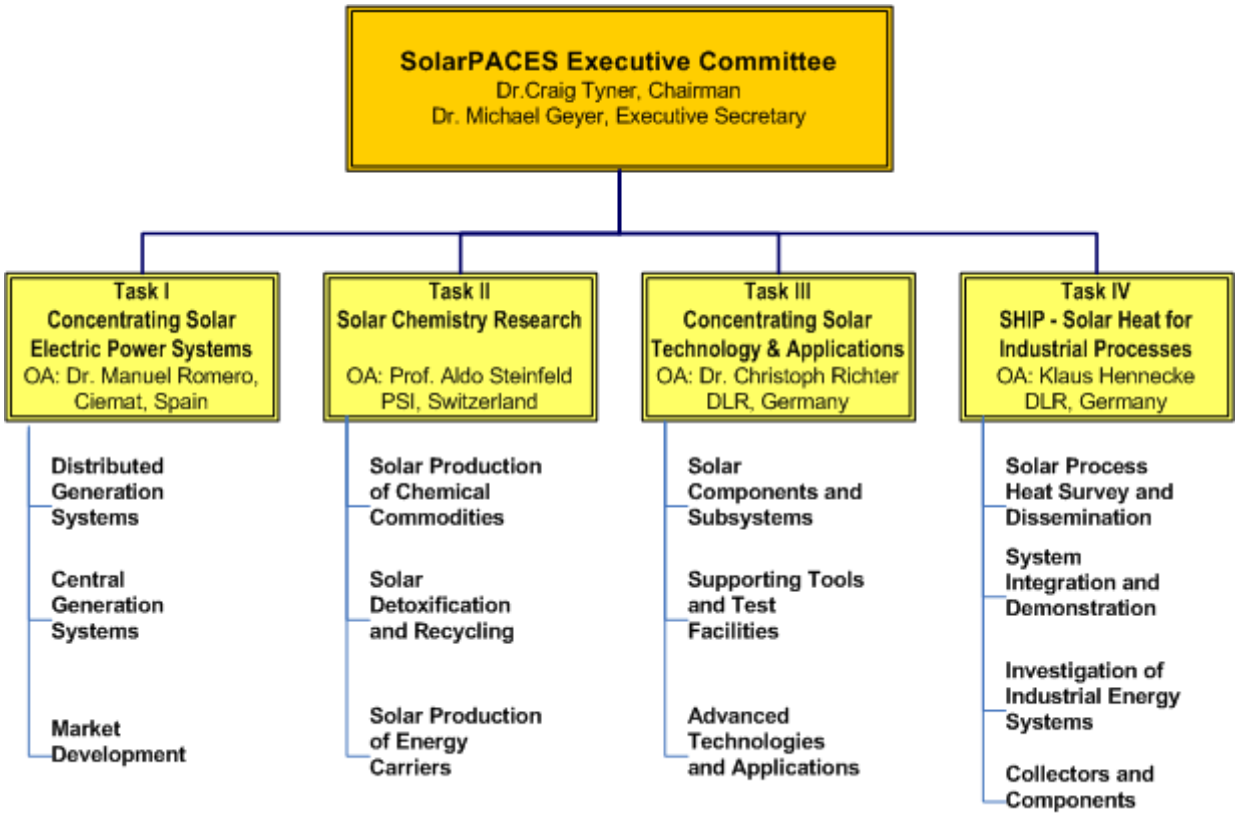

Figure 3 Organization of Work within the SolarPACES Task Structure

4.1 Task I: Concentrating Solar Power Systems

Task I addresses the design, testing, demonstration, evaluation, and application of concentrating solar power (also known as solar thermal power) systems, including parabolic troughs, power towers, and dish/engine systems. The focus of our efforts is on the ultimate application of complete systems and the needs associated with getting them to the marketplace. The component and research efforts of Task III will logically feed Task I as new components are merged into systems, while the results of Task I will help provide direction on new component needs that could be addressed through Task III.

Organization and Structure: The Task Operating Agent, currently CIEMAT, is responsible for organization and operation of the Task, including reporting. Activities are divided into sectors, as designated by the OA and approved by the ExCo. A Sector Leader appointed by the OA coordinates each sector. Sector Leaders have responsibility for coordination of activities within their Sector. Current Sectors are:

I.1. Central Generation Systems, including activities primarily associated with large-scale parabolic trough and power tower systems. This sector is currently led by CIEMAT.

I.2. Distributed Generation Systems, including activities associated with dish/engine and other systems capable of providing power on a distributed basis. The Australian SolarPACES consortium currently leads this sector.

I.3. CSP Market Development, addressing financial, environmental, regulatory, and marketing issues. The Executive Secretary currently leads this activity.

Task activities are cost-shared, task-shared (either through SolarPACES or between SolarPACES participants), and/or information-shared. Cost-sharing and task-sharing activities involve cooperative efforts between two or more participants where either costs of activities or responsibilities for activities, respectively, are mutually agreed upon and shared by the Participants. Information sharing is used for the exchange and discussion of results of projects carried out independently by Participants, but of interest to all.

4.2 Task II: Solar Chemistry Research

Task II (Solar Chemistry Research) encompasses activities that deal with solar-driven thermochemical and photochemical processes for:

- the production of energy carriers: conversion of solar energy into chemical fuels that can be stored long-term and transported long-range. During this term, special focus is the solar thermal production of hydrogen.
- the processing of chemical commodities: use of solar energy for the processing of energy-intensive and high-temperature materials.
- the detoxification and recycling of waste materials: use of solar energy for treating polluted air, water, and soil, and for recycling waste materials.

Organization and Structure: The Task II Operating Agent, currently the Paul Scherrer Institute, is responsible for organization, operation, and reporting. Coordination of international efforts towards research, development and demonstration of solar chemical technologies is made through cost-, task- and/or information-sharing activities. This goal is being achieved by making use of an efficient network, via the **National Coordinators**, for the rapid exchange of technical and scientific information. The Task II Annual Meeting provides a forum for presenting and discussing the major technological achievements. The Task II Program of Work provides an up-to-date description of the national and international projects. When appropriate, Task II conducts a status review on novel technologies for assessing their technical and economical feasibility. Task II is continuously striving to stimulate public awareness on the potential contribution of solar chemistry to the delivery of clean, sustainable energy services. This goal is being achieved by publishing the newsletter *Solar Chemistry News.* Activities are classified into 3 sectors, namely:

II.1 *Solar production of chemical energy carriers*: solar reforming of natural gas; solar reduction of metal oxides; solar splitting of water; solar conversion of carbonaceous materials; solar cracking of hydrocarbons; solar heat pipes based on methane reforming and ammonia dissociation; and solar decarbonization of fossil fuels.

II.2 Solar processing of chemical commodities: solar production of metals, hydrogen, synthesis gas, methanol, carbon filaments, fullerenes, cement, and other fine and bulk chemicals.

II.3 Solar detoxification and recycling of waste materials: solar detoxification of contaminated water, soil, and air; solar recycling of hazardous waste and "secondary" (by-product) raw materials.

4.3 Task III: Concentrating Solar Technology and Applications

The objectives of this task deal with the advancement of technical and economic viability for the emerging concentrating solar technologies and their validation with suitable tools by proper theoretical analyses and simulation codes, as well as by experiments using special arrangements and adapted facilities. For this purpose, procedures and techniques are defined on how to design, evaluate and use the components and subsystems, which concentrate, receive, transfer, store and apply solar thermal energy in an optimized way. In essence, the goals are to investigate innovative multi-discipline advances needed for the further development of concentrating solar systems. This also concerns, among others, process heat applications, the utilization of solar concentration for the development of improved materials, and the introduction of hybrid solar/fossil power plant concepts.

Task III is an ongoing effort covering R&D-oriented activities with clearly defined technical objectives, time schedule and expected results.

For structuring purposes, each of the these activities is assigned to one of the following sectors:

III.1 Solar Specific Technology Components and Subsystems

III.2 Supporting Tools and Test Facilities

III.3 Advanced Technologies and Applications

4.4 Task IV: Solar Heat for Industrial Processes

This Task is a collaborative research project of the IEA Solar Heating and Cooling Programme and the IEA SolarPACES Programme bringing together experts and industries from the residential solar heating field and the high temperature solar power field. The industrial sector accounts for approximately 30% of the energy consumption in the OECD countries. The major share of the energy which is needed in trade and industrial companies for production processes and for heating production halls, is below 250°C. To be able to make use of the huge potential for solar heat in the industry and to open a new market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the industrial processes in a suitable way. Especially it is necessary to further develop the solar thermal components so that they fulfil the requirements stipulated. Applications, systems and technologies, which are included in the scope of this task, are:

- All industrial processes where heat up to a temperature level of approx. 250°C is needed
- Space heating of production or other industry halls is addressed, but not space heating of dwellings.
- Solar thermal systems using air, water, low pressure steam or oil as a heat carrier, i.e. not limited to a certain heat transfer medium in the solar loop.

All types of solar thermal collectors for an operating temperature level up to 250°C are addressed: uncovered collectors, flat-plate collectors, improved flat-plate collectors - for example hermetically sealed collectors with inert gas fillings, evacuated tube collectors with and without reflectors, CPC collectors, MaReCos (Maximum Reflector Collectors), parabolic trough collectors.

To accomplish the objectives of the Task, the Participants are carrying out research and development in the framework of the following four sectors:

Sector IV.1: Solar Process Heat Survey and Dissemination of Task Results (Lead Country: Spain)

Sector IV.2: Investigation of Industrial Energy Systems (Lead Country: Austria)

Sector IV.3: Collectors and Components (Lead Country: Germany)

Sector IV.4: System Integration and Demonstration (Lead Country: Germany)

5 Co-ordination with Other Bodies

SolarPACES is the only agreement and international program working on Concentrating Solar Power technologies. The SolarPACES ExCo represents delegates from national CST (concentrating solar technology) programs with a composite budget of 40-50 Million USD per year, and is the only international, multilateral umbrella for CST cooperation.

In Europe and in the US, industry with an interest in CST has associated in their respective industry associations—ESTIA (European Solar Thermal Industry Association) and SEIA (Solar Energy Industry Association of the USA). SolarPACES is cooperating closely with these associations and has regularly invited their representatives to its ExCo Meetings.

Neighbouring technologies are the general solar utilization technologies and the power generation technologies. In this field, SolarPACES is cooperating closely with the International Solar Energy Society (ISES) and its national associations by contributing regularly to their conferences and journals. SolarPACES is also contributing regularly to the international power industry conferences like PowerGen and others.

Special acknowledgement is owed to the European Union and its support of transnational CSP projects within Europe, like INDITEP, DISTOR, EuroTrough, EuroDish, SolAir, SolGate, SolZinc, AndaSol, PS10 and SolarTres. The information on these projects has been shared with the non-European SolarPACES partners.

SolarPACES also gave special support to the Solar Initiative of the World Bank by in-kind contributions of the contracting member institutions to the project identification studies in Brazil, Egypt, and Mexico, and to the World Bank's Cost Reduction Study.

Proactive cooperation with the IEA Renewable Energy Unit has continued together with other renewable implementing agreements, by participating in the Exhibition at the IEA Ministerial Meeting in April 2002, contributing to the Renewable Energy Working Party and preparing now an exhibit for the Renewables 2004 Conference in Bonn.

Figure 4 Participation of SolarPACES in the 2002 Ministerial Exhibition at IEA in Paris

Proactive cooperation has been established with the Solar Heating and Cooling (SHC) Implementing Agreement by the implementation of a joint task on Solar Heat for Industrial Processes (SHIP) and another joint task on "Solar Resource Knowledge Management" is now being developed together with the SHC and PVPS Implementing Agreements.

6 Information Dissemination

The SolarPACES key event for information dissemination is the biennial International Symposium on Concentrating Solar Power and Chemical Energy Systems, the international forum for scientists, engineers, users and students to learn about the latest ad-vances in concentrating solar technology. At the 11th SolarPACES International Symposium on Concentrated Solar Power and Chemical Systems, held September 4-6, 2002 in Zurich, some 230 participants from 24 countries gathered in Switzerland, where a notable highlight was the Keynote presentation by Nobel laureate Prof. Carlo Rubbia. The Proceedings of the Sympo-sium include 92 peer-reviewed papers. About a third of the 150-200 participants at the biannual Symposium came from industry and utilities.

Publishing joint SolarPACES information material on CST and sharing all national CST publications through SolarPACES-wide distribution lists has become another important means for information sharing. The ***SolarPACES Annual Report 2002*** has been published and distributed to 500-1000 interested experts worldwide, giving detailed literature reference and contact addresses for encouraging further cooperation.

Figure 5 Participants in the 11th SolarPACES International Symposium held September 4-6, 2002 in Zurich

The ***SolarPACES Annual Report 2003*** is now in print and will be distributed at the Renewables 2004 conference. Ten SolarPACES newsletters distributed to 2000-4000 recipients have provided actual information on the Task progress and CSP project developments. Six ***specialized newsletters on Solar Chemistry*** have been mailed to 500-1000 recipients in this field and to keep them informed about project progress. ***Three general CSP brochures*** have been distributed to 1000-2000 recipients to expand awareness about CSP as a future power generation option.

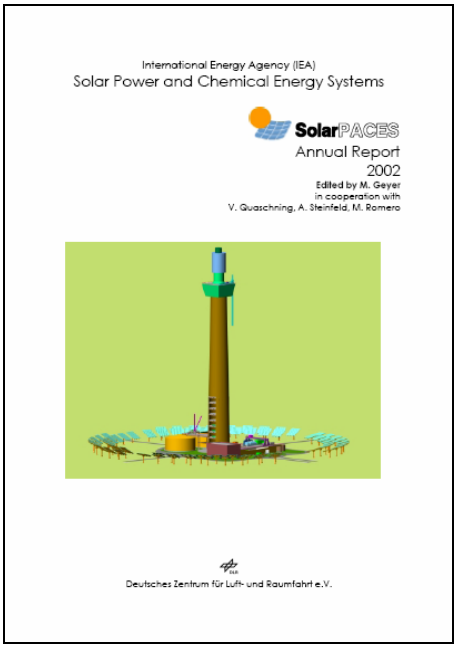

Figure 6 Cover Page of the 2002 SolarPACES Annual Report

Figure 7 Home-Page of the SolarPACES web site www.solarpaces.org

A new ***SolarPACES web page*** has been implemented to provide information across the world-wide-web at **www.solarpaces.org** . It has been visited by over 50'000 visitors since 1.1.2002.

6.1 Further Enhancement of Communications and Increase of Visibility

In spite of the 20 years of joint efforts, concentrating solar power technologies remain under appreciated by the majority of power market decision makers, regulators, investors, developers and industry. For expanding awareness of the potential of concentrating solar technologies (including long-term fuel supply and the potential for solar chemistry), we follow the following strategies:

- ***Expand SolarPACES membership***, particularly to lesser-developed countries in the world's solar belt. Actively promote formalized industrial and user partnering with SolarPACES.
- Establish an ***information dissemination program to contact governments***, ***financial institutions and developers***. For example, establish "road shows", poster sessions, elevator speeches, etc. and aggressively pursue opportunities to promote the technology through international non-solar (i.e., financial, environmental, third-world development) conferences, workshops, government and international agencies, etc.

- ***Team with IEA and other international working groups*** (photovoltaics, wind, geothermal, etc.) to bring a unified message on renewables to appropriate governments, agencies, financial institutions, etc.

6.2 Further Scope for Technology Transfer to non-IEA Members

A success in CSP cost reduction and market introduction can only be achieved in close cooperation with the prospective CSP market countries in the world's sun belt – most of them non-IEA members. In the past 5 years, such cooperation included joint task work, training measures at CSP facilities in IEA member countries, and START missions.

The next stage for technology transfer requires the buildup of expertise and manufacturing capabilities to lay the groundwork for local production of CSP components by local manufacturers at upcoming projects. SolarPACES can act here as a catalyst for the formation of joint ventures between CSP technology carriers and local manufacturers and suppliers.

6.3 List of Major Publications

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Neumann, A., and A. Witzke: The Influence of Sunshape on the DLR Solar Furnace Beam. Solar Energy vol. 66, No. 6, 447-457, 1999.

Price, H., and Kearney, D. (1999) Parabolic-Trough Technology Roadmap - A Pathway for Sustained Commercial Development and Deployment of Parabolic Trough Technology. Prepared for the U.S. Department of Energy Trough Initiative. NICH Report No. TP-550-24748.

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7 Scale of Activities

7.1 Meetings

Figure 8 Participants of the 66th SolarPACES ExCo Meeting, April 20-21 in Paris

Executive Committee. The Executive Committee meets twice per year with the meetings being rotated around the Member Countries. Attendance is normally in the range 15-20 people, counting members and guests. Table 2 below shows the meetings that were held during the period of this review. Also shown in the footnotes are the countries that accepted invitations to observe an Executive Committee meeting.

Meeting	Location	Date	Members	Task Leaders	Others/ Observers	Total
ExCo62	Aguadulce, Spain	23-24 Apr 2002	13/3	4	5/3	21/6
ExCo63	Zurich, Switzerland	02-03 Sep 2002	9/3	4	1	15/7
ExCo64	Rio de Janeiro, Brazil	19-21 Mar 2003	11/3	4	6/2	20/5
ExCo65	Johannesburg, South Africa	30 Sep - 2 Oct 2003	7/3	2	5/2	15/5
ExCo66	Paris, France	20 Apr - 22 Apr 2004	11/3	3	7/2	24/6
ExCo62	Aguadulce, Spain	23-24 Apr 2002	13/3	4	5/3	21/6
ExCo63	Zurich, Switzerland	02-03 Sep 2002	9/3	4	1	15/7
ExCo64	Rio de Janeiro, Brazil	19-21 Mar 2003	11/3	4	6/2	20/5
ExCo65	Johannesburg, South Africa	30 Sep - 2 Oct 2003	7/3	2	5/2	15/5
ExCo66	Paris, France	20-22 Apr 2004	11/3	3	7/2	24/6

Table 3 Executive Committee Meetings since 1.1.2002

Tasks. The Tasks normally have two business meetings a year and technical workshops of a wide variety ranging from small groups to special sessions at major conferences. This is a very effective way to exchange information between the participants. These meetings are described in the progress reports from the different Tasks which are published each year in the IEA SolarPACES Annual Report and are summarised in Section 9 "Major Achievements". The Annual Report also lists the papers presented at these meetings.

International Symposia. Every two years, the ExCo organizes the International Symposium on Concentrating Solar Power and Chemical Energy Systems.

Symposium	Location	Date	Participants	Papers /Posters	Countries
9th Symposium	Font-Romeu, France	22-26 Jun 1998	140	53/40	22
10th Symposium	Sydney, Australia	08-10 Mar 2000	100	40/30	18
11th Symposium	Zurich	06-08 Sep 2002	231	92/85	20

Table 4 International Symposia on Concentrating Solar Power and Chemical Energy Systems organized by the ExCo

The next Symposium will be held October 6-8, 2004, in Oaxaca, Mexico. More information can be obtained on the web under ***http://solarpaces2004.iie.org.mx*** .

7.2 SolarPACES Budget

2004 Common Fund Contributions	Euro
Algeria	10.500
Australia	0
Brazil	10.500
Egypt	10.500
EU	5.250
France	10.500
Germany	10.500
Israel	10.500
Mexico	10.500
South Africa	10.500
Spain	10.500
Switzerland	10.500
UK	0
USA	10.500
Extraordinary BMU Contribution	69.000
Surplus	-3.840
Total	185.910

Figure 9 Contributions to the SolarPACES common fund in 2004

A common fund has been established by the Executive Committee for the purpose of funding the dissemination work and publications of the SolarPACES Secretariate, funded by the Contracting Parties in equal shares. Figure **Error! Bookmark not defined.** shows the most recent incomes and expenditures of this common fund. Task activities are mostly task-shared.

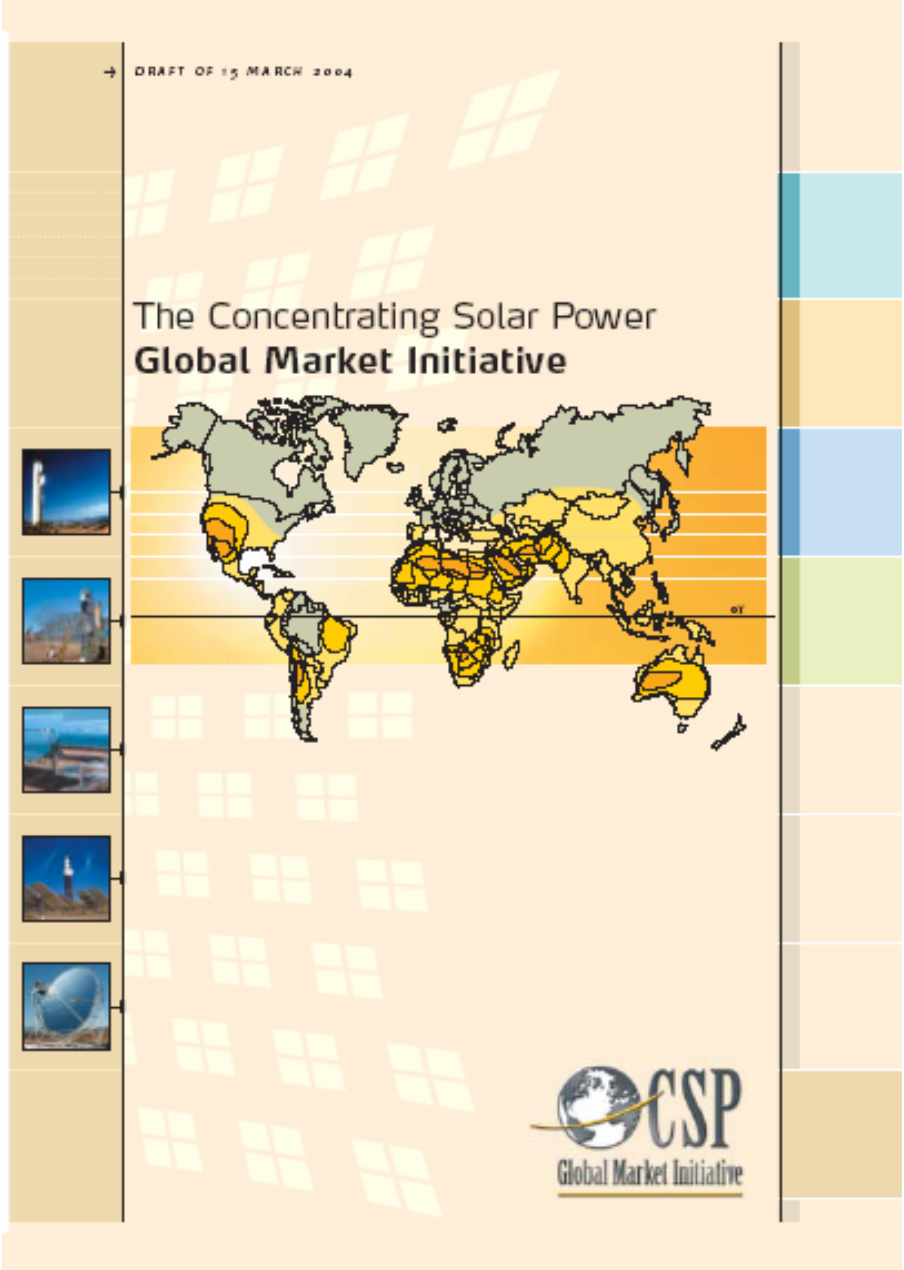

Figure 10 Titlepage of the CSP Global Market Initiative Proposal

8 Achievements, Benefits and Issues

8.1 Technology Development

In task- and information-shared cooperation, it is difficult to quantify the added value of the SolarPACES Implementing Agreement to the national CST projects. It is mostly the networking and catalyzation effects of the joint meetings, workshops and symposia that give the communication basis and forum for initiating new projects, coordinating their methodologies and objectives, and sharing their results. The overall benefit to the member countries (and their respective CST programs) from these joint activities is to eliminate the potential for each country to “reinvent the wheel”, so to speak.

Being the only international CSP forum, SolarPACES was the catalyst and birthplace for most of the European R&D projects supported by the 5th and 6th Framework Programs of the European Union. Special acknowledgement is owed the European Commis-sion and its support of transnational CSP demonstration and R&D projects within Europe. The 5th and 6th Framework Programs contribute a total of 15 million Euro to the three CSP demonstration projects AndaSol-1, PS10 and Solar Tres and approx. 10 million Euro to CSP R&D projects such as EuroTrough II, EuroDish, Inditep, SolAir, SolGate and SolZinc (see http://europa.eu.int/comm/research/energy/nn/nn_rt_cs5_en.html) . Information on these projects has been shared with non-European SolarPACES members.

SolarPACES has been the joint forum and platform for all CSP related applications, for which no other forum or research association exists in Europe. It would be desirable to have similar international framework programs that would cover the participation of partners from the US and Australia. At the last ExCo meeting in Paris in April 2004, discussions were held with the EU about how the 7th Framework Program can ease such cooperation.

8.2 CSP Global Market Initiative – A Deployment Success Story

Some of the most notable results of the Johannesburg 2002 World Summit on Sustainable Development (WSSD) are the alliances that were developed at the margins of the official negotiation process - in particular the socalled "Type II Partnerships". Driven by emerging market opportunities rather than formal international agreements, these public / private teams are pioneering new ways of advancing the sustainability agenda. A remarkable example is the CSP Partnership, which was launched in Berlin in June 2002 and accepted as a WSSD Type II initiative in September 2002. More than 50 key actors interested in emerging CSP markets were assembled under the leadership of the United Nations Environment Program, IEA SolarPACES, and the German Government.

The CSP Partnership is an effort to facilitate CSP uptake in markets that offer the most favorable conditions. Ten investment opportunities were identified as the initial targets.

At the 65th SolarPACES Executive Committee Meeting, which took place in Johannesburg from September 30th to October 1, 2003, the ExCo mandated the Executive Secretary to offer the full support of the IEA SolarPACES Implementing

Agreement as an international cooperation platform for the CSP Global Market Initiative at its Palm Springs Conference.

On October 21-23, 2003, at the invitation of the then Governor Gray Davis of California, approximately 100 people from 14 countries and 4 international organizations gathered in Palm Springs, California to finalize and launch the Concentrating Solar Power (CSP) Global Market Initiative (GMI). The International Executive Conference on Expanding the Market for CSP was sponsored by the United States Department of Energy (DOE), the German Development Bank (KfW), the California Energy Commission, the Global Environment Facility (GEF), the United Nations Environment Programme (UNEP), the German Federal Ministry for the Environment (BMU) and IEA SolarPACES. The conference was further supported by members of the CSP industry who hosted the conference events, including the conference reception and dinner.

This Executive Conference was the second of two conferences focusing on the international market for CSP by removing barriers to deployment and accelerating the expansion of the CSP market. The first conference was held in Berlin in June 2002, sponsored by BMU, KfW and GEF, and focused on identifying and overcoming barriers to current CSP projects. Following the Berlin conference, two working groups were formed, focusing on different regions of the world, and collaborated to formulate an integrated strategic plan for a global expansion of the CSP market. At the Palm Springs conference, the draft Global Market Initiative created by the working groups was reviewed and revised into a more formal draft that was endorsed by the participants on Day 3.

A GMI Interim Management Team (GMI IMT) was set up consisting of delegates from the European Solar Thermal Industry Association ESTIA (represented by R. Aringhoff) and the U.S. Solar Energy Industry Association SEIA (represented by F. Morse and J. Myles), the IEA SolarPACES Implementing Agreement (represented by M. Geyer), the financing sector (represented by R. Seifried of KfW), Region II (represented by T. Hasni from Algeria) and Region III (represented by Kevin Nassiep from South Africa) in order to:

- finalize the full Global Market Initiative text in accordance with this protocol by early December 2003,
- secure the endorsement of the Global Market Initiative by interested States and Countries,
- cultivate ancillary support and raise awareness for GMI (develop marketing strategies, media approach etc…) and
- prepare the GMI participation in Renewables 2004 in Bonn, Germany in June 1-4, 2004 with the support of the IEA SolarPACES Implementing Agreement and assure that an emphatic mandate for the implementation of the CSP Global Market Initiative be obtained there.

The IEA SolarPACES Implementing Agreement has been mandated to act as a coordinating Secretariate for the GMI Interim Management Team and the GMI Participants to prepare the GMI participation in the Renewables 2004 in Bonn, Germany in June 1-4, 2004. The CSP Global Market Initiative Proposal is attached.

8.3 Networking

In almost 25 years of SSPS and follow-up SolarPACES cooperation, a strong and efficient network has been established within two generations of CSP experts from research, industry and utilities, who regularly meet at the biannual international CSP symposia and in subgroups at the Task meetings and workshops.

There is no other academic network in the field of concentrating solar technologies, nor other international CSP research or trade associations. The industrial CSP associations ESTIA (European Solar Thermal Industry Association) and SEIA (Solar Energy Industry Association in the US) are geographically limited and represent only a very small fraction of the worldwide CSP community.

8.4 Policy Relevance

The work of SolarPACES has already added explicit CSP value to the policy goals of three members: In Spain, the National Spanish Plan for the "Introduction of Renewable Energies in Spain" (*Plan de Fomento de las Energías Renovables en España*), approved by the Spanish Council of Ministers on December 30th, 1999, explicitly foresees implementation of 200MW of concentrating solar power plants in Spain by 2010. In Egypt, the parliament has approved a national long-term power extension plan, which explicitly includes concentrating solar power plants. In Algeria, a feed-in law with incentive premiums for Integrated Solar Combined Cycle systems was developed with the expert support of SolarPACES and published in March 2004.

8.5 More Efficient Use of R&D Resources

From the beginning of the SSPS Implementing Agreement, the CSP community has tried to reduce total costs of technology development by dividing and sharing the development responsibilities for the various CSP subsystems (concentrator, receiver, storage). This has continued successfully in the SolarPACES cooperation.

Typical examples are the CSP projects at the Plataforma Solar with European co-funding (such as Inditep, EuroDish, SolAir, SolGate), where each project partner concentrates on a different subsystem, engineering service, or scientific task to the transnational project and receives access to the full results and technology. It would be desirable to expand this transnational funding mechanism of the European framework programs to the framework of other IEA countries.

SolarPACES has many examples of information transfer, either in research or technology demonstrations, which have enabled participants to avoid duplication. Among them figures the sharing of complex CSP simulation tools within the SolarPACES community, the exchange of expensive flux measurement devices, the use of each other's CSP test facilities for component tests, the joint development of standardized evaluation procedures, the sharing of solar resource data, and many more.

SolarPACES has helped to strengthen national R&D capabilities for many of the participants through improved access to personnel exchanges, training, information, technology or equipment. The birthplace for this exchange has been the former IEA SSPS Implementing Agreement, which served as the genesis for the Plataforma Solar

de Almeria, where many of the leading CSP experts received their first CSP hands-on education. Based on this experience, the SolarPACES follow-up work program always gave high priority to personnel exchange, training and student programs. New SolarPACES members from non-IEA countries (like Algeria, Egypt, Mexico, Brazil) have joined SolarPACES among other reasons for the opportunity to send their CSP pioneers to CSP test facilities of other SolarPACES members.

9 SolarPACES Detailed Objectives for 2002 to 2006

9.1 CSP Policy Issues for 2002 - 2006

If solar technology is to achieve sustained market penetration, large projects (up to 100 MW) must be developed. Without large projects, economies of scale and mass-production techniques (essential to lowering the cost of solar energy) cannot be achieved.

CSP was identified by the EU, as well as by the World Bank and the Global Environmental Facility, as an excellent option to provide a significant fraction of renewable bulk electricity that constitutes an essential part of the package of measures needed to comply with the Kyoto Protocol. What appeals to these organizations is that the energy payback time of a CSP plant is less than 1.5 years and that the power plant produces orders of magnitude less carbon dioxide per gigawatt-hour on a life-cycle basis than competing fossil-fired plants.

Within the EU's Fifth and Sixth Framework Program, several approaches to restart the commercial success of CSP technology in Europe have been kicked-off (i.e., the projects ANDASOL, PS10, and SOLAR TRES). All of these projects are delayed due to non-technical barriers, resulting in essential additional costs for the industry involved, which reduces the likelihood of replication projects and endangers the overall success of CSP market implementation. With the recent publication of Royal Decree 436/2004 in March 2004, the Spanish government has removed the economic barriers and equalized the conditions for large scale solar thermal and photovoltaic plants. This will make the a.m. Spanish projects feasible.

To overcome these non-technical barriers, SolarPACES will join forces with its national member governments, the IEA Renewable Energy Unit, the various Solar Thermal Industry Associations (ESTIA, SEIA), the development banks (i.e., World Bank, KfW, etc.), and the UNEP and GEF networks to identify and remove such barriers by the following means:

- ***monitor the progress of commercial CSP projects, like those in Spain, Egypt, India, Mexico and Morocco.***
- ***elaborate on the generic characteristics of CSP grid integration*** (like special issues of capacity penalties, plant dispatching, and synchronisation of CSP generation and customer load).
- ***develop methodologies for CSP certification for Green Labels, Emission Trading (ET), Clean Development Mechanism (CDM), and Joint Implementation (JI).***

9.2 Task I Objectives for 2002 – 2006

The major need of CSP technology is large-scale implementation of the technology in early commercial plants. While Task I cannot directly initiate projects of this magnitude, the expertise of the SolarPACES community, available through Task I, has and will continue to actively promote and support industry development of these plants and support research and technology demonstrations.

- ***Large-scale system testing and evaluation.*** R&D advances in the CSP area (see Task III) are making numerous technology improvements available for future plants. Large-scale thermal storage testing, advanced trough system testing, high-temperature receiver system (interfaced with Brayton engines, for example) testing, and advanced dish system testing and evaluation are all likely options for Task I cooperative activities.
- ***Integration Concepts.*** Special focus shall be given the promising options of combining different CSP technologies, such as tower to the topping and troughs to the bottoming of a modern power cycle to increase the annual solar contribution, integrating CSP with other renewables, such as biomass and others and integrating CSP with local energy systems.
- ***Early commercial plant technical support and evaluation.*** As some of the many commercial opportunities under investigation mature to real projects, the resources of Task I participants will actively support their industry teams in making these projects successful. Resource assessment, design support and review, start-up and O&M support, and data collection and evaluation for these projects are all areas where SolarPACES support can significantly contribute to industry efforts.
- ***Market support.*** Technical support to potential customers, funding agencies, and non-member governments employing the technology can be critical to addressing the many political, financial, and policy issues important to deploying any new technology. Such cross-cutting efforts are a natural SolarPACES function, since they can help open the doors to commercial opportunities for all members.

9.3 Task II Plan for 2002-2006

Continue the efficient network of collaboration via National Coordinators for the rapid exchange of technical and scientific information; organize the annual Task meeting for presenting and discussing major technological achievements; disseminate information through scientific publications, web sites, annual reports, and active participation in international conferences; conduct status reviews on novel technologies for assessing their technical and economical feasibility.

- ***Solar reforming of natural gas, LPG, and other hydrocarbons***: demonstrate the solar reforming technology at a solar power level of 400 kW, for the production of synthesis gas for fuelling a combined-cycle system (with industrial partnership).
- ***Solar production of zinc, hydrogen, and other solar fuels***: Design, construct, and test a 0.5 MW solar chemical reactor for the carbothermic reduction of ZnO; evaluate the industrial economic potential of the technology for reducing CO2 emissions (with industrial partnership).

- ***Solar recycling of waste materials***: development of solar thermochemical processes for the efficient and clean recycling of solid waste materials, with focus on handling the following hazardous wastes: Electric Arc Furnace Dust (EAFD); Automobile Shredded Residue (ASR); and discharge batteries (with industrial partnership).
- ***Solar production of lime and cement***: design and construct a 5-10 kW prototype solar reactor that is scaleable to the aimed 0.5 MW solar lime plant; experimentally establish its thermal performance; compare experimental data with numerical models; establish the economic feasibility of a 0.5 MW solar lime plant (with industrial partnership).
- ***Solar detoxification of water***: development of more efficient photocatalytic reactors; technology transfer and implementation of the solar detoxification technology for water decontamination in developing countries.
- ***Cross-Cutting R&D***: Fundamental investigations of the mass and heat transfer of solar chemical processes, including chemical kinetics for processes under direct solar irradiation; development and testing of materials for high-temperature applications (at > 1500 K); improvements in secondary solar concentrating components (e.g., CPC) for obtaining very high flux intensities (> 3000 suns); development of novel and efficient processes for the production of chemical commodities; achieving higher energy conversion efficiencies in the production of solar fuels (e.g., solar hydrogen); large-scale demonstration (power level > 1 MW) of solar chemical reactors and processes; continuing life-cycle and economic analyses of solar chemical processes; proof of performance and reliability of solar chemical systems.

9.4 Task III Plan for 2002-2006

With trough, power tower and dish technologies all approaching readiness for the market, a number of commercialization opportunities are beginning to appear (i.e., Spain, PS10, Solar Tres). In parallel, R&D projects—led by industry and including substantial industrial resources—are currently preparing the next generation technology, needed to significantly lower costs and increase plant output (i.e., US-Trough, EuroTrough, EuroDish, SolarAir, SolGate). Computer tools have come far and are ready to be applied in the scope of the ongoing project developments and will serve to optimize the plant design. Robust measurement systems will be needed based on current lab systems to allow for quality control during construction and start-up of these new power projects. A small market for concentrating collectors for CHP applications is also about to emerge.

While our industry partners will competitively pursue project development and R&D on component development, the following activities appear to be appropriate for collaboration to support our efforts and move the technology forward:

- ***Standards for component testing,*** which can be referred to in tender documents and component specifications.
- ***Autonomous Control*** of autonomously operating power systems, as a basis to further reduce O&M costs for solar systems.

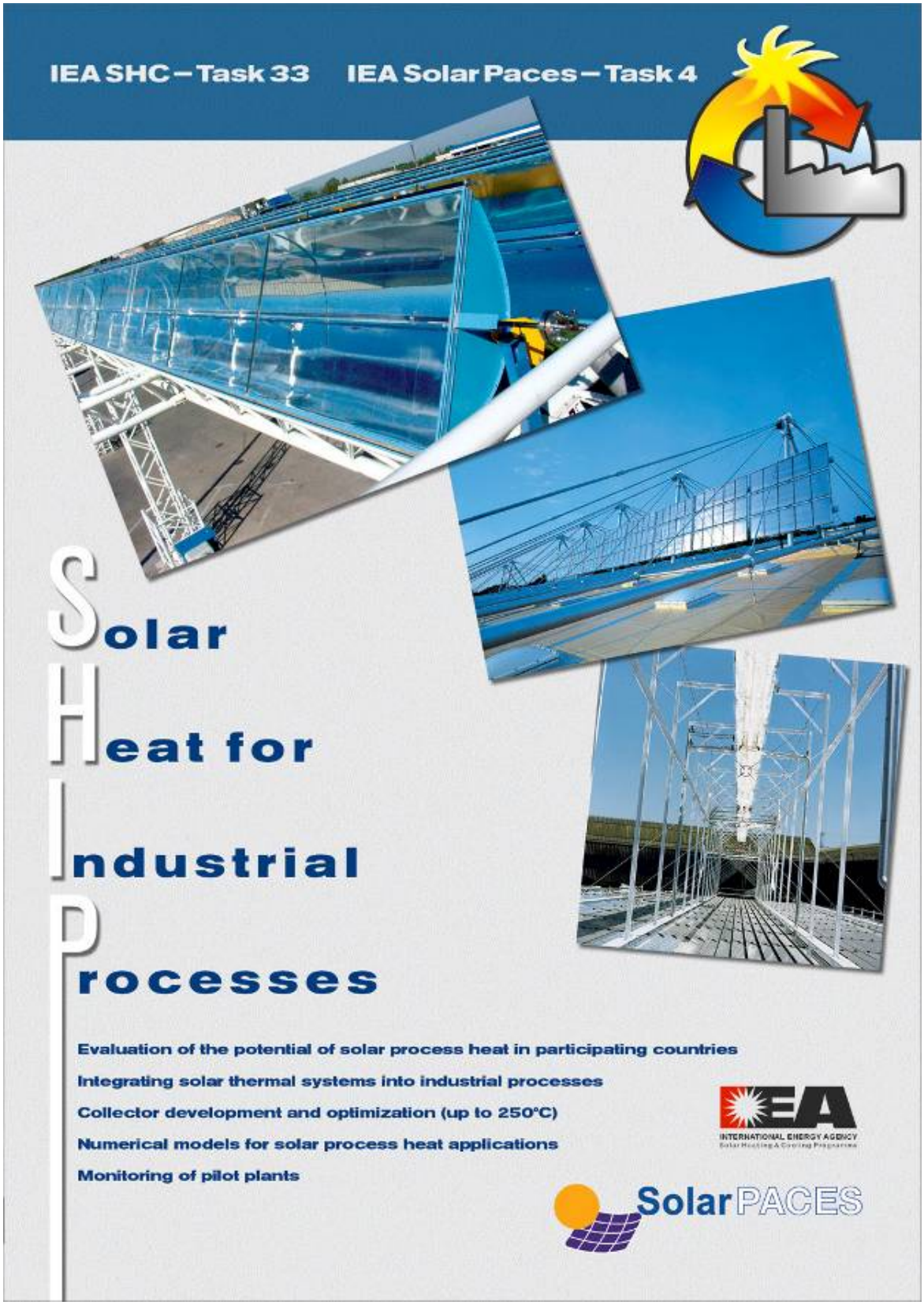

Figure 11 New cooperative Task IV with the IEA Solar Heating and Cooling Implementing Agreement on Solar Heat for Industrial Processes

- ***Trough collector performance comparison,*** to provide independent information on the performance of various solar collectors available in the market.
- ***Long-term stability testing*** of solar components, like evacuated receiver tubes.
- ***Evaluation standards for plant performance,*** to allow an objective comparison and provide future plant investors with an appropriate procedure.
- ***Tools and methods for quality assurance of concentrator systems,*** to assure the optical quality of concentrators.
- ***Combined Heat and Power Systems*** for industrial process heat applications.
- ***Storage Concepts*** ranging from few hours to multi-day storage of solar energy

9.5 Task IV Plan for 2002-2006

Task IV is a collaborative research project of the IEA Solar Heating and Cooling Programme and the IEA SolarPACES Programme bringing together experts and industries from the residential solar heating field and the high temperature solar power field. The industrial sector accounts for approximately 30% of the energy consumption in the OECD countries. The major share of the energy which is needed in trade and industrial companies for production processes and for heating production halls, is below 250°C. To be able to make use of the huge potential for solar heat in the industry and to open a new market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the industrial processes in a suitable way. Especially it is necessary to further develop the solar thermal components so that they fulfil the requirements stipulated. The objective of this Task is to improve conditions for the market introduction of solar heating systems for industrial applications in order to promote a reduction of fossil energy consumption and thereby to develop an environmentally friendly way of industrial production. The main focus in 2002-2006 of the Task will be to:

- ***Collect*** the resulting knowledge and experiences
- ***Provide methods and tools*** to analyse a wide range of solar applications for industry
- ***Help to co-ordinate research and development*** of solar thermal systems for industrial applications leading to improvements in both performance and costs
- ***Ensure the reliability of new materials and component***
- ***Make sure that this knowledge is made available*** to those who can benefit from it
- ***Spread the awareness*** that solar thermal can be an integral part of industrial processes
- ***Demonstrate*** that systems providing solar heat for industrial applications are reliable and economical, as well as environmentally useful