Australia

Austria

Canada

Denmark

France

Germany

Italy

Netherlands

Norway

Portugal

Spain

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United States

2005

Solar Energy Activities in IEA Countries

A Report of the Solar Heating and Cooling Programme

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Solar Energy Activities In IEA Countries – 2005

A Report of the IEA
Solar Heating and Cooling
Programme

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Executive Secretary
IEA Solar Heating and Cooling Programme

October 2006

Copies may be downloaded from the
IEA Solar Heating and Cooling web site, www.iea-shc.org

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Introduction

INTERNATIONAL ENERGY AGENCY

SOLAR HEATING AND COOLING PROGRAMME

The International Energy Agency (IEA) is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) based in Paris.

Established in 1974 after the first "oil shock," the IEA is committed to carrying out a comprehensive program of energy cooperation among its members and the Commission of the European Communities.

The IEA provides a legal framework, through IEA Implementing Agreements such as the Solar Heating and Cooling Agreement, for international collaboration in energy technology research and development (R&D) and deployment. This IEA experience has proved that such collaboration contributes significantly to faster technological progress, while reducing costs; to eliminating technological risks and duplication of efforts; and to creating numerous other benefits, such as swifter expansion of the knowledge base and easier harmonization of standards.

The Solar Heating and Cooling Programme was one of the first IEA Implementing Agreements to be established. Since 1977, its members have been collaborating to advance active solar, passive solar and photovoltaic technologies and their application in buildings and other areas, such as agriculture and industry. Current members are:

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

A total of 39 Tasks have been initiated, 30 of which have been completed. Each Task is managed by an Operating Agent from one of the participating countries. Overall control of the program rests with an Executive Committee comprised of one representative from each contracting party to the Implementing Agreement. In addition to the Task work, a number of special activities—Memorandum of Understanding with solar thermal trade organizations, statistics collection and analysis, conferences and workshops—have been undertaken.

Overview of National Programs

INTRODUCTION

The 9th National Programme Review Workshop was held December 2005 in Sydney, Australia in connection with the meeting of the IEA Solar Heating and Cooling (SHC) Programme's Executive Committee. This workshop is held every two to three years so members may exchange information on their national solar programs, markets, and technology developments.

To share what was learned that day with the wider solar community, the IEA SHC Executive Committee has published this report. This document begins with an overview of the national activities and key trends. The next section includes the individual reports from each of the Member countries, with the exception of Belgium, Canada, Finland, Mexico, New Zealand, and Sweden. The national reports include information on the structure of the national solar program, funding, RD&D programs, other government supported activities, and commercial activities. Each report concludes with an outlook for solar over the next five years in that country. Please note, the exchange rate for the Euro used throughout the report is 1 Euro = 1.2 US dollar.

For additional information on specific national activities, please contact the appropriate Executive Committee member listed at the end of this report. More information on the IEA SHC Programme can be found on the Programme's web site, www.iea-shc.org.

OVERVIEW OF THE NATIONAL PROGRAMS

This document reports on the status of solar building technologies, funding levels, research, technology advances and commercial developments in the Member countries of the IEA Solar Heating and Cooling (SHC) Programme during 2003 and 2004. The overview section summarizes some of the trends and developments in these areas for active solar, passive solar and photovoltaics (PV) for buildings. More information on photovoltaics is available from the IEA Photovoltaics and Power Systems Programme (www.iea-pvps.org).

Main Developments

Since the last overview made in 2002, the market for active solar systems has shown healthy growth.

The most dynamic markets for flat-plate and evacuated tube collectors worldwide are in China, Australia and New Zealand as well as in Europe. The average annual growth rate between 1999 and 2004 was 25% in China and Taiwan, 19% in Australia and New Zealand and 13% in Europe. The market for flat-plate and evacuated tube collectors has been consistently low in Canada and the USA. The IEA SHC Programme now publishes a yearly overview of the world market *Solar Heating*

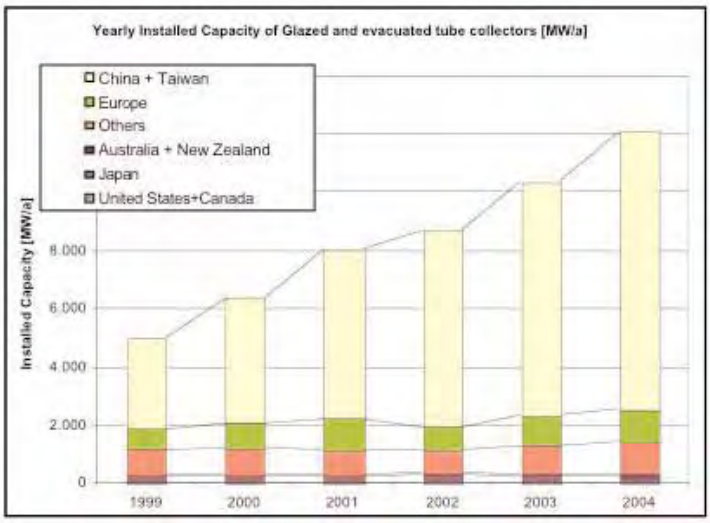

Figure 1. Yearly installed capacity of glazed and evacuated tube collectors in MW/a.
Europe: EU 25 plus Luxemburg, Switzerland, Norway
Others: Barbados, Brazil, India, Israel, Mexico, South Africa, Turkey

Worldwide, downloadable from www.iea-shc.org.

The market for non-glazed collectors is also growing, and the USA and Canada lead in the application of this technology. They are mainly used for the heating of swimming pools. The non-glazed collectors form 23% of the total installed collector capacity.

In the field of solar design, the focus has shifted from maximizing solar gains to integrated design where the day-light features, the solar gains and the cooling all play an important role. Several countries in Europe have introduced building codes where the total energy performance of a building (including passive gains) is rated. The leading edge buildings are those referred to as passive houses. The Solar Heating and Cooling Programme has focused on the same level of performance, but using solar energy.

In the field of solar cooling, the technology is still in the development stage, but several new demonstration projects have been realized. The work in IEA SHC Task 25, *Solar Assisted Air Conditioning of Buildings* has boosted the interest and development of solar cooling technologies.

General Trends

The reports of the national programs show that there are large differences in solar activities between countries. The market for solar heat and the building sector are local, and therefore, where one government is increasing its efforts another is ending its incentive programs. Despite the differences between the countries, several general trends can be distinguished. The main ones are described below.

Building Codes

In several countries (Australia, Netherlands, Germany, Denmark, Austria), the buildings codes limit the energy use of new buildings and include solar energy in this calculation. In Europe, all countries will be obliged to introduce such a building code under the EU's Energy Performance of Buildings Directive. Some countries are even going a step further and requiring all new buildings to have solar water heating systems. For example, what started in Barcelona, Spain, is now prevalent in some form throughout all of Spain, and in Australia, Portugal, France and Mexico City.

Incentive Programs

Where some countries are increasing incentives and starting new programs (e.g., Australia, USA and Portugal), other countries have ended or reduced incentives (e.g., Netherlands and Switzerland). One trend that has emerged is that countries which have had a stable incentive program for several years (e.g., Austria, Germany and France) also have a strong and growing solar market. China is an exception because the market continues to grow with no government incentives. Another trend is the shift in incentives provided by national governments to incentives provided by regions (e.g., Italy, USA, Switzerland and Spain).

Standards and Labels

In several countries (Australia, France, New Zealand, Canada and Portugal), the incentive programs require a certain level of system performance or a quality certificate for the installation work. In Europe, an international certificate, the Solar Keymark, has been introduced for solar heating systems.

Government Funding

In general, funding for active and passive solar has decreased and remains small compared to funding for other renewables, such as wind and bio energy. But there is hope—new programs focused on reducing the energy use of the whole building are beginning to fill these funding gaps.

Table 1
Government Funding for Renewable Energy R&D (in thousands USD)

Country	Active Solar		Passive Solar		Photovoltaics		High Temperature Solar Thermal		Wind Energy		Bioenergy		Geothermal		Other		Total 2003	Total 2004
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004		
Australia[1]	520	436	16	0	14,656	11,980	0	0	4,719	1,466	883	1,760	178	0	2,930	3,078	23,902	18,720
Austria[2]	1,800	650	328	148	1,310	384	0	196	844	421	5,290	7,196	8	281	334	267	9,914	9,543
France																		
Germany[3]		5,904				50,353		6,185		20,262		12,689		12,800		14,238		122,431
Italy	1200-2,400	1200-2,400	600-1200	600-1200	6,000	6,000	5,400	6,361									13,200 - 15,000	14,161 - 15,961
Netherlands[4]									2,700	1,900	2,400	2,100			5,900	17,700	11,000	21,700
Norway[5]	59	34	66	156	1,484	1,201	0	0	14,706	58,731	8,824	11,848	147	0	18,382	10,149	43,668	82,119
Portugal[6]	639	677	276	985	146	175	0	0	193	178	780	774	0	0	128	120	2,163	2,909
Spain[7]	312	627			6,764	2,005	10,483	10,507	4,418	9,553	5,415	4,628	0	0	0	667		
Switzerland[8]	3,120	2,106	3,638	2,618	3,174	2,230	1,522	1,399	778	684	3,120	2,879	1,189	970	380	385	16,922	13,270
United States[9]	3,500	2,500	1,000	1,000	1,000	1,000												

1. Other for Australia is hydro, wave, storage and unspecified.
2. Other for Austria is small and large hydro.
3. Other for Germany includes the building related passive solar and efficiency projects; all numbers for 2004/2005.
4. All solar bugdets for the Netherlands solar figures are part of the renewables in buildings budget - $1.3 million in 2003 and $1.2 million in 2004.
   Other for the Netherlands is funding for renewable energy research.
5. Other for Norway is ocean, hydrogen, heat pumps and others.
6. Other for Portugal is ocean.
7. Active Solar for Spain includes solar heating and cooling and daylighting; Bioenergy includes biomass, biofuel and biogas; Other is hydropower.
8. Other for Switzerland is small hydro.
9. Photovoltaics for the United States is for building integrated PV and Passive Solar is for Whole Buildings. Funding for dynamic windows is $2.1 million in 2003 and $1.9 million in 2004.

Solar Energy Activities in AUSTRALIA

Mr. Max Maffucci

Standards Australia International

PROGRAM STRUCTURE

The Australian Government's policy relating to renewable energy is outlined in the white paper 'Securing Australia's Energy Future'.[1]

The white paper states: 'Renewable energy will play an important part in Australia's long-term greenhouse response, and the Australian Government will continue its extensive and effective support for these technologies. The Mandatory Renewable Energy Target will continue to 2020, providing incentives for over $2 billion in renewable energy investment. Renewable energy will also continue to be an important focus of Australia's innovation effort, including through national research priorities and CSIRO's Energy Transformed flagship.

In addition, the Australian Government will provide $134 million to address specific barriers impeding the uptake of renewable energy:

- $100 million over seven years, comprising $50 million new funding and $50 million from the Commercial Ready Programme, will be allocated to promote strategic development of renewable energy technologies, systems and processes that have commercial potential.
- $20 million will be provided to support development of advanced electricity storage technologies, including batteries, electro-mechanical and chemical storage. Important renewable energy technologies, including wind and solar, produce electricity intermittently, which can reduce their attractiveness and ability to contribute to the electricity system. Breakthroughs in storage could rapidly accelerate renewable energy use, and Australia has technological leadership in some storage technologies.
- $14 million will be used to develop and install systems to provide accurate long-range forecasts for wind output. This will facilitate greater penetration of wind in energy markets and allow for more strategic planning of new wind farms.

In addition to this funding dedicated specifically to renewable energy, the Australian Government is introducing significant new measures to promote low-emissions technology more generally.

- The new $500 million Low Emissions Technology Development Fund will provide support for demonstrating new low-emissions technologies with significant long-term abatement potential. This will include those renewable technologies that can demonstrate the potential for wide uptake.
- $75 million allocated to Solar Cities trials will directly support focused uptake of solar electricity and hot water as well as energy efficiency and efficient pricing signals. This will include

trials of more effective energy market signals.

- The Australian Government will also work with states and territories to identify and overcome energy market rules that provide impediments to the uptake of smaller-scale local generation (distributed generation), including renewable energy sources.
- $230 million was also included for the Australian Greenhouse Office to continue support for greenhouse technology projects under programmes such as the Remote Renewable Power Generation and Greenhouse Gas Abatement programmes.

The Department of Environment and Heritage is responsible for the national program which is administered through their Agency the Australian Greenhouse Office which is responsible for solar energy technologies - both R&D and market activities.

As well as the Federal Department of Environment and Heritage most States have a support program for renewable energy technologies and markets. These state programs are managed by state based agencies or departments. These include:

- The New South Wales Department of Energy Utilities and Sustainability,[2]
- Sustainability Victoria[3]
- Sustainable Energy Development Office of West Australia[4]
- Energy Division of the Department for Transport, Energy and Infrastructure South Australia[5]; and
- The Queensland Environment Protection Agency[6]

FUNDING

The funding provided directly to renewable energy developments by the Department of Environment and Heritage is set out in Table 1 below.

In addition to funding provided directly to renewable energy developments by the Department of Environment and Heritage the Mandatory Renewable Energy Target (MRET) provides additional market support to renewable technologies that generates, or in the case of solar water heaters, displaces electricity. This support is provided through tradeable Renewable Energy Certificates (RECs). Each REC represents the generation of 1 MWh of renewable electricity. For solar water heaters the RECs are allocated on a deeming basis that represents the electricity saved by installing a solar water heater.

Table 1

	YEAR 2003		YEAR 2004	
	AU$ thousands	**US$** thousands	**AU$** thousands	**US$** thousands
ACTIVE SOLAR	800	520	670	436
PASSIVE SOLAR	24	15.6	0	0
PHOTOVOLTAICS	22,547	14,656	18,431	11,980
HIGH TEMPERATURE SOLAR THERMAL	0	0	0	0
WIND ENERGY	7,260	4,719	2256	1,466
BIOENERGY	1,359	883	2708	1,760
GEOTHERMAL	275	178	0	
OTHER (Hydro, Wave, Storage and unspecified)	4,507	2930	4736	3,078
TOTAL (All Renewable Energy)	36,772	23,902	28,801	18,720

Department of Environment and Heritage figures only

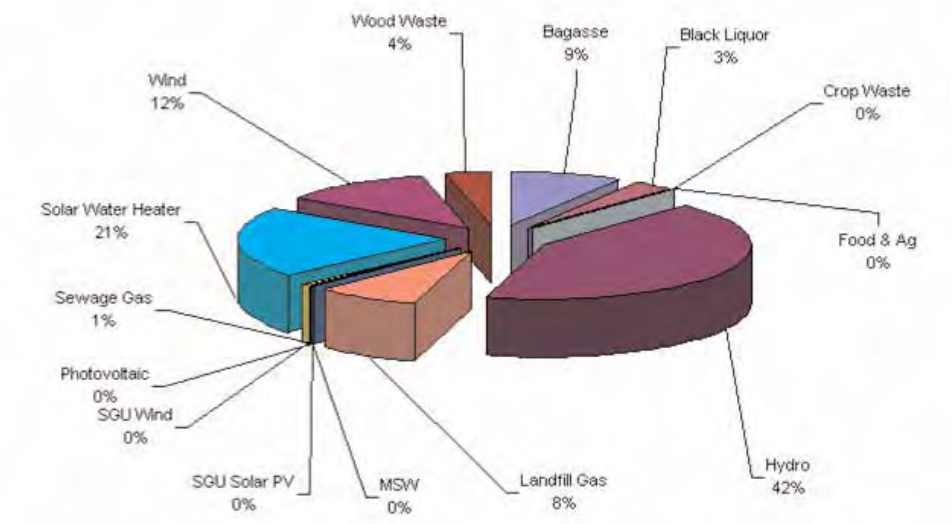

Figure 1. Breakdown of RECs from eligible sources to 31 December 2004. 7

Figure 1 illustrates that deemed RECs from the installation of solar water heaters contribute 21% of the certificates created from April 2001 until the end of 2004. The only technology that provided more certificates was hydro-electricity.

Some States provide support for solar water heaters by offering a subsidy for their installation. It is estimated that the MRET and the state subsidies provide an additional approximately AU$30 million per annum.

The trend for direct support in recent years is declining although the additional indirect market support from MRET has increased since it was instituted in 2001. The reduction in support during 2005 was due to substantial drop in price of RECs and the reduction or cessation of some state subsidy schemes.

Table 2
Technology Assessments

MARKET LEADER	FAST FOLLOWER	RESERVE
Play a leading role in international R&D efforts.	Strongly position Australia to follow international developments quickly.	Position Australia to monitor international developments and follow as needed.
Energy supply technologies		
Advanced brown coal	Advanced black coal	Hydrogen
Geosequestration	Natural gas	Tidal
Hot dry rocks	Wind	Large-scale hydro
Photovoltaics	Biomass	Nuclear
Remote area power systems	Wave	
Coal mining and extraction		
Energy demand technologies		
Solid Oxide Fuel Cells	Intelligent transport systems	Other fuel cells
	Energy efficiency	
	Advanced conventional vehicles	
	Hybrid electric vehicles	

RD&D PROGRAM

Australia's relatively small size in the global economy means it cannot be a leader in all technologies. An assessment of strategic interests identified the following broad categories of energy technologies:

- market leaders- technologies with strategic importance for Australia that international efforts will not adequately address, or in which Australia has a clear technology advantage
- fast followers- technologies where Australia has a strategic interest but where domestic efforts should focus on supplementing international developments, adapting technologies to suit Australian needs and, adopting these technologies quickly when available
- reserve- technologies in which Australia has a lesser strategic interest at this stage, but which may become more important in the future

These assessments provide a strategic backdrop when assessing innovation priorities for energy. They do not override the need for research excellence. As there are many individual components within technologies, niche opportunities in all areas of energy-related innovation will continue to be pursued.

The Australian Government will also continue to engage actively with the rest of the world, and the government will undertake a major review of these agreements with a view to identifying opportunities to better coordinate and strengthen our engagement with the international community.[8]

The Solar Cities program[9] is a major Federal Government initiative that is to be undertaken by consortia across Australia. Consortia have been short listed and final selection will be in 2006. The program is designed to evaluate the demand management benefits of renewable electricity and it will also support other renewable and energy efficiency technologies that can impact on electricity demand. The Australian Government will provide $75 million to fund major trials of a sustainable energy future for urban Australia. These Solar Cities trials will provide a living model of how solar energy, energy efficiency and responsive market signals can deliver economic and environmental benefits in an integrated package.

The program will provide funding to support significant penetration of solar technologies and energy efficiency in urban areas. The Federal Government plans to subsidise specific technologies and facilitate their incorporation

into existing and new residential and commercial buildings. The Federal Government will also engage with state and local governments to introduce improved market signals that appropriately reward technologies and behaviours aimed to reduce system-wide energy costs.

As a form of distributed generation, solar energy can reduce the need for transmission and distribution. Peak output from solar energy often coincides with peaks in demand for electricity - generally hot days with high air conditioner usage. Wholesale prices for electricity in these periods can be 100 times the average.

Asia-Pacific Partnership on Clean Development and Climate

On 12 January 2006 Ministers from Australia, China, India, Japan, Republic of Korea and the United States launched the Asia-Pacific Partnership on Clean Development and Climate. The partnership Work Plan that outlines a model of private-public taskforces to address climate change, energy security and air pollution. The partnership aims to promote the deployment of clean technologies by technological development.

The two taskforces that are relevant to the renewables program are the Renewable Energy and Distributed Generation Task Force and the Buildings and Appliances Task Force

Renewable Energy and Distributed Generation Task Force

Chair: Republic of Korea
Co-chair: Australia

Renewable energy technologies, such as hydro (large and mini), solar, geothermal, wind and tidal can deliver power with virtually zero emissions. Distributed generation (including landfill waste methane-based generation) also has the potential to significantly reduce emissions and promote greater cost and network efficiencies. The wide scale deployment of renewable energy and distributed generation technologies increases the diversity of energy supply, and can contribute to improving energy security and reducing fuel risks, particularly in remote and fringe-of-grid areas.

These energy sources and distributed generation technologies, which are ideally suited to mid-sized and smaller scale applications can also assist in alleviating poverty by improving access to energy services, as well as increasing job opportunities and improving air quality and public health.

The emerging nature of many renewable energy technologies means that there can be market and technical impediments to their uptake, such as cost-competitiveness, awareness of technology options, intermittency and the need for electricity storage. Work is currently being undertaken by many members of the Partnership to address these barriers to increase the wide-scale uptake of renewable energy. However, advances in technology design, system planning and grid operations are demonstrating the financial viability of distributed utility applications. In addition, alternative fuels, such as biodiesel and ethanol, also can potentially offer significant environmental benefits in the future. Similarly these alternatives are also on the pathway to becoming cost competitive and for deployment on a large-scale. The Task Force will focus on the most promising technologies and applications, particularly rural, remote and peri-urban applications, where renewable energy and distributed generation applications can be cost competitive.

Objectives:

- Facilitate the demonstration and deployment of renewable energy and distributed generation technologies in Partnership countries.
- Identify country development needs and the opportunities to deploy renewable energy and distributed generation technologies, systems and practices, and the enabling environments needed to support wide-spread deployment, including in rural, remote and peri-urban applications.
- Enumerate financial and engineering benefits of distributed energy systems that contribute to the economic development and climate goals of the Partnership.
- Promote further collaboration between Partnership members on research, development and implementation of renewable energy technologies including supporting measures such as renewable resource identification, wind forecasting and energy storage technologies.
- Support cooperative projects to deploy renewable and distributed generation technologies to support rural and peri-urban economic development and poverty alleviation.
- Identify potential projects that

would enable Partners to assess the applicability of renewable energy and distributed generation to their specific requirements.

Buildings and Appliances Task Force

Chair: Republic of Korea
Co-chair: United States of America

Reducing our use of energy for buildings and appliances decreases the demand for primary energy and is a key means to deliver better economic performance, increase energy security and reduce greenhouse gas and air pollutant emissions. Partner countries have recognised for some time the importance of cooperating on energy efficiency for buildings and appliances, and have already taken a range of bilateral and other collaborative actions in this area. As the Partners represent a majority of the world's manufacturing capacity for a diverse range of appliances, we have the potential to drive significant regional and global improvements in energy efficiency in this sector.

The Partners will demonstrate technologies, enhance and exchange skills relating to energy efficiency auditing, share experiences and policies on best practices with regard to standards and codes, as well as labelling schemes for buildings, building materials and appliances

Objectives:

- Use cooperative mechanisms to support the further uptake of increasingly more energy efficient appliances, recognizing that extensive cooperative action is already occurring between Partner countries.
- Promote best practice and demonstrate technologies and building design principles to increase energy efficiency in building materials and in new and existing buildings.
- Support the integration of appropriate mechanisms to increase the uptake of energy efficient buildings and appliances into broader national efforts that support sustainable development, increase energy security and reduce environmental impacts.
- Systematically identify and respond to the range of barriers that limit the implementation of end-use energy efficiency practices and technologies.

Industry Involvement

Industry involvement is encouraged widely and in many cases research and market programs are carried out by industry and government partnerships.

One such example of industry involvement in market development mechanisms is the building energy and sustainability label developed by the Green Building Council of Australia.

The Green Building Council of Australia[10] is a government - industry partnership. Launched in October 2002, its establishment was another major step forward to sustainability in Australia's built environment.

The Green Building Council of Australia's mission is to define and develop a sustainable property industry in Australia and to drive the adoption of green building practices through market-based solutions.

The Council's objective is to promote sustainable development and the transition of the property industry to implementing green building programs, technologies, design practice and operations.

A key achievement of the Green Building Council is the development of green star - a national, voluntary rating system that evaluates the environmental performance of buildings, by measuring various environmental factors including energy and water efficiency, occupant health and well-being, and resource conservation.

State Activities

There are a number of activities undertaken at the state level to support renewable energy markets. For example both New South Wales (NSW) and Victoria have instigated regulations that require more sustainable building fabric and promote the use of solar water heating in the new housing market.

BASIX[11] is a NSW Government initiative that ensures new homes are designed and built to use less potable water and produce fewer greenhouse gas emissions. The BASIX online tool allows the user to select from a range of options in order to meet specified energy and water reduction targets.

Each development application for a residential dwelling in New South Wales must be submitted with a BASIX Certificate.

The 5 Star standard[12] for all new homes in Victoria came into full effect from 1 July 2005, after a 12 month transition period. The 5 star standard makes it compulsory for new houses to have:

- 5 Star energy rating for the building fabric, plus
- A rainwater tank for toilet flushing or a solar hot water system

Additionally Queensland has a similar sustainable housing program, while South Australia has sustainable water heating requirement and West Australia is planning to use the NSW BASIX programme.

OTHER GOVERNMENT SUPPORTED ACTIVITIES

Information and Capacity Building

Solar House Day[13] is a program that is undertaken by the Australian and New Zealand Solar Energy Society, the local affiliate of ISES, with the support of the Department of Environment and Heritage. It provides the opportunity for interested persons to visit a range of solar houses in their local area and to discuss solar housing features with the occupants and designers.

There are also opportunities for the building and consulting industry to investigate solar opportunities in new and refurbished commercial and community buildings through programs such as the Victorian Solar Innovation Initiative and the Commercial building Energy Innovation Initiative that operate in the state of Victoria.

Standards and Certification

Solar water heating standards support the inclusion of solar water heaters in the Mandatory renewable energy target certificate-trading scheme. Solar water heaters are 'deemed' to provide ongoing electricity savings over a10 year period after they are installed. Consequently, the calculation of average savings for each model of solar water heater and the suitability of design and construction methods must be evaluated and accredited using Australian standards.

For residential construction there are a range of computer based tools that estimate the energy use impacts of the fabric to provide a means of calculating the acceptability of particular house designs against a regulated minimum performance level. The standard for consistency of computer modelling has been developed by the Australian Buildings Code Board as a precursor to a nation minimum requirement for domestic construction to become mandatory in May 2006.

Commercial building minimum energy performance standards will also be required as part of the Building Code of Australia from May 2006.

COMMERCIAL ACTIVITIES

There are five manufacturers of solar water heaters that produce over 90% of the products sold in Australia. In addition, there are a number of smaller suppliers some of whom manufacture locally or import collectors.
The sales of solar water heaters are shown in Figure 2. Sales have increased dramatically since 2001 due to the support of MRET and state based subsidies. However, the recent drop in REC price and reduction in state subsidies has considerable reduced the rate of increase in 2004 and 2005.

Utility Involvement

Electricity retailers have recently reduced their support for sales of solar water heaters due to their ability to buy RECs at lower prices. However, the Solar Cities program will have support from a number of electricity retailers and distributors that will be involved in the trials to ascertain the benefits of solar and energy efficiency measure within discrete communities to assisting in the control of electricity demand.

OUTLOOK

The medium to long term outlook for solar energy building tech-

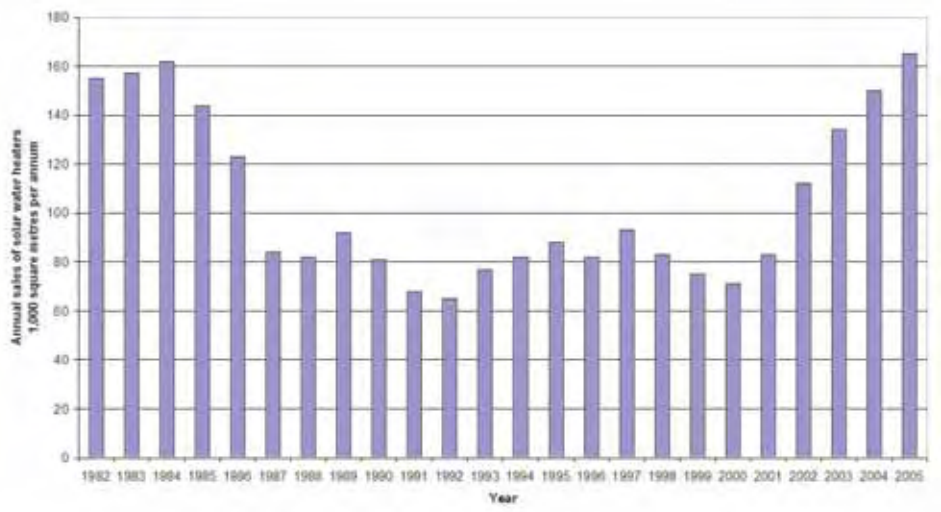

Figure 2. Australian Solar Water Heater Sales.

nologies and active solar technologies is positive over the next five years although it is expected that there will be some slowing of market uptake as subsidies reduce and supportive regulations are gradually implemented.

The Australian government's priority is energy market reform and resource development across the full range of energy technologies. There is a lower emphasis on solar technologies than on cleaner electricity production. Under the heading of "LOOKING FORWARD" the white paper states[14]:

"Although Australia's energy sector has delivered prosperity, security and sustainability, this cannot be taken for granted. To maintain this into the future, Australia must meet the challenge of implementing policies that ensure the right investments are made at the right time to develop the nation's resources, meet its energy needs and protect the environment.".

The Australian Government, through the strategy in the Energy White Paper, responds to challenge of implementing policies that ensure the right investments are made at the right time to develop the nation's resources, meet its energy needs and protect the environment by delivering a strong, practical and long-term strategy for energy in Australia. Under the strategy:

- Australia's energy resources will continue to be developed for the benefit of all Australians.
- Australia's energy markets will be further reformed to ensure that they deliver reliable supplies of competitively priced energy.
- High levels of energy security will be maintained and enhanced.
- Australia's energy efficiency performance will be improved, delivering economic and environmental benefits.

A balanced, practical approach will deliver on Australia's environmental responsibilities, while preparing the nation for a greenhouse-constrained future. Investment will be made to deliver the low-emission technologies needed to meet demand for energy and lower Australia's long-term greenhouse emissions signature.

The Australian Government will continue to engage internationally and with the states and territories to ensure Australia's economic, security and sustainability goals are delivered. In doing so, it will work towards an energy future where:

- Australia's energy resources continue to be developed for domestic and export markets providing prosperity and eco
- growing demand for energy by Australians and Australian businesses is met by reliable supplies of competitively priced low-emissions energy

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1 http://www.dpmc.gov.au/publications/energy_future/overview/19_renewable.htm
2 www.deus.nsw.gov.au
3 www.sustainability.vic.gov.au
4 www.sedo.wa.gov.au
5 http://www.sustainable.energy.sa.gov.au
6 http://www.epa.qld.gov.au
7 Office of Renewable Energy Regulator
8 http://www.dpmc.gov.au/publications/energy_future/overview/19_renewable.htm
9 http://www.dpmc.gov.au/publications/energy_future/factsheets/factsheet_4.htm
10 www.gbcaus.org
11 www.basix.nsw.gov.au/information/about.jsp
12 http://www.5starhouse.vic.gov.au/
13 www.solarhouseday.com
14 http://www.dpmc.gov.au/publications/energy_future/overview/20_forward.htm

Solar Energy Activities in AUSTRIA

Prof. Gerhard Faninger

University of Klagenfurt, Austria

PROGRAM STRUCTURE

Public funded energy related R&D in Austria is guided by an overall strategy that takes into account a portfolio of different policies and developments. Compared to other research areas, energy research has a special position due to its significant impact on environmental targets as well as social goals (e.g., affordable energy), and due to the potential damage to economic development that increasing dependence on imports could cause. Austria has taken account of this for more than three decades by formulating and repeatedly updating energy concepts and by engaging in international cooperation. In the last few years, the targets set by "traditional" energy research have been readjusted to the goal of developing a sustainable energy system.

Apart from fundamental changes in the energy markets (particularly the liberalised markets for electricity and natural gas), and an emerging paradigm switch from energy supply to energy services, what made updating the energy research and energy technology concept most necessary was the institutional changes surrounding research and technology policy in Aus-tria. Accession to the European Union and the movement towards a European research area have, together with international obligations in the field of climate change, created a whole new context for energy research and technology. These institutional and market changes have led on one side to a shortening of the time horizons for energy research and technological development, and on the other to increased competition between national innovation systems.

With this in view, the task of the energy research and energy technology concept is to estab-lish medium-term focus points that cover the areas not sufficiently dealt with by existing in-struments, and to work out a clear position for Austria within the European Union. Its aim is to strengthen existing competencies in the energy sphere and to intensify research and tech-nological development according to the main principles of sustainable development.

In November 2001, a new and energy focused research and technology program, *"Technolo-gies for Sustainable Development"* was developed by the Austrian Federal Ministry of Trans-port, Innovation and Technology (BMVIT). It initiates and supports trend-setting research and development projects and the implementation of exemplary pilot projects; /1-8/.

The Subprogram *"Building of Tomorrow"* makes use of the two most important developments in solar and energy efficient building: the passive house and the low energy solar building method. For the purposes of the *"Building of Tomorrow"* subprogram, these energy centred innovations are expanded to take in

ecological, economical and social concerns.

"Building of Tomorrow" includes residential and office buildings that differ from current con-struction practice in Austria by fulfilling the following criteria:

- Higher energy efficiency throughout the whole life-cycle of the building.
- Greater use of renewable energy sources, especially solar energy
- Greater use of sustainable raw materials and efficient use of materials in general.
- Increased consideration of user needs and services.

However, the costs should be comparable with conventional building methods.

The *"Building of Tomorrow"* subprogram has a planned duration of five years. It comprises the following elements:

- Technology and component development.
- Development of innovative building concepts for residential and office buildings.
- Setting up and evaluating demonstration projects.
- Market diffusion of the "Building of tomorrow".

These innovative projects with an overall budget of about 120 million Euros is now coming in the final phase and will be continued with a new program *"Building Renovation"*.

The subprogram *"Factory of Tomorrow"* – started in 2001 contains some energy relevant topics, such as:

- Aiming at zero-waste and zero-emission technologies and methods of production.
- Increased use of renewable sources of energy in the production process and in the enter-prise as a whole. For example, a survey of the potential of the use of solar-thermal energy in the industry sector.

In 2003, a new subprogram *"Energy Systems of Tomorrow"* started. It addresses three focus topics of the Austrian energy research and energy technology concept:

- Bio-energy & hydro-power
- Electricity supply systems orientated towards climate protection
- Long-term climate protection technologies in international networks.

This subprogram focuses on the electricity system and will address the challenge of increasing the share of renewables in the electricity supply system while maintaining a high level of reliability. It will include basic analyses of the Austrian energy system, studies on the interac-tion of the persons and institutions involved technology development and demonstration ac-tivities in a selected region.

In the framework of programs for research, technology and innovation activities with public support to foster private-public partnership, there are some important ongoing energy related activities. For example "klima:aktiv", a joint project between the Ministry for Environment and industry partners. The program *"Solar Heat"* in the framework of "klima:aktiv" supports the faster market deployment of solar thermal systems and the opening of the market to other sectors, such as apartment housing, commercial and industrial buildings, hotels and tourist centres. Main activities focus on information and education, technical support of planners and architects, monitoring of demonstration projects with know-how transfer, improving of tech-nical equipment and systems. The duration of this market deployment initiative is until 2012 with an annual budget of 3 million Euros.

FUNDING

Austria has to reach its emission reduction targets set out by the Kyoto Agreement, and the energy sector plays a crucial role to meet these obligations. The broad and long lasting con-sensus regarding the need of emission reduction found also its reflection in the priority setting of public energy R&D spending in the 1990s.

The following Figures show the priority setting of public R&D spending in the renewable sector. According to public strategies, the main focus was put on biomass, followed by solar energy (solar thermal and PV); /9/.

The maximum governmental RD&D budget was in 1985 with 33,548 million Euros, the minimum budget in the year 1990 with 10,000 million Euros. In 2004, the RD&D budget reached was 33.534 million Euros the second best value (see Figures 1a – 1d).

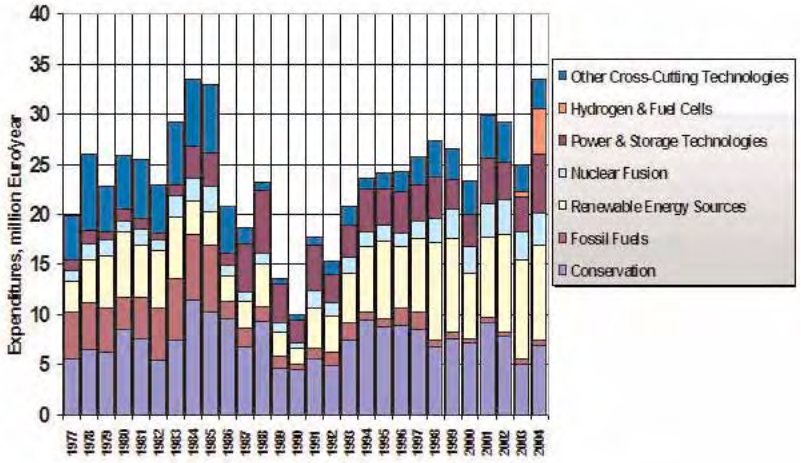

Figure 1a. Public expenditures for energy RD&D from 1977-2004.

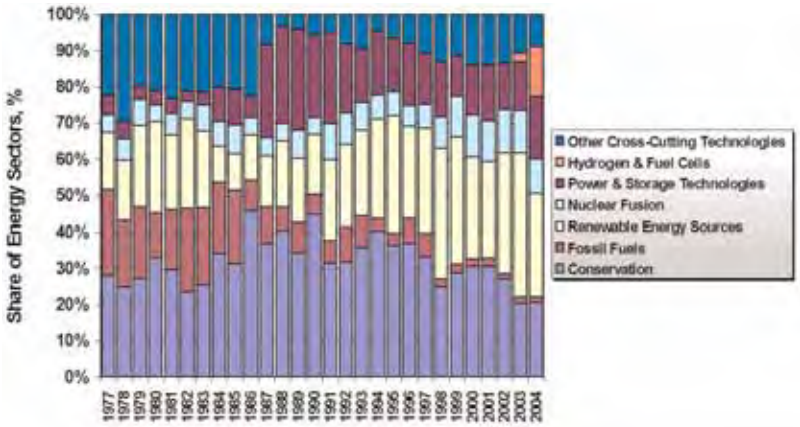

Figure 1b. Public expenditures for energy RD&D by share of energy sectors from 1977-2004.

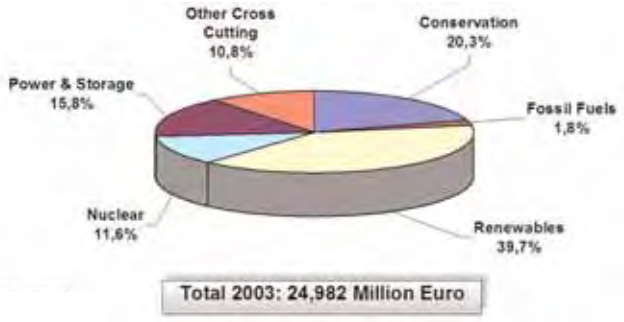

Figure 1c. Public expenditures for energy RD&D by share of energy sectors in 2003.

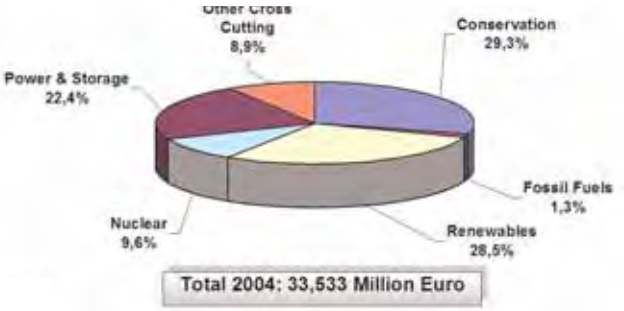

Figure 1d. Public expenditures for energy RD&D by share of energy sectors in 2004.

Approximately 28.5% of Austria's federal energy R&D budget in 2004 was allocated specifically to renewable sources (39.7% in 2003). The public expenditures for renewable energy RD&D was split in 2004 to 75.4% for biomass, 8.4% for solar thermal, 6.1% for solar electric (PV), 4.4% for wind, 2.9% for geothermal and 2.8% for hydropower (see Figures 2a and 2b).

There is a broad consensus in Austria to raise R&D efforts. The Austrian Government declared a target of 2.5% R&D spending related to GDP, which has to be reached in 2005 (the current status is about 2%, more or less the average value of EU-countries).

OTHER GOVERNMENT SUPPORTED ACTIVITIES

International Co-operation

International co-operation plays an essential role for Austria's comparably small national economy. For the energy sector analyses show a high success rate of Austrian R&D in Eurpean Programs (especially in the Framework Programs for R&D). Participation in the Framework Programs has influenced Austrian energy R&D in several ways:

- Fostering of internationalisation,
- Additional budget (energy R&D funding by this programs is in the range of 25% of the national public expenditures), and
- In some areas the participation has led to some modifications of R&D priorities.

Vice versa, Austria has supported the position of the European Parliament for a stronger focus of the European programs on sustainable development, with special emphasis on renewable energy and energy effi-

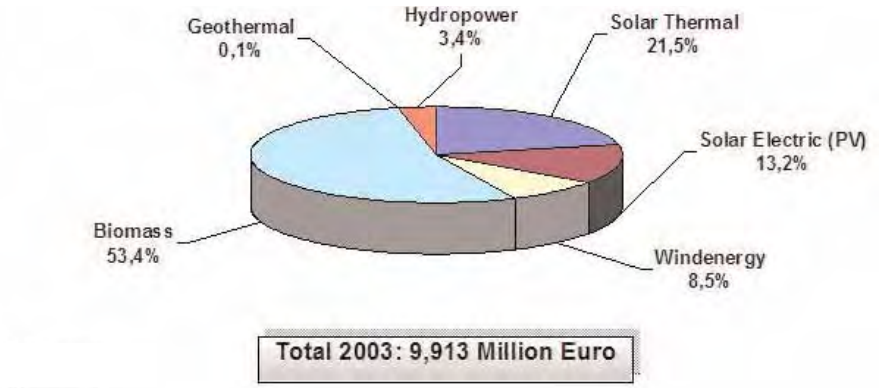

Figure 2a. Public expenditures for renewables RD&D by share of energy sectors in 2003.

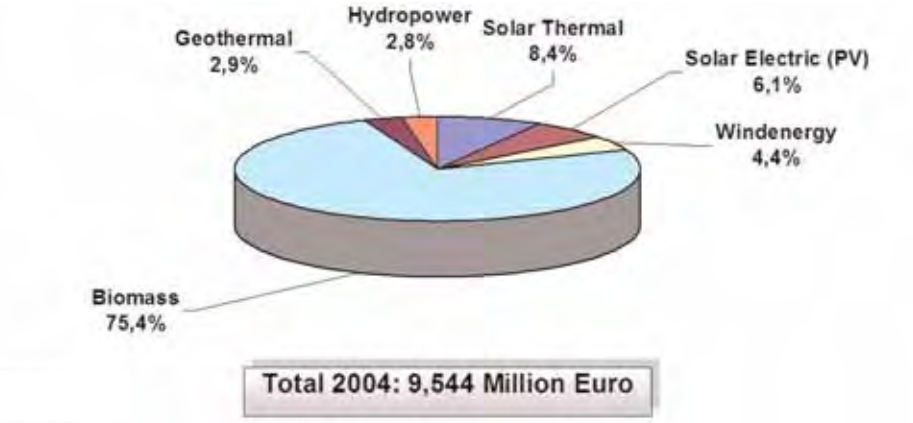

Figure 2b. Public expenditures for renewables RD&D by share of energy sectors in 2004.

ciency. This not only with the aim to protect the environment, but also to penetrate an emerging market with huge potential worldwide.

Currently, Austria actively participates in IEA Working Parties, expert groups and 11 Implementing Agreements. A broad spectrum from researchers at universities and research centres to industry representatives is working on key energy technologies.

The Austrian Federal Ministry of Transport, Innovation and Technology have commissioned the development of an overall IEA R&D strategy, including requirements for assessment and evaluation.

Know-How Transfer

Know-how transfer is a topic high on the agenda of public financed R&D supporting activities. In addition to a broad and "easy access" publication of public funded RTD-projects (see www.forschungsforum.at) and conferences, an internet-based platform for innovative technologies in Austria started in 2000 (see http://energytech.at).

Conditions for the Market Deployment of Renewables in Austria

Austria is among the top countries in Europe using renewables. Renewables contribute about 21.3% to the total energy supply in Austria. Renewables share in electricity production equalled 65% in 2004, compared to OECD/Europe of 18.2% (see Figures 3a and 3b). The share of electricity production from "other" renewables (excluding hydropower) was 3.4% in 2003. The electricity production by Eco-Power Plants in 2004 was 5433 GWh, from which 73.38% was produced from small hydropower, followed by wind at 17.04%, and solid bio mass and renewable waste at 5.76% (see Figures 4a and 4b).

Hydropower and biomass are the major renewable energy sources in Austira. Besides these recourses, Austria is one of the pioneering countries in the use of solar thermal energy, the production of bio-diesel, and the use of ambient heat. Combined with the increasing use of renewables, the design and production of hydropower plants, solar thermal installations, biomass boilers as well as the manufacturing of components for the use of wind energy and photovoltaic increased in the past years.

Both the extension and the use of renewables have created other positive effects, for example, technological innovations. The industry producing the facilities for the use of renewables belongs to the most dynamic sectors of the Austrian economy. This guarantees regional value-added and secure jobs not only today, but offers excellent chances for the future.

Promotion Measures for Market Deployment of Renewables

In addition to "tax revenue" and "green electricity support", the market penetration of reneables

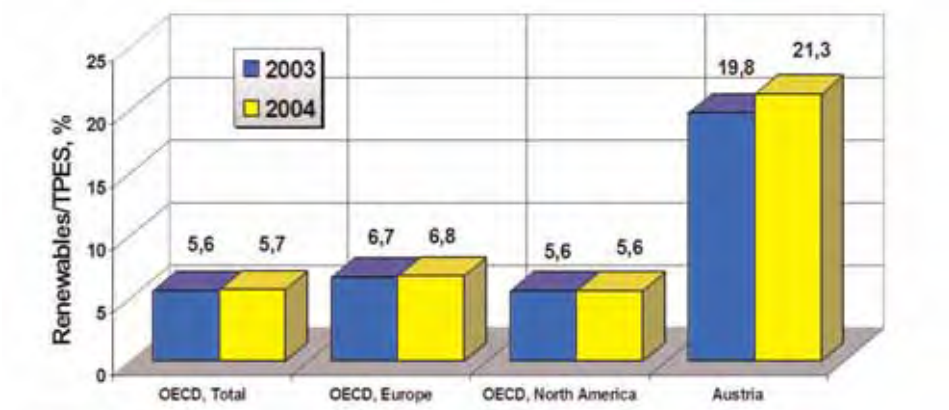

Figure 3a. 2003 and 2004 contributions of renewable energy sources to total primary energy supply in the OECD and Austria.

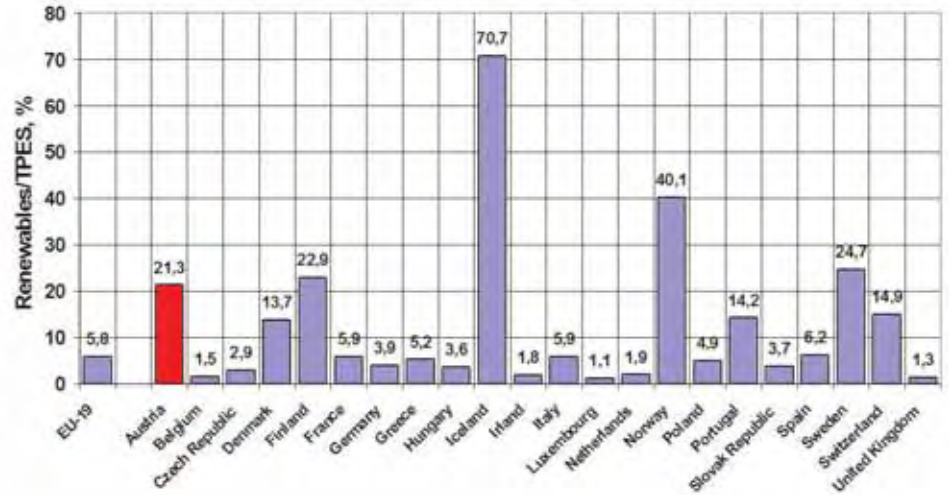

Figure 3b. 2004 contribution of renewable energy sources to total primary energy supply in Europe.

in Austria is supported by a large number of other promotion instruments such as housing and agricultural subsidies as well as financial support for business and industry. For example, the market penetration of renewables in housing (domestic, commercial and indus-trial) was supported by subsidies of about 50 million Euro in 2004 (see Figures 5a and 5b). The market deployment of solar thermal systems in housing was supported by the local gov-ern-ments with about 25 million Euro in 2004. Also research promotion funds of about 10 million Euro promoted activities in the field of renewables in 2004 – from basic scientific work to market launch. Federal grants and incentives for renewable energy producers such as firms, associations and public entities are administered primarily by the "Kommunalkredit" (see Figure 7). These federal grants typically constitute 30% of eligible costs and are granted to entre-preneurs in-vesting in small hydro plants, modern biomass-based heating systems which include small networks for district heat-ing, biogas, sewage gas, geother-mal systems, heat pumps, solar thermal above 10 m^2, photo-voltaic and wind installations. These grants can also be com-bined with financial support from the local governments ("Länder") to cover 66% of costs.

The solar market is influenced by the financial support in the local governments, which are offering subsidies for solar installations in housing. In 2004, 10571 solar systems for hot water preparation and space heating in housing were subsidised in Austria: 10%–40% of the investment costs. The supported collector area was 11328 m^2, related to 72% of the total in-stalled collec-tor area (see Figure 6).

Additionally, about 11210 m^2 col-lector areas (255 solar systems) were financial supported in com-mercial and industrial buildings (see Figures 7a and 7b).

Summarising, by constantly step-ping up renewables in Austria, a domestic sales market as well as stable investment and innovation framework conditions for the fur-ther development of renewables has been created. These favourable framework conditions in Austria facilitated not only the introduction of renewables tech-nologies to the market, but also formed the basis for the domes-tic economy to develop further internationally outstanding posi-tion in the areas of renewables technologies.

But the reasons for the positive market development for renew-ables is not only the continual promotion by means of Austria's energy, research and promotional policies (including subsi-dies), but also the traditionally strong envi-ronmental awareness of the Austrian citizens, who have sup-

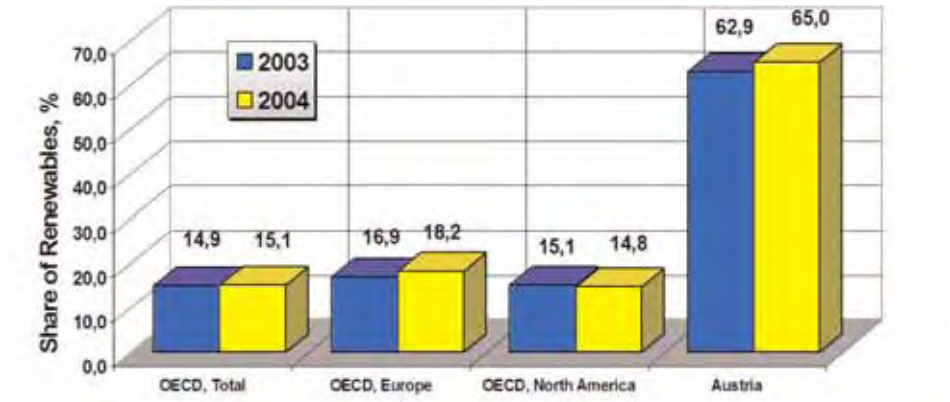

Figure 4a. 2003 and 2004 share of electricity production from renewables in the OECD and Austria.

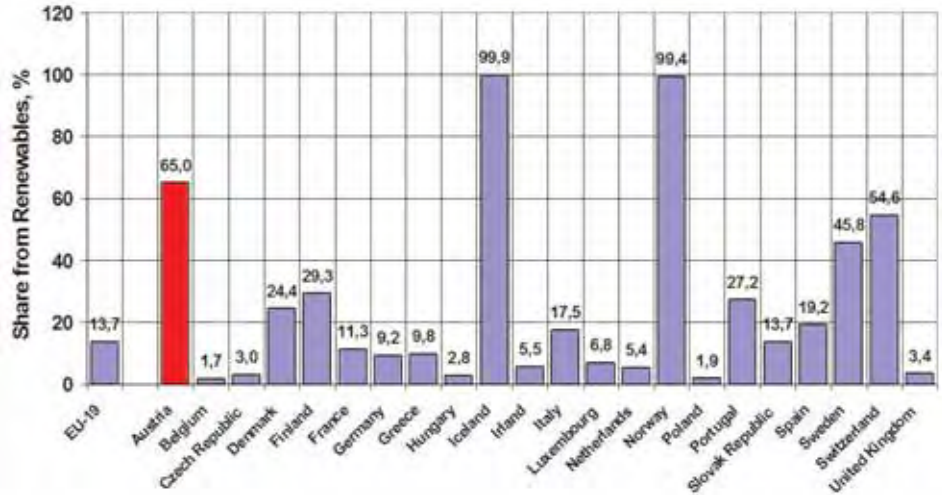

Figure 4b. 2004 share of electricity production from renewables in Europe.

ported the idea of using renewables right from the outset.

COMMERCIAL ACTIVITIES

The market development of solar thermal systems is continuing its positive tendency. At the end of 2004 about 2.8 million m^2 collector area were in operation, from which 77.5% were glazed collectors, 1.3% vacuum-tube collectors and 21.2% unglazed plastic absorbers (see Figures 8a and 8b; /10, 11).

At the end of 2004, about 947 GWh (3.561 TJ) of useful heat was contributed from solar thermal systems to the energy supply in Austria. The installed heat load of solar thermal sys-tems in operation reached at the end of 2004 1.938 MW (see Figures 9–13).

With the rapid market development of solar thermal systems, new firms for collector production were formed and the export rates increased in the last years remarkable.

The hot water preparation in new buildings is today standard in Austria. In the area of build-ing renovation, solar systems for hot water preparation are attractive on the market. Especially ineffective heating systems for hot water preparation outside the heating season have been replaced by solar hot water preparation. Thus pollutant emissions through heating (wood, coal, oil boilers) could be reduced and at the same time a high comfort in hot water preparation could be reached.

In solar systems for hot water preparation in residential and commercial buildings flat plate collectors of different designs (non evacuated and evacuated collectors with and without selective coating) are used (see Figures 14 and 15).

The use of solar energy for space heating in buildings can be justified in the case of low energy buildings (new buildings) with a maximum design temperature of the heating distribution system of 40°C. Quite satisfactory technologies and approaches exist for heating systems. Combined solar heating systems increased remarkable in the last five years. About 20% of the installed solar thermal systems are connected to the heating system; (see Figure 16). Favourite solar combined heating systems are solar assisted biomass and ground-coupled heat pump systems.

Combined solar-biomass heating systems, individual as well as in combination with district heating are attractive applications for renewable energy heating technologies in Austria.

The actual share of solar thermal systems in the building sector is illustrated in Figure 17. Single family houses are dominating. The Competence of the Austrian Industry in Renewable Energy Technologies The promotion efforts for the market deployment of solar thermal technologies

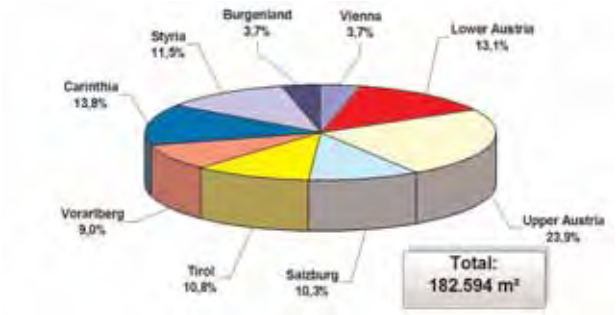

Figure 5. Solar market by share in provinces in 2004.

Local Government	Supported Systems	Supported Collector Area	Public Budget
	Number	m≤	Euro
Vienna	144	2.004	361.097
Lower Austria	1.889	19.700	3.090.500
Upper Austria	2.800	41.981	7.780.000
Salzburg	566	7.551	441.287
Tirol	950	13.563	2.170.000
Vorarlberg	924	13.351	2.339.601
Carinthia	2.223	21.983	4.189.255
Styria	676	7.395	230.758
Burgenland	399	3.800	633.500
Total	**10.571**	**131.328**	**21.235.998**

Figure 6. Subsidies for solar thermal systems in 2004.

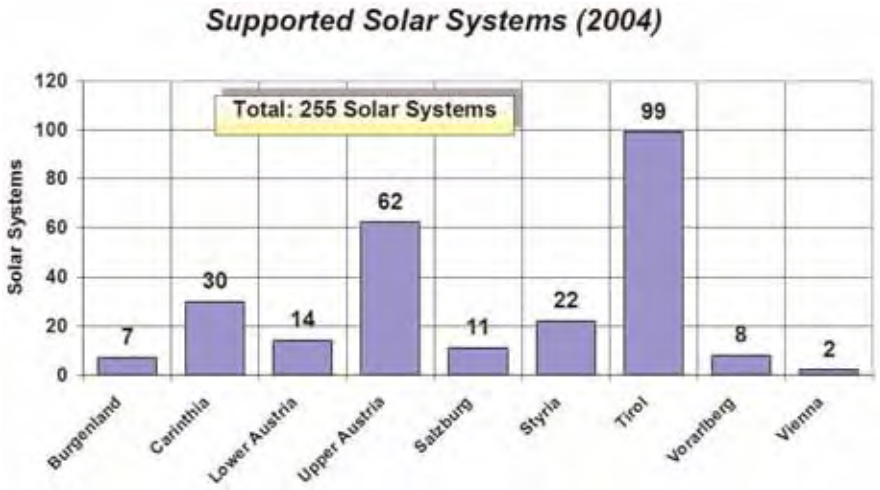

Figure 7a. Subsidies for solar thermal systems in commercial and industrial buildings in 2004.

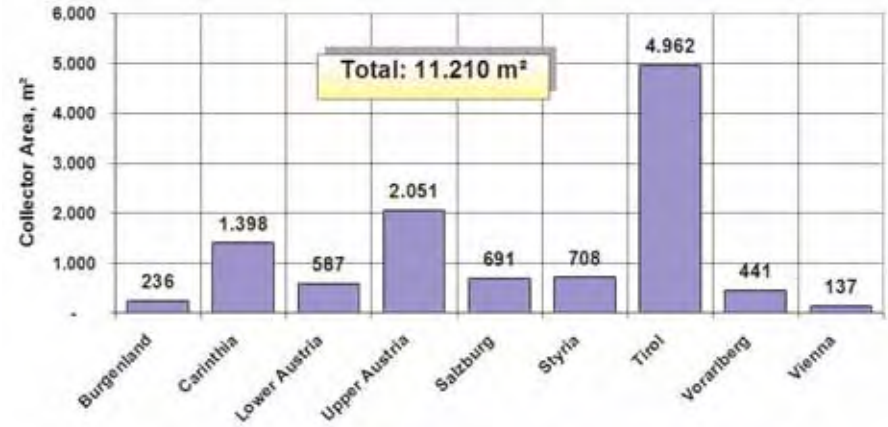

Figure 7b. Subsidies for solar thermal collectors in commercial and industrial buildings in 2004.

resulted in the creation of a domestic sales market and stable investment and innovation conditions for a further development of solar thermal technologies.

The sector of industry constructing and producing the facilities for the use of solar thermal technologies is one of the fastest growing sectors in Austria. The situation in the solar thermal business is illustrated in Figures18 and 19 /10/. The sales, value added and employment in the business sector of solar thermal technologies are reported in references /11-13/.

The overall domestic sales of solar thermal technologies in Austria amounts to more than 200 million Euros per year (2003), the value added in this sector amounts to more than 108 million Euros per year (2003), and about 1846 employees were involved in the construction and production of facilities in the solar thermal sector /11/. The overall domestic value results di-rectly from investments (directly and indirectly in supplying industry). The estimated 1846 employees are attributed directly or indirectly to the activities in the area of construction of facilities for the utilisation of solar thermal applications. About 3600 employees are esti-mated in the business area of solar thermal technologies, from which are 900 additional.

The solar thermal technologies in Austria (2004) are analyzed and documented in references /12-13/. The aspects of sales, value added and employment are illustrated in Table 1. The re-sults of the study show the importance of

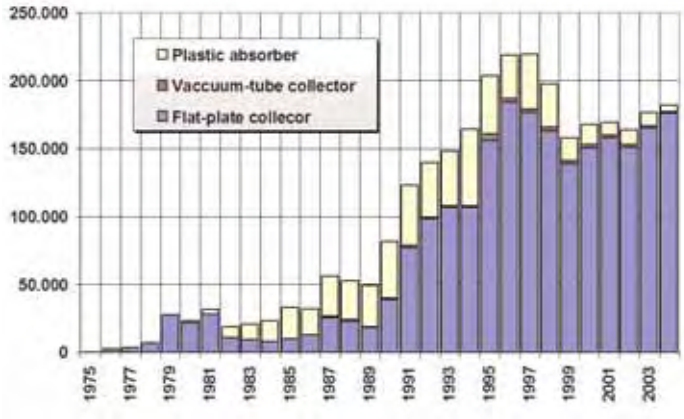

Figure 8a. Solar market by yearly installed collector area from 1975 – 2004.

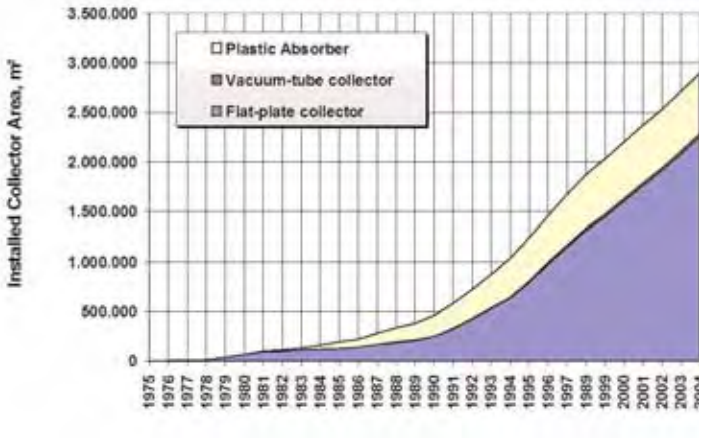

Figure 8b. Solar market by cumulative collector area from 1975 – 2004.

Collector Market in Austria: 2000 - 2004						
Yearly installed collector area						
Year	**Collector area, m≤/a**				**Thermal load, MW $_{thermal}$ /a**	
	Plastic absorber	**Flat-plate**	**Vacuum-tube**	**Total**		
2000	14738	150543	2401	167682	117,4	
2001	9067	157860	2220	169147	118,4	
2002	10550	151000	2050	163600	114,5	
2003	9900	165200	1720	176820	123,7	
2004	8900	180000	2594	191494	134	
Collector area in operation, cumulative data, 20 year life-time expectation						
Year	**Collector area, m≤**				**Thermal load, MW $_{thermal}$**	**Thermal-output, GWh**
	Plastic absorber	**Flat-plate**	**Vacuum-tube**	**Total**		
2000	571806	1581185	26219	2179210	1525	739
2001	578873	1732645	28439	2339957	1638	795
2002	589423	1883645	30489	2503557	1753	853
2003	594823	2066145	32209	2693177	1885	919
2004	587224	2147045	34803	2769072	1930	947

Figure 9. Yearly installed collector area in Austria 2000 – 2004.

Solar Thermal Systems in Austria 2004					
Installed collector area, installed heat load, heat output, oil-equivalent, CO_2-reduction					
In Operation (1984 - 2004)	**Area**	**Installierte Leistung**	**Heat output**	**Oil-equivalent**	**CO_2-Reduction**
	m≤	**MW(thermisch)**	**GWh/Jahr**	**Tonnen/Jahr**	**Tonnen/Jahr**
Flat-plate collector	2147045	1503	751	124529	614362
Vacuum-tube collector	34803	24	19	3202	15796
Plastic absorber	587224	411	176	22315	110089
TOTAL	**2769072**	**1938**	**947**	**150045**	**740247**

Figure 10. Solar thermal collectors in operation in 2004.

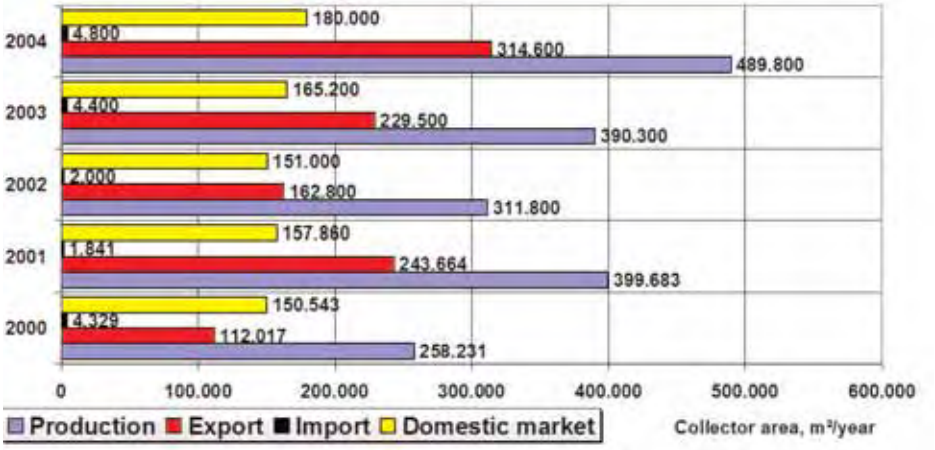

Figure 11. Market for flat plate collectors–production, export, import and domesticn market from 2000 – 2004.

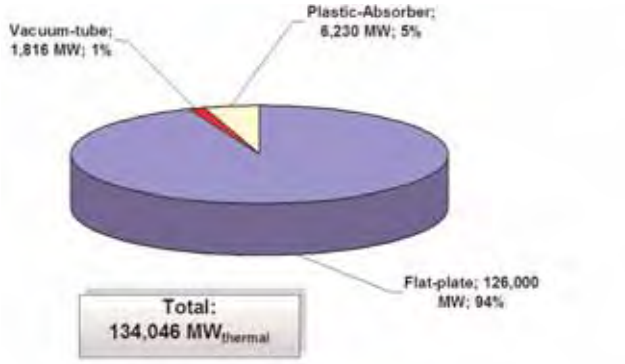

Figure 12. Solar market by installed thermal load in 2004.

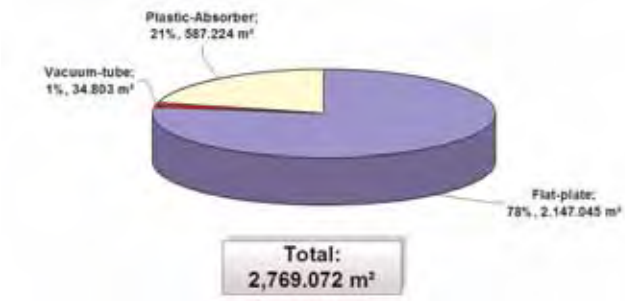

Figure 13. Solar thermal collectors operating in 2004.

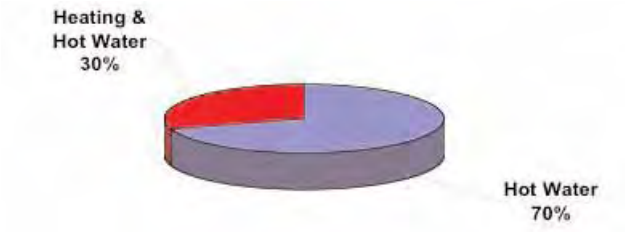

Figure 14. Applications of solar thermal systems for hot water and combined heating (combisystems) in 2004.

solar thermal technologies for Austria. In the year 2004, sales reach the value of 232 million Euros. The corresponding value added was 164 millions Euros. The total number of jobs (full-time equivalent) created by the production and installation of solar thermal technologies was 2262, and for this reason solar thermal technologies have a strong impact on the national job market. Sales, value added and employment in the business sector of all renewable energy technologies are reported in references /12/ and /14/.

The impact of renewable energy technologies on climate protection is also important to point out. The reduction of CO_2 emissions caused by solar thermal technologies in Austria in the year 2004 was 471 thousand tons (gross) and 430 thousand tonnes (net, considering the pro-duction of solar thermal systems). When the total life cycle emissions of technologies are taken into consideration then there are remaining reductions of 9420 thousand tonnes (gross) and 8600 tonnes (net) CO_2 /12/.

A moderate scenario for the year 2012 shows that there is a high additional emission saving potential in Austria. In the case of continuous political efforts for research and development and the diffusion of technologies there can be a net reduction of annual CO_2 emissions in 2012 of about 717 thousand tonnes (gross) and 658 thousand tonnes (net) /12/. Certain solar thermal technologies are appropriate for decentralized applications, and there-fore, provide a high value for rural areas. Regionally created jobs, regional value added, the reduction of nec-

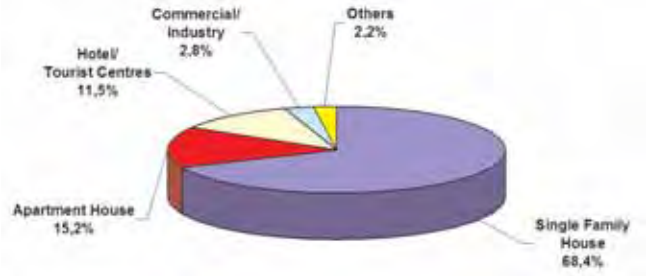

Figure 15. Solar thermal systems for hot water preparation in 2004.

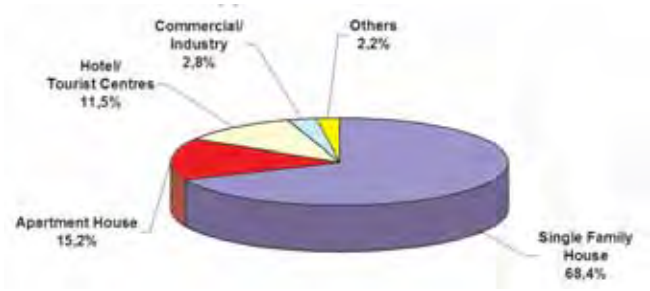

Figure 16. Solar thermal systems for combisystems in 2004.

Figure 17. Share of solar thermal systems in the building sector. *(Source: G. Faninger, AEE-INET, Solution)*

essary transport of persons and goods, and the increasing security of energy service provision by decentralized units are some of the additional positive effects of solar thermal technologies. In this sense. solar thermal technologies provide a major contribution to sustainable development of Austrian society. Austrian energy policy has the opportunity to force this development by supporting research and development and the diffusion of these technologies.

OUTLOOK

Today, Austrian enterprises are technological pioneers in the world market, especially in the area of solar collectors and components for hydropower plants and photovoltaic systems (e.g., inverters). Austria also plays a pioneering role concerning the utilisation of biogas in large facilities that use energy crops as substrate. In the field of heat pump production, Austrian companies assume a leading position concerning efficiency and quality. Austria's excellent position on the export markets constitutes a great opportunity for Austrian companies and their employees.

The remarkable market development of renewable energy technologies in Austria has only been possible because Austrian firms have in co-operation with research centres developed cost-effective technologies, especially for solar thermal and solar electric (photovoltaic) ap-plications (including equipment like inverters, modules for solar cells) as well as wind energy converters and advanced environmentally-friendly biomass heating systems with optimised combustion technology. In particular, test results have led to technical improvements in re-newable energy technologies as well as the basis for a common standardisation.

Solar energy technologies in Austria range from full economic competitive-ness to being ten times more expensive than conventional energy technologies. Some tech-nologies which have not reached commercialisation yet need more development to improve efficiency, reliability or cost so as to become commercial. This would include material and system development, pilot plants or field experiments to clarify tech-nical problems and demonstration plants to illustrate perform-ance capabilities and to clarify problems for commercialisation.

The market deployment of solar thermal systems in Austria has been quite successful. Larger shares of solar energy in total energy consumption require more activities to reduce the energy demand within higher energy-efficiencies in all sectors of energy consumption. For example, to reduce the total energy consumption in a building it is necessary to consider more than one of the systems: energy conservation, day lighting, passive solar, active solar, and photovoltaic.

Table 1
Economic Aspects of Solar Thermal Systems in Austria 2004.

Economic Aspects of Solar Thermal Systems in Austria					
2004					
Energy Economics Group (EEG), Technical University of Vienna					
Sales	**Mio Euros**	**Value added**	**Mio Euros**	**Employment**	**Jobs**
direct	117	direct	83	direct	1055
indirect	61	indirect	43	indirect	516
primary	178	primary	126	primary	1571
secundary	54	secundary	38	secundary	691
total (1)	**232**	**total (1)**	**164**	**total (1)**	**2262**
(1) Total: direct + indirect + secundary					

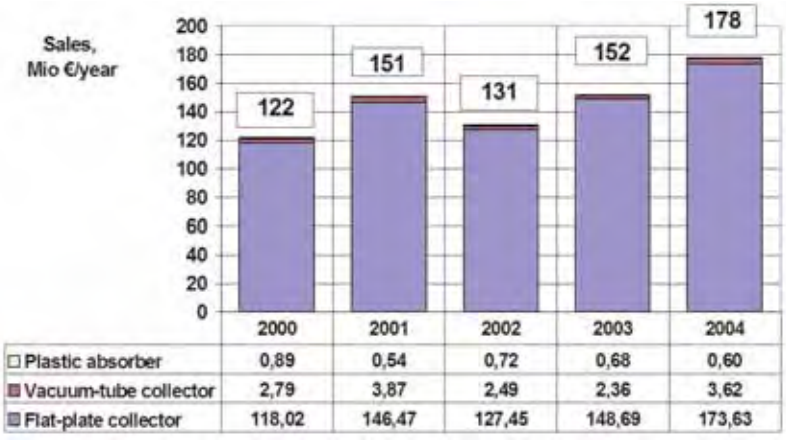

Figure 18. Sales in solar thermal business in 2000 – 2004.

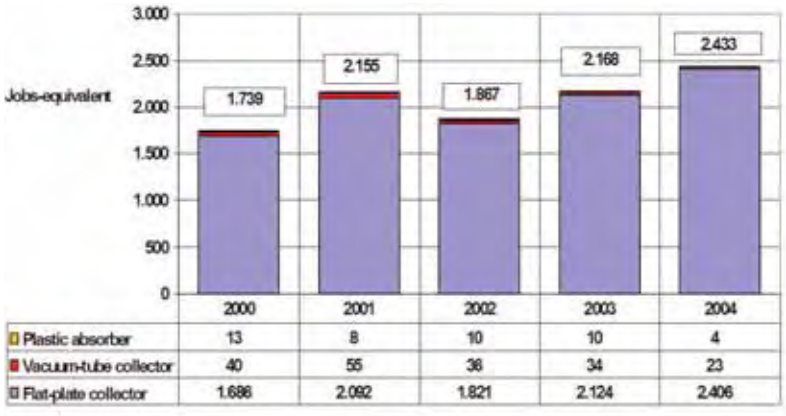

Figure 19. Jobs in solar thermal business in 2000 – 2004.

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Solar Energy Activities in CANADA

Mr. Doug McClenahan
Natural Resources Canada

PROGRAM STRUCTURE

Natural Resources Canada (NRCan) is the lead federal department responsible for renewable energy including solar energy activities in Canada. Renewable energy currently provides 17% of Canada's primary energy production, primarily from large hydro (11%) and biomass (6%). Canada's goal is to reduce the overall energy intensity of Canada's buildings and community energy systems and to integrate the use of local renewable energy sources to achieve dramatic reductions in the use of conventional energy resources for building heating and cooling.

Most of Canada's federal activities in solar energy R&D are carried out through the CANMET Energy Technology Centre (CETC) of NRCan's Energy Technology and Programs Sector. Within CETC, the CANMET Energy Technology Centre in Ottawa (CETC-O) has responsibility for active and passive solar programs and the CANMET Energy Technology Centre in Varennes (CETC-V) near Montreal has responsibility for photovoltaic technologies. Within CETC-O, the Sustainable Buildings and Communities Group, has responsibility for both active and passive solar R&D.

The National Solar Test Facility (NSTF) operated by Bodycote Materials Testing Canada near Toronto is Canada's leading solar research and testing centre. Featuring a 200 kW large area indoor solar simulator, climate controlled chamber and 4 technical staff, the NSTF conducts testing and evaluation of solar thermal and photovoltaic technologies under tightly controlled conditions all year-round. It performs tests for both product development and to Canadian and international standards for certification and rating.

200 kW Solar Simulator at the National Solar Test Facility.

Other federal organizations that conduct activities in support of solar energy and buildings research include Environment Canada's Atmospheric Environment Service, located in Toronto, which continues to manage solar resource measurement and meteorological data base development activities, the

Table 1
Funding for Renewable Energy R, D & D in Canada (in thousands)

	2003		2004	
	Can$	**US$**	**Can$**	**US$**
Active Solar	3,948	3,403	3,242	2,795
Passive Solar, Lighting & Daylighting	613	528	902	778
Photovoltaics	8,540	7,362	9,800	8,448
Wind Energy	2,856	2,462	5,068	4,369
Bioenergy	8,419	7,258	11,052	9,528
Small Hydro	1,392	1,200	1,948	1,679
Geothermal (Heat Pump)	1,188	1,024	807	695
High Temperature Solar Thermal	-	-	-	-
ALL RENEWABLE ENERGY	**26,957**	**23,239**	**32,819**	**28,292**

1 US$ = 1.16 Can$

National Research Council's Institute for Research in Construction in Ottawa (windows and daylighting technologies), the Public Works and Government Services (commercial fenestration and daylighting technologies) and the Canada Mortgage and Housing Corporation (passive solar and net-zero energy homes).

In addition to the above, a Solar Buildings Research Network, consisting of 24 top Canadian researchers in solar energy and buildings from 10 Canadian universities, have joined forces to develop solar-optimized homes and commercial buildings of the future. The Network also includes researchers and experts from Natural Resources Canada, the Canada Housing and Mortgage Corporation, Hydro Quebec, the Royal Architectural Institute of Canada and the Building Owners and Managers Association. The budget of the Network is about $6 million, with $4.8 million from the National Sciences and Engineering Research Council's Strategic Research Networks.

Most of Canada's programs with regard to financial incentives and information awareness for solar energy are carried out through the Electricity Resources Branch (ERB) of NRCan's Energy Policy Sector. Within ERB, the Renewable and Electrical Energy Division (REED) in Ottawa has responsibility for the Renewable Energy Deployment Initiative (REDI). Initially a three-year $12 million program which began in 1998, REDI was extended to a nine-year, $49 million program aimed at stimulating market demand for commercially reliable and cost-effective renewable energy systems for space and water heating and cooling, such as solar water heating systems, solar air heating systems, ground-source heat pumps and high-efficiency/low-emissions biomass combustion systems.

In 2003 the federal government committed an additional $1 billion to complement the earlier investments of $1.7 billion in support of meeting climate change objectives. Included in the above, the Technology Early Action Measures (TEAM) program provided $100 million support to federal programs that fund technology projects including solar energy to reduce GHG emissions nationally and internationally, while sustaining economic and social development. The program includes cost-shared support for development and deployment activities.

FUNDING

The federal government programs in Canada contributed to a significant increase in funding levels for renewable energy technologies since 1998, particularly with respect to near term development and deployment. Federal funding for renewables increased from $8 million in 1997 to $21 million in 1999, and to $33 million in 2004. Funding for solar energy activities has increased more than five-fold from $2.5 million in 1997 to $5.8 million in 1999 and $14 million in 2004. The active solar budget has increased from about $700,000 in 1997 to $3.2 million in 2004. The photovoltaics budget has increased from $1 million in 1997 to $9.8 million in 2004. During the same period, funding for passive solar has increased slightly from $800,000 to $900,000. Funding for 2003 and 2004 is summarized in Table 1.

R&D ACTIVITIES

Active Solar Energy

Canada's energy costs are among the lowest in the world, a factor that continues to be a major impediment to the development and commercialization of alternative energy sources, including solar energy. Nevertheless, active solar energy technologies hold great promise in Canada, particularly for low-temperature (< 60°C) heating applications. New areas of focus include large-

Seasonal Storage Borehole Field, Drake Landing.

scale solar seasonal storage, concentrating solar collectors for integrated solar heat and power, and solar assisted cooling for commercial buildings.

Solar Seasonal Storage

In Canada approximately 80% of residential GHG emissions come from space heating and domestic hot water while on average, solar radiation received ranks sixth out of all IEA countries and is higher than many European nations currently active in the solar energy market. From April to September, on average, Canadian cities receive over 90% of the incident solar radiation in Miami, Florida and high levels of renewable energy are available and accessible across Canada. However, a long-standing barrier to large-scale adoption of solar-heating technology is the relative lack of sunshine during the fall and winter seasons. Recent advances in solar seasonal storage development in Europe coupled with cost reduction in solar collectors in Canada led to the evaluation of utilizing the local solar resource to displace large fractions of fossil fuel use for residential space heating on a community scale in Canada. Promising evaluation results prompted the implementation of the first solar seasonal storage community in North America and the first in the world with a solar fraction over 90%.

The Drake Landing Solar Community project, located near Calgary in Okotoks, Alberta, connects 52 detached energy-efficient homes (built to meet the R-2000 Standard) with a large-scale solar seasonal storage district heating system capable of supplying more than 90% of the space heating requirements. The system will use solar energy captured by collectors mounted on the roof of the detached garages to heat a transfer fluid, store this heat underground, and later extract the heat from the ground to circulate it through a district system into each home in the subdivision. The district energy plant will use conventional energy to supplement stored solar energy when required to meet community energy demands. Separate solar domestic hot water systems installed on every house will supply more than 50% of the water heating load. For each house the annual greenhouse gas emission reductions will be more than 6 tonnes. Results from the project are critical for the evaluation of future applications of solar seasonal storage technology in Canada. System performance will be monitored for a minimum of five years and results used for model validation and replication considerations. Major financial support from the federal government is provided by the Federation of Canadian Municipalities, the TEAM program, the REDI program and the Program of Energy Research and Development.

Concentrating Solar Collectors for Integrated Heat and Power

An innovative solar collector is

Installation of Short-term Storage Tanks in the Energy Centre.

Power Spar Concentrating Collector.

being developed by an Ottawa based company, Menova Energy. The Power Spar is designed to combine solar heat and power generation in a unit that is very efficient in Canada's cold climate and has the potential to be manufactured at low cost. The collector concentrates solar energy, and uses liquid to efficiently remove heat at suitable temperatures for space or service hot water use and it can optionally be equipped with photovoltaic (PV) cells located at the reflector's focus.

It is the first use of a solar-concentrating technology for combined heat and power in Canada. Controlled testing will be performed at the National Solar Test Facility to characterize collector and system performance and several sites have been identified by Menova for field trials of the technology. A TRNSYS based model is being used to simulate performance of the Power Spar system. Financial support from the federal government is provided by the TEAM program, the REDI program and the Program of Energy Research and Development.

Solar Assisted Cooling

Annual energy consumption in Canada for cooling of commercial buildings is approximately 15% of that for space heating and this fraction is likely to increase. Space cooling is also major contributor to the electrical system peak demand in Ontario which now occurs in summer. Solar cooling has been successfully demonstrated with several different cooling cycles but earlier work showed that solar assisted liquid desiccant systems used in conjunction with either vapour compression or ground-water systems can be economic when applied to commercial cooling loads such as library, hospital and retail, where the latent component is important. Solar cooling benefits from excellent alignment of the cooling requirement with the availability of solar insolation. Liquid desiccant systems have two distinct advantages over their solid desiccant counterparts: the effective regeneration of the desiccant can take place at lower temperatures and the regenerated desiccant can be easily stored for use when required. Solar cooling systems also have the potential to broaden the economic application of solar space heating by improving the utilization of the collection/storage equipment during the cooling season. The technology is expected to be applied first to commercial buildings, however, it should be applicable to single-family residential loads as well. Solar cooling systems may be driven by many other heat streams including those from fuel cells or other CHP systems

Improved thermodynamic component models that have been developed and incorporated into a TRNSYS system model at Queen's University are being compared with laboratory component tests. The resulting component and system models will allow the sizing and configuration of thermally-driven cooling and dehumidification units. A prototype unit will ultimately be lab and field tested. Financial support from the federal government is provided by the Program of Energy Research and Development and the Natural Sciences and Engineering Research Council.

Windows, Lighting & Daylighting

Canada's Windows, Lighting & Daylighting R, D&D program focuses on two key areas:

- Advanced product research and characterization of high performance windows
- Lighting & daylighting system research

Over the last 15 years, the focus has been on developing energy efficient and cost competitive fenestration products for the residential and commercial buildings. These efforts led to the development of low-profile fiberglass frames, silicon-foam filled spacer bars and high performance glazings. Lighting and daylighting system research encompasses the development of innovative light pipe systems coupled with gas lighting, work on the impact of

lighting on office workers performance and satisfaction, and the assessment of daylighting potential in office environments, mainly in collaboration with the National Research Council of Canada. Most of this lighting work will feed into the refinement of the Model National Energy Code of Canada, to introduce credits for lighting & daylighting measures. Tools are under development in support of building the industry capacity to perform building energy simulation, and assess and adopt energy efficient strategies at the building design stage.

Characterization of High Performance Windows

Modeling of window heat transfer and surface temperatures in particular provides an assessment of condensation resistance, an important issue during Canada's winter. To help architects and designers of commercial buildings, a simplified web based application for fenestration specification software has been developed. This web-based application, FRAME™plus Online (www.frameplus.ca) can assist in developing appropriate specifications for better windows and fenestrations systems.

Canada is engaged in the harmonization of window standards (ISO 14099), in particular energy standards, with leading US Standard Bodies and the ISO. The end goal is to enhance the trade of fenestration products worldwide. Canada is also participating in the ENERGY STAR program of US EPA for windows and skylights.

Lighting & Daylighting System Research

The assessment of daylighting potential and it use, in spaces lighted by windows with blinds or skylights, is a difficult task for building designers. Research is underway to determine, through stochastic models, the daylight autonomy in office environments and the actual use of daylight when blinds are used by the occupants for daylight control. This work is mainly in collaboration with the National Research Council of Canada and the IEA SHC Task 31, *Daylighting Buildings in the 21st Century*.

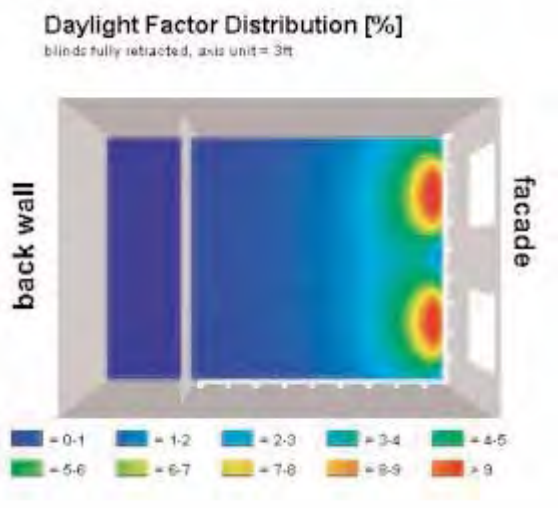
To foster the use of daylighting concepts throughout the design of a building, the lighting group at the National Research Council, in partnership with Natural Resources Canada, has developed an online support service called Lightswitch Wizard. The Wizard helps architects to design perimeter offices and classrooms and it helps lighting designers assess the energy savings of lighting and window blind controls.

Photovoltaics

NRCan's CANMET Energy Technology Centre in Varennes (CETC-V) is responsible for the management of the federal photovoltaic R&D and technology transfer program. This includes technical support for research on components and systems in collaboration with industry and major end-users, as well as the development of standards and codes. The R&D program is financed by the Program of Energy Research and Development (PERD) and other federal programs in support of meeting climate change objectives. The Technology Early Action Measures (TEAM) program provides funding for technology demonstration and the Renewable and Electrical Energy Division (REED) is responsible for policy and supports PV training and marketing activities which promote the use of photovoltaic and other renewable energy technologies in Canada .

The Canadian R&D program supports the development of technologies and the evaluation of performance of new PV applications and their adaptation for use in cold climate conditions. In addition, a program has been initiated to address technical, institutional and regulatory barriers and to promote the grid integration of decentralized energy resources. Recent projects include:

- Integration of renewable energy technologies in off-grid residences in Canadian climatic conditions
- Evaluation of the energy performance of novel PV modules



Lightswitch Wizard – A daylighting prediction system developed by the National Research Council.

operating in Canadian climatic conditions
- Integration of PV-thermal systems in buildings
- Optimization strategies for Zero Energy Solar Homes
- Evaluation of the use of small PV-hybrid systems in off-grid applications
- Assessing the performance of PV products designed for building applications
- Collaboration with Measurements Canada on Net-metering to address the regulatory issues
- Simulation of the impact of inverter-based systems and utility interconnected PV systems
- Development of a national guideline for the interconnection of small distributed generation systems
- Support for the development and adoption of performance and safety standards for use in Canada.

Demonstration projects include a 35 kW grid-connected PV system on the office of the Toronto Hydro-Electric System Ltd., a subsidiary of a major municipal electric utility and 13 other grid-tied PV applications, totaling 100 kW, on facilities owned by the federal government and funded through the Government of Canada's On-site Generation at Federal Facilities initiatives.

Technology Partnerships Canada and TEAM are funding the development and commercialization of Solar SpheralTM technology and Sustainable Development Technology Canada is contributing to the development and demonstration of solar powered

Residential System utilizing roof-integrated amorphous PVtechnology.

The Toronto Hydro Energy Services 35kWatt PV façade.

LED technology for edge-lit signage. The latter project is enabling solar powered lighting to enter mainstream applications.

OTHER GOVERNMENT SUPPORT ACTIVITIES

In addition to R&D, NRCan provides information support to the public, financial incentives and regulatory programs, and other market development activities for solar energy through the Electricity Resources Branch (ERB) of the Energy Policy Sector and the Office of Energy Efficiency (OEE) of the Energy Technology and Programs Sector.

In 1998, NRCan launched the Renewable Energy Deployment Initiative (REDI) to promote renewable energy technologies for heating and cooling of new or existing commercial and institutional buildings. Technologies supported include solar water heating systems, solar air heating systems, ground-source heat pumps and high-efficiency/low-emissions biomass combustion systems. Participants are eligible for a contribution of 25% of the cost of a solar system, up to $80,000. Other markets including residential water heating are also supported on a special project basis. Solar heating of industrial processes was not originally included but has recently been added to the scope.

Response to the program was initially modest but to date, approximately 300 commercial solar heating projects have been completed under the REDI program. These represent a collector area of over 50,000 m^2 and an installed thermal capacity of 36 MWt. Annual GHG savings are estimated to be approximately 8,500 tonnes.
At the same time, NRCan has launched the Commercial Building Incentive Program for the same period which provides financial incentive for the design of new or retrofit buildings that are 25% more energy efficient than a similar building meeting the Energy Code requirements. During 2003-04, the CBIP program has influenced more than 750 new construction commercial

projects. Energy efficient systems and envelopes, passive solar and daylighting measures are typically considered. Data for the CBIP buildings indicate that they will typically use 30% less energy than a similar building designed to the Model National Energy Code for Buildings. This concentration on energy has the advantage of forcing an aggressive review of all building systems, from envelope and fenestration through mechanical and electrical.

Other government support is also available for Photovoltaics. Equipment for PV systems of at least 3 kW of capacity receive special tax treatment under Class 43.1 of the Federal Tax Act that allows for accelerated depreciation of system costs (30% declining balance). As well, early intangible project expenses are 100% deductible and these can be financed through flow-through shares since December 1996. In addition, a green power purchasing agreement is being negotiated in the province of Alberta, as a trial project, by the federal government to purchase a certain amount of its power requirements from "green" sources.

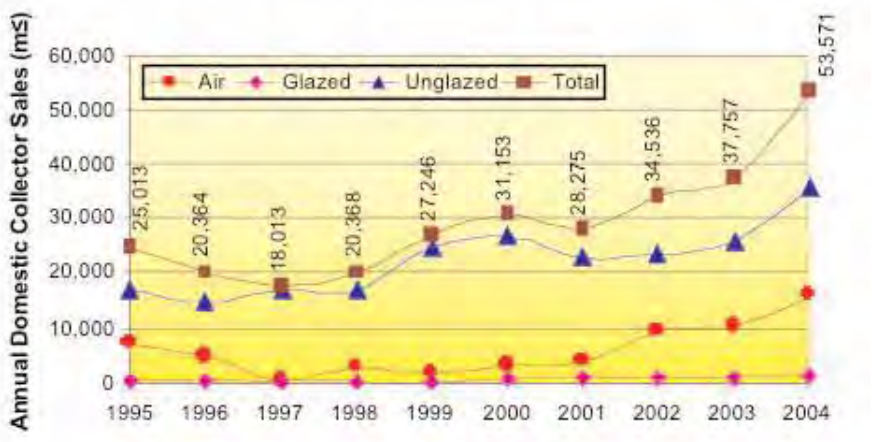
Information and promotion continue to be a priority for the solar energy programs. The department provides financial support to industry associations, conferences, and workshops. NRCan has also developed consumer guides for solar domestic hot water systems, solar pool heating systems, energy-efficient windows and doors, as well as fact sheets on window technology and an advanced houses builder's manual that includes details on solar design.

COMMERCIAL ACTIVITIES

Canada's active solar industry comprises more than 30 companies representing between 100-120 person-years employment. Manufacturing includes products ranging from residential pool heating collectors and domestic hot water systems to solar pre-heating ventilation air systems. Domestic solar collector sales were about $4.5 million in 2003 and $6.1 million in 2004. The key markets are: swimming pool heating, ventilation air heating, and commercial/domestic water heating. Unglazed solar collector sales for swimming pool heaters were $1.4 million in 2003 and $2.2 million in 2004. Solar air heating system collector sales were $1.8 million in 2003 and $2.4 million in 2004. Glazed water heating collector sales including evacuated tube collectors were $1.3 million in 2003 and $1.6 million in 2004. The 25% grants provided by the REDI program directly contribute to the growth in the commercial air and water heating markets.

It is estimated that at the end of 2004, there were 368,000 m^2 of solar thermal collectors operating in Canada with a total capacity of 258 MWt. Domestic sales in 2004 of 53,600 m^2 were up 42% over sales of 37,800 m^2 in 2003. Unglazed solar collectors for heating swimming pools account for 67% of the total collector area and unglazed air heating collectors 30%, with the remainder being glazed flat-plate and evacuated tube water heating collectors. The average annual growth rate for air heating collectors over the last five years was 58% compared to 38% for the glazed/evacuated tube collectors and 8% for unglazed water heating collectors. The Figure shows domestic collector sales, by type, for the last 10 years.

The market for high performance windows in residential and light commercial applications continues to grow both in absolute number of units sold and relative share of the window sales. More than 40% of the product sales included low-e and inert-gas filling options. This is about 6.2 million units sold annually. However, a highly fragmented window and building industry, coupled with a



Annual solar collector sales.

virtual absence of adoption of the Model National Energy Code for Housing by relevant jurisdictions across Canada, did not produce the expected growth in high performance window market share in the new construction. The majority of high thermal performance window sales are in the existing retrofit/renovation segment. In 2003-04, ENERGY STAR for windows assisted in promoting high performance windows.

There has also been significant growth in the non-residential window market, with current total annual vision area of about 19.2 million square feet, of which 42% features low emissivity glass. The current focus is on commercial envelope systems, including curtain walls, that are notoriously inefficient, and daylighting systems such as atrium glazings.

The Canadian PV industry has grown steadily serving both its domestic off-grid market and the export market. There are approximately 150 organizations actively promoting PV. There was a 24% increase in the manufacturing employment in Canada in 2004 (equipment, PV and balance of system products). The largest manufacturers are Xantrex, Carmanah, Spheral Solar Power and ICP Global. The only module manufacturer in Canada in 2004 is ICP Global with production capacity of 2 MW.

Installed capacity in 2004 was 13.9 MWp, up 18% from 11.8 MWp in 2003. In 2004, off-grid installations accounted for 96.3% of capacity and 59.7% of module sales were in the off-grid non-residential sector with a growth of 14.8% over 2003.

OUTLOOK

The outlook for solar energy use in buildings and other applications in Canada is positive with growth in sales expected for active, passive, and photovoltaic solar technologies, in domestic and international markets. Anticipated improvements in the cost of solar products coupled with increasing cost of electricity and other energy sources, the trend to higher energy efficiency standards, more utility involvement, and an increasing concern for the environment are helping to reduce the market barriers.

Solar Energy Activities in DENMARK

Mr. Jens Windeleff

Danish Energy Authority

At this time, Denmark has no specific solar heating and cooling RD&D programme, and no standard subsidies for solar systems. The subsidy programme that provided a maximum of 30% of the cost for a SHC system ended in 2002 after 25 years. The reason for this shift in policy was based on the belief that after such a long period of government support in combination with increasing prices of oil and gas that the technology was mature enough for commercial competition.

Funding for RD&D projects is still available, but this field is not profiled as a programme in itself with a development strategy, targets, etc. Funding is given on a case by case basis, if it can be documented that a need exists for further research or development. This funding mechanism has allowed the participation of Denmark in two IEA Solar Heating and Cooling Tasks – Task 32, Advanced Storage Concepts for Solar and Low Energy Buildings and Task 35, PV/Solar Thermal Systems. Recently, new possibilities of funding for solar thermal plants and solar heat storage in combination with the combined electricity/heat production in the utilities have arisen.

In addition to the IEA Solar Heating and Cooling Programme work, a demonstration project of a 5,000 m^2 solar heating system has been funded. The project started in 2004 and is at the Ulsted district heating company in North Jutland. Funding being provided is 20% of the costs, up to a maximum of 300,000 Euros.

It is the hope that the proposed European Commission directive on renewable heat will once give solar heating a higher order of priority in Denmark.

Solar Energy Activities in FRANCE

Yves Boileau

ADEME

PROGRAM STRUCTURE

In the 2002 IEA SHC report, *Solar Energy Activities in IEA Countries*, we presented the main actions planned in the French "Plan Soleil" 2000/2006 program. This national promotion and information program is now entering the last year of deployment so it is the right time to have a look at its results and to give short comments on some success stories. It is also time to mention some barriers and difficulties we encountered during the past six years.

A Brief Overview

At the beginning of 1998, within the framework of the compliance with the Kyoto commitments, the French government decided to re-launch actions aimed at energy management and the development of renewable energies. ADEME (French Agency for Environment and Energy Management) was assigned the task of implementing specific programs.

"Plan Soleil" (formerly known as "Helios 2006" program) belongs to a whole set of RE programs, such as PV, biomass, etc. Originally it was dedicated to re-launching solar heating equipment within the building sector, with some clear targets and domains:

- Plan Soleil program has focused on mainland France. As a matter of fact, French overseas departments in the tropical area (Caribbean islands and Guyana, Reunion Islands, etc.) have been part of government solar programs since 1983, in conjunction with regional authorities support. These local and relatively small-scale programs have been operating almost continuously from this time, with their own procedures and varied forms of incentives (public subsidies, specific RE tax exemption, EDF complementary subsidies, etc.). Even if the public support has been somewhat lowered, the local markets seem to be firmly established and the current annual sales are now around 10,000 SHW domestic systems (mainly "bread-boxes" and thermosiphonic systems).
- During the last 25 years (until the end of the 1990s), only limited or short-period national support (subsidy or tax-credit scheme) has operated in the European part of France. Plan Soleil aimed at creating a rapid change in this situation within a "long-term" framework of seven years, and at emphasizing development of partnerships between industry and installers, and between national and local public authorities.
- From its beginning, Plan Soleil has clearly targeted three different applications, each of them benefiting from specific procedures: hot-water production (single-family units, or SDHW small systems), collective hot-water production (centralised

plants) and space heating combined with hot-water production (solar combisystems or SCS), applied mainly to detached houses.
- Specific support (tools for feasibility studies), incentive procedures (for installing systems and monitoring them) and other accompanying measures (professional training, communication campaigns, technical audits, on-site measurement programs, etc.) were progressively set up from mid-1999 until now. Following is a description of the evolutions that have happened during the last years of the program and comments on the main results.

Summary of Main Program Objectives

In order to meet Kyoto Protocol targets and to ensure better coherence within the whole set of government proposed measures, the initial objectives of the Program were slightly revised in 2002. The objectives of the 2006 Plan Soleil Program are shown in Table 1.

During the first two years of the Program, the emphasis was placed essentially on support schemes concerning SDHW individual systems (item 1 above), ranging from system certifications to training courses and installer labelling, and promotion. The other main application sectors have been addressed to a greater extent from 2002 on.

OVERVIEW OF MEASURES AND SUPPORT

SDHW Single-Family Systems

Government incentives managed by ADEME have been made available all over the territory from 2000 to the end of 2004, provided that the solar collector/systems are "certified" and installed by plumbers with specified professional skills ("Qualisol" chart commitments must be signed by the enterprise).

These national incentives amounted to an average value of 900 Euros, depending on size of the SDHW unit (4 m^2 collector area / 200 litres storage). Through partnership with ADEME, most Regional Authorities and some lower-level ones (Departments, Urban Districts, even municipalities) have already decided to give additional incentives to buyers of SDHW systems. The amount of these subsidies varies considerably, ranging generally from 300 to 1,300 Euros (most of time on a cumulative way).

Starting in 2005, the national subsidies ("prime CESI" and "prime COMBI") from ADEME were stopped and replaced by a national tax-credit scheme. At the same time, a large number of public local authorities generally confirmed their local subsidizing procedures (when existing), or decided to set up their own procedure if they do not exist before. The tax-credit scheme—the principle of which has been approved for the whole 2005/2009 period—is opened only to family investments (restricted to the principal home of the family). The procedure was based on a 40% reimbursement (this was raised to 50% in 2006) of the net solar equipment purchase, (sold and installed by any professional company), under condition that the solar collectors benefit from an official certification (French, European Solar-keymark or equivalent). It is likely that this condition should be some time extended and completed with a minimum performance requirement.

Table 2 shows data related to the 1999-2005 period show the signs of a remarkable market expansion.

Comments:

- Excepting three or four companies from Australia, Israel and Turkey, most firms are now the EC (with only 2 French manufacturers). A large majority of the solar collectors, which equipped the small systems, are flat-plate glazed selective-coating ones. A few other systems

Table 1
Plan Soleil Program Goals

	Planned to be installed during year 2006		Total installed area 2000/2006 (m^2)
	Units	m^2	
SDHW individual units	33,000	134,000	315,000
SHW medium/large-scale Systems		15,000	48,000
Individual solar Combisystems	1,600	24,000	78,000
TOTAL		**173,000 m^2**	**441,000 m^2**

Table 2
Number of Manufacturers/Importers & Installers Yearly Installed SDHW Small Systems

Year	1999	2000	2001	2002	2003	2004	2005	2000/ 2005
Manufacturers or Importers	3	6	10	14	23	32	40	n/a
"Qualisol" enterprises	46	435	1,250	2,300	4,000	7,000	9,500	n/a
SDHW units	150	700	2,600	3,300	5,200	8,000	14,000	33,800
10^3 m²	0,6	3,2	11,7	14,8	23,4	36	65	154,1

are equipped with vacuum-tube solar collectors (manufactured in China or in Europe).

- Three or four companies (among 40 companies) represent more than 50 % of the annual production sold on the French market. The average installed price in 2005 was approximately 4,500 Euros (4 to 5 m²/250 to 350 l).
- The raising of number of "Qualisol installers" shows a growing interest of these professionals through the years. It is mainly due to a "snowball effect" after the numerous large-scale communication campaigns aiming at individual customers.
- In most cases, Qualisol labelling resulted from participation in training solar courses –requiring a minimum of 2 days of standardized sessions organized either by installer unions or by manufacturers or importers-and concerned very small enterprises (2 to 5 persons).
- It should be noted that only a small proportion (20-30%) of these installers has effectively achieved more than two individual operations until now. But the situation also shows a growing number of firms trying to "specialize" in installing RE equipment (solar thermal and also PV, domestic heat-pumps).
- Changes in Qualisol procedure, which are now in progress, will make it more selective and support the most active and dynamic installers. As a matter of consequence, their number will probably decrease during 2006.
- Even if the data remain relatively small (compared to several European neighbours), the SDHW market shows a steady growth rate during the Plan Soleil period of 2000 to 2005. The annual installed quantities multiplied by a factor 20 (more than +70% per year).
- It should be noticed that the major part of solar houses equipped during Plan Soleil (SDHW or SCS systems) relates to existing buildings. Only 5-7 % of these solar houses are new ones. This proves that builders are just beginning to find some interest in these solar niches and starting to propose standardized solar solutions for the customers.

Solar Combisystems (SCS)

Demonstration projects have been carried out for the 1999/2001 period in several regions. They have been devoted to the testing (or dissemination) and promotion of solar combined space and water heating systems with solar heating floors in single-family houses. For a long time, this type of SCS (called "Plancher Solaire Direct" or "PSD," which refers to a commercial brand) used to be the only commercialised factory-made solar heating system in that field.

During this first period, public subsidies (average amount of 2,000 Euros) were made available to SCS individual buyers of the above standardized systems, according to a procedure very similar to the one applied to SDHW small systems. Other types of SCS, based on different technological choices (control strategies, storage medium, hydraulic schemes, etc.), have begun to spread in the French market during the next period, since 2002. They were coming mostly from Austrian and German manufacturers. As information on real systems' thermal performances was hardly available, ADEME started a first "SCS on-site evaluation project" in partnership with all "voluntary" short-listed operators/manufacturers.

Approximately 40 units related to 6 different kinds of systems were accurately monitored and assessed between 2003 and 2005. The qualitative and data results will soon be available and published, out of which some indication and tendencies are commented below.

Public subsidies were granted during the second period (2002/2005) to several types of "standardized" SCS installed by "qualified" installers (the Qualisol

Label is required) on main residences. National subsidies could have reached 2,000 Euros, depending on the type of roof-integration of the solar collector and on the availability of tested performance and global solar fraction of the SCS (determined through validated in-situ measurements made in Europe). ADEME set up partnerships with Regional Authorities in the aim that additional incentives could be granted to buyers of SCS. Most Regional Authorities have agreed on giving about 1,000 additional Euros. During the third period, which started in 2005, the SCS subsidies ("prime COMBI") coming from ADEME were stopped and replaced by the same national tax-credit scheme applied to SDHW solar systems. Table 3 below shows evident signs of a growing interest in solar combisystems among French citizens.

Comments:

- Even if this market remains a small when compared to SHWD, the recent data show a strong expansion of individual SCS in the first year of the new tax-credit scheme. It must be noted that this procedure allows public financial support up to 6,400 Euros (8,000 Euros in 2006) for a two-person family, which is a relatively high-level incentive.
- About 15 industrial companies, among which three to four make the main part of the sales in France, are now active in this sector. Except for one small French firm (120 staff) selling only in France and specialized in this sector, most of the other companies deal with heating boilers or electricity storage manufacturing as their basic activities.
- Findings and trends that have emerged from the on-site SCS measurements made during the 2003/2005 period include:

—Effective thermal performances (annual solar contribution to thermal needs) seem often lower than expected in preliminary studi es. In most cases, no evident conclusion referring to low quality of essential components can be drawn. Poorly installed systems could be the main reason for such situations. Nevertheless, some design and control strategies chosen by manufacturers seem to be more efficient than others according to significant differences sometimes observed.

—Design guidelines and technical documents given by the manufacturers are not always followed by the installers due to their wish to customize as much as possible the solar system to the local project. This can lead to solar malfunctioning (sometimes very low solar fraction and in some cases a higher auxiliary energy consumption when compared to reference cases).

—A lack of technical training given by manufacturers to installers is one important feature, and must be rapidly addressed.

Medium and Large-Scale SDHW Systems

Subsidies for "check-up" studies, up to 70% of costs (with a limit of 2,300 or 3,800 Euros, depending on the complexity of the study) are still provided by ADEME and regional authorities for technical studies of medium or large-scale hot water plants. A large number of these studies have been performed during the last six years, and a relatively high proportion of them has led or will probably lead to solar investment decisions.

A four-year Guaranteed Solar Results procedure is being carried out between the building owner and the solar project team that is responsible for design, installation and maintenance of the solar system. For smaller projects, the

Table 3
Installed Solar Combisystems Between 1999 and 2005.

Year	1999	2000	2001	2002	2003	2004	2005	2000/2005
units	100	150	240	300	450	600	1,600	3,340
m²	1,500	2,200	3,600	4,500	6,700	9,000	24,000	50,000

Table 4
Installed Medium and Large-scale SDHW Systems (in m²).

Year	1999	2000	2001	2002	2003	2004	2005	2000/2005
Medium and large-scale solar plants	600	1,500	2,500	4,500	6,500	10,000	15,000	40,000

only requirement is the commitment to perform ongoing measurements of the solar output on either a weekly or monthly basis. According to the European regulation, the level of public subsidies can range from 40-50 % of solar-over costs for private owners and up to 70-80 % for communities and other public bodies. Total public support amounts frequently range from 350 to 500 Euros/m^2.

The main observed target sectors are hospitals and other health buildings, hotels, multi-family dwellings, retirement homes, holiday houses and camping-sites, and sports halls.

Other General Accompanying Measures

The "Plan Soleil" promotion campaign was progressively widespread covering 22 "regions" of the French territory in three annual waves. Starting with 5 regions in 2000, 9 regions in 2001, and then 13 more regions from 2002 to 2005, different media and marketing tools have been used, including regional TV spots, local newspapers ads, free brochures and booklets, free phone "green numbers," diffusion of local Qualisol lists and selected individual SDHW or SCS lists, and installers' information meetings. The results of the campaign were highly encouraging, and contributed to awaken the energy and environment-consciousness among individuals.

The national training program for SDHW system installers (2-day sessions organised by ADEME, the two main professional representative structures, and a majority of manufacturers) have been clearly amplified all along the six years of Plan Soleil Program. But this topic needs more permanent attention, with updated courses, revised learning tools, new ways of integrating solar systems and knowledge into traditional technical courses, etc.

Some New Trends and Orientations For 2006–2010

During 2005, frequent and thorough discussions were conducted between ADEME and five professional structures (representative of the manufacturers and importers on one hand, and of the installers on the other hand) in order that the "Qualisol labelling concept" (enhancement of quality and service by ways of training, auditing and communication actions) should be transferred from ADEME to a new "professional-driven" structure, managed by the private sector. This was finally achieved during the last week of December 2005. Qualit'EnR is the name of this structure, which is now in charge of:

- managing the Qualisol concept (applied to solar thermal installing activities), and
- developing similar labelling concepts applied to other RE sectors, such as PV, biomass (wood-burning), geothermal small heat-pumps, etc.

2006 will be the last year of Plan Soleil Program. A comparison between the 2006 objectives and the first estimation for 2005 shows a good general concordance, in terms of market growth, availability of local professional skills, diversity and maturity of commercialized solar systems. Taking basis of the 250,000 m^2 of solar glazed collectors installed during the whole 2000-2005 period (with an estimation of more than 100,000 m^2 during the single year 2005), it seems highly probable that we shall come very near the cumulated 440,000 m^2 which was planned for the end of 2006. Nevertheless, some important and general questions should be addressed:

- Are the financial incentive measures to be maintained beyond the next 4 to 5 years?
- Aside from national regulatory measures concerning mainly new houses and buildings (thermal regulation in this sector need to be revised every 5 years, but really impact each year 2 or 3 % of the total market), is there a way to promote "natural" solar dissemination within the large existing building sector?

We must also honestly confess that a huge mass of actions—technical, regulatory and quality related—still need to be accomplished and improved during the next years, in conjunction with the professional partners we worked together in the frame of Plan Soleil.

Just a few examples of what should be considered as priorities or topics to be deepened:

- Settling a real harmonized (i.e., compulsory) European certification of solar systems, accompanied by a serious and coherent labelling scheme accessible to final consumers (classes of performances, with stars or equiva-

lent). This appears now like a primary condition for the good information and customers' protection. Why are solar thermal systems all over Europe so late on this topic?

- Settling training courses in the basic education network existing for building professions, at different levels (designers and consultants, contractors and installers, maintenance firms, etc.)
- Starting to develop and promote technical offers which mix both solar applications (thermal/PV). In France, these manufacturers generally belong to separate sectors, and they are use to working in different market segments. This also implies moving the installers' point of view and to find solutions to overcome some professional barriers, such as most plumbers cannot easily deal with electrical RE appliances, and installing thermal or PV collectors on roofs is not always handled by the right-skilled firms.
- So many questions are still pending (related to building insurance, fire protection, or protection from rain and snow, or wind stability) and need to be solved.
- In July 2005, a new law was voted on by the French Parliament which deals with Energy orientations 2006-2010, in connection with the long-term objective called "factor 4" (reducing the green-house emissions by a factor 4 from now to 2050).

Closer objectives are mentioned for 2010:

- Producing 50% more RE heat (15 MToe against 10 MToe in 2003).
- Aiming at 21% RE contribution to electricity production.
- Increasing new buildings energy performances by 40% by 2020.

Among short-term measures concerning PV, wind-energy, etc. a new solar thermal program has been globally decided (called: "Face Sud" Program, for "south-facing buildings program") and some general objectives for 2010 have been settled and shall be precisely defined in due time:

- 200,000 equivalent units of SDHW systems (this category probably mixes small individual and large centralized systems).
- 50,000 "solar roofs" (PV + Thermal, or hybrid solar systems).

Figure 1. A medium-scale SDHW plant (180 m²) for the health center at BRIANCON (Hautes-Alpes).

Figure 2. Single-family solar heater at LUSSAS (Ardèche, centre of France), with roof-integrated collectors

Solar Energy Activities in GERMANY

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PROGRAM STRUCTURE

For many years, the energy policy of the German Federal Government has been devoted to a sustainable and secure energy supply (www.bmwi.de). Recently, after the elections of the Federal Parliament in September 2005, the new Government confirmed previous commitments to reduce the CO_2 and greenhouse gas emissions into the atmosphere. A challenging first goal was set in 1990: reduction of CO_2 emissions by 25% of 1990 levels by 2005. To achieve these goals, a high priority has been given to energy efficiency and utilization of renewable energy. During the previous period of legislation between 2002 and 2005, the Federal Government took important additional steps to implement the strategy of a sustainable deployment in Germany through both legislation and subsidy programs as well as continued RD&D funing. In June 2005, the 5th Programme: “Innovation and New Energy Technologies” was passed, which follows the 4th Energy Research Programme (1996-2005), for the next 3 years 2006-2008. A high priority is given once again in this new program to energy efficiency and utilization of renewable energy sources.

The Government initiatives comprise:

- Deployment of renewable energy and high efficiency technologies by public subsidies and low interest loans.
- Regulations and laws.
- The R&D Programme "Energy Research and Technologies."

In spite of the recent extraordinary expansion of wind and photovoltaic power installations in Germany, so far only hydropower and biomass contribute about 3.1 % to the total primary energy demand of about 15,000 PJ. By the end of 2005, the installed wind power capacity in Germany expanded to 17 GW and the installed PV power to 1,400 MW. There is also a rapid expansion of the solar thermal market. Nevertheless, so far the contribution of solar thermal energy (not including passive solar) to the total heat demand of Germany is negligible. In the long term, however, solar thermal and photovoltaic energy is expected to cover a substantial fraction of German’s low temperature heating demand. In fact, the commitment of the Government is to cover 4.2% of the primary energy demand by renewable energy until 2010 and to increase the share of renewable energy to 50% by 2050.

In addition to the activities of the Federal Government, several promotion and demonstration programs are carried out by the Federal States. In 2000, the German Energy Agency DENA (www.dena.de) was founded by the Federal Government to promote deployment of energy efficiency technologies and utilization of renewable energies. The

diverse objectives of DENA include the promotion of rational and environmentally friendly production, conversion and use of energy, and the development of sustainable energy systems with a greater emphasis on renewable energy sources.

The governmental independent agency, Deutsche Bundesstiftung Umwelt DBU (www.dbu.de: German Endowment for Environment) provided more than 1 billion Euro, especially for small and medium enterprises SME. Since it was founded in 1991 more than 5,000 R&D projects have been supported in various areas of energy conservation and renewable energy technologies including information dissemination, training and teaching.

This report mainly summarizes RD&D building-related activities carried out in the field of Renewable Energies and Rational Use of Energy of the 4th Program on Energy Research and Technologies until 2005. In 2003, the Program was divided in two parts. The part: "Renewable Energies" (solar, geothermal, wind) was transferred from the Federal Ministry of Economics and Works (BMWA, after the elections in 2005 the Ministry was renamed BMWi: Federal Ministry of Economics and Technology) to the Federal Ministry of Environment and Nuclear Safety (BMU: www.bmu.de). As in the past, the Program Management Projektträger Jülich (PTJ: www.fz-juelich.de/ptj: in Forschungszentrum Jülich) is responsible for the management of the total Program. PTJ is supporting the Ministries with technical advice, reviewing RD&D proposals, recommending projects and controlling the scientific/technical as well as the financial execution of the Program.

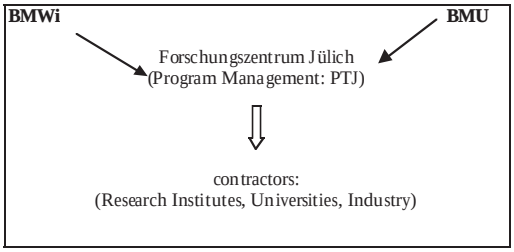


Figure 1. Organisational structure.

FUNDING

In general, R&D funding is carried out on a 50% cost sharing basis in compound projects between research institutes and industry. Technology transfer from research institutes to industry is of high priority.

A breakdown of the budget can be found in Table 1, an overview of national programs. This table does not include the budget allocated for the topics: "Clean and high efficient power generation from fossil fuels" and "Energy efficiency in industry" and basic funding of Research Centres (provided by the Ministry of Education and Research). Additional funds of about 150 million Euro were provided in the years 2001 until 2003 (so called Future Investment Program ZIP). These funds were allocated mainly for RD&D of environmental friendly energy technologies (e. g., fuel cell technologies). The industrial compound project "Innovative Phase Change Materials (PCM) Technologies" with a budget of about 15 million Euro for 5 years was completed successfully in 2004. Twelve project partners in an industrial consortium have been co-operating with research institutions to develop PCM applications in buildings. Over the past years, the total budget has been rather stable. The funds were adjusted to specific topics as needed. Recently, the new Government announced to increase the budget for R&D over the next years.

R&D PROGRAM

In Germany, many research institutions have been engaged mainly in basic R&D and numerous joint projects with research institutions and industrial partners have been carried out. The deployment of R&D results has become a key issue of project funding.

In the past 15 years, the research capacities in Germany of major research organisations (Table 1) and universities have expanded extensively. RD&D has been partly funded from the basic funding of the research organisations (basic research), partly by direct project funding by the Federal States and BMWi (applied research). Recently ZAE Bayern e.V. joined the "Forschungsverbund Sonnenenergie" ("research co-operation solar energy"), which was established to co-ordinate R&D of major research centres and institutes (HMI, ISE-FhG, ISFH, FZJ, ISET, DLR, ZSW).

R&D in the building sector includes the following priority program activities:

- Solarthermie-2000 (large scale solar-thermal active systems).
- Energy Optimized Buildings ("ENOB": new buildings and existing building stock).

A short summary of the scope and recent achievements of the RD&D topics of the building sector is presented in the following paragraph.

Solarthermie-2000 and Solarthermie2000Plus

In 2003, after 10 years of execution, the program Solarthermie-2000 was successfully completed. In total, about 60 large-scale solar assisted heating plants were designed and constructed. All projects included long-term monitoring to show the operational performance, the technical feasibility of the concepts and the cost/benefit ratio of large-scale plants of the second and third generation.

The program was divided in three parts:

Part 1: Long term behaviour of solar-thermal systems.
Part 2: Solar-assisted demonstration plants in public buildings.
Part 3: Large scale solar-assisted district heating plants with seasonal storage.

Taking into account the results of comprehensive investigations in Part 1, the lifetime of solar collectors was re-calculated. As a result, a prolonged lifetime of 20 years was deduced (before 15 years). The longer lifetime leads to improved economics of solar energy. In Part 2 of the program, the designers of the solar plants had to show and guarantee solar energy costs (including costs for design and VAT (16%) calculated with an annuity of 8.72% of the system costs) of less than 0.12 Euro Cent/kWh. The demonstration plants also served to raise interest and trust on solar installations of new clients and customers (e. g., utilities, building services, building owners, contractors).

Within Part 3 of the program, various concepts of solar-assisted district heating systems with seasonal storage have been demonstrated. So far eight large scale solar thermal plants were designed, constructed and monitored. Different seasonal storage concepts (pit, duct, man-made aquifer, natural shallow aquifer) have been investigated and realised in large scale. Specific requirements for the building standard and the utilization of solar energy by both passive and active systems had to be met in the demonstration projects. First priority was given to the reduction of the specific heating demand of the buildings. Some of the solar installations were funded by the Federal States. The Federal State of North-Rhine Westfalia has launched the program: "50 solar settlements." The uniform evaluation of the data of all plants was carried out by the Institute of Thermodynamics and Thermal Engineering (ITW) of the University of Stuttgart. The goal is to show the economic and technical feasibility of the different storage and system concepts.

Table 1
Major renewable energy research institutes in Germany.

Institution	Activities
Fraunhofer Gesellschaft (FhG)	
ISE-Freiburg	Photovoltaics: solar cells, system technology, fuel cells, active and passive solar technologies, solar buildings
IBP-Stuttgart	Building research, low energy buildings, daylighting
ISI-Karlsruhe	System studies
Forschungszentrum Jülich	
ISI	Photovoltaic solar cell research
IEV	Hydrogen technology, fuel cells
STE	System and potential studies
Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR)	
DLR-Stuttgart	Receiver technology, solar-thermal concentrator technologies, solar power plants, system studies
DLR-Köln	Solar chemicals, solar power plants, Test Centre Almeria (PSA)
Hahn-Meitner Institut Berlin (HMI)	Photovoltacis, Photo(electro)chemistry
Solar Institutes of the States	
ISFH-Hannover-Hameln	Active and passive solar-thermal, photovoltaics, photochemistry.
ZSW-Stuttgart	Solar hydrogen, photovoltaics, solar-thermal and energy storage.
ISET Kassel	Photovoltaics, wind energy, electrochemical storage, PV-facades, system technology
ZAE-Bayern	Active solar-thermal, thermal energy storage, absorption heat pump technology, fuel cells

To summarize the results of Part 3 of Solarthermie-2000 (seasonal storage)—the technical feasibility of the solar assisted district heating plants was successfully demonstrated. Initial technical problems were due mainly to failures of conventional components (e. g., malfunction of pumps, heat exchangers) and could be eliminated just after operation. With the construction of large-scale demonstration plants reliable cost figures of various technical concepts could be gathered for economic calculations. However, in most installations the design values of the performance (solar fraction 50%) were not fully achieved mainly due to unfavorable conditions of the district heating and the heat supply system in the buildings. In particular, higher than anticipated de facto return temperatures (above 50°C) of the district heating system had an adverse effect on the solar fraction. With increasing return temperature the thermal capacity of the heat store is reduced considerably. This problem on the consumer side shows how important it is to prove the concepts in practice. Advanced concepts have to be developed and demonstrated to surmount this problem. In addition, the seasonal heat losses were larger than calculated.

In 2003 the program Solarthermie-2000 was extended to program Solarthermie2000 Plus. The new program has been scheduled for the next 7 to 10 years (20003-2010) to develop and prove new promising solar thermal applications. The new priorities include the following topics:

- Solar assisted district heating plants with a solar fraction between 10% - 30%
- Solar assisted district heating plants with seasonal storage (new storage concepts and integration of other renewable energy sources than solar)
- Solar air-conditioning and solar process heat

As in the previous program, Solarthermie2000Plus focuses on large scale central solar thermal plants. Solar heating of buildings is focused on systems with a solar fraction between 10% (only hot water preparation) and 30% (hot water and space heating). In this range of moderate solar fractions a large energy substitution and deployment potential is expected. Regarding the systems with a very high solar fraction (50% and higher) of Part 3 of Solarthermie-2000, the specific costs are smaller and the economics are better. Therefore, a quicker implementation seems possible. Further R&D is devoted to advanced seasonal storage concepts to reduce the specific storage costs.

Extended laboratory investigations deal with new plastic liner materials for hot water pit stores. Advanced construction concepts are being developed. At present, two large-scale plants are under construction: a 5,700 m^2 advanced hot water storage for the demonstration plant in the solar quarter München-Ackermannbogen and a 37,500 m^2 hybrid duct store in a renovation quarter of Crailsheim. To be able to use the storage capacity more effectively, the heating scheme of both heating plants includes a thermally driven heat pump. The store can be discharged below the return temperature of the district heating system.

Figure 2. Solar Plant Neckarsulm-Amorbach in Phase II (expanded 6,300 m^2 solar collector roof and a 65,000 m^2 duct storage) and operating since 1997.

Energy Optimized Buildings
(ENOB: www.solarbau.de)

The sub-program ENOB comprises both new and existing buildings. A high priority is given in the Energy Research Program to the topic "Energy efficiency and utilization of renewable energies in buildings." The building sector accounts for more than 1/3 of the total end use energy in Germany, and therefore a tremendous energy saving and substitution potential remains both for new and existing buildings. Especially the existing building stock offers

a great energy saving potential as old buildings exhibit in general a very high specific heating demand in Germany (200 to 400 kWh/m²a). During the past 30 years, the building codes of new buildings have been tightened in several steps. Recently, in the energy saving regulation EnEV 2002 the primary energy demand of residential new buildings is reduced by another 30% to a limit of about 70-100 kWh/m²a (depending on the surface to volume ratio). A special technical low energy building concept is the "Passive House" (www.passivhaus.de). It can be shown through the monitoring of several pilot installations that the specific heating demand does not exceed 15 kWh/m²a. So far about 4,000 solar Passive Houses have been constructed in Germany, and the market deployment of Passive Houses is expanding rapidly. The so called 4-liter low energy buildings are based on more conventional building and heating concepts, which include controlled ventilation with heat recovery in airtight buildings.

The short-term goal of the ENOB program is to halve the specific primary energy demand of buildings compared to the present upper limit valid in EnEV 2002. This goal requires a proper building design, the integration of different new advanced technologies and the optimized control of the heating systems. The long-term goal is a "zero emission" building with a positive annual energy balance. These buildings can produce more energy than they consume from renewable energy sources (e. g., roof integrated PV systems, small scale co-generation plants or fuel cells) and supply surplus energy to the electric grid or to the district heating system.

The main R&D topics of the ENOB program are:

- Investigation and development of new promising materials, components and building construction systems and technical heating equipment. New concepts are investigated: development of evacuated panels, advanced glazings (evacuated and electro-chromic), advanced technologies of day-lighting, innovative concepts of large-area heating and cooling systems also with phase change materials (PCM), advanced heat pump systems, decentralized heating pumps of small power.
- Development of advanced concepts and technologies of thermal energy storage for heating and air-conditioning of buildings with PCM and thermo-chemical reactions, use of the underground and aquifers for heating and cooling for long term storage, use of concrete floors and walls for short term storage.
- Optimization of control and regulation of the heating and cooling systems based on modern communication technologies.
- District heating and cooling systems for heat and cold supply from co-generation heat and power plants.
- Adaptation of the new technologies to the energetic renovation of buildings.

Research and Development

R&D is focused on advanced new concepts and technologies that improve the energy efficiency and lower the specific primary energy demand of buildings. One new concept deals with micro-encapsulated PCM incorporated in plaster and gypsum boards. The use of PCM increases considerably the thermal capacity of the light-weight walls (e. g. wooden construction or gypsum boards). Overheating of the room during hot summer days can be reduced or even avoided by passive PCM cooling with cold night air ventilation. Large area plastic capillary mats (Figure 3) and PCM plaster walls and ceilings can serve as low temperature heating and cooling systems which can be coupled to ambient air or to the ground ("LowExergy" system). This concept may replace the use of electric chillers for air-conditioning. In a joint project of ISE with industrial partners, the concept is extensively investigated and will be demonstrated in first pilot systems.

The technical-economic feasibility of new advanced components and their proper integration in energetically optimized systems are to be demonstrated under practical conditions in pilot and demonstration plants: so far in ENOB more than 25 new commercial buildings (usable floor area larger than 1,000 m²) have been constructed and about 23 existing buildings have been energetically renovated. For all installations long-term monitoring is carried out to show the energetic improvement.

Figure 3. Micro-incapsulatd PCM and plastic capillary mats for "LowEx" heating and cooling in walls and ceilings.

Solar Optimized Buildings
(Solarbau: www.solarbau.de)

In 2005, the new office building of the Federal Office of Environment (UBA) in Dessau was completed (see Figure 4). The architectural design focused on high energy efficiency and the use of renewable energy including daylighting. The heating demand of the building was designed to a limit of less than 50% of EnEV 2002. Fresh air is supplied through earth channels during summer for pre-cooling and in winter for pre-heating. The air-conditioning is assisted by a solid adsorption heat pump system with 354 m^2 evacuated solar collectors. PV panels of 32 KWp peak power are installed as semi-transparent elements in the glass roof of the atrium.

Energetic Renovation of Existing Buildings (ENSAN: www.ensan.de)

So far, 23 pilot and demonstration buildings have been realized in the program to show different concepts of energetically renovated buildings. One example is the application of vacuum panels (fig. 5) in the facade to reduce the specific heating demand of 200 kWh/m^2a of the existing building of a Kindergarten by 50%. In this case the architectural view of the building was preserved. The vacuum panels also were used to reduce the heat losses in the ground floor where no space was available for thermal insulation with glass or foam.

Figure 4. Umweltbundesamt Dessau (photo provided by So.li.dar Berlin).

OTHER GOVERNMENT SUPPORT ACTIVITIES

Several regulations and incentive programmes of the Federal Government support the utilization of renewable energies and rational use of energy and energy conservation in buildings. These include:

- The Energy Saving Regulation (EnEV) in buildings is effective since February 1, 2002. It tightens the upper limit of the total primary energy demand of new buildings by another 30% compared to the previous building code (WSVO1995: 50-100 kWh/m^2a depending on the surface/volume ratio of the building). The new regulation comprises both the efficient heat generation and supply as well as the reduction of heat demand by heat protection. The regulation has been amended to comply with the Energy Performance of Buildings Directive of the European Commission. Therefore, the primary energy consumption for lighting and air-conditioning of

buildings was included in the amendment. In the future an energy pass will be obligatory for selling a building. The energy pass classifies the energy demand in several categories.

- The "Market Program on Deployment of renewable energies and rational use of energy" was greatly expanded, and an annual budget of more than 200 million Euros was provided. Subsidies are granted to private investors for renewable energy installations including, in particular, solar thermal domestic hot water and heating systems and low energy buildings. The subsidies for solar thermal collectors were reduced slightly from 110 /m² to 105 /m² for SDHW, but have been increased to 130 /m² for solar combi-systems (SHDW + space heating).
- The Renewable Energy Sources Act (EEG) effective since April 1, 2000 passed a comprehensive amendment in 2004 in order to further support deployment the renewable energies. It requires electric utilities to pay for electricity from renewables (PV, wind energy, biomass) at a rather favourable rate (rate depending on the electricity power of the plant and energy source). This law is the basis for the boom of wind and PV installations in Germany as the investment is profitable for private investors.
- Utilities or industrial investors can receive loans of low interest rate (KfW-program, Landesausgleichsbank) to support the installation and economic operation of small-scale co-generation plants.
- Climate Protection Program of BMU. The Federal Government has allocated a budget of about 1 billion Euros in the period 2001 to 2005 to finance low interest loans for the energetic improvements of existing buildings under this Program. Low interest loans can also be received for the construction of new buildings of the solar Passive House standard (40 KWh/m²a total primary energy consumption for heating and electricity). It is the goal to construct 30,000 units in the Program.
- The first step of the “eco-tax” was introduced on April 1, 1999. The tax of fossil fuels and electricity was increased by 2.05 Euro Cent/liter light fuel oil and 0.164 Euro Cent/kWh gas with an additional increase every year. The last step of the eco-tax followed on January1, 2003.
- DENA: German Energy Agency (www.dena.de) The German Energy Agency (DENA) was founded in 2000 by BMWi in order to support the promotion and deployment of RE and energy conservation in Germany. Various initiatives and information campaigns have been launched by DENA. Recently DENA started an ambitious program on building renovation (low energy buildings by renovation). In the second phase of the program that just started at the beginning of 2006, a total of 110 projects have been selected to demonstrate the reduction of the primary energy demand of old existing buildings by 80%. This goal will be achieved through several measures including thermal improvements of the facades and windows as well a higher energy efficiency

Figure 5. Renovation of the Kindergarten with vacuum panels in the facades and ground floor (photo by IBP)

of energy supply with use of renewable energy sources. The project sites are distributed uniformly over Germany. Low interest loan are provided for the energy renovations.

- Information dissemination is a very important strategic element for the implementation of new energy saving and solar technologies. A special information service called BINE (www.bine.info: "Bürgerinformation Neue Energiequellen") is supported by BMWi and BMU. It prepares and distributes publications and information brochures free-of-charge to more than 20,000 registered addresses in Germany. The project flyers include results from the most successful and interesting projects. Every 2-3 years status seminars and workshops on specific topics of R&D are organised especially for technical experts. In these seminars, the results from the funded projects are presented and discussed.
- The market deployment of solar technologies will only be successful if the components and systems are reliable and durable as well as highly energy efficient in the long-term. In order to guarantee high quality, commercial products have to fulfil specific test requirements outlined in the regulation DIN 4757, part 1-4. The tests on SDHW systems are be performed regularly at several test institutes (e. g. ITW-Universität Stuttgart) officially appointed by DIN. Comprehensive test programs are carried out on commercial solar-thermal and photovoltaic systems. The results are published by Stiftung Warentest, which is an industry independent test institute for commercial products, highly esteemed by the public. With the publication of test results, confidence in solar technologies is being strengthened. Recent tests again showed that the quality of solar systems have improved and the majority of the tested solar systems are efficient and technically mature.

COMMERCIAL ACTIVITIES

Recently, the solar companies have expanded their market activities and production capacities enormously to meet the requirements of the growing solar market. At the end of 2005 the two major solar trade associations BSi (Bundesverband Solarindustrie) and UVS (Unternehmensvereinigung Solarwirtschaft) merged to the "Bundesverband Solarwirtschaft e.V." (BSW) (www.solarwirtschaft.de). About 140 manufacturers (PV and solar thermal) have gathered in BSW e.V.

The following preliminary figures of installed capacities until 2005 are quoted by BSW:

- PV: 1,400 MWp (200,000 PV installations).
- Solar thermal: 4,700 MWth corresponding to 6.7 million m^2 solar collectors and 800,000 solar-thermal plants (new installed in 2005: 950,000 m^2 solar collectors and 100,000 solar-thermal systems).

In 2005, the solar thermal market recovered after a strong decline in 2004. Typically, the heating plants in Germany are water based; about 15% are evacuated tube collectors. Most flat plate collectors are produced nowadays with selective absorber coatings and anti-reflective glazings. Meanwhile about 20% of the new solar thermal installations are combi-systems for hot water preparation and solar-assisted space heating. Solar air-heating installations are rather rare, figures are no longer quoted by BSW. Solar heating of swimming pools applies to uncovered plastic absorbers.

OUTLOOK

The market penetration of renewable energies in Germany is growing rapidly. Implementation is strongly supported by government programs (in particular the Renewable Energy Act and subsidies). Energy savings and higher energy efficiency is supported. A new market push is expected by the "renewable heating law." At present, various concepts are being examined on behalf of BMU. According to the renewable heat law, the heat production will hopefully be equally favoured as the electricity production from renewable energy sources. It has been recognized that the heat sector is at least as important as the electricity sector. A great fraction of primary energy in Germany is used for the production of thermal energy, the heat sector offers a very high energy saving and substitution potential. The Federal Government also has announced stronger financial support of R&D in the future.

Solar Energy Activities in ITALY

Dr. Paolo Zampetti

National Agency for New Technologies, Energy and Environment

PROGRAM STRUCTURE

Renewable energy use reduces environmental damage, increases energy system security, and provides the opportunity for local social, occupational and territorial development; therefore, the National energy program strongly encourages the diffusion of renewable energy technologies. The amount of renewable energy, in the energy national balance, was estimated to be about 14 MToe in 2003, compared with a total energy consumption of 190-195 MToe.

In order to increase the renewable amount, some public actions and strategies have been in progress for many years, such as:

1. To develop coherent politics among the different levels of State administration: Ministries, regions, local administrations, and public agencies that are responsible for renewable energy technologies.
2. To charge regions and local organizations with the development of diffusion programs, to assure that the necessary money to give direct incentives in renewable production and utilization and to finance the technical support structures.
3. To diffuse energy-environment knowledge to local administrations and citizens.
4. To assign a very important role to the research activities, to collaborate with industries for mature technologies.
5. To sustain European Union actions, to participate in European programs for long-term research, to construct agreements in the Mediterranean area.
6. To promote the renewable sources market with a good equilibrium between taxes on conventional sources and incentives for renewable energy (simple juridical and technical rules, funding) according to European Community policy.
7. To define large projects in collaboration with Mediterranean countries and to take advantage of the important southern Italy solar source.

The main government agency which is responsible for solar energy for building technologies is ENEA (National Agency for New Technologies, Energy and Environment). ENEA is a public agency working in the field of research and development for a sustainable growth.

FUNDING

While the diffusion and promotion of renewable energy programs are funded mainly at the regional level, the research, development, demonstration and information (RD&D) activities are funded directly by the central government via different ministries: Ministry of Industry, Ministry of University and Scientific Research, and Ministry of Environment.

Research activities are carried out primarily by ENEA, Universities

and CNR (the National Research Council). Other Institutions working on specific topic are involved too. An estimation of government funding for SOLAR ENERGY RD&D activities is reported in Table 1. Funding for 2003 and 2004 may be estimated at the same amount.

RESEARCH, DEVELOPMENT & DEMONSTRATION

Envelope Components

The modern building envelope is characterized by opaque and transparent new materials and components. The aim of the RD&D program is to focus on the components' performance as well as their integration into buildings. Research activities are basically carried on transparent and opaque components, solar materials (as reflectors and absorbers for solar facades), reflective paintings for building roofs and external walls. Optimising the building envelope performance implies and optimisation of the overall thermal performance of the building.

The activities on transparent systems were basically focused on the testing of glazing materials associated with shading systems, aiming at reducing the cooling loads of buildings, especially the commercial glazed ones, and ensuring the visual comfort for users. They were carried out by means of laboratory testing with photometric and gonio-photometric facilities, and by simulation/calculation.

Reducing the cooling loads is also possible by increasing the reflectance of opaque surface of the building envelope, reducing the solar gains through such components. New materials were tested in laboratory through optical characterisation of some interesting new products. Also on-site monitoring were carried out at the material (temperature monitoring) and building (influence of reflective paintings on the cooling loads and temperature profiles) level.

Methodology analyses were carried out on the opaque components of the building envelope in order to define the thermo-physical properties that optimise the thermal and economic performance of Italian residential buildings during the heating season. Also environmental issues were considered. The study was carried out by means of calculation/simulations tools.

Several activities see the participation of other institutions, such as ENEA, Stazione Sperimentale del Vetro (a research and development institute), Galileo Ferraris (a research and development institute), ITC-CNR (a research and development institute), ASSOVETRO (a glass manufacturer association), UNCSAAL (a frame manufacturer association) and manufacturers and importers.

"Intelligent" Building

There is great interest in building automation technology. Building automation influences several aspects of building energy performance and internal comfort (indoor air quality, visual comfort, heating and cooling loads, etc.). Some of these are related to solar technologies too. In particular, the following topics are research activities:

- Daylighting and artificial lighting control systems;
- Dynamic (and static) shading devices;
- Smart windows;
- Solar facades.

Monitoring on daylighting and users' visual comfort were run during the past years. A field test campaign at the experimental building Casa Intelligent in ENEA on cool roof and its effect on the energy performance of residential buildings was carried out in 2005 and extended into the summer of

Table 1
Government Funding For Solar Energy
(Funding for Research, Development, Demonstration and Information Programs) (*)

	YEAR 2003		YEAR 2004	
	1000 € Euro	1000 US$	1000 € Euro	1000 US$
ACTIVE SOLAR	1000-2000	1178-2356	1000-2000	1177-2354
PASSIVE SOLAR	500-1000	589-1178	500-1000	589-1178
PHOTOVOLTAICS	5000	5890	5000	5890
HIGH TEMPERATURE SOLAR THERMAL	4500	5301	4500	5301

(*) Note that only funding for SOLAR ENERGY is reported. Government Funding for RD&D in the other renewable energy technologies is not included.

2006. New activities related to the energy performance of installed heating systems, thermal comforts, temperature distribution are in progress. Demonstration, dissemination and informative projects on the advantage of smart building technologies have been carried out and are in progress at European and at the national level.

Active Solar

Research and development activities on domestic hot water systems are in progress at ENEA's Trisaia Centre. The main activities are characterisation of materials and components, system testing, and system optimisation. Also demonstration, information and dissemination programs are being carried out to promote the demand for new installations.

As for solar assisted cooling, the activities have been carried out at the University of Palermo and at Politecnico of Milano. The work has been performed within the framework of IEA SHC Task 25, Solar Assisted Air Conditioning of Buildings, and focused mainly on the modelling of systems for active cooling.

Building-Integrated PV Technologies

Research activities are performed in the following areas new materials, devices and system components; performance and evaluation of photovoltaic systems. R&D activities are conducted by ENEA, CESI (The Institute for Research and Certification of electric components and systems), and some activities by universities, industries and some institutes of CNR (the National Council of Scientific Research).

R&D activities of ENEA are being carried out in the Casaccia Research Centre on the optimization of innovative solar cell fabrication, and in the Portici Centre on thin films, amorphous-Si based multi-junction devices, new activities on poly-Si. ENEA also is carrying out a program based on concentration, the PhoCUS (Photovoltaic Concentrators to Utility Scale) Project which is investigating this technology and assessing the technical and economic feasibility.

R&D activities of CESI are carried out in the field of space solar cells, in PV roof projects and in the manufacturing of faced and stand alone systems, in the development of GaAs solar cells on silicon substrates for concentrator systems. CESI also is involved in research and demonstration activities for the electrification of remote communities.

Funding for R&D activities in PV technologies have been of about 5,000 Euros in the years 2003 and 2004. Some of these activities are performed under the framework of the IEA Photovoltaic Power Systems Programme.

Concentrating Solar Power Technologies

The CSP (Concentrating Solar Power) technologies can play a fundamental role in the world's future energy supply by exploiting high temperature solar heat to produce a significant amount of electricity – via thermodynamic conversion – and hydrogen – via thermochemical water splitting – using fully renewable and emission-free conversion cycles, at competitive costs.

In Southern Europe areas, for example, in Italy the CSP technologies can easily be integrated among other new renewable technologies (wind and PV) that will be asked to contribute to the increasing European demand for "green electricity."

Starting in 2001, ENEA has been involved in the development of CSP technology as a prime actor in the present phase, but with the aim of promoting the full and prompt participation of national enterprises to the potential global market of CSP technologies.

The ENEA programme in CSP spans from laboratory R&D to industrial prototyping in connection with industrial operators, proposing forefront solutions. The activities, involving about 60 researchers and technicians are focused on two complementary topics:

1. On the short term perspective, the development of a "medium" temperature (about 550°C) CSP technology, primarily finalised to electricity production; and
2. On the long term perspective, the study and development of a high temperature CSP technology finalized to hydrogen production by means of thermochemical water splitting.

As far as electric power generation is concerned, the technology developed by ENEA combines the solutions used in linear parabolic collector systems and solar towers, by introducing a series of

significant innovations to overcome the critical points of both.

The main innovations include:

- the design of a new type of concentrator, based on the use of thinner mirrors mounted on a support structure allowing considerable savings in terms of construction and installation costs;
- the introduction of an adequate thermal storage to overcome the solar input variability;
- the use of a molten salt mixture (KNO_3 – $NaNO_3$), stable up to 600°C, as heat transfer fluid and as storage media; and
- the development of a high performance receiver able to operate at the higher operating temperature of ENEA design.

The world's first linear parabolic collector test facility PCS (Prova Collettori Solari) is shown in Figure 1. It is installed at the Casaccia Research Centre and began operation at the end of 2003. A leading position in Europe has been gained by ENEA in the molten salt technology for solar applications. This facility, that is able to test units operating with such kind of heat transfer fluid and up to 100 m long, gave ENEA researchers the possibility to build-up an almost exclusive know-how regarding all the main components of molten salt systems, such as circulating pumps, pipe preheating systems, sensors and transducers (pressure, level, flow rate), control systems and operating procedures. Moreover, the first prototypes of trough collectors manufactured by Italian industries, according to the ENEA design, were tested in this facility, with very satisfactory results.

Concerning heat collecting element technologies, an industrial pilot plant for the deposition of high performance spectrally selective coatings, based on CERMET (CERamic and METallic materials) technology, was recently completed at the ENEA Portici Research Centre. It will be able to produce full-scale receiving tubes with the patented ENEA coating showing one of the best figures of emittance at 550°C.

Most of the current R&D initiatives carried out by ENEA and private industries are funded by a national research and demonstration program started in 2001 consisting of 48 million Euros in total, 20 million Euros for research and 28 million Euros as a contribution for the realization of a demonstration plant. Other funding was recently approved on this topic by Italian Research Ministry.

OTHER GOVERNMENT SUPPORTED ACTIVITIES

Government supported activities are managed both at the regional and national level. Some examples of incentive programs are given below.

Financial law provides subsidies for the application of renewable technologies and is funded at the regional level. Each region can assign part of the budget to promote solar and renewable energies, installations of solar collectors in private buildings integrated PV systems, etc.
A national incentive is the tax reduction for a building retrofit investment, the purchase of a domestic hot solar system or the replacement of windows.

COMMERCIAL ACTIVITIES

Thermal Solar Market

Italy represents an increasing European market. In 2004 almost 60,000 m^2 of glazed collectors have been installed with a 15% growth respect to 2003. In Italy there are about 30 national producers of solar collectors and many specialized companies that supply complete thermal solar systems and the necessary technical assistance.

A large part of the market (about 50%) is occupied by branches of foreign producers that import thermal systems, mainly from Austria, Australia, Germany, Greece, and Israel. A particular dimension of market is in the districts of Trento and Bolzano where the installed solar collector surface is about 30% of the total national installations. This high percentage is due to a local subsides policy and the proximity to Austria, which has a well established commercial network.

An installed solar plant for hot water production, with a surface of 4 m^2 and a storage reservoir of 250-300 litres, costs about 2,000-2,500 Euros. For environment heater integration costs increase to 6,000-10,000 Euros, depending on the covered solar fraction. National and local incentives may be estimated at 25-30% of the plant cost.

Photovoltaic Market

There are two major PV module manufacturers in Italy—

Enitecnologie (formerly Eurosolare), that has a production capability of 3 MW/year per shift and Helios Technology that has a production capability of 4.5 MW/year. There are many other smaller companies assembling especially designed modules (such as windows integrated cells, etc.) and about one hundred companies installing PV systems in Italy. The most important operators in this field are associated in the Italian PV firms Group GIFI.

In 2003 and 2004, the Ministry of Environment and Land Protection and the Italian Regions appropriated about 20 million Euros/year under the framework of the Regional Roof-Top Program for the realization of grid connected PV systems installed or integrated on public or private buildings.

As far as the market is concerned, the average prices of the modules have slightly decreased in 2004, reaching the values of 3 Euros/W, for reasonable volume orders, and of about 3.8 Euros/W for small orders. A similar trend has been recorded for system prices.

OUTLOOK

Thermal Solar

In Italy, there are many conditions to promote the development of solar domestic hot water production, such as the increasing sector industry and market and the creation of new occupancy opportunities in the installation and maintenance activities and organizations. The most important conditions are a favorable climatic situation, applicability of the technology to residential buildings, and a very diffused use of electric energy for hot water production.

Taking into account also the public buildings sector, an increase of installed systems is expected over the next years. Research will be finalized in energy storage and district-heating techniques.

Photovoltaics

In the year 2003, a law was approved regarding the implementation of the European Directive 2001/77/CE for the promotion of electricity produced by renewable sources. This law forecasts dedicated suprt measures for photovoltaics. For instance, decreasing fixed feed-in tariffs over time for different installations and a purchase obligation by utilities. In the next months, the details will be defined by dedicated government acts. There is a strong expectation in the Italian PV market.

Concentrating Solar Power Technologies

Electric Power Generation

The industrial demonstration of the innovations in a 28MW_e solar plant to be integrated in a traditional combined cycle power plant is foreseen. The project, named "Archimede," will be realized jointly by ENEA and ENEL (Ente Nazionale Energia Elettrica, the major Italian utility) and will be located in Sicily nearby Siracusa.

The above mentioned activities were completely financed by national funds. Nevertheless, after the deployment of a domestic strategy, a stronger connection with the EC research programs on CSP technology is forecasted. Regarding further domestic research programmes, another nation-wide program (ELIOSLAB) is proposed with an excellent probability to be financed. It is focused on the setting-up of a joint private and public effort concerning R&D activities on high temperature solar technologies.

Solar Hydrogen Production

The use of thermochemical cycles for hydrogen production from water has received increasing interest in the last years as a means to reduce carbon oxides emissions. The possibility of coupling it to renewable energy sources is an appealing objective for current research, and represents one of the main objects of the ENEA research programme on concentrating solar energy, which is essentially aimed at demonstrating the scientific feasibility of hydrogen production by means of thermochemical cycles powered by solar energy.

In this area, the ENEA R&D activities currently financed by a national program named TEPSI (TEcnologie e Processi innovativi per il Sistema Idrogeno), are mostly focused on two specific thermochemical cycles, the Sulfur-Iodine and the Mixed Ferrites cycles. The above mentioned project TEPSI has a scheduled duration of three years (2005-2008) and a budget of 4 million Euros.

Other two national projects are going to be approved concerning the realization of a public-private laboratory on high temperature solar technologies both for electricity and for hydrogen production.

OTHER RENEWABLE ENERGY TECHNOLOGIES

Tables 2 and 3 show the energy production by renewable energy

Table 2
Electric Energy Production by Renewable Sources.

Year	2002		2003	
Technology	**GWh**	**kToe (*)**	**GWh**	**kToe (*)**
Hydro < 10 MW	8048	1770	7192	1582
Hydro > 10 MW	31472	6924	29483	6486
Geothermal	4662	1026	5341	1175
Wind energy	1404	309	1458	321
Photovoltaics	18	4	23	5
Firewood	1052	231	1648	363
Biogas	943	207	1033	227
Waste	1428	314	1812	399
Total	**49027**	**10785**	**47990**	**10558**

(*) According to the Italian convention, the conversion from GWh to kToe is made by an equivalence factor equal to 0.220 [kToe (primary source energy) / GWh (electric energy)].

Table 3
Thermal Energy Production by Renewable Sources.

Year	2002	2003
Technology	**kToe**	**kToe**
Thermal solar	14	16
Geothermal	213	213
Firewood (and similar)	2258	2419
Biofuels	94	177
Biogas	63	69
Waste	504	639
Total	**3146**	**3533**

Figure 1. The PCS (Prova Collettori Solari) facility operating in the ENEA Casaccia Research Centre. It consists of two parabolic linear collector 50 m long having an overall collecting area of about 600 m2. The heat transfer fluid flowing through the collector is a mixture of molten salt (40% KNO3 60% NaNO3). The PCS main parameter are: operating temperature 270-550°C, heat transfer fluid flow rate 3.0-7.5 kg/s, molten salt volume 5 m3, peak thermal power 500 kW.

technologies in the years 2002 and 2003. The data are from the ENEA Report of Energy and Environment 2004. In the tables, firewood consumption in the residential sector is not represented (about 3600 kToe according to an ENEA estimation of 2002).

The contribution of photovoltaics and solar thermal are not so large by a quantitative point of view, but they are very important by an industrial and strategic point of view.

Solar Energy Activities in NETHERLANDS

Mr. Lex Bosselaar
SenterNovem

PROGRAM STRUCTURE

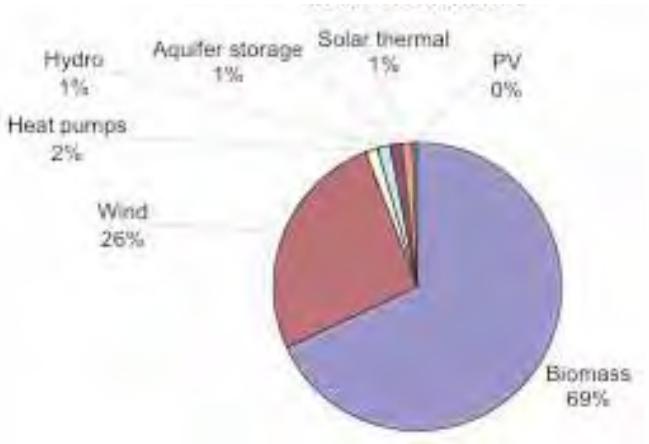
The Netherlands is very dependant on fossil fuels. The aim of the government is to increase the amount of renewable energy produced to 10% in 2020. In 2000, it was only 1.2% and it already has increased to 2.4% by 2005. The current focus is on electricity from renewables where the EU has set a target of 9% for the Netherlands in the renewable electricity directive. The current contribution is 6.2%.

The energy production and distribution, including renewable energy is the responsibility of the Ministry of Economic Affairs. The programs for renewable energy, energy saving and innovation are contracted to SenterNovem, the agency for energy and innovation. SenterNovem is a merger of the organization Senter for innovation and subsidies and Novem for environment and energy. This merger has linked the energy programs more to the innovation programs.

FUNDING

The funding for solar heating has gone down over the last years. The main change was the sudden ending of the subsidy scheme EPR for solar thermal and PV at the end of 2003. The PV-market has gone down from 20 MWp to 3 MWp. The solar thermal market has been more stable, specifically for new buildings. For renewable electricity, a feed-in tariff exists which is 0.10 maximum (for PV and wind at sea). The rate is too low to be effective for PV. The feed-in tariff MEP has been very successful, particularly for the co-firing of biomass. The increase went so fast that funding became a problem, and for some project categories the funding for new projects was suddenly ended. The production of renewable electricity has increased so much that the target of 9% by 2010 seems within reach.

The funding in Table 1 is basically the program that SenterNovem is running for renewables. The trend is that funding is reducing except



Renewable Energy Production (electricity and Heat) in the Netherlands.

Table 1
Funding for Renewables in the Netherlands.

	YEAR 2003		YEAR 2004	
	Euro	**US$**	**Euro**	**US$**
Renewables in buildings	1.1 M	1.3 M	1 M	1.2 M
PASSIVE SOLAR				
PHOTOVOLTAICS				
HIGH TEMPERATURE SOLAR THERMAL			0	
WIND ENERGY	2.3 M	2.7 M	1.6 M	1.9 M
BIOENERGY	2 M	2.4 M	1.8 M	2.1 M
GEOTHERMAL				
OTHER (SPECIFY) Funding for energy research (only renewable part)	5 M	5.9 M	15 M	17.7 M
ALL RENEWABLE ENERGY	10.4 M	12.3 M	19.40 M	22.9 M

Remarks:

- The feed-in rates are not mentioned in this table.
- Tax incentives are not included.

700 million Euros is available for the feed-in of renewable electricity.

The funding is partly shifted towards a new program for long-term energy research (Energy Research Strategy EOS). For this new program 20 million Euros is available.

RD&D PROGRAM

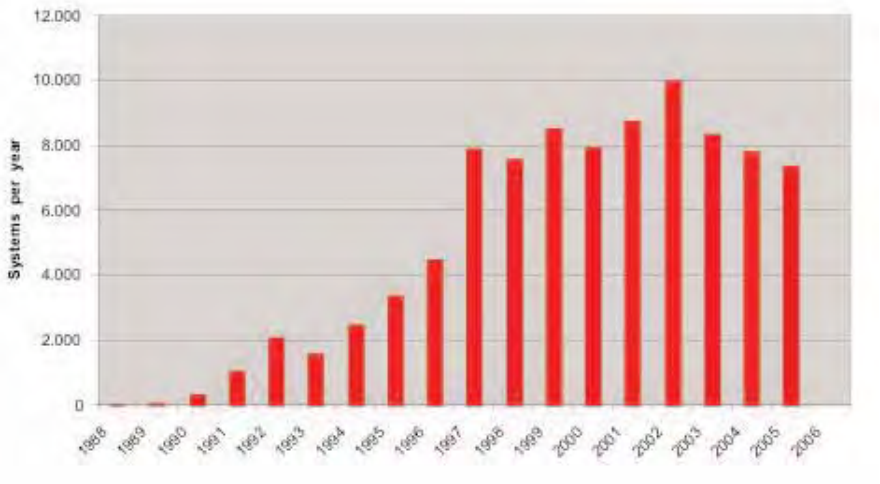
In 2005, a new subsidy for long-term energy research (EOS) began. In a long, thorough process the priorities for this program were set together with the major market actors. The priorities include energy efficiency, energy in buildings, clean fossil fuels and energy networks. In a tender process the best projects were selected. For 2005, 20 million Euros available for demonstration projects in the field of energy technology. More information is available at www.senternovem.nl/eos.

Active solar is not a separate priority, but low energy buildings is a key item. The focus lies on a systems approach for reaching a low fossil energy use. The aim is to develop new buildings that are heat neutral and renovation concepts that will half the energy use in existing buildings. Until now, only a few projects in the building sector have been successful in obtaining funding from this EOS-program for long-term research. In the demonstration part of this program, the building sector has been more successful with demonstrations for passive houses, PVT-systems and new solar water heaters.

The main research institutes for solar heating are TNO and ECN. They have started a co-operation for the building sector under the name, building future. This co-operation is focused on the whole building. The activities in the field of active solar and testing of solar systems has been reduced.

The industry is still quite active with developing new products for active solar, mainly aimed at reducing the price so that the ending of the subsidy can be offset with a lower price. Another development is a collector that can be placed on the ridge of a building. In the building sector, a number of active frontrunners of the project developers have set up a group for renewable energy for sustainable housing. This group has developed a toolkit with several concepts to develop low-energy buildings. Their book has been very well received with nearly 2,000 copies sold and much interest from municipalities. The book, in Dutch only, is available from their website www.toolkitduurzamewoningbouw.nl. The calculations for the book were funded by

The "Toolkit" book for developing low energy building.



Market for solar water heaters.

SenterNovem to ensure the independence of the information. Several cities have programs for CO_2-reduction in which they also focus on the building sector. Mostly, the aim is at a reduction of the energy use of 10 to 20%. Some cities have more ambitious project, for example, the “stad van de zon” (Solar City) in Heerhugowaard.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Most of the supporting activities from the government are left to the cities, of which about 25% have targets for renewable energy use. The general promotion is limited to a website which covers all environmental issues for consumers (www.mileucentraal.nl). In addition, the promotion a tax reduction is possible for businesses investing in energy efficient technologies (including renewables). The effect is a reduction of about 15% of the investment.

In the field of regulation, the most effective measure is the energy performance requirement (EPC) for new buildings. This requires the calculated total energy amount of a new building to be below a certain level. The use of active or passive solar will help in reaching this level. At the beginning of 2006 the maximum allowed energy amount was reduced by 20%. This will lead to a higher use of solar collectors, but also other techniques like high efficiency heat recovery and heat pumps. In 2005, about 10% of the new houses (80,000 homes per year) have a solar collector. For existing buildings there is not yet a requirement. The EU has demanded a certification scheme for existing buildings, but the Netherlands haS decided to delay the introduction because of the high administrative costs involved.

There are no special requirements for solar hot water systems. The only requirement is that they conform to existing building standards for water safety, electrical safety, wind load, etc. For building integration, a preliminary standard for building integration exists (NVN 7250). It can be used both for PV and solar thermal systems. For certification, a local quality label exists which is Zonnekeur, but some manufacturers prefer the Solar Keymark. Currently, only a few systems have a certificate.

For the whole building a solar house certificate does exist (www.zonnewoning.nl) that certifies solar energy is used and that the energy performance is better than that of a standard home.

COMMERCIAL ACTIVITY

The market for solar water heaters has decreased slightly over the last years. The main reason is the disappearance of the subsidy scheme. The market for solar water heaters on new houses is reasonably stable, but the market for existing homes has decreased a lot. Most industries are still active, but they have very little funds left for promotion. Five manufactures produce their own system and several importers are active. Most of them are member of the trade organization Holland Solar (www.hollandsolar.nl). The main market is for small systems in single family houses.

About 15% of the collector area is sold in collec-

tive systems for multi-family buildings. The market for industrial applications is extremely small. The market for collective hot water systems is dominated by one utility (Eneco). Another utility (nuon) is now starting the first large- scale solar collector system coupled to a district heating network with a collector area of 6,900 m^2.

OUTLOOK

The outlook in the Netherlands is that there is little growth expected for active solar systems over the next year. Probably a renewable heat directive from the EU and the increasing fuel prices will lead to a market increase in a few years time. For the building sector as a whole, a new program will be implemented called the transition program for the building sector. In the program, government and industry will plan together a transition path to reach long-term goals for the building sector.

Solar Energy Activities in NORWAY

Fritjof Salvesen
KanEnergi AS

PROGRAM STRUCTURE

The energy situation in Norway is quite special compared to most other countries. Most other countries have to import a substantial part of their energy supply, and energy security is highly focused. In Norway, the annual production of energy is approximately 10 times the domestic use, and more than 99% of electricity production is hydropower. However, Norway is a part of the international energy market, and the energy costs in Norway reflect the international market.

Table 1
Government R&D Funding

2004	TWh
Oil	1 875
Gas	770
Hydropower	110
Bioenergy	14
Heat pumps	4.5
Waste derived heat	1.1
Wind power	0.26
Solar energy	0.01
Geothermal energy	0

Hydro power is the dominant source of renewable energy produced in Norway, accounting for 99.3 % of electricity production.

Annual hydropower production fluctuates heavily from year to year, mainly dependent on reservoir inflow. The average production capability of Norway's hydropower plants is estimated to be about 118 TWh/year. The production span, however, is between 90 and 150 TWh/year.

The total energy consumption in Norway in 2004 was 805 PJ (228 TWh), excluding offshore industry and international shipping. Almost all electricity production, 99%, stems from renewable hydropower. According to the White Paper No. 29 (1998/99), which deals with Norway's energy policy, growth in energy production must to a greater extent be based on new, renewable energy sources. A set of national goals were approved by the Parliament in the spring of 2000:

- An additional of 4 TWh/year of water-borne heat to be produced by 2010. This shall reduce the dominance of electricity for heating. The heat is to be produced from new renewable energy sources, such as heat pumps or waste heat.
- To establish wind farms that will produce at least 3 TWh/year of electricity by 2010.

The Government is preparing the introduction of a mandatory market for green certificates for electricity from renewable energy. Originally, the market was planned operational in 2006, but in order to synchronize preparations with the Swedish govern-

ment and develop a common market, the plans are postponed a year to 2007. A proposition for a law to regulate the market will be presented in spring 2006. The Swedish certificate market was established in 2003. This implies that there is a strong interest in developing the Norwegian regime in parallel with the Swedish, where i.e. all renewable sources, including hydro power, are legitimate. The regulations will also be set with an eye to the development of a future European market.

The most important public or Government owned institutions being responsible for the administration of policy instruments within renewable energy and energy efficiency are:

Norwegian Research Council plays a vital role in developing and implementing the country's national research strategy, acting as a government adviser, a funding agency and coordinator of research activities. The Research Council is responsible for the administration of most of the public funding available for R&D in the field of energy and water resource management. www.forskningsradet.no

Enova SF became operational on January 1, 2002. Enova SF is a public enterprise owned by the Royal Norwegian Ministry of Petroleum and Energy. The main mission is to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals. Stimulating construction of natural gas infrastructure, primarily as a measure to displace use of oil, is also among Enova's tasks. The establishment of Enova SF signals a shift in Norway`s organization and implementation of its energy efficiency and renewable energy policy. By gathering strategic policy responsibilities in a small, flexible and market oriented organization, Norway has wanted to create a pro-active agency that has the capacity to stimulate energy efficiency by motivating cost-effective and environmentally sound investment decisions. Enova SF enjoys considerable freedom regarding the choice and composition of its strategic foci and policy measures. Enova SF advises the Ministry in questions relating to energy efficiency and new renewable energy. www.enova.no

The Norwegian Water Resources and Energy Directorate (NVE) is a directorate under the Ministry of Petroleum and Energy, with responsibility for managing the country's water and non-fossil energy resources and for monitoring the energy market. NVE's mandate is to ensure integrated and environmentally sound management of the country's watercourses, to promote efficient energy markets and cost-effective energy systems and to work to achieve a more efficient use of energy. NVE also has the overall responsibility for maintaining national power supplies. NVE is involved in R&D and international development co-operation. www.nve.no

The Norwegian State Housing Bank (The Housing Bank) is the main instrument of the Norwegian Parliament, the Norwegian government and the Ministry of Local Government and Regional Development for the implementation of national housing policy. Additional loans at a modest interest rate may be granted for installations and efforts to reduce use of energy or use of flexible heating systems. www.husbanken.no

Table 1
Energy Production in Norway (2004)

(All numbers in 1,000)	YEAR 2003		YEAR 2004 NOK	
	NOK	US$	NOK	US$
ACTIVE SOLAR	400	59	230	34
PASSIVE SOLAR	450	66	1,045	156
PHOTOVOLTAICS	10,090	1,484	8,050	1,201
HIGH TEMPERATURE SOLAR THERMAL	0	0	0	0
WIND ENERGY	100,000	14,706	393,500	58,731
BIOENERGY enova varmeenergi 108 mill.kr	60,000	8,824	79,380	11,848
GEOTHERMAL	1 000	147	0	0
OTHER (Ocean+hydrogen+heat pumps+others)	125,000	18,382	68,000	10,149
ALL RENEWABLE ENERGY	**296,940**	**43,668**	**550,205**	**82,120**

Innovation Norway. As of January 2004, the new state owned company Innovation Norway has replaced the following four organisations: The Norwegian Tourist Board, the Norwegian Trade Council, The Norwegian Industrial and Regional Development Fund, SND and the Government Consultative Office for Inventors, SVO. The new organisation has no specific mandate in terms of promoting renewable energy and energy efficiency. However Innovation Norway promotes nationwide industrial development profitable to both the business economy and Norway's national economy, and helps release the potential of different districts and regions by contributing towards innovation, internationalisation and promotion. Innovation Norway has offices in all the Norwegian counties and in more than 30 countries world wide. The core group of clients are Norwegian companies, predominantly SMEs. www.invanor.no

FUNDING

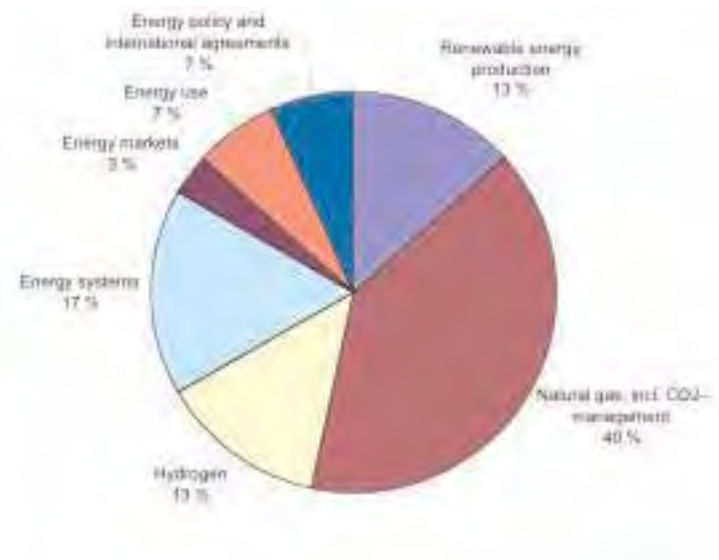
Table 1 represents the fundings from governmental organisations (The Research Council and Enova and Innovation Norway):

RESEARCH, DEVELOPMENT AND DEMONSTRATION (R,D&D)

The objective of research and development in the field of energy is to strengthen economic growth, promote sound use of energy resources and ensure that environmental considerations are taken fully into account. About half of the overall research funding in the energy sector is provided by the public sector. For 2005, the Ministry of Petroleum and Energy has allocated NOK 160 million for energy research and development programs.

Most of the R&D funds are allocated to user-driven research programs. The Research Council also provides support for longer-term basic research and the development of expertise at research institutes and universities, which provides a basis for other, commercially promising projects in co-operation with industry and others.

2004 project portfolio of R&D program Renergi.



It is possible to apply for public funding to more market oriented activities from other government bodies, like Innovation Norway and Enova.

The current relevant research programs are:

- *The Clean Energy System of the Future (RENERGI)*. RENERGI represents a confluence of three existing programs: Energy for the future, SAMSTEMT and the Innovation Program Energy, Environment, Building and Construction (EMBa). The plans for these programs and the project portfolios contain important priorities that will be of relevance to the new program. The program is to facilitate research in both the long-term (30 years) and the short-term perspective (5 to 10 years). The program started in 2004 and will endure for 10 years. RENERGI will be limited to energy production and transmission, and to stationary and mobile energy use.

The following fields will form the basis for ranking priorities within RENERGI:

—Renewable energy production
—Natural gas and gas-fired power plants with CO_2 management
—Hydrogen
—Energy systems
—Energy markets
—Energy use
—Energy policy and international agreements

Many issues for research will cover several of the areas mentioned above, or must be considered vertical in the energy value chain from primary production to end user, with the focus on the role of the authorities and private players. As an example; new renewable energy production may require public participation of dif-

ferent types. Phasing new production capacity into existing energy systems will call for investments in network infrastructure, new marketing and sales schemes must be adapted, and the operation of the other system will have to be adapted to the new situation. RENERGI will attach importance to accommodating projects that address such interdisciplinary issues between the areas.

The program's project portfolio in 2004, featuring contributions from several programs and including earmarked funding for high-priority fields, breaks down roughly as follows among RENERGI's target areas (Figure 1).

The 2005 budget contains an allocation of NOK 160 million for RENERGI. In addition, the Ministry of Transport and Communications has granted NOK 22.6 million to promote the development of environmental technologies, hydrogen and alternative fuels in the transport sector.

- *Strategic programs at research institutions.* The Research Council supports a number of strategic research programs at universities and research institutions. Programs should focus on topics of fundamental importance related to the production and use of energy.
- *Applied research on energy and water resource management* is administered by NVE. These activities are a supplement to, and are coordinated with, the activities of the Research Council. Some important programs in 2002 were applied R&D on energy, environmental flows, and micro, mini and small power plants.

A new White Paper on R&D entitled 'Commitment to Research' (Report to the Storting No. 20, 2004–2005) was presented in March 2005. The Norwegian Government plans to raise total investment in research to three per cent of GDP by 2010, one per cent of which will come from public funding. It is proposed that the Norwegian Fund for Research and Innovation be increased to NOK 50 billion. The Norwegian White Paper on Research highlights three general areas of priority: internationalization, basic research and innovation.

In the energy sector, the IEA is seen as an very important body for international collaboration. As the IEA programs formally are Government collaborations, the best national laboratories and institutes very often are represented in the IEA-projects. The IEA activities are considered to be a very good mechanism to get the latest results and trends, and the industry pays increasingly more interest to this work. The Norwegian participation of IEA tasks are all co-financed from the industry, normally by setting up a cluster of companies working together with the R&D institutions.

The major solar energy research organisations are:

- SINTEF (The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology), Trondheim
- The Norwegian University of Science and Technology (NTNU), Trondheim
- Institute of energy technology (IFE), Kjeller
- Department of Physics at the University of Oslo
- Agder University College, Grimstad

In addition, a few architects and consulting engineers are involved in some of the experimental building projects.

For solar energy R&D projects over the last 4-5 years, the PV-sector stands for more that 80% of the funds. The activity is focused on the material chain from silicon feedstock to the PV-system.

A brief description of a few solar R&D projects is presented below.

The Norwegian State Housing Bank is working together with SINTEF and several Norwegian housing related companies and organisations to develop low energy houses ready for the commercial market. This work is done as a part of IEA SHC Task 28, Sustainable Solar Housing, where the Bank also fincanced the

SHC Task 27 experience used in the design of the new Opera House in Oslo.

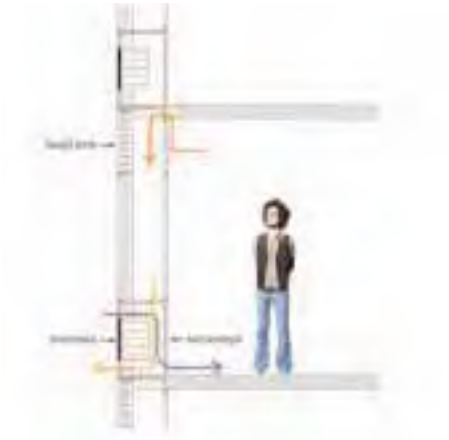
report “Business Opportunities in Sustainable Housing - A Marketing Guide Based on Experiences from 10 Countries”.

Norway also participates in the IEA SHC Task 27, Performance of Solar Façade Components. This work is organised through a trade association of companies within the shading sector. The Norwegian participation is based on three national projects dealing with solar shading and double facades. As one outcome of this project, a Norwegian guideline has been published on how to design glazed facades in buildings which are optimazed with regard to daylighting and energy performance is published. The experience from SHC Task 27 have also been used in the design process of the new Opera House in Oslo.

NEGST (Next Generation of Solar Thermal Systems) is an EU project with the aim is to introduce to the market more cost-effective solar thermal systems, for domestic hot water preparation and / or space heating. University of Oslo participates together with ESTIF and several European research organisations. The project activities will be closely linked to the work of the SHC Task 32 (Advanced storage concepts for solar thermal systems in low energy buildings) and with regard to standardization work to CEN TC 312 (Thermal solar systems and components).

INTFAS (Intelligent energy efficient facades) is a project at SINTEF and the University of Science and Technology ion with industgry and international research organisations. The activities include the building envelope, double facades at high latitudes, system analysis of smart facades and advanced interactive facades.

REBUS (Competitive Solar Heating Systems for Residential Buildings) is carried out as a cooperation between research institutes and industrial companies in the Nordic and Baltic countries, among them the Department of Physics, University of Oslo and Solarnor AS. The aim of the project is to develop solar heating systems, which are attractive to buyers. Up to 50% of the energy consumption in the building should be covered by solar energy, the remaining energy demand will be supplied by conventional energy resources. Solar heating for new buildings as well as for retrofits are be addressed. The project includes education, research, development and demonstration. By the end of the project the industry partners will be able to bring the developed systems onto the market.



Work under the INTFAS project.

PASKLIM (Passive Climatization) is a Norwegian financed project which inludes basic research and several doctoral students. The projects aims to develop buildings with a 30-50% reduction in the energy demand and significantly lower operation and maintanace costs compared to a standard Norwegian building. The buildings should have a healthy indoor air qualtiy and the total investment costs should be equal or lower than a traditional building.

Participants in REBUS.

The project SOLTEK (New technology for solar thermal utilization) aims to investigate the application of polymeric materials in

The Energy Park at Agder University College in Grimstad.

solar thermal systems or similar environments and to enhance the efficiency of solar collectors. Polymeric materials reveal a large potential for cost reduction of solar heating systems, innovative designs and might be the key for the break-through with regard to solar thermal heating. The projects is supportet by the Norwegian RENERGI-program, and partners are Solarnor, University of Oslo and General Electric Plastics and Kaysersberg Plastics. SOLTEK includes further the collaboration with the research partners at the Polymer Competence Center Leoben (PCCL) and the University of Leoben (UL) in Austria. The work within the project SOLTEK has influenced and contributed to the start-up of a new so-called Task under the International Energy Agency's Solar heating and Cooling Program "Polymeric materials for solar thermal applications", which is presently in the start-up definition phase.

On the campus of Agder University College in Grimstad, the “Energy Park” was opened in 2000. The park is established in close collaboration with local industry. The centre encompasses a broad spectrum of different renewable energy technologies; solar cells, biomass cells, electrolyser for production of hydrogen, fuel cells, heat pumps, solar thermal systems as well as ground wells. The centre has the necessary instruments and computers for measuring, evaluation and optimisation of all systems.

The main activities of the centre are to provide information to the public, teaching and research. It will be a laboratory for teachers and students where they can study renewable energy systems and how these systems work together. Different external partners can use the centre frequently for demonstrations and short courses.

OTHER GOVERNMENT SUPPORT ACTIVITIES

Financial support and subsidies
Enova is the responsible body for achieving the national energy targets by 2010. The activities of Enova are financed by the Energy Fund, which receives the revenues from a levy on the electricity distribution tariff (NOK 0.01 per kWh). In 2005, the Fund will receive a total of about NOK 660 million which is an increase of 17% from 2004. Enova uses this Fund to promote energy savings, to reduce the use of electricity for heating purposes and to promote new environmentally friendly forms of energy production. Enova also provides information and educational measures to the public.

Several programs have been introduced to support production on renewable energy. In all programs, financial support is given on an individual basis. In general, projects are ranked based on maximizing estimated production (output) per NOK granted. Another general criterion is that financial support should be deemed necessary for realization of the project. In 2005 Enova supports the following types of projects which could be relevant for solar heating and cooling projects:

- Introduction of new energy technologies. Support is granted to new energy technology full-scale projects. The program aims at promoting technologies that have only been tested in laboratories or small-scale pilots or does not exist in today’s market, or technologies for which adaptations are necessary to function under Norwegian conditions. The program targets all relevant energy technologies, like production of renewable energy or technologies for efficiency improvements leading to reduction of energy consumption
- Pilot program - innovative energy technologies. In order to support new and innovative energy technologies, Enova SF and the Research Council of Norway have jointly established a program for technology introduction. Applications will be evaluated by both organizations The program is aimed at two technology areas: Production of heat from sun and biomass, and energy efficiency (except transport sector). Public support can amount to maximum 30 % of documented project cost. Projects with a high degree of innovation (although not R&D), good potential for business development and that are market based will be prioritized. In 2005, the program has NOK 10 million at its disposal. Continuation of the program If

the pilot program is successful.

- Energy consumption – existing buildings. The program objective is to reduce energy consumption in private homes as well as private and public commercial buildings. In cases where electricity is used for heating, a switch to other, more environmentally friendly sources of energy will be registered in addition to the reduction target.
- Energy consumption – new buildings. Flexible energy solutions and energy saving measures that are implemented during the building phase are both cheaper and more efficient than modifications of existing buildings. It is important that building owners, developers, architects, consultants and entrepreneurs choose the most energy efficient solutions in the planning phase. Enova SF can cover parts of additional costs for pre-engineering and planning of these solutions.

In addition to the programs, Enova SF prepares and disseminates information material concerning renewable energy.

Taxes

Electricity consumption is subject to a tax. Private consumers, all businesses except industry and administration buildings in the industry pay NOK 0.0988 per kWh in 2005. All consumers and businesses (including some parts of the industry) in the county of Finnmark and the northern parts of the county of Troms are exempted from this tax. The industry pays 0.045 NOK/kWh, which corresponds to the minimum rates specified in the energy tax directive of the EU. In effect since 1 January 2004, the grid companies took over responsibility for collecting the tax. It had previously been collected by the electricity suppliers through their invoices.

Total tax on end use of fuel oils includes:

- heating oil tax of 0,0414 NOK/liter heating oil, or approximately 0.0545 NOK/kWh
- CO_2 tax of 0,052 NOK/liter mineral oil
- sulfur tax (17 NOK/kg SO2)

To prevent a switch from electricity to oil as a source for heating, the heating oil tax should be analogous to the electricity tax per kWh.

The Norwegian State Housing Bank administers various loan and grant schemes for residential energy efficiency measures. The bank offers an extra mortgage loan, and grant to house-builders who intend to invest in alternative forms of energy solution such as water-based central heating and heat pumps which may be combined with solar heating systems and use of bio fuel. The level of support will be based on the actual case. Development and pilot projects with high environmental ambitions, may receive grants and loans up to 80 – 90 % of the costs. The bank has stated a goal that half of all new houses built in 2010 shall have a reduced energy demand of 50% compared to the present standard.

Legal Framework

The provisions of the Energy Act, the Planning and Building Act, labeling requirements and standards for electrical equipment represent some of the legal framework having an influence on energy consumption, and on how energy is used.

The National Office of Building Technology and Administration is responsible for administering the building regulations. The technical regulations pursuant to the Planning and Building Act contain rules governing energy use in buildings. New requirements relating to energy use and a new method of calculating energy use in new buildings are being reviewed.

There are no codes for certification of solar energy components in Norway.

COMMERCIAL ACTIVITY

Up to now, the commercial market on solar heating has been very limited. A rough estimate indicates that approximately 8,000 m^2 of solar collectors for DHW and space heating have been installed. These collectors are estimated to produce approximately 2 GWh heat.

The present solar heating market represents an annual sale of 1,000 - 1,500 m^2 of solar collectors. The market is expected to increase in the coming years as Solarnor will become more active on the domestic market. The last two years we have also seen a few more commercial actors in the Norwegian market importing both evacuated tubular collectors from

Prefabricated home using Solarnor solar heating system.

China as well as flat plate collectors from European countries. SOLARNOR AS was established in 1995 and is manufacturing solar collectors as well as total solar heating systems for DHW and space heating. Until very recently, Solarnor was the only Norwegian manufacturer of solar heating systems, but still they are by far the largest one. Their high temparture polymer solar collector has been developed in collaboration with General Electric Plastics. Building on more than 20 years of research and development, the company supplies integrated solar heating systems in terms of roof or façade covers which may substitute conventional building materials. The company also offers controllers for solar heating systems. www.solarnor.no. Together with Typehus AS, a company making prefabricated houses, Solarnor has presented a solar heating system including verital solar collectors.

UN Habitat Award 2005 to Swedish project with Norwegian solar technology. The Gårdsten Housing Estate close to Gothenborg was given the prize for the innovative, environmentally and socially sustainable approaches in the renovation of the housing estate. The project includes several solar energy technologies and one of these is the Norwegian solar air collector "The Friendly Wall". This system, a facade integrated solar air collector, has been developed by SunLab in collaboration with ABB Miljø AS (now YIT Building System). ABB togehter with Pilkington Norge have manufactured the installation at Gårdsten.

The Norwegian Solar House is a follow up from the Norwegian House at the Malmo Building Exhition in 2001. The concept is a single family house using low emission and renewable building materials as well as renewable

The Norwegian Solar House.

energy. The house is based on massive wood structures. The house is heated with vertical solar collectors for DHW and space heating in combination with pellets boiler. It is estimated an energy demand which is appr. 40% of a house according to standard building codes. The house is designed by Bjørn Larsen architect.

Solar dryers, it is estimated that 400.000 m^2 of solar hay and grain dryers have been installed in Norwegian farms. The concept has a very simple unglazed collector which preheats the outdoor air 2 - 6°C before entering the dryer. The main argument is

The Gårdsten Hosing Estate.

Schematic of a typical solar hay and grain dryer.

higher quality rather than saving energy, the alternative usually being cold air drying. It is estimated an annual installation of 250 solar dryers representing appr. 25,000 m^2.

OUTLOOK

In a Norwegian Public Study from 1998 (NOU 1998:11), the growth potentials for renewable energy with an energy price to the consumer below 70 Nok/kWh (EUR 0.09/kWh) (before value added tax) was estimated:

The potential for solar heating in Norway is estimated to 5 - 25 TWh by the year 2030. The big interval between the low and the high estimate is due to by uncertainties on the future cost of conventional energy sources, technical development and competitive alternatives (energy conservation, heat pumps, wind energy, etc.). A market based on

Table 2
1998 estimates for future energy production in Norway.

	2001 (TWh)	2020 (TWh)
Hydropower	122	126
Wind power	0.03	6
Bioenergy/Energy from waste	15	22
Heat pumps	4.5	10
Solar energy	0.01	8
Geothermal energy	0	0.1
Wave/Tidal	0	0.5

just a small portion of these figures represents after all a substantial industry potential also for the home market.

Solar Energy Activities in PORTUGAL

Mr. Joao A. Farinha Mendes
INETI
PROGRAM STRUCTURE

After our adhesion to the EU in 1986 and connection with the Community Support Framework Programs, the Portuguese Government created the corresponding National Program to help the economy where the energy related issues were always considered in particular subprograms. R,D&D and promotion of renewable energy was always included in these subprograms, but during the last decade the main objective has been the conservation of energy in industry and the introduction of natural gas through the creation of the national grid that is still expanding.

With the Third Community Support Framework Program, the national Program - POE, Operational Economy Program (2000-2006) – included a Sub-Program called MAPE related with energy sector – to give support to the need to achieve the goals established in the international documents signed by Portugal, like the EU White Paper and Kyoto Protocol. Because of these international agreements, Portugal is committed to achieve 39% of electricity production coming from RE by the year 2010 and to achieve by the year 2012, no more than 27% increase in CO_2 production, comparing to the level of 1992.

In its initial design, the POE/MAPE Program was mainly devoted to sponsor the electricity production by RE, but in 2001 it was redesigned and the economy team prepared a series of documents which constitute the first Energy Policy Plan for Portugal where RE in general and Solar in particular were appropriately considered in connection with other energy vectors, more conventional like the natural gas, considered equally important for Portugal.

In the document approved by the Portuguese Government (Ministers Council Resolution No. 154/2001 dated of 19th October), called E4 Program – Energy Efficiency and Endogenous Energies, is expressed that the main objectives of Portugal Energy Policy are the security of energy provision, the reduction of the external energy bill and to assure the competitiveness of Portuguese economy in the global market, while keeping constrained the environmental impact of energy production, according to the international agreements signed by Portugal.

To achieve these objectives, several Programs and Measures were then proposed like, between others in the supply side, the Energy Provision Security, Market Regulation and Liberation, the Promotion of Decentralized Energy Production and of Alternative Fuel Usage, as well as on the demand side the sub-programs Solar Hot Water for Portugal (AQSpP) and Energy Efficiency in Buildings (E3). They all include innovative measures, reaching all types of users of the domestic, industrial, private and public sectors [1,2].

Table 1

Sources	Year 2001(MW)	Year 2010(MW)
Wind	101	3,750
Mini Hydro	215	400
Biomass	10	150
Biogas	1	50
Solid Waste	66	130
Ocean	0	50
PV	1	150
Hydro	4,209	5,000
Total	**4,603**	**9,680**

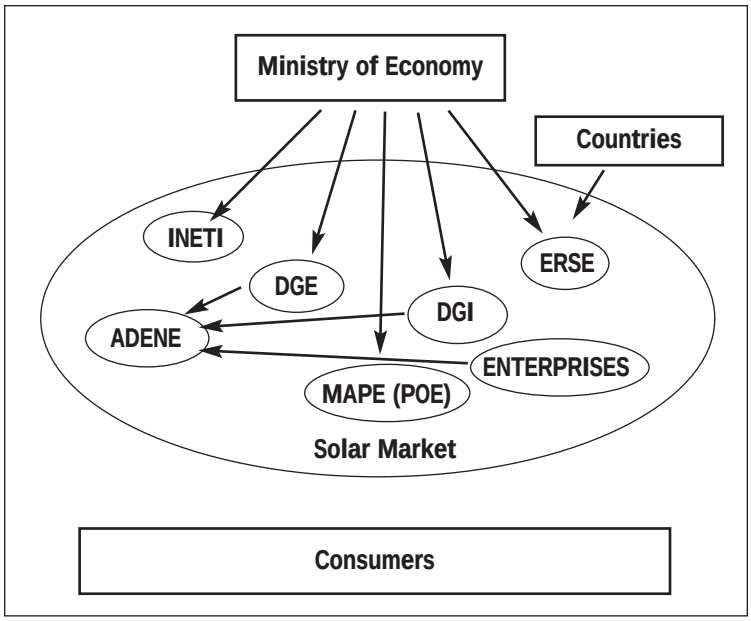


Figure 1. Renewable energy agencies in Portugal.

In 2002 the POE/MAPE program was renamed as PRIME/MAPE and in 2003 the Portuguese Government approved a new Resolution on Energy Policy (RCM 63/2003, dated of April 28) that follows the same path of E4: it maintains the subprograms on solar thermal and on building efficiency and the goal to attain more than 5000 MW of additional power coming from RE by the year 2010 (see Table 1).

The substantial increase in oil prices during 2004 and 2005 is speeding national actions to account for the additional problems of Portugal on this subject and it continued external dependency of more than 85% of our final energy consumption. Energy imports are increasing dramatically.

In consequence, a new goal was established in 2005 (RCM 169/2005) for wind contribution to be 5,100 MW in the year 2010.

Also, PV sector has been given permission to construct the biggest PV power station in the world with 62 MW.

In the solar thermal sector and in addition to the AQSpP sub-program, the most emblematic measure is associated to the new Code on Building Thermal Characteristics, which requires hot water with solar when technically possible and for a minimum solar fraction in all new and renovated buildings.

The Ministry of Economy is responsible for all energy related issues, acting on the market through the following entities:

- DGGE – General Directorate of Geology and Energy (licensing) [3]
- DGI – General Directorate of Industry (licensing)
- ERSE – Regulatory Entity of the Electric Service (energy prices)
- REN – National Electric Grid (electricity distribution), is a public enterprise
- INETI – National Institute of Engineering, Technology and Innovation, IP (research and testing) [4]
- PRIME/MAPE – Energy Vector of the Economy Program: sponsoring program for systems using solar or other renewable sources, energy conservation measures, change to more efficient and clean energy technologies, etc...

Solar energy for buildings is mainly concerned with:

- DER/INETI (Renewable Energy Department of INETI) - activity in the field of research of active and passive solar and solar collectors testing
- DGGE project evaluation of solar thermal systems submitted to MAPE for sponsoring.
- ADENE, Energy Agency, sponsored to promote solar, other renewable and energy conservation [5].

Figure 1 shows the connections and dependencies of the most important agencies acting in Portugal in the RE energy field.

FUNDING

Although there are small teams in some universities working in RE,

Table 2
Government Funding For Renewable Energy
(Funding for research, development, demonstration and information programs)

	FY 2003		FY 2004	
	Euro	US$	Euro	US$
ACTIVE SOLAR	532,500	639,000	564,000	655,200
PASSIVE SOLAR	230,000	276,000	821,000(*)	985,200
PHOTOVOLTAICS	122,000	146,400	146,000	175,200
HIGH TEMPERATURE SOLAR THERMAL	0	0	0	0
WIND ENERGY	161,000	193,200	148,000	177,600
BIOENERGY	650,000	780,000	645,000	774,000
GEOTHERMAL	0	0	0	0
OTHER (OCEAN)	107,000	128,400	100,000	120,000
ALL RENEWABLE ENERGY	1,802,500	2,163,000	2,424,000	2,908,800

(*) Part of the value, corresponds to national funds for the construction of a demonstration self- sufficient building of DER (566,000, which is 50% of total cost of the building)

they do not receive direct funds from the Government for that purpose. In general, they are paid by national or international contracts to perform the work. In the case of INETI, and although there is also an enormous pressure to cover more and more its R&D work by direct contracts or international projects, there are also important funds coming directly from the Ministry of Economy. So the area of R&D in energy is practically centered at INETI and the renewable energy area in its Renewable Energy Department (DER). The budget of DER in the last years is shown in Table 2.

The values in this table correspond to the funds that came directly from the Government and do not include the funds of national or international projects in the field of RE. The total budget of DER in 2003/2004, respectively, was 2,535,000 and 3,735,000 Euros.

The values in Table 2 reflect the very low investment of Portugal and that they are stationary. The funds for R&D in general in Portugal are far from the desirable values and last years, in particular, have been very bad because of a tentative reduction in the national deficit. Anyway, the particular interest to continue investing on R&D has been assumed this year by the new Government and so the prospects for the near future are very good, not only for solar but also for the other renewable energy sources.

Accompanying the business in wind farms, there are also prospects for one or two demonstration units to produce solar thermo-electricity as well as of a big PV unit (62 MW). A parallel investment in R&D in these areas is expected.

RD&D PROGRAM

RD&D in Solar Energy Applications in Portugal is mainly concerned with activity of INETI in this area. In fact, the Renewable Energy Department (DER) of INETI is the institution in Portugal where a regular activity in RE is being performed for the past twenty five years, which is being sponsored directly by the Government (Ministry of Economy), by the EU through the participation of its scientists in European projects, and by national contracts with industry and municipalities. The main activity areas of DER/INETI are:

Solar Thermal

Non-imaging optics and new materials in solar collector development (low, medium and high temperature), software for meteorological data and system performance, agriculture applications (greenhouses, long term storage with solar ponds), desalination, solar cooling, solar system design, monitoring and evaluation, normative work on solar collectors and greenhouses, installers and designers formation.

LECS

Solar Collector Testing Laboratory is an accredited laboratory performing tests on factory made systems and solar collectors according to the CEN standards.

Building

Building simulation, normative work, contribution to the development of the new Portuguese Code on Building Thermal Characteristics, passive systems design, building monitoring, day lighting.

PV

System applications – water pumping, illumination, hybrid systems, stand alone applications.

Biomass

Bio-fuels production and characterization, biogas (design, monitoring and evaluation of installations), solar detoxification, algae for pigments and hydrogen production.

Wind

Production of the Portuguese Wind Atlas, site potential evaluation, modeling of integration on the national electric grid.

Ocean

Production of the Portuguese Wave Atlas, site potential evaluation, demonstration activity with Oscillating Water Column principle and reversible axial turbine. Most of the work performed (research and pre-normative work) in solar and building areas is being directly used to the implementation of the Collector and System Certification Scheme, of the Installers Certification Scheme and of the new Code on Building Thermal Characteristics and Code on Air conditioning Systems. The first two are promoting the quality on the solar thermal market and the last two are on the base of the upcoming Building Certification Scheme according to the European Directive on Buildings.

There are also some teams, namely connected to the University performing research in the RE area in specialized subjects. This is the case of:

- FCT/UNL (Science and Technology Faculty of New University of Lisbon) and FC/UCL (Science Faculty of Lisbon Classic University): solar cells production;
- DEMEGI/FEUP (Engineering Faculty of Porto University): solar passive technologies;
- UM (Minho University): new materials development for solar collectors.

As a consequence of the involvement of INETI on the energy matters, changes on the RD&D field in Portugal are strongly connected with changes in the internal research policy of INETI. The renewable energy area was identified as one of the main vectors for INETI work in the near future, and this will certainly be in favor of the Solar Energy work at DER.

The research institutions that play a major role in the program and their areas of responsibility.

- DER/INETI – The Renewable Energies Department of INETI covers the Biomass, Wind, Ocean and Solar areas. The Unit UESTE (Energy Efficient Buildings and Solar Energy Unit) covers the Buildings, Solar Thermal and PV applications.
- DEMEGI/FEUP – From University of Porto, is mainly concerned with passive technologies and Energy Efficiency in Buildings.
- FCT/UNL and FC/UCL - Performs research in solar cells.
- UM – Performs research in materials for solar applications.

Industry participates in a few RD&D projects. The exception is the Portuguese company producing CPC type solar collectors – AOSOL Ltd – which is collaborating with INETI in many European projects where non-imaging optics has an important role for solar thermal applications, solar detoxification and solar cooling applications. This company was owned by the major Portuguese oil company – GALP. As of October 2005 AOSOL was in the process of being sold to a group of private investors, but plans to keep its technician expertise in the non-imaging optics field and to enlarge its capacity in the development of new products able to perform efficiently above 100-120 ºC for industrial and cooling applications.

Due to the last developments, mainly oil price increases, new factories are trying to move to solar in their renovation and reorganization process and some of them are coming to INETI to have R&D support. In this field it is also expected to be a good evolution for industry involvement in R&D because there are also funds to promote such cooperation.

LECS, the solar collectors testing facility of INETI, is normally asked by the solar companies, to perform tests in their collectors, which are mainly directed to water heating applications.

At the regional level, the RD&D activities are connected with the work of small teams in the regional universities, where activities are primarily devoted to educational and information purposes.

In the case of Madeira Island, there is also another entity, LREC, the Civil Engineering Regional

Laboratory, that has a small team that has been working for more than one decade in the promotion of passive technologies, solar drying and desalination, wind and PV installations, and monitoring demonstration systems.

OTHER GOVERNMENT SUPPORT ACTIVITIES

These activities are mainly committed to the DGE (General Directorate of Energy) as a state institution and to ADENE (Energy Agency) as a subcontracted institution. During the past years, a series of regional agencies were also created in the framework of the European ALTENER Program, which are acting at a local level on the dissemination of RE in general and solar in particular.

The dissemination and information work of these regional energy agencies, regularly spaced along the country should be stressed. Some of them are participating in European projects, realizing seminars and producing studies to the municipalities, to which they are in general financially connected. The case of Municipal Agencies of Vila Nova de Gaia (ENERGAIA), Aveiro (AREAVE), Sintra(AMEN), Almada (AGENEAL), Lisbon (LISBOA-E-NOVA), Algarve(AREAL), Beja(ARECBA), Madeira(AREAM) and Azores(ARENA), should be stressed.

On a voluntary level there exists also the SPES (Sociedade Portuguesa de Energia Solar), the Portuguese section of ISES. SPES is a non profit organization that publishes a magazine, participates in national and international dissemination projects, and promotes, in collaboration with the correspondent Spanish section, a biannual Ibero-American Solar Energy Congress. In the year 2002 it was held in Vilamoura (Algarve), in 2004 in Vigo (Galiza), Spain and in 2006 in Lisbon, Portugal.

Subsides and incentives that were available in the past two years were connected with the PRIME/MAPE program. The main points to consider here are:

National Funding Programs

- The solar thermal systems can have a subsidy of 20% (with a limit value of 300 k) and more 20% to be returned but without taxes, if they are going to be implemented by private entities. The public entities can have a subsidy of 40% with the same limiting value (300 K).
- Companies investing in solar equipment can amortize the related investment over a period of four years as part of their corporate annual income tax. This is a very important measure because it leads to the amortization of solar systems in almost four years, even without taking into account the subsidy.
- The specific equipment for solar systems (mainly solar collectors) has a VAT of 12%.
- On the domestic side, the legislative measures, allow one third of the solar thermal system cost to be deducted from annual taxation of families (with a maximum of 728).

Regional Funding Programs

Madeira Regional Government has had legislation since 2002 to give an incentive to solar thermal systems (domestic and services), which is connected with energy production of the system along its lifetime.

Standards and Certification

In July 1993, the Accredited Solar Collector Testing Laboratory (LECS) was created at INETI to support the industry on their efforts to improve their equipment and along the last 15 years INETI participated in all standardization work that was taken over in Portugal and in the CEN and ISO Organizations.

The CEN standards EN 12976_1, EN 12976_2, EN 12975_1, and EN 12975_2 are at the moment the Portuguese standards, and since 2003 are in the base of the Portuguese Certification Scheme for Solar Collectors and for factory made systems. The Portuguese certification scheme is similar to the Solar Keymark Scheme developed also with participation of LECS. There is also an ongoing Certification Scheme for installers mainly based, for the moment, on technical courses given at INETI.

The definition of these schemes of certification is a result of the agreement between the main partners of public and private entities acting in the Portuguese solar market that were encouraged to perform such work to give support to the AQSpP (Solar Hot Water for Portugal Sub-Program). In fact, only certified collectors as well as certified installers can apply to the incentives and subsidies of the already mentioned PRIME/MAPE Program.

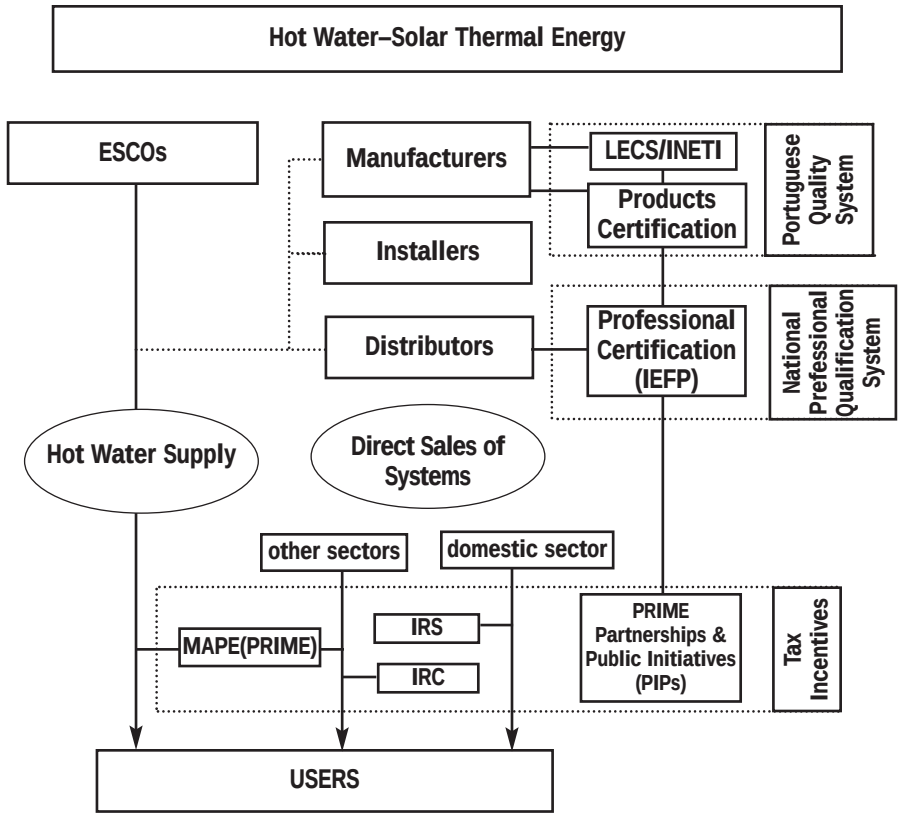


Figure 2. Scheme of integrated actions preview in the AQSpP Sub-Program.

The scheme that was proposed by the AQSpP Program for integration of the set of needed actions, is shown in Figure 2. One important action that can be seen is the possibility of selling solar hot water instead of solar systems. For doing that, the companies can get funding from the PRIME/MAPE funding program, which constitutes a way to subsidy indirectly the domestic sector when applying by this way. Nevertheless, until now, this possibility has not been used and there is no notice of enterprises trying to take profit of it.

The creation of a Commission to study projects to be implemented in underdeveloped countries within the framework of Clean Development Mechanisms was announced in November 2005. Portugal will be involved in the near future to get credits in CO_2 emissions, given the incapacity to reach the already adopted measures internally. It is expected that INETI will be involved in such studies and surely solar thermal will be considered. It is also expected that Portugal will give priority to countries speaking Portuguese in Africa and Asia.

COMMERCIAL ACTIVITY

Table 3 shows the distribution, by category of the market agencies in Portugal, which is mainly based on the knowledge of INETI and complemented by information available on the site of SPES and on the site of AQSpP sub-program. This last one only lists the companies fabricating solar thermal products in Portugal that have been certified or are in the course of being certified; even for the importers, only those certifying in Portugal or importing Keymark products are listed on the site. The same site also reports the installers of solar thermal systems that have already formed by INETI in the framework of the AQSpP.

For the PV and sustainable buildings sectors there is nothing for the moment controlling the quality of the products or the work of those agencies. So, that information results from knowledge we have of the activity in those sectors.

The market is rapidly changing with more and more companies appearing on the market as producers and importers, and with more and more people interested in courses given by INETI for installers and designers of solar thermal systems.

Also, the European Directive on

Table 3
Solar Market Agencies in Portugal

Solar Thermal	
Manufactures	8 agents
Importers	15 "
Installers	88 "
Designers	40 "
PV	
Modules Manufact.	1 "
Installers	21 "
Designers	8 "
Sustainable Buildings	
Designers	20 "
Industry	2 "

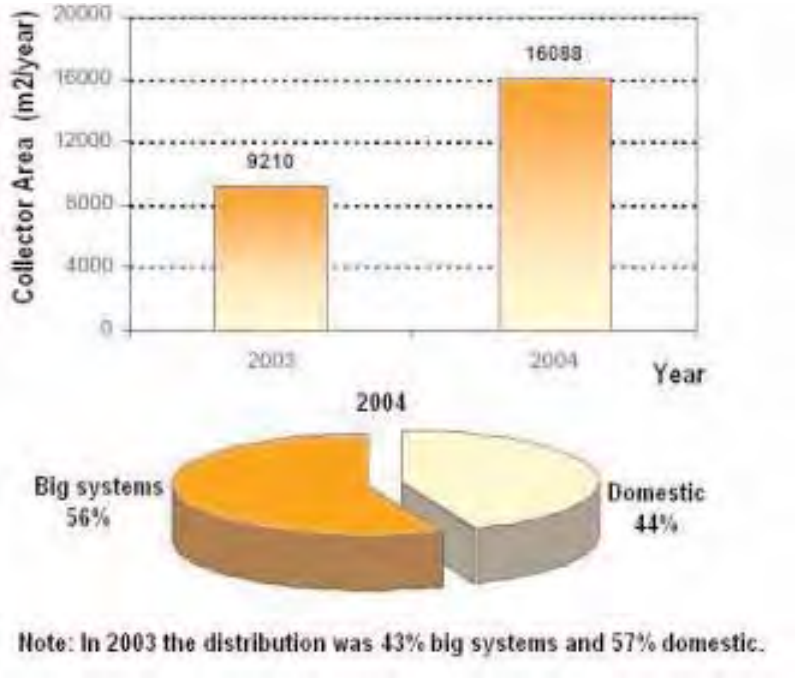


Figure 3. Recent evolution on the solar thermal collector market in Portugal [1].

Buildings as well as the Portuguese new code on thermal behavior of buildings is leading to the entrance on the market of new agencies. The civil construction sector is very strong in Portugal, but so far the sustainable building market and the numbers above reflect the situation over the past three years. However, its strength and dynamics will certainly change its investment priorities in the very near future and surely the present situation will be different from the new one that will be reported three years from now.

Regarding the number of installed solar collectors in Portugal, the value for the year 2002 is clearly low (near to 6,000 m^2) and was given by APISOLAR the Portuguese Solar Collectors Industry. Since 2003, there is a methodology to collect the data that was implemented by ADENE (the national Portuguese Energy Agency) in the framework of AQSpP program. So the values reported for the years 2003 and 2004 are shown in the graph of the Figure 3. We can see a clear acceleration of the solar collector market caused by AQSpP program, but also by the international uncertainty about security and price of conventional fuel during the last year.

As stated and shown above the market is clearly growing shared almost fifty-fifty between the small systems (typically 4 m^2 for residential sector) and the big systems installed in public buildings to heat water for swimming pools, gyms pavilions, elderly houses, hospitals, etc. The growing market is not being supported by state incentives – fiscal or others – but mainly by the perception of the need to change from the fossil fuels because of its growing price, in last years.
As written in the previous report, it is clearly the programs, AQSpP (Solar Hot Water for Portugal) and E3 (Energy Efficiency of Buildings), created three years ago that will have a significant impact in the solar energy market in Portugal. The last one, matched with European Directive on Buildings, will put in operation in 2006 the Portuguese Certification Scheme of Buildings. This scheme will take into account the energy produced by renewable systems installed in buildings. This scheme is based in two improved Codes: the code of air-conditioning equipment of buildings and the code of thermal behavior of buildings being mandatory to use renewable energy - solar collectors or other renewable energy technology – when technically possible. The evolution of the solar collector market during the last three years shows that only after the implementation of such an obligation, the market will accelerate to values expected from the first beginning of AQSpP program.

The other measures of this program are centred on offering long-term (6 years or more) complete warranties to users, complemented with i) incentives, and fiscal measures, ii) solar hot water selling service, and iii) promotion of the solar image by using certified products and qualified installers.

OUTLOOK

The energy bill of Portugal, due to its high external dependency and increasing fuel prices, allied to the international compromises of Portugal (Kyoto Protocol) is pushing the energy policy to a point of no return on renewable energy usage. At the moment is the wind energy that is receiving the most important support and in

lower level the PV, with favorable tariffs, but it is sure that in the near future the contribution of biomass and solar thermal will be in the sequential steps. Building sector in Portugal responsible for more than 20% of final energy consumption and this shows the importance of an adequate energy policy for buildings, to decrease such consumption, and in country like Portugal that has also to be done without sacrificing the comfort which was far from main worries in the past. The next 5 years will be the time for implementation of certification scheme of buildings and the time to implement all supporting measures in favor of solar collectors in all new and renovated buildings. The market is waiting by the new Codes, laws and incentives that will make the situation irreversible.

As already stated, the important civil construction sector in Portugal will certainly have an evolution towards the development and adoption of solutions implementing the large use of those solar collectors, in cover and building facades. It is recognized by everybody that is the solution to a large use of solar energy, and that will give also opportunity to R&D on that field, to experiment and optimize such solutions.

Our optimism on this field results from the fact that we are very far from our compromises with Kyoto Protocol and that there is no way to come back due to the penalties associated with its no accomplishment.

REFERENCES

1 AQSpP (www.aguaquentesolar.com) - Solar Hot Water for Portugal Sub-Program.
2 P3E (www.p3e-portugal.com) - Energy Efficiency in Buildings Sub-Program
3 DGGE (www.dgge.pt) - Directorate General for Energy of Ministry of Economy.
4 INETI (www.ineti.pt) - National Institute of Engineering, Technology and Innovation.
5 ADENE (www.adene.pt) - National Energy Agency.

Solar Energy Activities in SPAIN

Dr. Manuel Romero
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CIEMAT

PROGRAM STRUCTURE

During the period 2002-2004, the procedure developed by the Spanish Government to promote, not only solar heating and cooling activities, but the whole spectrum of renewable energies was by the Program for Promotion of Renewable Energies 2000-2010 (PPER or PFER in Spanish). Approved at the end of 1999, the strategic target of PFER is to achieve by 2010 a 12% of primary energy consumption by renewables , through a joint combination of subsidies, tax exemptions and feed-in-tariffs for electricity production. The specific target fixed by the Government for solar thermal collectors is to achieve 5 million m^2 installed in 2010.

The structure of the program in Spain is as follows:

- Ministry of Industry and Energy: Elaboration and supervision of PFER and responsible of public funds for industrial R&D.
  - –IDAE (Institute for Energy Diversification and Saving) is the organization supervising and monitoring the development of PFER (www.idae.es).
- Ministry of Economy: Regulation of electricity tariffs
- Ministry of Education and Science: Responsible of public R&D.
  - –CIEMAT (National Laboratory on Energy Research) is the responsible of Renewable Energy R&D at national level (www.ciemat.es).
  - –CENER (Centre of Renewable Energy) is a foundation responsible of technology transfer and more applied research (www.cener.com).
- Regional Governments (17 Regional Governments in Spain with their own structures and regional energy agencies supporting renewable energy programmes).
  - –R&D and promoting centers supported by regional authorities like SODEAN (Andalusia), ITER and ITC (Canary Islands), ICAEN (Catalonia), EVE (Basque Country), etc.

FUNDING

The financial instruments applied to achieve the goals stated in the PPER have been continuously revised and improved. The applicability of the PPER had to be done in coordination with all the institutions give subsidies in Spain, as the regional governments and the European Commission. The limit to the all-possible sources of subsidies is given by the paragraphs E.1.3, E.1.4 and E.1.5 of the 2001/C/37/03 Directive.

In solar thermal, the achieved results in 2004 were 8% related to the ones planned for 2010 (see Table 1). The best results have been obtained in Andalusia, Catalonia and Canary Islands; regions where there have been (and there are) specific programmes to promote the use of solar thermal energy as the

PROSOL (Andalusia) and PROCASOL (Canaries) are. The majority of projects use compact systems. The number of projects diminishes proportionally to the size of the collector field, being in the range of 60 to 100 m^2 (42kWth to 70kWth) the less utilized.

In solar PV, the regions of Navarre, Andalusia and Catalonia have the best results (representing 50% of the total). Most installations (85% in 2004) are grid connected with a power generation lower than 5kW (this installation size was better granted so in a way specially promoted).

In 2002, the Spanish Government counted on two clear distinct lines to support the PFER: one line, which supported the investment for the installation, and another line to facilitate loans by the Instituto de Crédito Oficial (ICO), which is a state-owned corporate entity managed by the Ministry of Economy and Finance of Spain. In 2003, both lines were integrated into a single line called the ICO-IDAE Line, which improved the management of every specific typology and gave a well-balance combination of low interest loans and cash incentives. There were several projects typologies:

(1) Saving energy in industry
(2) Energy efficiency in buildings: retrofitting, lighting, renewing thermal equipment and cogeneration in buildings
(3) Energy efficiency in public lighting
(4) Wind energy not connected to grid
(5) Biomass
(6) Minihydropower (<1MW)
(7) Solar: PV not grid connected, PV grid connected, thermoelectric, compact thermal systems, thermal systems with elements)
(8) Biogas
(9) Waste materials

Solar PV has also been promoted nationwide by being included in the Special Regimen (feed-in-tariff) for electricity generation by RES. Three Royal Decrees (the latest approved in March 2004) oblige utilities to pay a special price to PV generators for a 25-years period. Such special price can adopt two modes: guaranteed price, which is a percentage of a reference electricity value (rev) fixed every year, and sale price plus a bonus. Considering that Solar PV for buildings has usually an installed power lower than 100kW, the only mode that it can be adopted is the guaranteed price. In Table 2 the related numbers for 2002-2004 years period are shown.

Finally, nationwide the entities that invest in RES have been discounted by fiscal incentives.

Regional governments have promoted SHC activities during the 2002-2004 period with subsidies specific for every region. In this sphere, it is the regional programs PROCASOL (Canaries) and PROSOL (Andalusia) that should be highlighted. These programmes were so welcomed and so many applications that the available time period allowed for the subsidies had to be reduced or limit. For example, PROSOL was first published in May 2000 to cover the years 2000 to 2006 (last date to apply was fixed on 15th October 2006). In October 2000 the limit to submit applications was limited to November 2000. In 2001, the PROSOL characteristics and budget were revised and since then it has been revised every year.

It is interesting to mention that at the end of 2003, the Strategy for Saving and Energy Efficiency in Spain 2004-20012 (E4) was approved by the Government. Although it is not a direct action for promoting SHC activities, it is another line of action to reduce fossil fuel energy consumption. The overall goal of such a plan is to enhance the energy production and consumption in Spain to reduce the consumption 0.83% per year, which implies a 7.2% at the end of 2010. The plan con-

Table 1
Evolution of Achieved Results and Comparison with the Planned Ones in PFER

	Solar PV	Solar Thermal	
	kWp	M^2	kWth
Objectives PFER (up to 2010)	135,000	1,504,350	84,553.7
Accumulated 1999-2001	6,999 (5.2%)	120,791 (2.7%)	45,570.7
2002	4,965	65,101	58,290.4
2003	6,617	83,272	63,000.0
2004	10,000	90,000	251,414.8
Accumulated 1999-2004	28,581 (21.2%)	359,164 (8%)	84,553.7

(Reference: La Energía en España 2004. M. de Industria, Comercio y Turismo)

Table 2
Guaranteed Prices for Solar PV Installations under 100kW.

Year	2002 2003	2004
Reference	R.D. 2818/1998 R.D 841/2002	R.D.436/2004
Guaranteed Price	36 c€/kWh (<5kW) 18.03 c€/kWh (>5kW)	575% rev (41c€/kWh for 2004) (<100kW) 300% rev (20c€/kWh for 2004) (>100kW)
Total Limit	50 MW	150 MW

siders several sectors in which residential and tertiary buildings can be found. New construction and retrofitting are considered.

RD&D PROGRAM

In terms of the R&D Program in Solar Heating and Cooling during 2002-2004, the government funding was almost negligible, as shown in the Figure 1. R&D activities remain in CIEMAT, CENER and some small groups of universities and regional institutions.

In the Renewable Energy Division of CIEMAT, the Energy Efficiency in Buildings group has focused its SHC activities during 2002-2004 on consultancy for local/regional governments. Thus, several urban planning projects (in Barcelona, Madrid and Navarre) have consulted to introduce bioclimatic aspects. It deserves special attention the contribution to the Forum 2004 in Barcelona. Collaboration with local/regional governments has also covered the energy monitoring of residential buildings. In 2003 a new R&D line over natural ventilation in buildings initiated.

The PV group of CIEMAT carries out its R&D distinguishing between PV-cell and PV-system activities. During the 2002-2004 period, within the regional funded project MARISOL, a co-evaporation system was designed and manufactured. This system allows the preparation of poly-crystalline semiconductors of the type CuInGa(SSe)2 and In2S3 windows, being ready to produce large area films for flexible cells easily adaptable to buildings. PV-system subgroup started a line to study and quantify the degradation of PV-modules more than 10 years old. Its activities on the qualification of PV-panels have continued.

At the end of 2003, the IEA SHC Programme's Solar Heat for Industrial Processes Task was initiated and includes the work of the Solar Concentrating Systems group of the Plataforma Solar de Almería (PSA). This group has been collaborating mainly in the development of a parabolic trough collector to supply heat for industrial processes and also for absorption machines for air-conditioning. In 2004, the group counted on a national funded project to support such activity.

CENER (National Renewable Energies Centre) is a very young foundation that indeed started its R&D activities in 2003. CENER is a non-profit enterprise formed by the Ministry of Education and Science, the Navarre Regional Government and Ciemat. Two departments mainly support the SHC activities of this centre: Bioclimatic Architecture and the Photovoltaic Solar Energy.

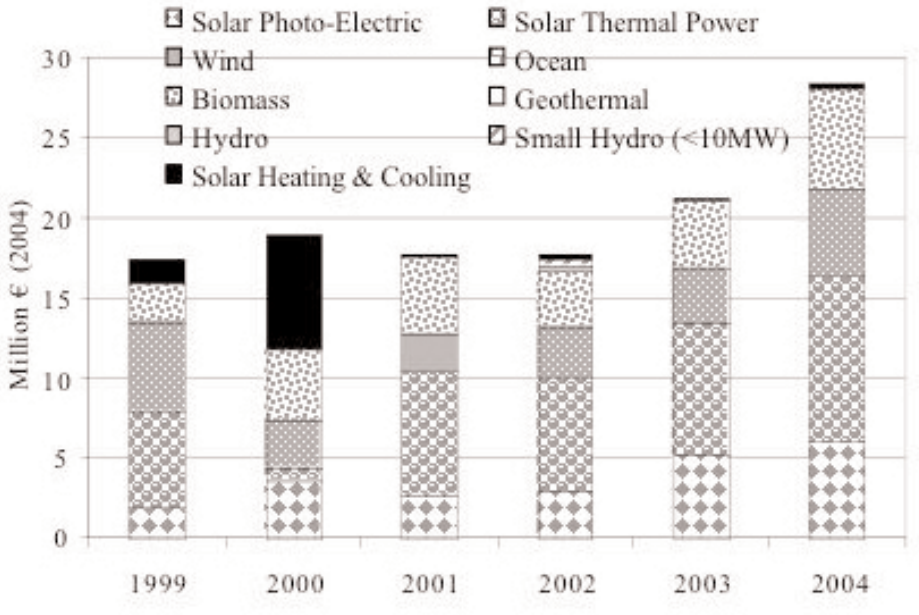


Figure 1. R&D funding distribution for renewables in Spain. The time period is enlarged to appreciate tendencies.

Figure 2. H_2O is the logo used in the PROSOL programme to promote the use of solar energy in domestic hot water. The PROCASOL brochure, the front page shown above, includes the advantages and possibilities of solar thermal for domestic hot water.

The Department of Bioclimatic Architecture is made up by the following groups:

- Integration of Renewables in Buildings: the most remarkable activity has been, and is, the laboratory of qualification and standardization of solar thermal collectors. Any installation subjected to any national or local subsidy must implement thermal solar collectors that had previously been qualified in any of the national laboratories recognized for so. Before the foundation of CENER there were only two recognized laboratories: INTA-Arenosillo in Andalusia and ITC in Canary Island. Having a third qualifying centre has been promoting the introduction in the Spanish market of non-Spanish solar thermal collector manufacturers, mainly, from north-European countries.
- Energy Simulation and Analysis Group, which can realize building-energy consulting or monitoring of buildings.

The Photovoltaic Solar Energy group organizes its activities between systems and cell analysis, as in CIEMAT. In 2003, the PV systems analysis subgroup initiated, together with Ciemat and ETSI of Madrid, the Invermulti project, a 2-year nationwide funded project. The PV cells subgroup participated in 2003 in the Silfcel project, along with Isofotón and the Institute of Microelectronic Technology (TIM) of the Polytechnic University of Valencia and national funded.

OTHER GOVERMENT SUPPORT ACTIVITIES

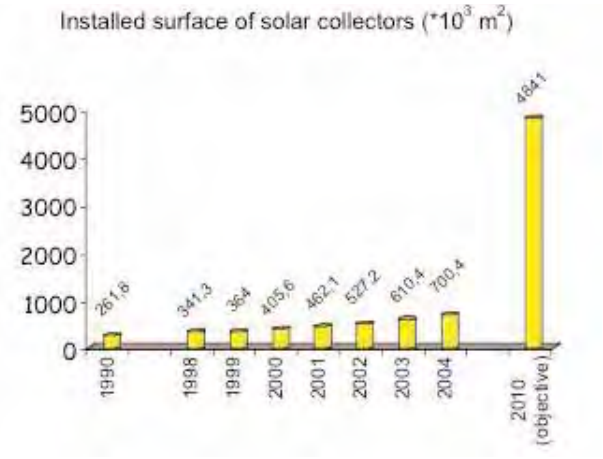
The regional governments have been the main responsible for the information and promotion of SHC activities. Most regional programmes to fund solar energy have been complemented by an important information campaign, including TV and radio advertisements. In Figure 2 the first page of the PROSOL (Andalusia) and PROCESOL (Canary Island) programmes are shown.

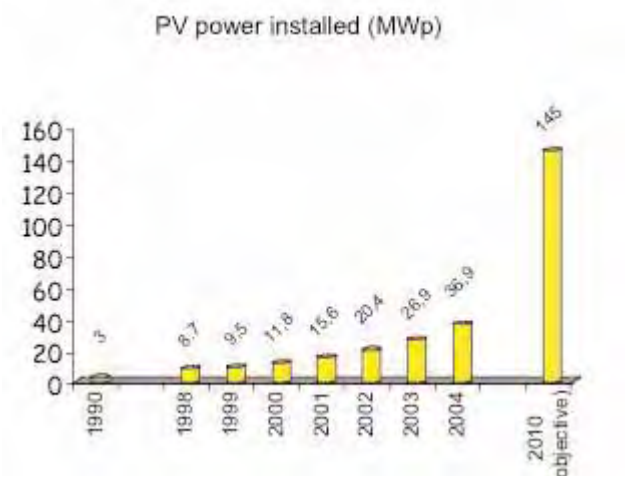
Nationwide, IDAE and Greenpeace signed an agreement in 2002 for the promotion of PV in public schools. Under the title SOLARIZATE ('make yourself solar' could be a free translation) PV installations have been integrated in schools and connected to grid. The message of caring about energy saving and efficiency is also included in the campaign.

COMMERCIAL ACTIVITIES

In 2004, Spanish PV-panel manufacturers represented 24% (81MWp) of the European PV-panels manufacturing. Isofoton is the main manufacturer with the 65% in 2004, of the Spanish share, followed by BP Solar (Spanish branch) with the 24%, and Atersa with the 5%. The panels are crystalline Si.

Isofotón also manufactures thermal flat-plate collectors. Another solar thermal collector manufacturer is Gamesa, which absorbed the former company Made. It should be mentioned that there has been an important growth in the number of companies involved in renewables, and in SHC, in particular. They are mainly limited to the Madrid and Catalonia regions and have a profile of a small-medium enterprise: 25% of them have less than 25 employees and only 4% have more than 500 employees. Most of these companies not only are able to make the solar installation but also the design and maintenance.





State of the Market

The solar thermal market has been poorly developed in Spain. The PPER plan assumed an objective for 2010 of 4.8 million m^2 installed, approaching an intensity use of 115m^2 per 1,000 inhabitants. Unfortunately in 2004, only 700,000 m^2 were achieved, being solar thermal, together with biomass, the two renewables with worse development in the plan. In contrast, wind energy has registered a dramatic increase.

More than 90% of the collectors in Spain are flat glazed units for solar heating, even though recently some solar cooling applications are arising, as well as the use of CPC collectors and unglazed units for swimming pools.

In Spain, there are 12 manufacturers of components and systems for solar thermal collectors with an annual production that has stabilized at less than 100,000 m^2. The two main manufacturers represent 65% of the total production. Because of the small market, the volume of collectors and the fabrication of panels in Spain has a low-degree of automation and competition.

The main manufacturers are– ALWEC, ACV, DISOL, ESE, GAMESA-MADE, ISOFOTON, LKN, PROMASOL, RAYOSOL, SILVASOL, TAMACA and TERMICOL.

OUTLOOK

A significant change is expected in the solar thermal market in Spain in the next few years. The recent approval of new regulations for the integration of solar collectors in buildings in several municipalities, such as Barcelona and Sevilla, and the approval of the new National Code for Energy in Buildings that it is to be in service in January 2006 will create a new situation more favorable for solar collectors in buildings. The new code obliges the introduction of solar thermal collectors in new buildings. The revised Plan of Renewable Energy (PER) in Spain projects a sharp change in the demand and still maintains that the objective of 4.8 million m^2 is feasible.

Solar Energy Activities in SWITZERLAND

Mr. Urs Wolfer
Swiss Federal Office of Energy

PROGRAMME STRUCTURE

In the period covered by this report, the national Programme "Swiss Energy" (www.swissenergy.ch) started the second half of its ten years duration. The planned overall goals for renewables were more or less achieved. The goals of this ten year programme are listed in Table 1. SwissEnergy is a collaborative effort among the federal government, cantons, industries, energy agencies and environmental organizations.

Table 1
Swiss Energy 10-Year Goals

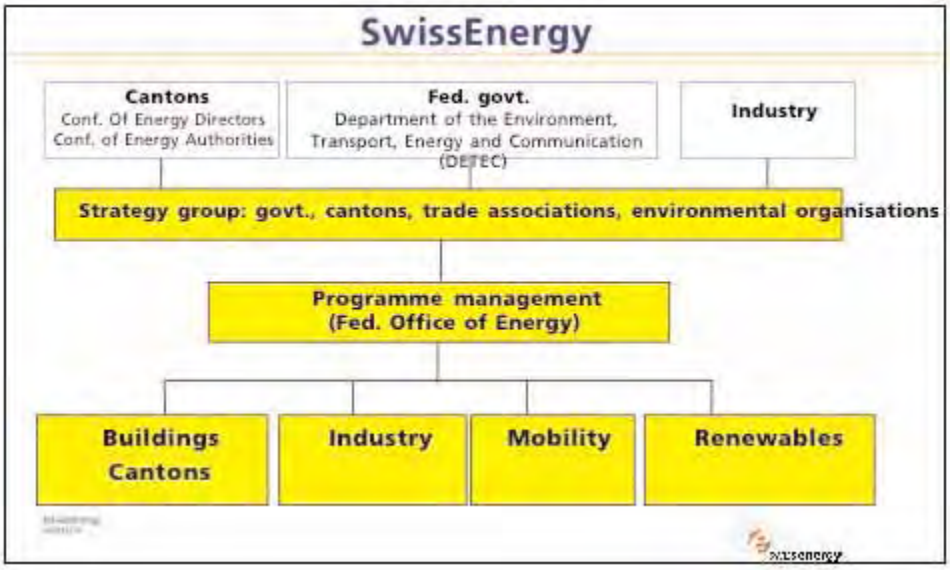
Area	SwissEnergy
Energy consumption	
Fossil fuels	-10%
CO2 (Reference 1990)	- 10%
Electricity	< +5%
Renewables	
Hydropower	stable
Others: Electricity	+ 0.5 TWh (+1%)
Heat	+ 3.0 TWh (+3%)

SwissEnergy is active in:

- Voluntary measures
- Enforcement with:
  - Agencies
  - Standards (for appliances, motor vehicles, etc.)
- Buildings (cantons)
- Enforcement of the CO_2 Act by means of agreements (industry)

Since 2001, a new energy law allows tasks to be delegated to private organizations. Such collaboration can be established by mandates or by agreements, depending on the nature of the goals.

A major solar network called "SWISSOLAR" (www.swissolar.ch) is responsible for information, quality-control and education with regard to solar applications. For the general building sector the



Organizational diagram of SwissEnergy.

Minergie–Agency (www.minergie.ch) shares the lead responsibility together with the cantons.

FUNDING

The Swiss Federal Office of Energy (SFOE) is responsible for maintaining an overview of Swiss research activities in the energy sector. Funds of the SFOE represent about 20% of the total energy-related research funding. The most important part of this funding is managed by the ETH-Board.

In the research area, funding has remained more or less constant. Differences result mostly from fluctuations in projects. Research funds have not been adversely affected by the changes in the legislative branch.

Market-orientated programs, however, have had to cope with modifications. Several activities (and their related budgets) were delegated to the cantons. Cantons typically place a higher priority on the rational use of energy than on encouraging the use of renewables. The budgets for demonstration projects have been drastically reduces because of governmental economizing. This has lead to budget reductions of nearly 50% relative to the year 2002.

RD&D PROGRAMME

The Buildings Programme (rational use of energy in buildings) focuses on four topics:

- High performance building components (with emphasis on retrofit)
- Use of solar energy (also including windows, shading, overheating, daylighting)
- Very low energy housing ("Passivhaus Standard") with optimized heating systems
- Environmental aspects of constructions

For active solar systems, the main activities include:

- "Combisystems" for space heating and domestic hot water heating as standardized systems
- Advanced storage systems (e.g. SHC Task 32)
- Advanced control systems for the whole building, optimizing the solar fraction
- Improved collector design for building integration (construction, mounting, colors)

A Chalet built to the "Passivhaus-Standard" in Lauterbrunnen.

An overview is presented under www.solarch.ch.

The Swiss solar thermal industry consists of small manufacturers and most of firms are producing components primarily for the Swiss market. Export is becoming an important market for some bigger companies. The Swiss PV-Industry, with a volume of CHF 100 million, exports about 80% of its products. The nearly absent home market limits industry financing of RD&D. Governmental research is closely tied to industry in order to compensate this situation.

Table 2
Government Funding for Renewable Energy
(Funding for research, development, demonstration and information programmes)

Funds of the SFOE:

	YEAR 2003		YEAR 2004	
	CHF	USD	CHF	USD
Active Solar	4,000,000	3,120,000	2,700,000	2,106,000
Buildings (including passive solar use)*	4,664,620	3,638,404	3,356,180	2,617,820
Photovoltaics	4,069,765	3,174,417	2,858,812	2,229,873
High Temperature Solar Thermal	1,950,742	1,521,579	1,793,426	1,398,872
Wind Energy	997,363	777,943	876,594	683,743
Bioenergy	4,000,000	3,120,000	3,691,561	2,879,418
GeoThermal	1,524,774	1,189,324	1,243,245	969,731
Other (small hydro)	487,082	379,924	493,350	384,813
All Renewable Energy	**28,959,765**	**16,921,591**	**16,901,763**	**13,270,270**

Table 3
Research Institutions in Solar Heating & Cooling

Address	Internet	Activities
SPF Rapperswil Hochschule für Technik HSR Prof. Andreas Luzzi 8640 Rapperswil SG	www.solarenergy.ch	Collectors, Solar thermal Systems, Storage
EIVD Ecole d'ingénieurs du Canton de Vaud Prof. Philippe Dind 1401 Yverdon	www.eicn.ch/cces/content.htm	Solar Cooling (small applications), Solar thermal Systems
EPFL/LESO-PB Prof. Jean-Louis Scartezzini 1015 Lausanne	http://lesowww.epfl.ch	Buildings, PV, Control systems
EMPA Mark Zimmermann 8600 Dübendorf	www.empa.ch	Buildings

Table 4
Responsibilities for Buildings and Renewable Energy

Government body	Area	Examples, target groups
Federal Government	RD&D	Research programmes
	Information & Agreements	Industry, Mobility, Renewables
Cantons	Building sector	Legislation, Information, Subsidies
	Promotional Programmes for renewables	Information, Subsidies

OTHER GOVERNMENT SUPPORT ACTIVITIES

While 20 of the 26 cantons have promotional programmes for thermal solar energy systems only 6 cantons have programmes for PV and 18 cantons currently support the "Minergie-Standard."

COMMERCIAL ACTIVITY

Swiss manufacturers of solar systems operate generally on a regional level. This leads to small production series and high system prices. Given the current market situation, a concentration to a few larger firms is necessary. The growing European market, with its less expensive products, provides stiff competition.

SOLAR MARKET

Building Market

The Minergie-Standard has been adopted by a majority of the cantons as a recommended voluntary standard. This standard is substantially below the levels required by current or recent building codes. During the first seven years after the creation of the Minergie-Standard, 4,700 buildings were constructed. About 25% of Minergie-buildings are equipped with solar domestic hot water systems. About 10% of the new housing buildings fulfill the Minergie-Standard. In renovation, until now, the success has been outstanding. For the next years, priority will be given to renovation.

The Soltop collector manufacturing facility constructed in the MINERGIE-Standard.

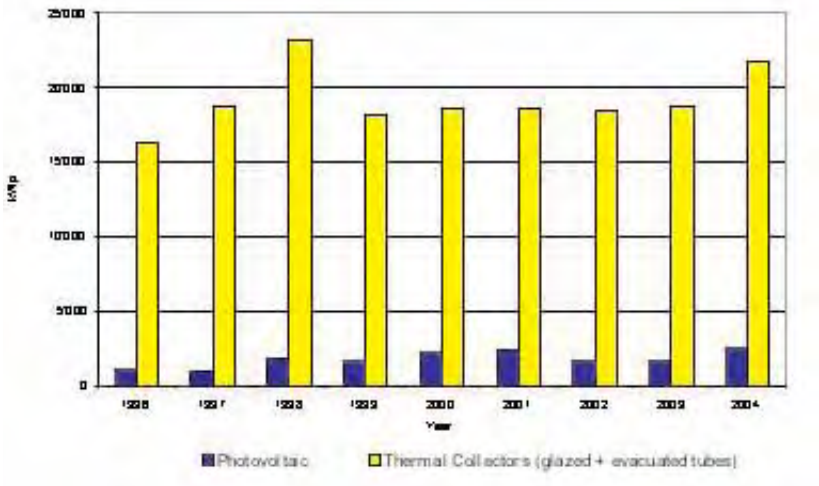
OUTLOOK

Further development of renewable energy depends very much on several bills to be voted on during the next three years which will address:

- The liberalization of the electricity market
  -> rejected in 2002, now planned for 2007?
- Feed-in tariff for renewables
  -> 2007?
- A CO_2 tax on non-renewables
  -> delayed and partly replaced by a voluntary new tax called "Klimarappen"

Each of these bills, if it should become law, has a component which includes a tax that would benefit renewable energies.

Table 4
Annual Installed Solar Power



Example of a house renovated to the Minergie-P-Standard (source: Minergie)

Accordingly, the Swiss market is in a “wait state” in anticipation of further governmental developments. The slope of the growth rate will strongly depend on the result of new laws being enacted or rejected.

The strategy of the cantons is to develop the renovation market and increase public interest in buildings fulfilling the Minergie-Standard. It is also planned to introduce a new "Minergie Plus" Standard that would be comparable to the current German and Austrian "Passivhaus" Standard."

Solar Energy Activities in UNITED STATES

Dru Crawley
U.S. Department of Energy

PROGRAM STRUCTURE

United States Solar Energy Building-Related Policies and Objectives

The long-term goal of the United States Department of Energy's (DOE) solar activities in buildings is to help create the technological foundation for buildings to use solar energy and energy efficiency strategies to help reduce energy consumption in buildings with the end goal of buildings creating as much energy as they consume. The Building Technology Program at DOE (BT) has created a long-term goal of creating marketable zero energy buildings by 2025. This roughly translates to a 70% reduction in building energy consumption with the remaining 30% being met by renewable sources. Achieving this ambitious goal will require investing in a broad range of passive solar, active solar, photovoltaic (PV), and energy efficiency technologies embodied by a whole-building design approach. In addition to reducing energy consumption, DOE's National Laboratories are striving to develop active whole building integration strategies, solar, and PV technologies that are cost-competitive that sustain levels of performance over a 20-year period.

To design, develop, and deliver improved solar technologies for targeted markets, DOE collaborates closely with the buildings industry, solar product manufacturers, utilities, and the research community. In addition, DOE recognizes the importance of international collaboration such as that sponsored under the auspices of the International Energy Agency Solar Heating and Cooling (IEA SHC) Programme and the PV Power Systems (IEA PVPS) Programme. While the core of the solar buildings-related programs remains research and development (R&D), integral to R&D are efforts to help industry properly use state-of-the-art technologies.

Government Agencies Responsible for Solar Energy Building-Related Activities

All solar buildings-related activities are conducted under DOE's Assistant Secretary for Energy Efficiency and Renewable Energy. The principal federal research organizations continue to be the National Renewable Energy Laboratory (NREL), the Lawrence Berkeley National Laboratory (LBNL), and Sandia National Laboratories (SNL). NREL supports all renewable energy research areas, including modeling, whole-building design and evaluation, dynamic windows research, photovoltaics, and wind technologies. LBNL focuses on daylighting and windows research. SNL conducts R&D in photovoltaics.

FUNDING

Funding for solar buildings-related activities has been decreasing over the last several years. With the completion of the Photovoltaics Building Opportunities in the United States

Table 1
Recent Funding History (in thousands of US$)

	FY 2003	FY 2004	FY 2005
Active Solar	3,500	2,500	2,000
Passive Solar - Whole Buildings	1,000	1,000	1,000
Dynamic Windows	2,100	1,900	1,800
Building-Integrated Photovoltaics[b]	1,000	1,000	1,000
Total	7,600	6,400	5,800

Table 2
FY 2005 Funding Distribution (in thousands of US$)

	R&D	Demonstration Projects	Market Support	Testing, Certification, Standardization
Active Solar	1,600		200	200
Passive Solar - Whole Buildings	1,000[a]			
Dynamic Windows	1,800			
PV in Buildings	700	300		
Total	5,100	300	200	200

a) Includes a small component of user support activities (workshops, awareness building).

(PV: BONUS) initiative, which accounted for $6 million in previous years, and a reduction in the active solar research area, the overall budget has dropped considerably over the past 10 years. Below is approximate funding information for the past three fiscal years.

Budget Trends

Tables 1 and 2 present funding information for the solar buildings-related programs.

RD&D PROGRAM

2003-2005 Program Activities

DOE's principal solar program activities, which include Active Solar Technologies under the Solar Heating & Lighting subprogram, Passive Solar Technologies through Commercial Building Integration and Residential Buildings Research, Dynamic Windows, and Building Integrated Photovoltaics, are described below.

Active Solar Technologies

The DOE Solar Heating and Lighting (SH&L) subprogram set a major goal in 1998 of reducing the life-cycle cost of energy (LCOE) for solar water heaters by at least 50%. This cost reduction work started in 1999, focused on passive solar water heating systems for mild non-freezing climates. In response to competitive solicitations to the solar thermal industry and universities, five teams were initially funded for concept development. After down-selection in 2001, two teams were "stage-gated" through engineering development to field trials and manufacturing development in FY05-06: Davis Energy Group/SunEarth (DEG/SE), and FAFCO, Inc. The mild-climate solar water heater development phase is planned to be substantially completed by FY06, with work on low-cost solar water heating systems for freezing climates begun at that time.

With the cost reduction objective, the technical strategy is to: i) use low-cost polymer materials and manufacturing technology and ii) simplify system designs and installation, exploiting the formability of polymers to reduce part count and to provide molded-in joining features. The two teams, DEG/SE and FAFCO, are partners with NREL to develop these systems. The DEG/SE team has been installing prototypes, seeking certification through the Solar Rating & Certification Corporation (SRCC), and addressing issues seen in production and in field testing. In FY05, they also developed a less-expensive, lower-performing unglazed version of the unit. The FAFCO team plans both a thermosiphon system and a direct active system, based upon their polymer pool collector. In FY05, FAFCO developed full-scale prototypes, addressing issues with overheating and freezing.

With the polymer strategy comes new opportunities and new problems. The key problem to be addressed is materials durability under harsh environmental stresses and high temperatures. A minimum lifetime for polymer solar systems was initially set at 10 years; the desired lifetime, however, is at least 20 years.

These criteria lead to need for sophisticated and capital-equipment-intensive accelerated testing to identify appropriate materials. Polymer materials testing expertise at NREL and the University of Minnesota have fulfilled that need. NREL concentrated on identifying and testing good candidates for glazings and absorbers and the University of Minnesota concentrated on heat exchanger design and performance testing, as well as materials durability testing for polymer heat exchangers.

Commercial Building Integration

The goal of commercial building integration is to create marketable zero-energy buildings by 2025. This involves reducing loads by approximately 70% from today's code compliant building. The demand reduction is done with a combination of passive solar technologies, increased thermal envelope and improved HVAC systems. The key is to integrate components such that they work to create a low-energy building. To accomplish this goal, the research staff works with building owners and their design teams, evaluating advanced solar strategies from design through construction, commissioning, and monitoring.

Six exhaustive case studies have been completed on buildings that were designed to be low-energy. The study documents common lessons-learned and begins to establish a list to carry forward in future buildings. The buildings had energy performance that ranged from 25% savings to 70% savings in a variety of U.S. climates. In addition, three of the buildings could achieve zero-energy building status if a significant portion of the roof was covered with PV. One of the buildings had PV that contributed 50% to the overall building load.
In support of this effort multivariate optimization theory is being developed to minimize the energy consumption by providing appropriate design solutions at each stage of the design process. These optimization methods will first be used to create a set of design technology packages that will provide set solutions to subsectors of the commercial building industry. The work includes costs to provide appropriate trade-off analysis.

In addition, national laboratory staff are working with major chain retailers to aggressively incorporate strategies to transform the retail sector. Two major companies with a total of 2000 U.S. locations have agreed to participate.

Simulation tools are also being developed to address special needs of future zero-energy buildings. EnergyPlus modules are being developed to address these future needs and to provide the technical basis for the optimization.

Federally funded efforts for Energy-10 are being completed in FY06. The program is licensed for distribution through the Sustainable Building Industries Council who provides training and workshops on the product. The federally funded program is now self-sufficient in the private sector.

Verification of energy analysis software tools, such as these, is provided by the Building Energy Simulation Test and Diagnostic Method (BESTEST) protocols. Originally developed as part of IEA SHC Task 12, Building Energy Design Tools for Solar Applications, they are now being expanded under IEA SHC Task 22, Solar Building Energy Analysis Tools. BESTEST is receiving increasing recognition and acceptance by various organizations concerned with the validity of performance information provided by energy analysis tools. The research efforts have focused on developing validation tests for HVAC systems. The methods are also included in ASHRAE Standard 140.

Residential Buildings

Several very low-energy buildings were studied including the van Geet residence that was completely off-grid. Over 90% of the energy needs were met by solar including passive solar, solar hot water, and photovoltaics. This house was monitored including an exhaustive case study. Based on the results of this home and several others, the research is focused on expanding the market to the larger builders.

The Building America Program is DOE's marquee activity for the advancement of new energy-efficient residential construction. Building America accelerates the adoption of innovative technologies in production-scale housing through construction industry teams. These teams apply cost and performance trade-offs to improve residential energy performance without increasing first costs. As active and passive solar technologies become increasingly cost-effective and market-attractive, they are incorporated into the production housing built by

Building America's industry teams.

Dynamic Windows

Dynamic windows (DW) R&D focuses primarily on controlling the energy flow through fenestration products in buildings. A dynamic window allows modulation of transmitted light over a wide range, thus keeping heat out of the building and reducing air conditioning requirements in warm climate conditions, or allowing controlled amounts of light into the building for daylighting and heat gain in cooler climatic conditions. There are many options for dynamic control of window transmittance, ranging from purely mechanical systems (automatic shades) to electrochromic windows. Of special note are the two technologies that have entered the window marketplace: electrochromics (Sage Electrochromics) and suspended particle devices (Research Frontiers). Other notable technologies that are still being considered are gasochromics, thermochromics, photochromics, electroplated films, and liquid crystals.

Research and development in the U.S. on Dynamic Windows includes:

- Window performance modeling, low U-factor dynamic windows, and reflective films at LBNL
- Dynamic window durability testing, electrochromic materials improvement, and long-term energy performance, and supporting fundamental research at NREL
- Private sector work on electroplated, organic electrochromic, and thermochromic devices.

Photovoltaics in Buildings (PVB)

The goal of the PVB Task is to foster widespread acceptance of PVB by the buildings industries and their customers by focusing on ways to increase the adoption of PVB in the near-term. EnergyPlus and Energy-10 both now include modules for analyzing PVB. The largest new initiative in this area in recent years has been the Solar Decathlon. http://www.eere.energy.gov/solar_decathlon/

First initiated in 2002, the second Solar Decathlon was held October 2005. The Solar Decathlon brings together up to 20 teams of college and university students from around the globe to participate in an unparalleled solar competition to design, build, and operate the most attractive and energy-efficient solar-powered home. The teams transport their solar houses to the National Mall in Washington, D.C., where they form a solar village. The solar houses are open to the public while the teams compete in 10 contests to determine an overall winner.

The Solar Decathlon is a competition sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy in partnership with its National Renewable Energy Laboratory, the American Institute of Architects, the National Association of Homebuilders, BP, the DIY Network, and Sprint.

New PVB technologies can be developed through participation in and support of activities within the National Center for Photovoltaics (NCPV) such as Million Solar Roofs and other areas of R&D Technology development will also be advanced by participating in the building codes and standards development process to address issues affecting PV/buildings systems and by conducting systems-testing activities to evaluate and improve the linkage of PV systems with building components and systems.

Recent Accomplishments/Benefits of Linking to Industry

Active Solar Technologies

An SH&L subprogram effort to provide manufacturing assistance to the U.S. solar thermal industry strives to develop partnerships with industrial entities (e.g., solar equipment manufacturers and end-users) to address important near-term problems or opportunities. Partnerships are favored in situations where strong replication possibilities exist. The objective of this task is to help the solar thermal industry reduce the manufacturing costs of current systems by up to 20% and to make solar products easier to manufacture, more reliable, as well as cost effective. The objective is met by providing technical support and making the National Laboratories' manufacturing, systems engineering, and testing capabilities available to the solar thermal industry. For example, Sandia National Laboratories worked with the solar thermal manufacturer Energy Laboratories Inc. in Florida and the electric utility Salt River Project in Arizona to develop a roof-integrated thermosiphon (RITH) solar water heating system. As innovative components and systems arise through these development activities, this task will work with solar

manufacturers to transfer the technologies.

Commercial Building Integration
DOE has adopted the whole-building design approach in its strategic planning framework, which is central to research in high-performance buildings. To date, high-performance building designs have been completed for 19 buildings and 12 of those buildings were constructed. Six of these buildings were studied in depth with exhaustive case studies.

The new case study database allows the industry to submit information about low-energy buildings for publication. This database is very flexible and contains actual energy information as well as lessons learned about buildings. The database structure also allows for multiple portals. Currently the US Green Building Council, BuildingGreen, Inc., Federal Energy Management Program, American Institute of Architects all display projects from the database. The database can be accessed at www.highperformancebuildings.gov.

The Designing Low Energy Buildings/ENERGY-10 software, developed under the High Performance Buildings research, won a prestigious Architecture magazine award. Over 1100 architects are currently using registered copies of the software and over 40 architecture schools are using it in conjunction with teaching classes.

The BESTEST protocols have also been adopted by a number of national and international organizations for: (1) screening energy analysis software used for the performance compliance path in building codes, (2) home energy rating system (HERS) software certification, and (3) evaluation and diagnosis of building energy simulation tools. The BESTEST protocols were adopted as an American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Standard Method of Test for Building Energy Software under Standards Project Committee 140 (SPC-140). In addition, NREL, in conjunction with the Solar Heating and Cooling Programme's Task 22, is developing a new procedure for testing and diagnosing coding errors, faulty algorithms, and documentation problems in mechanical equipment models used in building energy simulation software. The new procedure, Building Energy Simulation Test and Diagnostic Method for Mechanical Equipment (HVAC BESTEST), is an integral part of improving the overall quality of building energy analysis and design tools used for analyzing the cost-effectiveness of renewable energy and energy conservation technologies that may be applied in solar buildings.

Dynamic Windows
DOE has targets for zero energy building technologies, which require that window performance be greatly enhanced by the year 2025. The strategy is to move window performance first to an energy neutral position, then on to a net annual energy gain, when integrated over all climates in the U.S. The only way that this can be accomplished is to combine dynamic window technology with highly insulating window technology, so that we have windows with very low U-factors, while being able to modulate the solar heat gain over a very wide range.

The long-term investment in electrochromic technologies by DOE has resulted in windows, which are close performance goals in controlling solar heat gain. Sustained work in qualifying performance and durability has resulted in 6 ASTM Standards related to qualification tests for absorptive electrochromic windows. Excellent progress has been made by the private sector in developing the technologies to the point of emerging products. Both Sage Electrochromics and Research Frontiers are exercising market strategies to introduce dynamic building window products. The primary issues remaining to be addressed are those related to cost and market share.

Photovoltaics in Buildings (PVB)
The Solar Decathlon 2005 was another huge success with 18 teams competing from the US, Canada, Puerto Rico, and Spain. Over 100,000 people toured the solar buildings in the National Capital Mall in Washington, D.C. with numerous corporate sponsors, industry participants, and Congressional visitors in attendance.

Non-Research and Development Support Activities

In addition to the federal government's research programs, there are a number of activities conducted by federal, state, and local governments; industry; and financial institutions. These activities, which facilitate the adoption of solar building technologies and design know-how, include finan-

cial incentive programs; model building codes, standards, and certification procedures development; and information programs.

Financial Incentive Programs

Federal, state, and local agencies offer financial incentive programs. The federal government sponsors joint ventures with industry to promote the use of advanced renewable and energy efficiency technologies. Tax credits are available in some states and rebates are provided by a number of utilities for the purchase and installation of solar energy systems in buildings.

For many years, DOE has awarded State Energy Program (SEP) grants to State Energy Offices (SEOs) for Home Energy Rating Systems (HERS) programs. These grants were intended to promote the link between HERS and energy affiance mortgage (EEM) programs. HERS is a standardized system for rating the energy efficiency of residential buildings and can be used to qualify buyers for EEMs. Energy efficiency mortgage programs are available to help finance the cost of more energy-efficient residences. These mortgages take into account the reduced utility bills associated with buildings that incorporate solar or energy efficiency features. Consumers who purchase homes that qualify for EEMs are able to obtain larger loans than their income levels would normally permit. In actuality, the buyers' total outlays remain the same or less because of reduced utility bills. Home Energy Rating Systems are available in 47 states and the District of Columbia, and EEMs are offered nationwide by several national lenders. DOE also supports this effort by guiding the development of the BESTEST method to evaluate the software used in HERS. BESTEST provides the basis for the ASHRAE Standard Method of Test for building energy simulation and design tools.

Model Building Codes, Standards, and Certification Programs

Model building codes and technology standards are constantly changing to accommodate new technologies and methods of work. DOE, the Solar Rating and Certification Corporation (SRCC), and the National Fenestration Rating Council (NFRC) are currently working to identify building codes and technology standards that present roadblocks to the application of renewable, and energy-efficient technologies. Proposals to change building codes are prepared and sent to the International Code Council (ICC). The ICC is responsible for providing a consensus process for changing international building codes. The model code changes are monitored constantly to ensure other interests do not make changes that inhibit deployment of RE and EE technologies.

Changes such as these have started to break down barriers that have traditionally created roadblocks to applying new technologies in actual construction projects. While there is still a long way to go in removing these barriers, this work has far reaching influence in the widespread application of new technologies. Coordination with standards making bodies, including ASHRAE and SRCC ensures that model building code changes and proposals are recognized, and that new standards needed for building codes, are being developed.

In addition, the SRCC develops standardized national rating and certification processes for active solar technologies to streamline the introduction of new technologies. And the NFRC develops testing and labeling processes for windows to help consumers, designers, and builders make informed decisions on window purchases and to determine the performance/cost trade-offs.

Information and Technology Transfer Programs

The Energy Efficiency and Renewable Information Center is another information service that DOE provides on the Internet at http://www.eren.doe.gov. This service provides information about energy efficiency and renewable energy technologies and programs. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) provides an answer and referral service for questions about energy efficiency and renewable energy technologies. The EERE Information Center can be reached with questions on EERE's products, services, and the eleven technology programs by calling 1-877-EERE-INF (1-877-337-3463).

DOE's solar building activities also publish technical reports and articles about specific research activities in various technical and trade journals. In addition, the ongoing interaction between the building industry and the solar buildings programs serves to facilitate technology transfer.

The ENERGY STAR Homes program, a component of the DOE/Environmental Protection

Agency (EPA) ENERGY STAR Program, is another program that promotes technology transfer by working with builders to promote construction of homes that are 30% more efficient than the Model Energy Code (MEC). This program distinguishes energy-efficient homes with a brand name label certification system and a preferred mortgage financing network. According to EPA, as of July 1999, ENERGY STAR Homes certified over 9000 homes, recruited over 1,000 builder partners, and had over 250 rating providers as ENERGY STAR Homes Allies. EPA's program also provides information on energy efficiency and renewable energy through its ENERGY STAR Website at http://www.epa.gov/energystar/ and through other outreach efforts.

Other sources of information include state and local government energy offices, trade and professional associations, and the national laboratories. Examples include Web sites on the Internet maintained by the Partnership for Advancing Technology in Housing, California Energy Commission, Sustainable Buildings Industry Council (SBIC), Solar Energy Industries Association (SEIA), NREL, and LBNL. Transfer of design information is also made possible through conferences, workshops, courses, and design competitions sponsored by ASES, ACEEE, SBIC and the American Institute of Architects (AIA). Some of these workshops and courses focus on the use of specific design tools (e.g., Designing Low Energy Buildings/ENERGY-10 and Guidelines for Home Building/BuilderGuide). USGBC (LEED rating system).
The Energy Value Housing Award program accelerates technology transfer by recognizing innovative builders for their accomplishments in reducing energy consumption in homes. This series of awards for small, medium, and production-level residential builders is an excellent means of acknowledging innovative methods and technologies, and marketing the energy-efficient products as well.

COMMERCIAL ACTIVITIES

Market Status and Market Changes

Pool heating and domestic hot water applications continue to be the predominant end-uses for active solar systems. In 2004, approximately 1,270,580 square meters of collectors were shipped for pool heating and 47,245 square meters for domestic hot water. This represents a 25 percent increase in the pool heating market and a slight reduction in the solar domestic hot water market over the preceding year. The number of solar collector manufacturers has also decreased slightly, with the pool heating market dominated by a few companies. In 2004, 26% of all solar collectors were imported, mostly from Israel.

Passive solar market penetration estimates are not available; however, interest seems to be increasing, and high-performance building materials and improved design methods are increasingly accepted. Both residential and nonresidential passive solar buildings appear to be gaining in popularity. The glass industry continues to sponsor R&D on improved glazing, including work on electrochromic materials and reduced heat loss window designs.

The market for photovoltaics is increasing, especially in the residential sector. It is estimated that approximately 53,900 kW (peak) of PV modules were shipped for the residential market in 2004, representing approximately 30% of total shipments. Grid-interactive systems represent the single largest end-use market for PV technology.

OUTLOOK

Near-term federal funding for solar building technologies is expected to hold steady overall, but the amount going to the core research efforts of the program is decreasing. Due to earmarks in the appropriations process, funds are being directed to specific efforts rather than addressing the multi-year planning priorities of the program. There is an increased awareness of the central role that solar building technologies can play in achieving domestic and international environmental objectives. For example, the High- Performance Buildings Research serves as a model for Buildings for the 21st Century—a strategic planning framework that will guide DOE's efforts to implement its whole-building approach for all its programs. A whole-building focus will facilitate achievement of environmentally sound, low-energy buildings and, in the future, buildings that are net-energy producers.

Solar buildings activities should continue to advance through administration efforts such as the Solar Decathlon, where great visibility and awareness is being achieved with consumers, industry, and politicians.

Within the buildings sector, the trend toward single building codes and increased use of performance-based compliance should increase the opportunities for the adoption of solar technologies in new construction. Consumer interest in "green" or environmentally friendly buildings and sustainability should also increase the market for solar buildings. Furthermore, national retail organizations have seen the value of building a "green" corporate image. Several have translated this interest into buildings that incorporate solar features along with other environmental design decisions. Builders are also joining the green/sustainable building movement.
In 2005, the US Green Buildings Council kicked off a pilot for residential new construction LEED rating, which incorporates credits for active and passive solar. This will increase visibility and hopefully increase builder use of these technologies.

Within the federal sector, various agencies are committed to increasing the use of solar technologies in their operations. Improvements in the procurement process will facilitate use of solar design know-how and strategies for federal buildings.

With the growth of Renewable Portfolio Standards (RPS) in many states, a number of utilities and state regulatory bodies have expressed interest in ensuring that renewable energy remains an important component of their energy supply mix. Many green pricing programs now exist nation-wide that enable consumers to earmark utility payments for purchases of energy from renewable energy sources. Additionally, a number of states have established set-aside requirements, typically in the millions of dollars, for energy efficiency and renewable energy purchases.

The key to ensuring that these trends and opportunities turn into concrete results—a significant increase in the number of solar buildings—is developing strong partnerships among the various groups: building owners, solar product manufacturers, designers, builders and developers, utilities, and various government organizations. If partnerships occur, and the promised technology and design advancements can keep pace with expectations, solar buildings will play a much larger role in the energy future of the United States.

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IEA Solar Heating and Cooling Programme Tasks (*current Tasks)

Task 1	Investigation of the Performance of Solar Heating and Cooling Systems
Task 2	Coordination of Solar Heating and Cooling R&D
Task 3	Performance Testing of Solar Collectors
Task 4	Development of an Insolation Handbook and Instrument Package
Task 5	Use of Existing Meteorological Information for Solar Energy Application
Task 6	Performance of Solar Systems Using Evacuated Collectors
Task 7	Central Solar Heating Plants with Seasonal Storage
Task 8	Passive and Hybrid Solar Low Energy Buildings
Task 9	Solar Radiation and Pyranometry Studies
Task 10	Solar Materials R&D
Task 11	Passive and Hybrid Solar Commercial Buildings
Task 12	Building Energy Analysis and Design Tools for Solar Applications
Task 13	Advance Solar Low Energy Buildings
Task 14	Advance Active Solar Energy Systems
Task 16	Photovoltaics in Buildings
Task 17	Measuring and Modeling Spectral Radiation
Task 18	Advanced Glazing and Associated Materials for Solar and Building Applications
Task 19	Solar Air Systems
Task 20	Solar Energy in Building Renovation
Task 21	Daylight in Buildings
Task 23	Optimization of Solar Energy Use in Large Buildings
Task 22	Building Energy Analysis Tools
Task 24	Solar Procurement
Task 25	Solar Assisted Air Conditioning of Buildings
Task 26	Solar Combisystems
Task 28	Solar Sustainable Housing
Task 27	Performance of Solar Facade Components
Task 29	Solar Crop Drying
Task 31	Daylighting Buildings in the 21st Century
*Task 32	Advanced Storage Concepts for Solar and Low Energy Buildings
*Task 33	Solar Heat for Industrial Processes
*Task 34	Testing and Validation of Building Energy Simulation Tools
*Task 35	PV/Thermal Solar Systems
*Task 36	Solar Resource Knowledge Management
*Task 37	Advanced Housing Renovation with Solar & Conservation
*Task 38	Solar Air Conditioning and Refrigeration
*Task 39	Polymeric Materials for Solar Thermal Applications