

## TASK 7 OF THE IEA PV POWER SYSTEMS PROGRAM – ACHIEVEMENTS AND OUTLOOK

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**ABSTRACT** Since January 1, 1997, Task 7 is active within IEA's PV Power Systems Program. Objective of Task 7 is to enhance the architectural quality, the technical quality and the economic viability of PV systems in the built environment and to assess and remove non-technical barriers for their introduction as an energy-significant option. Task 7 is an international collaborative programme, linking PV developments of Europe, the US, Japan and Australia to each other. The work in Task 7 concentrates on assisting the long-term development of building integrated PV, as well as on contributing to the short term marketing opportunities. The Task will be completed end of 2001. This paper presents information about the various achievements of the Task, as well as an outlook towards future international collaboration in the field of PV in the Built Environment.

**Keywords:** Building integration– 1; R&D Policies– 2; Implementation– 3

### 1. INTRODUCTION

The value of building integration for the introduction of grid connected PV is recognised world-wide. Programs, aiming at large-scale application of solar photovoltaic systems as integrated power producing elements of buildings are carried out in Japan, Germany, the US, Australia and in many other regions of the world. Such programmes generally are based on the expectation that, within 10 to 20 years, PV will be able to become an important renewable energy source, even though PV now is still more expensive than traditional power sources. Programmes are also based on the concept that integrating PV into the built environment offers advantages when compared to large, centralised, solar power plants. Building integrated PV (BIPV) offers clean, silent and virtually maintenance free power on site. Solar modules can displace building materials. Grid interconnections can be made on-site, limiting additional wiring and infrastructure costs.

BIPV does not only offer perspectives for the long term, however. PV systems are installed today by building owners who appreciate the added value of solar roofs and facades, and who are willing to pay a premium for PV.

Based on the understanding of the need for international collaboration in the field of PV in the built environment towards long-term cost effectiveness as well as towards the development of concepts for the challenging



**fig 1** Fire Station Houten, the Netherlands – PV integrated into the overall sustainability concept of the building

and rapidly increasing market of today, the IEA PV Programme initiated a Task on this subject: Task 7.

IEA PVPS Task 7 gathers PV industry, architects and other specialists from a large number of countries, including those with the most ambitious and prominent PV roof plans: the US, Japan, Europe, Australia and Canada. Experts work together in a research and knowledge exchange programme aiming at enhancing building integrated PV. Task 7 started its work in January 1997, building on previous collaborative actions within the IEA (Task 16 of the Solar Heating and Cooling Program) and will complete its work end 2001. Task 7 works along three lines: architecture, technology and non-technical issues.

### 2. TASK 7 OBJECTIVES

The objective of Task 7 is to enhance the architectural quality, the technical quality and the economic viability of PV systems in the built environment. The objective is also to assess and remove non-technical barriers for their introduction as an energy-significant option.

It is expected that successful integration of PV systems into the built environment will contribute significantly to the future spread of PV. For this, active involvement of urban planners, architects and building engineers is required. Task 7 motivates the collaboration between these groups and PV specialists, utility specialists, PV and building industry and other professionals involved in PV.

Task 7 considers all grid connected systems other than classified as "ground based arrays". Primary focus of the Task is on the integration of PV into the architectural design of roofs and facades of residential, commercial and industrial buildings and other structures in the built environment (such as noise barriers, parking areas and railway canopies).

### 3. TASK 7 ACHIEVEMENTS

#### 3.1 Architecture

Architects are increasingly interested in BIPV. In order to assist newcomers, Task 7 has collected and evaluated

existing projects. Architectural criteria have been set by the Task Experts (table 1) and over three hundred projects have been collected in an internet database ([www.pvdatabase.com](http://www.pvdatabase.com)). The database gives a quick overview of PV projects with only key figures (size, location) and addresses of the building owner, architect and PV supplier. Main purpose of the database is to give architects and others easy access to a large number of projects, as references for new designs (figure 1).

At the end of the Task, a high-end book on PV and architecture will be published by the publisher IMAGES AUSTRALIA.

Task 7 assisted in the development of PVSYSY, a PC software package for the study, sizing and data analysis of PV systems. It is suitable for grid-connected, stand-alone and DC-grid (public transport) systems. It offers extensive meteorological and PV-component databases. PVSYSY is oriented towards architects, engineers, and researchers, and holds very helpful tools for education.

### 3.2 Technology

The integration of PV into new and existing buildings presents an exciting new market for manufacturers of roofing and cladding products. A wide variety of PV products have been developed. These include simple structures supporting PV modules on flat roofs, PV tiles and shingles, complex curtain wall systems and architectural features such as sky-lights and window shades. The projects database (see picture 1) contains a section on products available on the market.

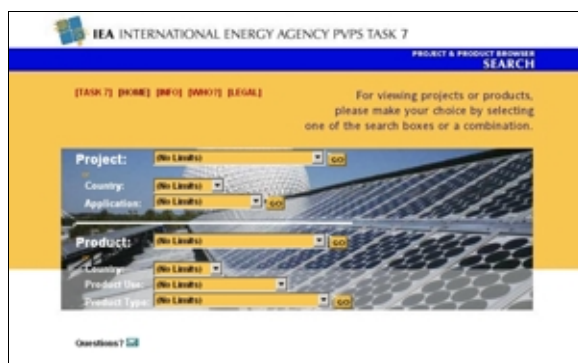
Task 7 not only deals with technologies for building integration. A design guide for non-building structures, such as street furniture and sound barriers, was issued in 2001. This guide provides a number of design strategies to enhance the design and appearance of non-building structures in the built environment [1].

### 3.3 Opportunities for new product developments

In May 2001, Task 7 organised a workshop for PV and building industry focusing on identifying opportunities for new product developments. Proceedings of this workshop are available from Ecofys as well as on the Task 7 website. Some of the findings from this workshop:

1) *product options* – the choice remains between standard products (high volume, mainstream process (large projects/DIY) and custom made products (specialist, project teams).

2) *market trends* - houses and commercial buildings vs. large scale PV power plants. Value market (green energy,



**fig 1** Opening page of the Task 7 project database, containing more than 300 projects world-wide.

**Table 1** Overview of Task 7 Architectural Criteria

<b>1. NATURALLY INTEGRATED</b>
<i>The PV system is a natural part of the building. Without PV, the building would be lacking something - the PV system completes the building.</i>
<b>2. ARCHITECTURALLY PLEASING</b>
<i>Based on a good design, does the PV system add eye-catching features to the design</i>
<b>3. GOOD COMPOSITION</b>
<i>The colour and texture of the PV system should be in harmony with the other materials. Often, also a specific design of the PV system can be aimed at (e.g. frameless vs. framed modules)</i>
<b>4. GRID, HARMONY AND COMPOSITION</b>
<i>The sizing of the PV system matches the sizing and grid of the building</i>
<b>5. CONTEXTUALITY</b>
<i>The total image of a building should be in harmony with the PV system. On a historic building, tiles or slates will probably fit better than large glass modules</i>
<b>6. WELL-ENGINEERED</b>
<i>This does not concern the watertightness of PV roof, but more the elegance of design details. Have details been well-conceived? Has the amount of materials been minimised? Are details convincing?</i>
<b>7. INNOVATIVE NEW DESIGN</b>
<i>PV is an innovative technology, asking for innovative, creative, thinking of architects. New ideas can enhance the PV market and add value to buildings</i>

green building, green image) remain essential elements.

3) *new products* - enforced interaction with building industry still needed; key elements: standardisation, low-cost, low-risk / high-yield.

An overall overview of the presentations and outcomes of the workshop is available from the Task 7 homepage.

### 3.4 Non-technical barriers

What problems will the introduction of building integrated photovoltaic systems (BIPV) encounter before being able to enter the market on a large scale? Within the framework of Task 7 a literature study was conducted. More than 200 literature sources world-wide were screened on non-technical problems for the application of PV in the built environment and renewable energy in general and strategies to overcome these [2].

Non-technical issues and potential solutions were summarised in a number of categories: financing; administration; architecture; communication; marketing and environment. They are categorised by target groups dealing with these problems: PV industry, building sector, energy sector, public government and financial sector.

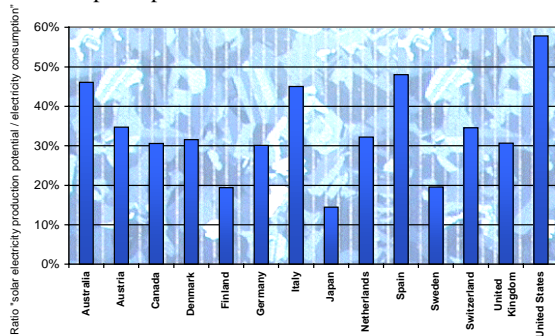
### 3.5 The BIPV potential

The main focus in the introduction of PV as renewable energy power source is on the use of building surfaces for PV installations. To assist the development of sound PV market introduction policies, it is valuable to have knowledge of achievable contributions of PV to renewable energy portfolios, given the availability of building surfaces.

In order to assess the potential for BIPV applications and opportunities, an analysis of the building stock with respect to suitability for BIPV deployment is required. Some building surfaces will have technical limitation, whereas other will have limited capabilities to generate PV

power due to bad orientation, inclination or shading effects. Task 7 has contributed to the development of methodologies for the determination of the technical potential for PV in the built environment [3].

Overall findings are that - if only building surfaces are used that generate more than 80% of the maximum solar power - the ratio between BIPV solar electricity production and current electricity consumption vary from 15 to almost 60 % throughout IEA countries. There are 18 m<sup>2</sup> roof area per capita potentially useable for PV in Central Western Europe. For the US or Australia, this figure is approximately 36 m<sup>2</sup>, whereas in Japan only 8 m<sup>2</sup> are available per capita.



**fig 2** Achievable levels of solar power production from PV roofs and façades in IEA countries. Levels are expressed in the ratio "solar electricity production potential / electricity consumption", given a solar yield criterion of 80% and a PV system efficiency of 10%.

### 3.6 Market Deployment Issues

Within the non-technical barriers framework, Task 7 has prepared a report on market deployment issues [4]. The core objective of this report is to determine the criteria for successful market deployment strategies for the broader dissemination of grid-connected PV systems in the built environment. The report is based on an analysis of strategies applied by different countries and entities during the last 20 years (see table 2).

### 3.7 The Demosite

Demosite is an international demonstration centre for PV building elements established by Task 7 in Lausanne, Switzerland. It provides comprehensive information on photovoltaic integration for architects, builders, authorities and other interested parties. Demosite hosts demonstration systems from a large number of Task 7 member countries. Two sites are available: a group of concrete pavilions that host facade and tilted roof products from various manufacturers and a flat roof, on which several integration systems specific to that environment are presented. All systems are displayed full-size, outdoors, and connected to the grid.

### 3.8 Design Competition

PV's have the potential to supply significant part of our electricity requirements and are expected to become increasingly visible in the built environment in the future. However integrating PV in the built environment should enhance that environment, rather than detract from it. The Task 7 design competition aimed to encourage the design of well-integrated and well-designed PV products. Architects,

**Table 2** Selected market deployment programmes

Year	Programme name
'82	US Net metering
'87-now	DE REN
'91-'95	DE 1000-Dächer-Programm
'91-2000	CH ENERGIE 2000
'92-'94	AT 200 kW PV-Programm
'92-'99	Kostendeckende Vergütung
'93-'97	US SMUD PV pioneer I
'94-now	JP Residential PV promotion programme
'94-now	ES Royal Decree
'94-now	DE Sonne in der Schule, SONNEonline
'96-now	DE RWE Umwelttarif
'96-now	CH Solarstrombörse
'97-now	NL Heading into the Solar age together
'97-now	CH Solarstrom vom E-Werk
'97-'01	DE Solarbörse Berlin
'99-now	AT Sonnenschein
'99-now	DE 100,000 Dächer-Programm
'99-now	NL SOLARIS
'99-now	US California's emerging renewables buydown programme
'99-now	AU PV Rooftop Programme
'00-now	DE Neues Einspeisegesetz (EEG)

engineers, designers and students of these fields with an interest in renewable energy, good design and the built environment were encouraged to enter the competition.

The competition was organised by Halcrow Gilbert on behalf of Task 7 Sponsors included Shell International Renewables and Shell Solar. A book of results is available from Halcrow Gilbert [5].

### 3.9 Training and education

There is a large need for high-quality training and education materials and programs for architects and system designers. Task 7 has developed a set of training materials, together with a proposed course lay-out, for training courses in the field of building integrated PV.

## 4. OUTLOOK

Within Task 7, work has concentrated on architecture and technology. Overviews of the state-of-the art have been prepared and published. International collaboration has also assisted in the development of new concepts and projects.

Project sizes are increasing. Customers are shifting from the Innovators to the Early Adopters, a new market



**fig 1** Fire Station Houten, the Netherlands – PV integrated into the overall sustainability concept of the building

segment with different needs and approaches. Overall, three main lines for a follow-up have been distinguished:

1. The building level. Focus on an holistic approach with PV as an integral part of a total RE building package. In particular applicable to high-quality commercial buildings and innovative residential projects. Mostly carried out on a project-by-project scale. A follow-up of Task 7 could work on improving the integration of PV into such projects. Architectural issues, building planning and processes, energy design issues play an important role.

2. The community level. Focus on the opportunity for PV to provide an energy solution on the neighbourhood level. Issues: design considerations for different climatic areas, interactions on the community and utility level, and technical implications.

3. The (national) market level. Focus on large-scale introduction of PV with marketing and financing schemes. Architectural issues play only a limited role, most systems are installed by end-users on existing property. Warranties, performance, reliability, standardisation and information & dissemination play an important role.

**Table 4** full list of Task 7 activities

<b>Subtask 1 – architecture</b>
<u>1.1 Documentation of high-quality projects</u> <i>evaluation and selection of existing PV projects</i>
<u>1.2 Case studies</u> <i>design and construction of new systems</i>
<u>1.3 Book of examples</u> <i>high-quality, focus on architecture</i>
<u>1.4 Design tools</u> <i>survey of existing tools, recommendations for new tools</i>
<b>Subtask 2 – technology</b>
<u>2.1 Commercial building integration concepts</u> <i>new integration concepts for commercial buildings</i>
<u>2.2 Residential building integration concepts</u> <i>new integration concepts for residential buildings</i>
<u>2.3 Integration in non-building structures</u> <i>design considerations for non-building structures</i>
<u>2.4 Guidelines, standardisation, certification and safety</u> <i>building codes and certification schemes</i>
<u>2.5 PV/T</u> <i>systems combining heat and electricity production</i>
<u>2.6 New electrical concepts</u> <i>new concepts such as direct DC use and AC modules</i>
<u>2.7 Reliability</u> <i>long-term operational performance issues</i>
<u>2.8 Interconnection issues</u> <i>follow-up of the activities of PVPS Task V</i>
<u>2.9 Electrical design issues</u> <i>architectural guidelines for electric design of PV</i>
<b>Subtask 3 – non-technical barriers</b>
<u>3.1 Barrier assessment</u> <i>barriers to usage of BIPV by targeted groups</i>
<u>3.2 Potential</u> <i>evaluation of the technical potential</i>
<u>3.3 Economics</u> <i>analysis of the economics of PV in buildings</i>
<u>3.4 Marketing and publicity strategies</u> <i>successful marketing of BIPV to targeted audiences</i>
<b>Subtask 4 – dissemination</b>
<u>4.1 Demosite</u> <i>operation and expansion of the Demosite in Lausanne</i>
<u>4.2 International Solar Electric Building Conference</u>
<u>4.3 International Ideas Competition</u> <i>architectural ideas competition for PV in buildings</i>
<u>4.4 Dissemination strategies</u> <i>use of new media for dissemination of Task results</i>
<u>4.5 Training and education</u> <i>BIPV training schemes for practising system designers</i>

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Within each line, both new target groups need to be addressed as well as the groups already participating, though the emphasis is different. For all levels, participation of building industry is required. On the building level, however, innovative products suitable for sustainable buildings are required whereas on the (national) market level low-cost solutions with well-understood warranties are required. The building level will require participation of fore-running architects, whereas the community level will require more emphasis on urban design and planning.

#### FUTHER INFORMATION

- Task 7: [www.task7.org](http://www.task7.org)
- PV Project Database: [www.pvdatabase.com](http://www.pvdatabase.com)
- Demosite: [www.demosite.ch](http://www.demosite.ch)
- IEA PV Power Systems Programme:  
[www.iea.org/tech/pvps/home.htm](http://www.iea.org/tech/pvps/home.htm)

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