#### STATUS REPORT OF TASK 7 OF THE IEA PV POWER SYSTEMS PROGRAM

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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. During the first three years of the Task, the work has resulted in a number of deliverables. Most noteworthy are the PV Project Database, a BIPV product overview and the Task 7 Product Design Competition. This paper presents information about the various deliverables, as well as an outlook to new projects which are planned by Task 7 for the next two years.

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 around the world. Rooftop programs, aiming at large-scale application in the next century are carried out in many countries. It is generally expected that within 10 to 20 years, PV will be able to contribute substantially to the renewable energy production, even though PV now is still more expensive than traditional power sources. Building integrated PV 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.

Innovations in building integrated PV therefore aim at long-term cost effectiveness, as well as on providing the products and services for the challenging and rapidly increasing market of today. It is exactly here were we need outstanding designs, intelligent products and new marketing initiatives. And it is exactly here where Task 7 focuses its work on.

Task 7 gathers PV industry, architects and other specialists from a large number of countries, including those with the most ambitious and prominent solar roof plans: the US, Japan, Europe, Australia, Canada and Korea.



fig. 1 Integrating PV into existing dwellings (picture courtesy R.Schropp; project Bear Architects)

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 axes: architecture, technology and non-technical issues.

### **Architecture**

Market enhancement requires acceptance of PV by builders, architects and users. The physical characteristics of PV products for integration in buildings must meet architectural requirements (colour, size, materials). The challenge for the PV R&D community together with architects and builders is to develop and demonstrate high-quality integration concepts that meet the industry's objectives as well as the architectural needs for buildings.

### The technology of building integrated PV

Technologies nowadays available for the integration of PV into buildings are, in general, too expensive for large scale introduction. Cost reductions can be achieved by carefully redesigning the PV support structure, but also by optimising the technical and electrical integration of the PV system into the built environment.

# The assessment and removal of non-technical barriers

A number of non-technical barriers exist that impede the implementation of PV in buildings. Assessment and removal of these barriers will result in enhancement of both the near-term and the long-term PV market.

# 2. BUILDING INTEGRATION

In buildings, photovoltaics can be installed on a wide range of surfaces and be integrated into materials such as glazings, rooftiles or facade elements, opening up the possibility of combining energy production with other functions of the building envelope, such as rain protection, sun shading and heat generation. Cost savings achieved through these combined functions can be substantial, for example in using photovoltaics instead of expensive

conventional facade systems, the cost of which might in any case be equal to the costs of the PV modules. Similarly, products are now available for conventional housing which replace traditional tiles, slates or shingles and blend harmoniously into the neighbourhood.

Using buildings to generate electricity makes sense, as high-value land then performs a dual function. Electricity is generated at the point of use, which avoids transmission and distribution losses, and, if the system is grid connected, reduces the utility's capital and maintenance costs.

Building integration implies however not only the mounting of PV modules onto roofs or facades. Real integration can be much more. It includes all the steps incorporated in the process of erecting or renovating buildings, starting with the planning, proceeding through the production of the construction materials, right through their operating lifetime and eventual recycling. Multiple integration does not produce multiple costs. Rather, if it is done the right way, it results in multiple savings. Saving of landscape, cladding materials, engineering effort and so on have all been mentioned often, yet further steps of integration have not yet been exploited to its full lengths.

# 3. TASK 7 ACHIEVEMENTS

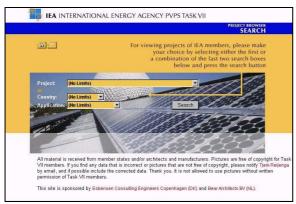
#### 3.1 Architecture

More and more architects are becoming interested in building integrated PV. In order to assist these newcomers, Task 7 has collected and evaluated existing projects. Architectural criteria have been set by the Task Experts and over three hundred projects have been collected in a database on the Task 7 homepage (<a href="www.Task7.org">www.Task7.org</a>). 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.

For the evaluation of projects, a set of seven architectural criteria was developed by the architects of Task 7 (see table 1). These criteria may guide architects when designing PV projects.

# 3.2 PVSYST

Task 7 assisted in the development of PVSYST, 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



**fig 2** Opening page of the Task 7 project database, containing more than 300 projects world-wide.

# Table 1 Overview of Task 7 Architectural Criteria

### 1. NATURALLY INTEGRATED

The PV system is a natural part of the building. Without PV, the building would be lacking something - the PV system completes the building.

### 2. ARCHITECTURALLY PLEASING

Based on a good design, does the PV system add eyecatching features to the design

# 3. GOOD COMPOSITION

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)

#### 4. GRID, HARMONY AND COMPOSITION

The sizing of the PV system matches the sizing and grid of the building

### 5. CONTEXTUALITY

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

#### 6. WELL-ENGINEERED

This does not concern the watertightness of PV roof, but more the elegance of design details. Have details been wellconceived? Has the amount of materials been minimised? Are details convincing?

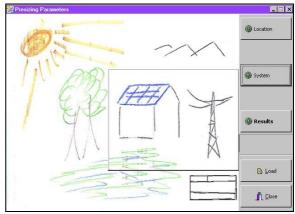
# 7. INNOVATIVE NEW DESIGN

PV is an innovative technology, asking for innovative, creative, thinking of architects. New ideas can enhance the PV market and add value to buildings

meteorological and PV-component databases.

PVSYST is oriented towards architects, engineers, and researchers, and holds very helpful tools for education. It contains several project levels:

- Preliminary design: an easy and fast tool, essentially developed for architects, allowing for grid and stand-alone system pre-sizing.
- Project design: performing detailed simulation in hourly values, includes an easy-to-use expert system, which helps the user to define the PV-field and to choose the right components. Economical evaluation (investment, annual cost and energy price) is also proposed.
- Data analysis: offering means for importing measured hourly data in almost any ASCII format, with facilities for displaying these data in hourly, daily or monthly values. Comparisons between measured data and simulation, which provide a very sensitive tool for analysing the real system behaviour, it's basic parameters and it's misrunnings.



**fig 3** Opening page of PVSYST, simulation tool for grid-connected and stand-alone PV systems.

## 3.3 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

Under the auspices of Task 7, a PV Integration Concepts Workshop was held at the École Polytechnique Fédérale de Lausanne (EPFL) in Lausanne on 11th and 12th February 1999. The objectives of the workshop were to assess the 'state of the art' of building integrated PV systems and to identify opportunities for the development of existing or new PV products and systems which address the short-comings of existing products and systems or exploit new openings for building integrated photovoltaics.

The workshop proceedings contain a world-wide overview of products for integrating PV into roofs and facades, giving descriptions and product information in a standardised format.

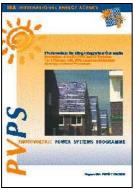


fig 4 Proceedings of the BIPV products workshop

# 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.

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 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



**fig** 5 Three of the Demosite pavilions, demonstrating different PV roof integration systems

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.

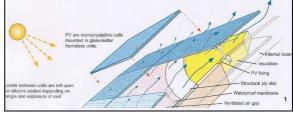
### 3.6 Design Competition

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, 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.

Entries were grouped into the following categories:

- Sloped roof products
- Flat roof products
- Façade products
- Other building products, e.g. shading devices
- Non-building products
- PV products recently released onto the market

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.



**fig 6** The overall winner of the Task 7 Product Design Competition: PV panels as a ventilated rainscreen system over a light weight stressed-skin timber construction by Robert Webb of Robert Webb Associates, UK. The judges admired the overall concept for the building and its consideration for environmental and passive solar issues in addition to electrical generation. The design had a holistic approach and spanned a number of categories.

#### 4. OUTLOOK

During the first three years of 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.

Within the remaining 2 years of Task 7, this work will be enhanced towards the assistance in further maturing building integrated PV. A full overview of activities is presented in section 5.2. A number of planned activities are described here in more detail.

## 4.1 Roof and facade integration

Following the success of the first workshop in Lausanne, Task 7 is preparing a design workshop for the actual assessment of opportunities for the design and development of innovative concepts for integrating PV's into roofs and facades.

In addition, Task 7 will publish a renewed product overview for roof and facade integration. This report is scheduled for the beginning of 2001.

### 4.2 Non-building structures

Within the built environment, there are many opportunities for the integration of PV into non-building structures, e.g. canopies, sound barriers, street furniture and other elements.

Task 7 aims to contribute to the development of such non-building structures from the design and construction point of view, where many of the architects and system designers working within Task 7 have appropriate experience. A design guide will be produced, together with a workshop on non-building structures to be held in Stockholm on September 6, 2000.

# 4.3 Non-technical barriers

The assessment of non-technical barriers and development of strategies to remove such barriers is becoming increasingly relevant for the implementation of PV in buildings. Following the survey of barriers, Task 7 is working on the analysis of the value of building integrated PV, the analysis of the technical potential for BIPV and the

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analysis and development of marketing strategies for the introduction of PV. An overall report on these findings is expected to be one of the final outcomes of the Task, towards the end of 2001.

#### 4.4 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 started the development of a set of training materials, together with a proposed course lay-out, for training courses in the field of building integrated PV.

# 5. FUTHER INFORMATION

- Task 7: www.task7.org
- PV Project Database: via Task 7 website
- Demosite: www.demosite.ch
- IEA PV Power Systems Programme:

www.iea.org/tech/pvps/home.htm

# Table 3 full list of Task 7 activities

# Subtask 1 - architecture

- 1.1 Documentation of high-quality projects evaluation and selection of existing PV projects
- 1.2 Case studies

design and construction of new systems

1.3 Book of examples

high-quality, focus on architecture

1.4 Design tools

survey of existing tools, recommendations for new tools

# Subtask 2 - technology

2.1 Commercial building integration concepts

new integration concepts for commercial buildings

- 2.2 Residential building integration concepts new integration concepts for residential buildings
- 2.3 Integration in non-building structures

design considerations for non-building structures

- 2.4 Guidelines, standardisation, certification and safety building codes and certification schemes
- 2.5 PV/T

systems combining heat and electricity production

2.6 New electrical concepts

new concepts such as direct DC use and AC modules

2.7 Reliability

long-term operational performance issues

2.8 Interconnection issues

follow-up of the activities of PVPS Task V

2.9 Electrical design issues

architectural guidelines for electric design of PV

# Subtask 3 – non-technical barriers

3.1 Barrier assessment

barriers to usage of BIPV by targeted groups

3.2 Potential

evaluation of the technical potential

3.3 Economics

analysis of the economics of PV in buildings

3.4 Marketing and publicity strategies

successful marketing of BIPV to targeted audiences

# Subtask 4 – dissemination

4.1 Demosite

operation and expansion of the Demosite in Lausanne

- 4.2 International Solar Electric Building Conference
- 4.3 International Ideas Competition

architectural ideas competition for PV in buildings

4.4 Dissemination strategies

use of new media for dissemination of Task results

4.5 Training and education

BIPV training schemes for practising system designers