

TASK 10 – URBAN SCALE PV APPLICATIONS

INTRODUCTION

The workplan for Task 10 is designed for flexibility towards the fast growing and emerging PV market. Task 10 work was initiated in January 2004 at which time the annual PV market was shy of 500 MW per year. Early estimates indicate that the 2008 market may exceed 5 GW. The Task's work was targeted at a wide array of stakeholders, realizing that this market requires new financial relationships beyond the network industry and their customers, as well as integration into traditional operations and planning of the broader stakeholder group involved in the urban environment. Solar Cities and multi-party utility scale business models are using the results of Task 10 and all PVPC products to assure benefits to all stakeholders.

Task 10 had a 5 year planned period of work, but was extended for six months. There were delays of resource commitment to the Task, but during the third year additional resource commitments were made through the PVPS and the European Commission project titled PV in Urban Policies: a Strategic and Comprehensive Approach for Long-term Expansion, PV-UP-Scale. PV-UP-Scale intended to expand Task 10 country contributions to include more European countries not formally participating in Task 10 (Netherlands, Spain, Germany and UK), enhance some current contributions (Austria and France), while utilizing the Task 10 participants to broaden the market perspectives most important to the European Commission. The results of Task 10 and PV-UP-Scale represent a broad range of work which will continue to facilitate creative solutions in the urban energy market.

OVERALL OBJECTIVE

The objective of Task 10 is to enhance the opportunities for wide-scale, solution-oriented applications of PV in the urban environment as part of an integrated approach that maximizes building energy efficiency and solar thermal and photovoltaics usage. Value analysis, policy incentives, analysis tools as well as system design and integration that have proven successful in the participating countries will be developed to the extent possible into a uniform international set of tools for the global market. This will be accomplished through:

- making connections between the building design and development industry;
- deriving recommendations for stakeholders to remove barriers to mass market uptake of photovoltaics;
- developing system components, design and applications with the largest global market penetration potential, including aesthetic values as well as the mechanical and energy related values;
- identifying gaps in currently available information and developing products to fill those gaps;
- developing materials and holding events targeted at meeting the needs of specific groups of stakeholders; and
- providing continuous communication, promotion and education throughout the period of the task.

Photovoltaics in the urban environment

Lessons learnt from large scale projects

Bruno Gaiddon
Henk Kaan
Donna Munro



Fig. 1 – Joint PV-UP-Scale and Task 10 Urban Planning Book.

In line with the objectives, the short term goal (5 years post) of the Task is to have a clear definition of the global market and all associated values, resulting in stakeholders considering urban scale PV in their respective spheres of activities. The Task's long term goal (10 years post) is for urban-scale PV to be a desirable and commonplace feature of the urban environment in IEA PVPS member countries. With traditional energy costs rising and PV costs declining this goal seems achievable even with the unstable economy. In the stakeholder list below, goals as related to stakeholders has been included.

APPROACH

There are four subtasks in Task 10. The total range of deliverables has been designed comprehensively to include and meet the various needs of the stakeholders who have been identified as having value systems which contribute to urban-scale PV. The deliverables are designed to optimise usefulness to multiple stakeholders. Through developing and producing these deliverables, Task 10 will contribute to achieving the vision of mainstreaming urban-scale PV.

The comprehensive list of targeted stakeholders is:

- **Building Sector:** builders and developers, urban planners, architects, engineers, permit and code authorities;
Goal – Solar technologies and energy efficiency – whole building energy design – is an option in all design, development and construction and a market differentiation as a standard feature.
- **End-Users:** residential and commercial building owners;
Goal – Full awareness of the financial, operational, and comfort features resulting in whole building energy design.
- **Government:** supporting, regulatory and housing agencies;
Goal – The benefits to government revenue, infrastructure and

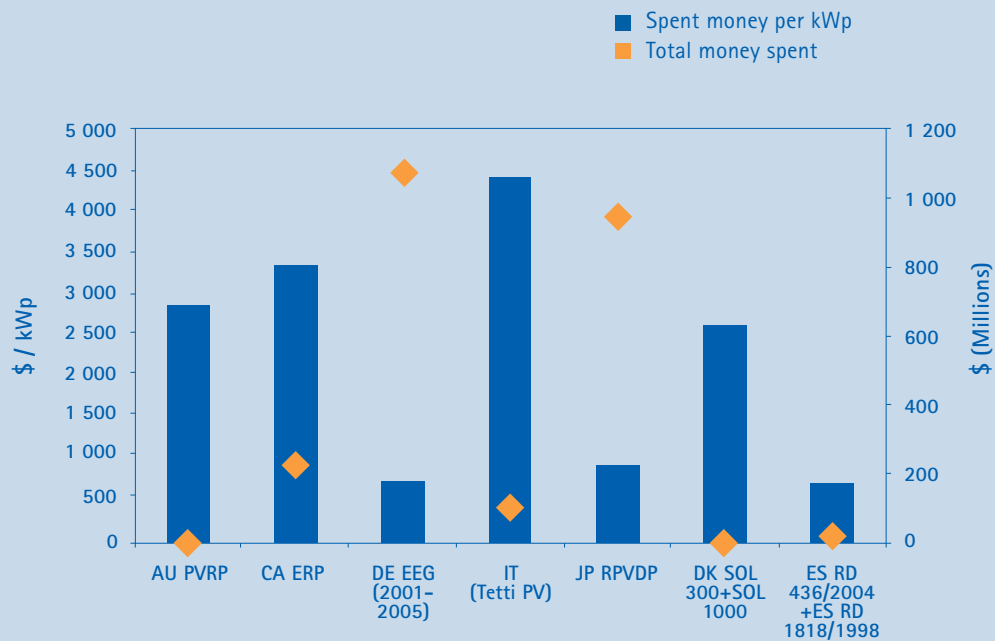


Fig. 2 - PV Market Drivers Success Criteria -Costs to the Public. From report titled, "Promotional Drivers for PV."

services, such as jobs, gross regional product, import/export, environmental and security are metrics to the development and revisions to energy market transformation policies.

- Finance and Insurance Sector:** Banks, insurance companies, loan for houses;
 Goal – The benefits and risks from both a credit and disaster perspective are included in the development of rates. As insurance companies base rates on the height above sea level of structures in a region, so could the resilience of the energy infrastructure influence rates.
- PV Industry:** system manufacturers, PV system supply chain, retail sector;
 Goal – PV industry has clear market knowledge, ensuring fair profitability throughout the supply chain, particularly to the influence of other stakeholders. An additional goal is internationally consistent standards and certification (to the extent possible, with differences clearly defined), as well as access to retail energy consumers.
- Electricity Sector:** network and retail utilities; and
 Goal – A full understanding of the business and operational opportunities related to energy efficiency and solar technologies. The comparative economics of generation planning will include the full life cycle economics of both traditional network design and whole building design as well as the energy coordination benefits such as disaster resilience and demand side management.
- Education Sector.**
 Goals – Basic education will include alternative energy and the life cycle impacts and benefits of energy choices. Specialised education in the building, sciences, and engineering sectors will include alternative energy options.

SUBTASKS AND ACTIVITIES

SUBTASK 1: Economics and Institutional Factors

This subtask seeks to provide opportunities for stakeholders to look beyond a single-ownership scenario to the larger multiple stakeholder value. In this way, utility tariffs, community policy, and industry deployment strategy can be used to create scenarios which combine all stakeholder values to the PV system investor through

sustained policy-related market drivers. Austria is the subtask leader and is also the corresponding work package leader for the PV-UP-Scale project. Activities include:

Activity 1.1 Value Analysis

This activity will develop a value matrix of stakeholders by the extended value stream beyond the economic market drivers (the market drivers will be included), allowing individual stakeholders to realise a full set of values. Austria leads this activity. The report, "ANALYSIS OF PV SYSTEM'S VALUES BEYOND ENERGY" draft was completed and balloted in 2007. The report was available to the public in March 2008. An executive summary is under development for this report.

Activity 1.2 Barriers Resolution

Recommendations to stakeholders will be developed for removing barriers to mass market uptake of PV. Austria leads this activity. As the report for this activity has progressed, it has been determined that the barriers are dependent on market activity and drivers. Larger markets like Japan and Germany have very few barriers. This work will be completed this year.

Activity 1.3 Market Drivers

Building upon existing lessons learned with financing, policy, environmental and rate structure issues this activity will analyse the economic contribution of these market drivers and develop best practice scenarios. Austria leads this activity. The PV-UP-Scale report, "Economical drivers and market impacts of urban PV, 2" was completed in 2006. The expanded Task 10 report is currently being balloted. A major objective of this study is to analyse which measures consumer's willingness-to-pay and which policies are necessary to achieve a favourable change of the supply curve. The report defines and quantitatively measures five success criteria, one of which is cost to the public as shown in Figure 1.

SUBTASK 2: Urban Planning, Design and Development

This subtask focuses on infrastructure planning and design issues needed to achieve the vision of a significantly increased uptake

of PV in the urban environment. The subtask will integrate PV with standard community building practices. Switzerland leads this subtask.

Activity 2.1 Integrating PV Development and Design Practices

This activity will develop guidance for integrating PV into standard whole building design models, rating tools, and building development practices. Emphasis will be placed on the building integration properties of PV for efficiency gains.

This activity has been dropped from the work plan, because no resources were ever committed. However, it is still an important part of the overall need to reach the objective of mainstreaming PV and will be included as such in the final report.

Activity 2.2 Urban Planning

A guide will be developed for integrating PV and the whole community energy infrastructure element into urban planning practices through a guide providing processes and approach for setting quantifiable urban-PV goals and objectives in the planning process. Architectural considerations such as building aesthetics, land use, shading, and urban renewal opportunities for BIPV will be included as planning elements. Additionally, community energy use forecast and planning impacts related to the whole building approach and coordinated utility or community system load control to increase demand reduction and increase PV capacity value. Switzerland leads this activity.

There are three deliverables for this activity:

Norway has developed a model of criteria and indicators which are used to lead planners to solar energy choices. This will be completed this year.

Switzerland has developed a case study analyzing electricity purchasing conditions for the city of Neuchâtel to determine the economic consequences of including PV in forward electricity purchasing mix. This work is in the ballot stage and should be finalized this year.

Switzerland also developed a report of analysis of Task 10 countries aspects of urban planning as collected through a questionnaire of 17 cities. This report will finalise the balloting process this year. A joint Task 10/PV-UP-SCALE project, led by France, has gathered case studies on urban planning and design from start to implementation. This information has been developed into a book which includes 14 existing urban area plans and 8 future urban plans. Also included in the book are lessons technical guidelines, impacts of regulatory and financial framework, as well as visions for the future. The book has been finalized and sent to the publisher, with an expected publication date of September 2009. See Figure 1.

SUBTASK 3: Technical Factors

This subtask concentrates on technical development factors for mainstream urban-scale PV. Large-scaled urban integration of BIPV systems faces technical challenges related to synergetic use as building material and for energy supply purposes. Other challenges



Pal-Town Jyosai-no-mori, located in Ota, Gunma, consists of 553 houses with PV systems, a total of 2,16 MW of PV power in the community. (2,6-5,0 kW/house). The Community-scale PV development serves as a test field for NEDO. The objective of the 5 year (FY2002-FY2007) test project is to demonstrate that a power system of several hundred residences, where each residence installs the PV system, can be controlled by the technologies developed in this program without any technical problems. All residences have data monitoring.

There are four research subject areas:

- 1) Development of technology to avoid restriction of PV output (including storage device trials on lithium-ion battery and electric double layer capacitor - EDLC)
- 2) Analyses and evaluation of higher harmonics
- 3) Analyses of mis-actuation of function to prevent islanding operation
- 4) Development of applied simulations including economic analysis

Fig. 3 – An excerpt from the Task 10 PV Communities Report.

involve the potentially negative impact on the grid and obstacles posed by the regulatory framework. The aim of this subtask is to demonstrate best practices and to advocate overcoming those barriers associated with extensive penetration of BIPV systems on urban scale. The deliverables focus on the broad set of stakeholders required to achieve the vision such as the building product industry, builders, utilities and PV industry. Japan leads this Subtask.

Activity 3.1 Building Industry/BIPV Products and Projects

By identifying the building material and energy use synergies of PV and of BOS as well as updating the existing Task 7 database of products and projects for BIPV, guidance will be developed for mainstreaming these products in the building industry. A major aspect of the building integration will be building energy management integration and coordinating energy use with lighting and HVAC systems to assure demand reduction and capacity value. Canada is the lead for this activity.

There are three deliverables for this activity:

The report, "Urban BIPV in the New Residential Building Industry," was completed and distributed electronically in March 2008. This report collected residential building statistics by country, analyzed processes for change in the building industry and calculated the potential for BIPV by country. It is available at www.iea-pvps-task10.org

The on-line version of the Task 7 database was updated to accept BIPV, public developments, and products. This was a PV-UP-Scale deliverable with contributions from Task 10. There are 250 new projects in the database at www.pvdatabase.org.

Japan developed the report on "Community-Scale PV: Real Examples of PV Based Housing and Public Developments," which includes 38 single family housing developments, multi-family housing and public building developments. Each development has a two page brief which can be used as a separate document and the main text of discussion summarizing the information. This is available at www.iea-pvps-task10.org and will also be included in the database above. See Figure 3.



Fig. 4 – Task 10 Experts in Langawi, Malaysia.



Fig. 5 – Task 10 Experts in Sydney, Australia.

Activity 3.2 Codes and Standards

This activity was initially planned to evaluate both electrical and structural codes as related to buildings. However, upon further investigation it was determined that this body of work should be a separate task. Instead the activity will develop a matrix of existing codes and standards and will be completed this year. Denmark is the lead for this activity.

Activity 3.3 Electricity Networks

This activity will analyse electricity network effects, benefits, impacts, and issues. Interconnection, operational effects, and market issues will be included. Japan leads this activity for Task 10 and Germany leads this activity for PV-UP-Scale.

The two deliverables for this Task 10 activity will be a comprehensive report and a visualisation tool. The report will include a matrix of the grid effects and impacts, guidelines and certification practices, counter measures and case studies. The report will be completed and currently being balloted. The Grid Effect Visualisation Tool is in a power point format and animates/narrates grid issues and solutions. The visual tool is completed and is available at www.iea-pvps-task10.org

PV-UP-Scale has developed a report on a network issue literature review, a report on utilities perception (developed through extensive utility interviews) and voltage drop software calculation. These deliverables are available at www.pvupscale.org.

Activity 3.5 Certification Practices

Certification practices will be reviewed and standard test procedures harmonized and transferred to the relevant stakeholders and standard committees. The US leads this activity. A set of documents developed by the US installer certification program in accordance with ISO/IEC 17024 Working Draft, "General Requirements for Bodies Operating Certification Systems of Persons," will be included as an annex in the report on network issues.

SUBTASK 4: Targeted Information Development and Dissemination

This subtask is focused on the information dissemination of all deliverables produced in Task 10. Some major accomplishments during Task 10's third year included the final drafts of reports in both Subtask 1 and 3. During the final 2007 Task 10 meeting, participants were asked to consider the remaining resources for Task 10, the work completed and expected relative to what types of products are most useful to achieve the Task 10 Goal of mainstreaming PV. Due to limited resources, the original plan of developing multiple stakeholder targeted products from each deliverable is not possible. The result of the discussion was to take an alternate approach to targeted products. All agreed that everything must be electronic, with high speed internet available almost everywhere. Along these lines, whenever possible, PowerPoint graphics of results and conclusions for each deliverable will be developed and posted. Each product will also be developed into tiered levels of detail.

- The first tier will be a one paragraph description that can be easily translated. The paragraph can be used for email notification of stakeholders and as the description on the front web page. The stakeholder targeted electronic notification was tested when PV-Up-Scale completed its first two reports on Grid Issues. France wrote a one paragraph description of the work and sent it to all French utilities. This resulted in a large increase of website activity specifically looking at these two reports.
- The middle level is an executive summary of results and conclusions, similar to the executive summary the European Photovoltaic Industry Association developed for the Energy Payback report which has proven much more popular than the full report.
- The full reports with analysis methodology and full appendices are the most detailed tier.

France is the Subtask leader, and is also the Work Package leader for the corresponding Work Package in the PV- Upscale project.

Activity 4.1 Educational Tools

The educational tool is a tool for posting both the start to finish process of BIPV installation as well as an information databank for related installation issues such as interconnection, net metering, and tender documents.

Activity 4.2 Competition

Lisbon successfully completed two urban ideas challenge competitions entitled "The Lisbon Ideas Challenge I and II." The final reports for these competitions have been completed.

TABLE 1 - LIST OF PARTICIPANTS AND THEIR ORGANISATIONS

COUNTRY	PARTICIPANT	ORGANISATION
Australia	Mr. Mark Snow	University of New South Wales
Austria	Mr. Reinhard Haas	Institute of Power Systems and Energy Economics Energy Economics Group Vienna University of Technology
	Mrs. Assun Lopez-Polo	
	Mrs. Demet Suna	
Canada	Mr. David Elzinga	NRCan/Climate Change Technology Early Action Measures/Ontario
Denmark	Mr. Kenn Frederiksen	Energimidt Erhverv A/S
France	Mr. Marc Jedliczka Mr. Bruno Gaiddon	HESPUL
Italy	Arch. Niccolo' Aste	Politecnico di Milano
	Mr. Michele Pellegrino	CER ENEA
	Mr. Carlo Zuccaro	CESI SpA
	Mr. Antonio Berni	ETA Florence
Japan	Mr. Keiichi Komoto	Environment, Natural Resources and Energy Mizuho Information & Research Institute Inc. Nihon University
	Mr. Tomoki Ehara	
	Mr. Shogo Nishigawa	
Korea	Mr. Hee-Jin Lim	Korea Photovoltaics Development Organization
Malaysia	Mr. Ahmad Hadri Harris	Malaysia Energy Center, PTM
European	Mr. Henk Kaan	Energy Research Centre of the Netherlands through EU, PV-UP-SCALE
Norway	Mrs Inger Andresen	SINTEF Civil and Environmental Engineering
	Mrs. Anne Grete Hestnes	
Portugal	Mrs. Maria João Rodrigues	Center for Innovation Technology and Policy Research Instituto Superior Técnico (Technical University of Lisbon)
	Mrs. Joana Fernandes	
Sweden	Mr. Mats Andersson	Energibanken AB
	Mrs. Anna Cornander	City of Malmo
Switzerland	Mr. Pierre Renaud	Planair SA
	Mr. Lionel Perret	
USA	Ms. Christy Herig	Segue Energy Consulting/Subcontractor to National Renewable Energy Laboratory

This is the official participant list for Task 10. However, through PV-UP-Scale, Spain, The Netherlands, Germany, and the United Kingdom have made contributions to the Task work.

**TABLE 2 – MEETING SCHEDULE
(2008 AND 2009 PLANNED)**

MEETING	DATE	PLACE
10 th Task 10 Technical Experts	March 3-4, 2008	Langkawi, Malaysia
11 th Task 10 Technical Experts	Nov. 24-25, 2008	Sydney, Australia
12 th Task 10 Experts Meeting	Week of May 11 th , 2009	Rome, Italy

Activity 4.4 Stakeholder Perceptions

This activity will analyse and assess the community, utility and customer perception and preferences regarding i) the security of energy, (including revenue protection) ii) certain and homogenous Quality and Safety levels. Additionally this activity will develop products in response to misconceptions such as energy required in manufacturing (Life Cycle Analysis). Denmark leads this activity.

Progress includes the report IEA-PVPS T10-01-2006 "Compared Assessment of Selected Environmental Indicators of Photovoltaic Electricity in OECD Cities," developed by France. The executive summary of this report as well as the country results were published by EPIA and are available on the European Photovoltaic Technology Platform website. This report was developed in response to the misconception of the energy required for PV manufacturing being more than ever produced in the operation of the system. The report did not perform lifecycle analysis, but rather took the most recent results, combined with solar energy availability to determine energy and environmental factors. Additionally, Denmark has developed a draft report on revenue protection which identifies ways to maximise the revenue from a PV plant regardless of size.

Activity 4.5 Continuous Communication

With France leading this activity under this subtask, as well as the similar work in PV-UP-Scale, the Task will continue to progress. A stakeholder meeting was held in Malmo, Sweden. Whereas most publications will be electronic, EPIA agreed to print the executive summary of the environmental indicators report. And the website and resources for Task 10 remain up to date.

INDUSTRY INVOLVEMENT

As Task 10 is completed, industry participation appears minimal relative to the technical experts participating in the Task. However, in individual countries and throughout Europe, it is evident that industry is giving feedback to Task 10. Also, industry uptake of Task 10 products is high, especially utilities and solar integration companies. The Activity under Subtask 1, entitled "Market Roadmap" was merged with the activity Market drivers because industry (EPIA and SEIA) felt that presenting the information as market drivers rather than a roadmap was more appropriate for Task 10. Both Lisbon Ideas Challenge I and II were supported by industry.

KEY DELIVERABLES (2008 AND 2009 PLANNED)

The following key deliverables were prepared and presented in 2008:

- Final Report "Community Scale Solar Photovoltaics: Housing and Public Development Examples"
- "Network Issues and Benefits Visual Tool"
- Final Report "Lisbon Ideas Challenge I"
- Final Report "Lisbon Ideas Challenge II"

The following key deliverables are planned for 2009:

- Report "Economic and Institutional Barriers"
- Report "Promotional Drivers for PV"
- Report "Municipal Utility Economics" and "Predictatool" for municipal utility forward purchasing
- Book "Photovoltaics in the Urban Environment"
- Report "Impacts & effects of PV connection, Guidelines & Network Operation Policies, Countermeasures & Technologies, and Case Studies" (including annexes of codes and standards and certification practices)