PHOTOVOLTAICS in 2010

PV 2010

A STRATEGIC PLAN FOR EUROPE

1. INTRODUCTION

Solar photovoltaics (PV) is the current commercially available energy technology offering the least negative impacts and significant environmental and social benefits.

These benefits include:

- PV is a clean electricity technology which avoids carbon dioxide greenhouse gas emissions (savings of over 50,000 tonnes in 1994).

- high energy ratio (energy used to manufacture PV can be generated by PV more than three times over)

- PV is the most suitable technology for urban on-site generation (e.g. on buildings, and sound barriers) with no additional visual intrusion, noise or exhaust emissions

- PV is in many cases the least cost solution to providing reliable energy to off grid applications in Europe and globally. There are thousands of occasionally occupied buildings in Scandinavia and remote homes in southern Europe electrified with PV.

- PV is the principal practical and economic technology for providing small amounts of electricity (for lighting, radio & TV) to the billion people in the developing world who now have no access to electricity

- Development of the European PV industry and market leads to employment creation throughout Europe over a wide range of new technology skills.

It is a European Union objective to stabilise Europe's carbon dioxide emissions at their 1990 levels by the year 2000 in order to counteract the threat of global warming. The European Union approved in 1993 the ALTENER programme which aims to develop the use of renewable energy sources in Europe and increase trade in renewable energy products internationally.

The ALTENER programme's specific target is to effect a 180M tonne reduction in carbon dioxide emissions by doubling the use of renewable energy sources by 2005. The programme aims to treble the production of electricity in Europe from renewable energy sources. Photovoltaics can play an important role in clean electricity production in Europe.

The strategic photovoltaic action plan presented here has been developed by the European Photovoltaic Industry Association (EPIA) after supply and demand side analyses and is an ALTENER supported project of the Directorate General for Energy of the European Commission. (DGXVII).

2. OBJECTIVES AND SCOPE

The objectives of the strategic plan is to create a framework for the sustainable growth of the European Photovoltaic Industry in partnership with the increased production of European and developing world electricity from a renewable energy source (photovoltaics) and to increase international trade in European PV products. The time frame considered is up to the year 2010.

The plan has been developed with due consideration of the ALTENER targets and also the conclusions and recommendations of other studies including The European Renewable Energy Study (TERES, DGXVII, 1993) and the conclusions of the 1994 Madrid conference an *Action Plan for Renewable Energy Sources in Europe* (DGXII, XIII, XV11, European Parliament STOA Programme).

The strategic plan has also been developed after a general invitation and discussion with the European PV industry to submit recommendations and prioritise initiatives.

3. STATUS OF EUROPEAN PHOTOVOLTAICS

The shipment of PV modules worldwide in 1994 was approximately 70 MWp - an increase of 15% on 1993. European companies (excluding European owned industries in the USA) increased their share of the market to just over 30% (22MWp) and produced more than the Japanese PV industry. The historic share of PV modules by European companies is shown in Figure 1 and the applications for which they were destined shown in Figure 2.

It is estimated that more than 2500 people are employed in the European PV sector. There are 13 principal PV module manufacturers in the EU15 and others in Croatia and Russia. The European Photovoltaic Industries Association (EPIA) represents the principal PV module suppliers and leading consultants.

The installed capacity of PV within the EU15 states at the end of 1994 was approximately 70 MW contributing approximately 0.06 TWh in 1994 a small fraction of the total European

electricity consumption (<0.005 %). However this percentage would save some 50,000 tonnes of carbon dioxide per year in comparison to being generated by fossil fuel plant.

The European PV industry is not only the fastest growing PV industry but also the most technologically advanced. For example European companies produce the most efficient PV modules (BP Solar Saturn modules), very cost effective wafers (Photowatt) and advanced cell technologies (e.g. Eurosolare). European companies are also at the forefront of new technology development such as Cadmium Telluride. European companies lead in small systems and consumer products (e.g. NAPS and Intersolar) and in value terms the European PV industry exceeds that of the main USA and Japan companies because the European companies are more active in systems as well as modules

Figure 1 Historic market share of PV producers

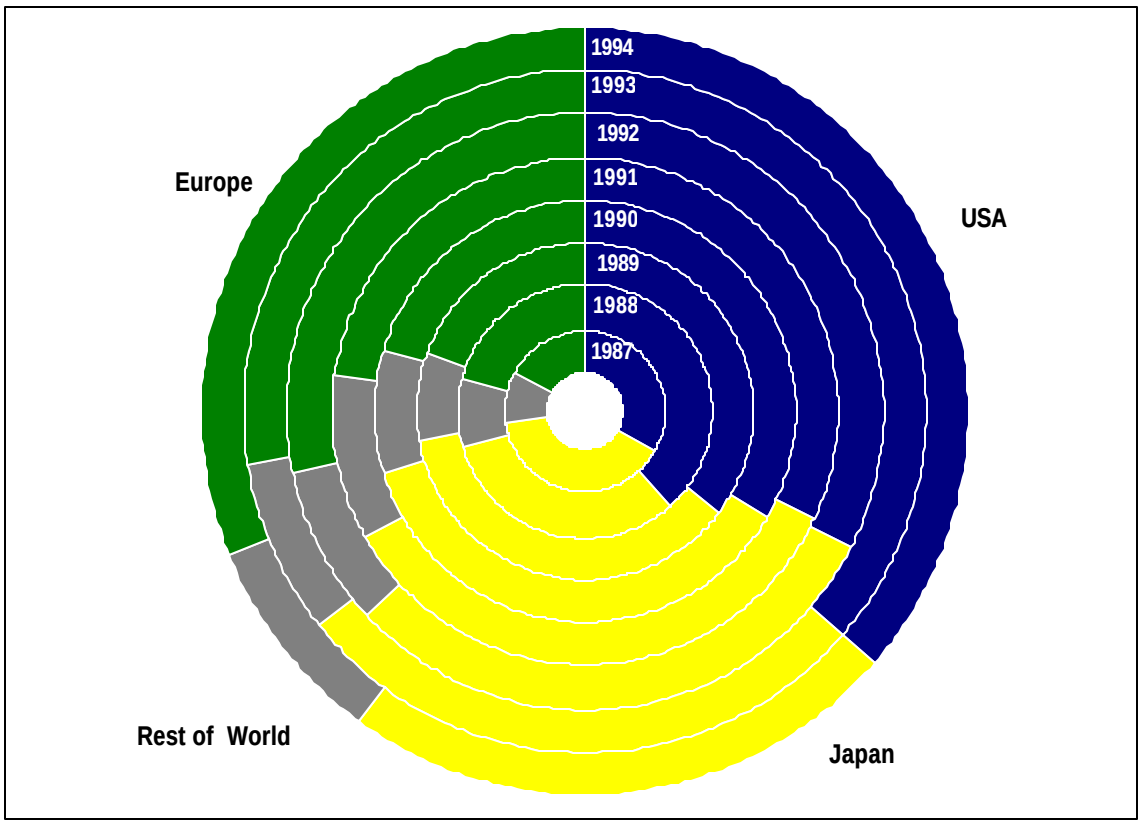
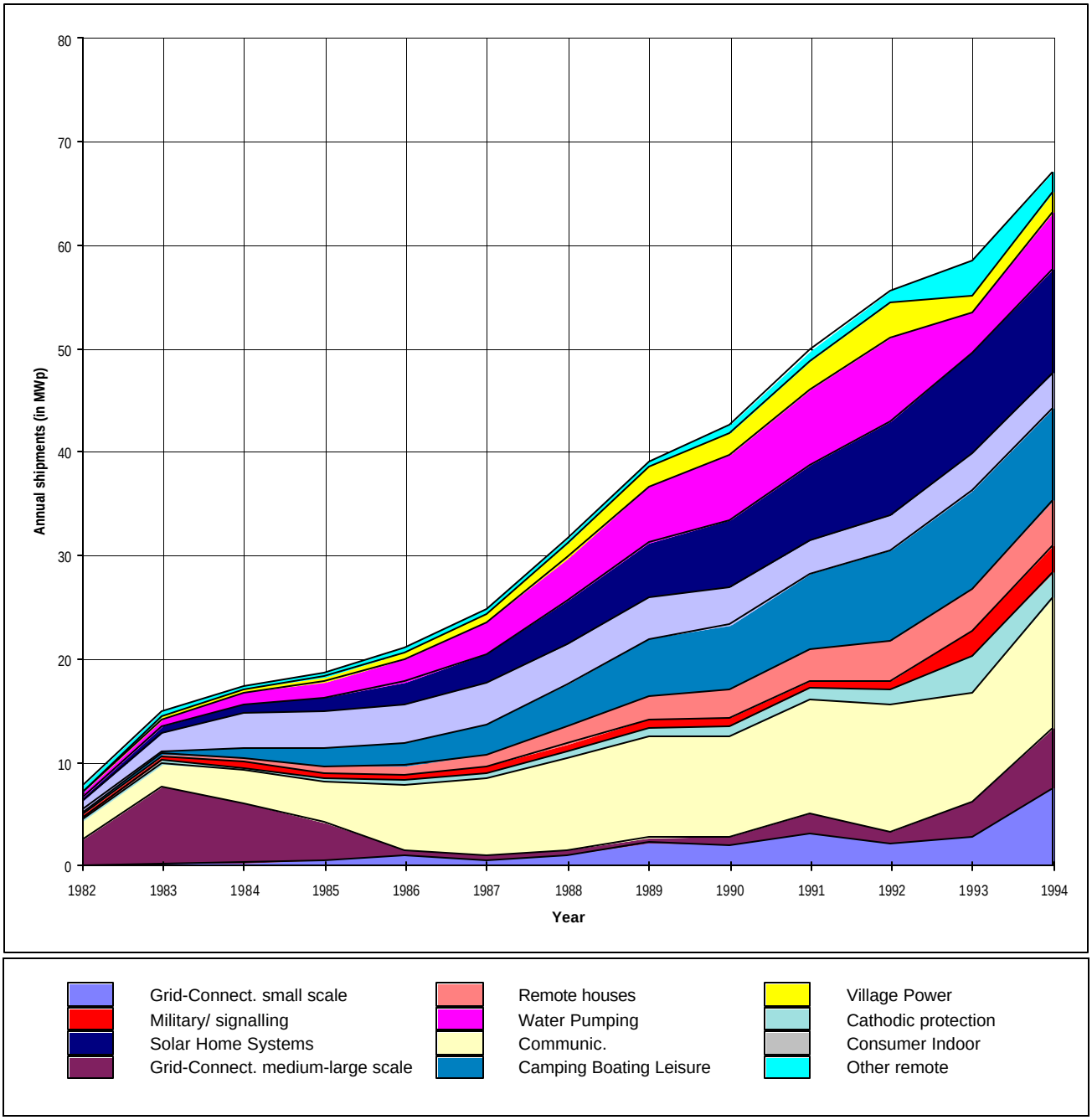


Figure 2 PV Module destination by application history



4. MARKET DEVELOPMENT ISSUES

4.1 Europe

The principal barriers to the more rapid dissemination of PV in Europe are summarised in Table 1 along with possible solutions to overcome these barriers.

Table 1 Barriers to the widespread use of photovoltaics in Europe

BARRIER	SOLUTION
Grid Connected	
High PV cost	-Transitional support through levies
	-Support for large-scale production facilities
High unit energy costs relative to conventional power plant	-Support for large scale production to reduce costs
	-Include external costs of conventional power
	-R&D on efficiency improvement
User uncertainty	-Demonstration and promotion (ALTENER and THERMIE
Regulatory grid connection barriers	-Legislation
Utility constraints:	
Interconnection needs	-develop and standardise utility connection
lack of demonstrated performance	-Demonstration and promotion
unattractive buy back prices	-transitional price support
Legislation not supportive of PV	-Carbon taxes, transitional levies, non-fossil fuel obligations required
Lack of awareness	-Architects and planners information programmes (ALTENER)
Lack of standards, utility certification	-Standardisation and utility certification programme
Stand Alone	
High PV cost	-Support for large scale production
lack of awareness of potential	-Information programmes (ALTENER)
Consumer reluctance	-Guarantee of performance
	-Industry charter
	-Education programmes
Subsidises diesel powered electricity in island communities	- Remove subsidies or support PV
Consumer Goods & OEM Market	
lack of awareness of OEM's	-OEM seminars
lack of know-how & skills in OEM's	-OEM seminars and training programmes

Table 2 Additional barriers in the non-EU, non-developing country markets

BARRIER	SOLUTION
International competition from USA and Japan	-Improve competitiveness on price, performance and product range

High cost of identifying market	-Export promotion support
High cost of servicing market	-Distributed manufacture and support

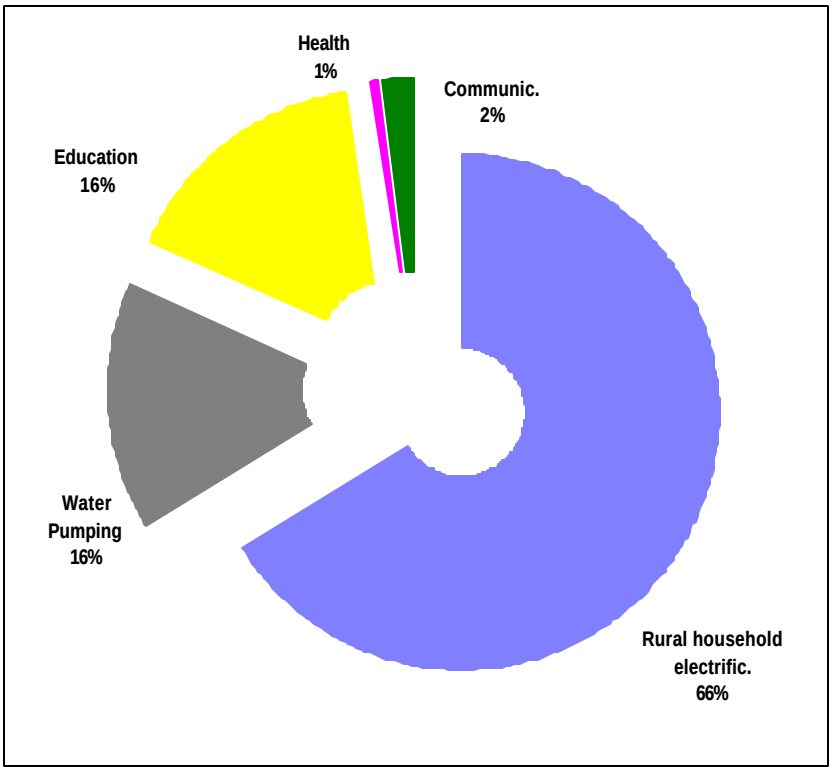
4.2 International Markets

In the international non-developing country markets the principal barriers to the development of the market for European photovoltaics are the same as for the European markets with two additional barriers. These additional barriers are the greater competition from the US and Japanese PV industry, particularly in their home markets and the high cost of seeking out projects and markets.

4.3 Developing World

The impact that photovoltaics can make on the developing world is potentially enormous. The proposed EU initiative *Power for The World: A Global Photovoltaic Action Plan* notes that there are more than 1 billion people in the developing world without electricity and that 10 Wp per capita is sufficient for survival, development and basic needs for lighting, water, health, education and social development. A market assessment of stand alone PV in the developing world suggests a potential market of 16 GWp with the applications as shown in Figure 4.

Figure 4 Developing world stand alone PV market potential



PV is acknowledged as the most practical and economic solution (on a life cycle and in some cases capital cost basis) to meet the energy requirements of the 1 billion people without electricity in the developing world. There remain significant barriers to market development however as summarised in Table 3.

Table 3 Barriers to the widespread uptake of European photovoltaics in the developing world

BARRIERS	SOLUTIONS
Lack of funds of many potential users	-International support
Lack of appropriate financing schemes	-Innovative finance schemes / credit
Price distortions	-Reduce subsidies on fossil fuels
Lack of awareness - decision makers	-Information programmes
Lack of awareness - users	-Information / advertising programmes
Lack of technical skills	-National / regional training programme
Lack of infrastructure support (eg. preventative maintenance, repair service)	-Ensure programmes are of critical mass to allow cost of infrastructure support -Integrated programmes
Lack of standardised products and quality control	-Product standardisation and certification -Product specification and monitoring
Institutional problems with project planning and implementation	-Facilitate longer term projects -Define responsibilities of organisations -Project management training
Import duties	-Lobbying
Government supported competition from US and Japanese PV industries	-EU supported programmes

5. PRIORITY MARKETS

5.1 Europe

A comprehensive demand side assessment of the PV market has been undertaken as part of the ALTENER PV2010 study and reported in Volume 3 of the study reports. As a result priority markets have been identified.

The recommended approach for Europe is that of significantly increasing the contribution of electricity generated from photovoltaics in Europe (and the developing world) in line with the ALTENER objectives thereby creating a sustainable photovoltaic industry that can maintain its internationally competitive position.

The priority application areas for Europe are shown in Table 4.The realisation of these targets, coupled with the cumulative installation of 200 MWp of PV by 2010 for "specialist" applications, including military/signalling, cathodic protection and communications purposes, would guarantee a total of 2000 MWp of PV capacity installed in Europe by 2010.

Table 4 Priority markets for PV in Europe - EU15

APPLICATION AREA	POTENTIAL (MWp)	CUMULATIVE TARGET IN 2010 (MWp)
PV roofs	620,000	900
PV facades on commercial and institutional buildings	in above	400
Other grid connect	-	400
Isolated buildings	150	100

5.1.1 PV Roofs

The generation of electricity by roof mounted photovoltaics is attractive because:

- generation is on-site thus reducing transmission losses and transmission costs
- there can be savings on avoided roofing tile costs
- there is no additional land usage for the power generation
- distributed PV has a more widespread and higher profile
- visual impact is limited (and sometimes enhances surroundings)

The installable PV capacity on European roof tops has been estimated as 618 GWp or approximately 1.6 kWp per inhabitant. The potential European electricity production could thus be as high as 500 TWh per year.

There has been significant PV roof top experience within European member countries. In Germany the 1000 roof programme generated 60,000 enquiries which resulted in 2,250 installations (1-6 kWp) during 1990-1994. The total installed power is approximately 6 MWp. In Austria a 200 kWp PV rooftop programme was launched in 1992. In 1994 Japan launched a 70,000 PV roof programme.

5.1.2 Commercial and institutional building facades

The benefits of distributed grid-connected photovoltaics on the facades of commercial and institutional buildings are similar to that of roof mounted PV with an additional benefit that often the building electricity demand profile is more closely matched with that of the solar energy resource (limited electricity requirements at night).

There have been several PV facades (also known as cladding or curtain walling) installed in Europe the most recent being the 1994 recladding of the University of Northumbria computer building at Newcastle, UK with 40 kWp of PV and opened in January 1995.

The building facade market is considered a priority market for European PV electricity production because of:

- the ability to benignly integrate PV into building elements
- the potential savings on conventional facade material used
- the relatively higher financial contribution the building users can make.
- many buildings are owned and operated by local and regional governments who may support the objectives of clean technology electricity generation
- it is an application of renewable energy in the urban built environment and be can applied in the renovation of large european cities (a specific area of interest of the EU 1994 Actions de Preparation, d'Accompagnement et de Support -APAS).

It should be noted that roof mounted systems are generally of greater interest in the lower latitudes of Europe whereas building facades (with the exception of PV sun-shades) are of greater interest in the higher latitudes (because of the lower solar altitude). The British Photovoltaic Association (PV-UK) recently proposed a 100 PV facade programme for the UK.

5.1.3 Other Grid Connect

In addition to building mounted grid connected PV there remains significant potential for photovoltaics:

- mounted on motorway and railway sound barriers
- grid-support and non-building mounted distributed PV

and in the longer term

- for multi-megawatt power plant in southern Europe

Noise abatement has become a major issue in many communities as new high speed rail links are introduced. At least two European railways are investigating combining sound deflecting barriers with the installation of photovoltaics.

5.1.4 Isolated buildings

It was estimated in 1987 that the total European (EU12) population that lives permanently or seasonally without electricity was approximately 1.2 million mainly in the isolated Mediterranean areas and that around 70,000 houses would be less expensively electrified with PV (totalling 50 MWp) than through grid extension.

With the isolated dwellings and occasionally occupied building market in Finland, Sweden and Austria along with island communities presently supplied by diesel fuelled generator sets in southern Europe a potential market of some 150 MWp of PV is estimated (after consideration that many summer houses in Scandinavia are already using PV systems).

The European isolated building market is considered a priority area because:

- the use of PV is often economic even without consideration of external costs

- many of the dwellings are in regions designated for regional EU support

5.2 Global Markets

The analysis of the global markets has identified priority regions and applications. These are summarised in Table 5.

These markets have been given priority with respect to a European PV Industry plan because they are markets that are presently underdeveloped and thus where concerted and co-ordinated market development is required.

In comparison there are established markets for the European PV industry in telecommunications, navigational aids, cathodic protection etc. where the market is already free and competitive. Developed regions such as North America, Japan and Australia are already key markets for many European PV companies and thus already being monitored.

Table 5 Priority applications and markets outside of Europe

APPLICATION	REGION	COMMENTS
Solar home systems	India	-very high recent growth -international support -60m ecu PV project underway
Solar home systems Health care systems	Indonesia	-proven market -World Bank GEF project initiated -50 MW government target
Solar home systems Industrial (telecomms, navaids etc.)	China	-high potential -indigenous industry outdated -World Bank projects under consideration
Solar home systems	Central Asia (CIS and Mongolia)	-high potential -many Nomadic families -international support developing -CIS PV industry underdeveloped
Solar home systems Health care systems Solar pumps	South Africa	-high potential -OPEC, US, EU support developing
Solar home systems Health care systems Solar pumps	Magrheb	-high potential -EU programme support -past initiatives (e.g. PV Euromed)
Solar home systems Solar pumps	Brazil/ Argentina & SouthAmerica	-high potential -relatively high income in some -rural areas
PV roofs and facades	OECD	-urban redevelopment - high level of interest

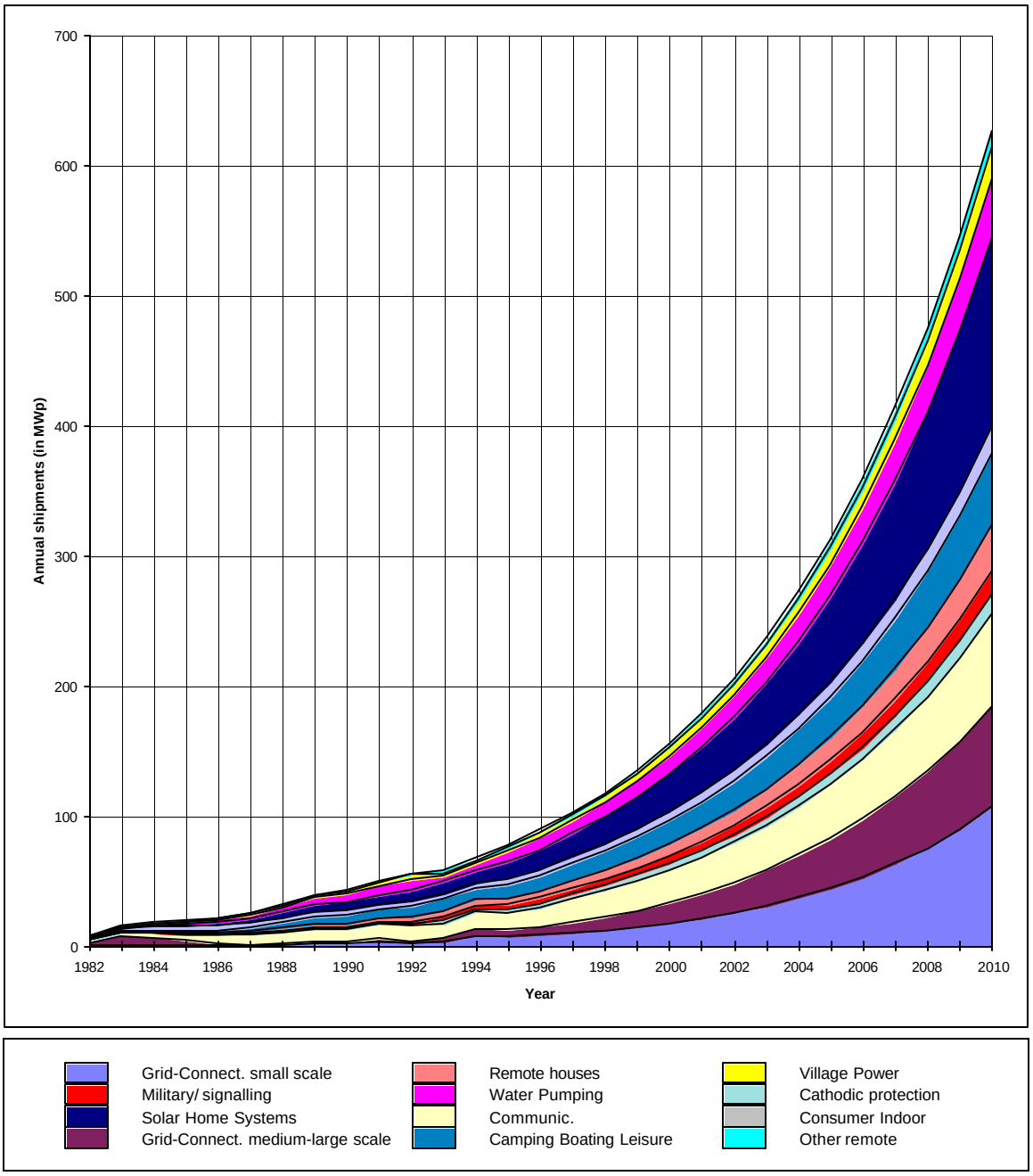
5.3 Forecast Of The Year 2010 Pv Market

A *business as usual* market forecast assuming a 15% growth in the market and the market segmentation as determined from analysis is shown in Figure 5. In this scenario annual shipments would reach 630 MWp/yr in 2010.

The largest two markets would be :

- solar home systems mainly in the developing world
- grid-connected small scale systems mainly in the industrialised countries

Figure 5 World PV Market forecast to the year 2010



6. ACTION PLAN

A strategic action plan is proposed here for the development of the European PV Industry and Market to create a framework for the sustainable growth of the industry and increased electricity generated from a clean energy technology. The plan calls for the following:

- Targets for installed PV in Europe by 2010
  - and resulting carbon dioxide saving contribution
- Target for European manufacturing capacity by 2010
  - and resulting employment generation
- Proposed programmes and recommended policies

6.1 The Year 2010 Targets

The proposed European photovoltaic targets for 2010 are summarised in Table 6.

Table 6 Proposed 2010 European photovoltaic targets

PARAMETER	YEAR 2010 TARGET
Cumulative installed PV capacity in Europe	2000 MW - PV roofs 900 MW - PV facades 400 MW - PV grid plant 400 MW - Isolated homes 100 MW - Other 200 MW
Manufacturing capacity	1000 MW/yr
European share of international PV trade	>40%
Solar homes supplied to the developing world	20 million

These targets are considered realistic and have been proposed taking into consideration the various barriers and proposed programmes and policies to overcome these barriers and the needs for a sustainable European PV industry.

For comparison targets and forecasts by other EU reports are presented in Table 7.

Table 7 European PV targets

PARAMETER Year	1994	PV2010 2010	ALTENER 2005	TERES Existing 2010	TERES Proposed 2010	MADRID Plan 2010
Installed PV in Europe (MWp)	70	2,000	500	1,135	6,730	16,000
PV Electricity (TWh/yr)	<0.05	2.0	1.0	1.25	7.4	
Manufacturing Capacity (MW/yr)	35	1000	-	-	-	2,000
European share of international trade in PV	>30%	>40%	-	-	-	500 MWp
CO2 savings mill. Tonnes/yr	<0.05	2		1	7	15

TERES = The European Renewable Energy Study, 1993 (DGXVII)
MADRID = Action Plan for Renewable Energy Sources in Europe , 1994 (DGXII, DGXIII, DGXVII)

It should be noted that to achieve 2000 MWp installed in Europe by 2010 requires a consistent 20% annual growth in European PV installations. (An annual growth of 45% is required to achieve the Madrid plan)

A European PV manufacturing capacity of 1000 MWp/yr requires an investment of some 2,000 MECU.

6.2 Proposed Programmes

6.2.1 European 500 MW grid connect programme

Lack of awareness and confidence among the general public and decision makers are important barriers to the diffusion of PV technology. The comparatively high capital cost of PV systems is also a significant obstacle to acceptance of PV, but module costs are heavily linked to production volumes, which in turn are linked to consumer demands.

PV is therefore in something of a “Catch 22” situation. Until the technology proves its value and gains consumers’ confidence, demand is likely to remain low and production costs will remain high.

Programmes of support for PV - whether these be at the European level, funded through the Commission of the European Union, national level, with funding from national government, or at the local level where regional authorities or individual states provide the financial backing - are essential to overcome this trend.

Government backing of PV, in the form of grants or subsidies for new installations, will serve not only to increase the number of practical demonstrations but also will be seen as an endorsement of PV power generation systems.

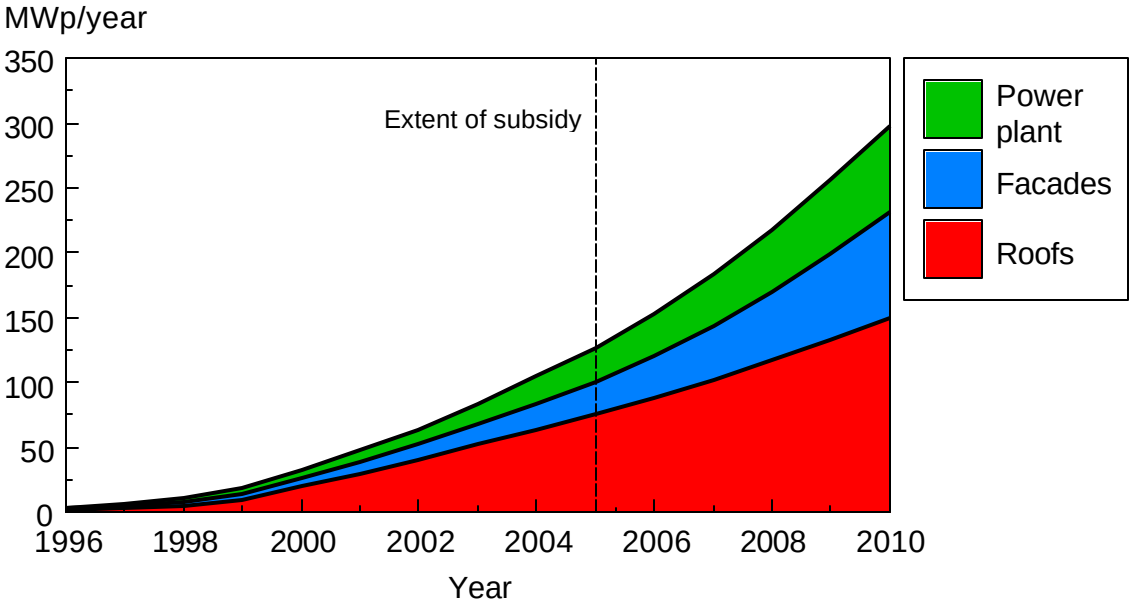
The benefits of PV as a source of electricity in Europe are more than sufficient to justify a major programme of public support, aimed at developing the market to the targeted 2000 MWp installed by 2010 and a commercially sustainable market of around 350 MWp/yr.

To meet the overall target of 2000 MWp installed in Europe by 2010 a 10 year (1995-2005) transitional market enablement programme is proposed with the following key projects:

- 100,000 PV roof project
  (average size = 3 kWp, total = 300 MWp)
- 2,000 PV building facades project
  (average size = 50 kWp, total = 100 MWp
- large scale power plant
  (0.1-1 MWp range, total = 100 MWp)
  (including noise barriers)

The scale of the programme is shown in Figure 6

Figure 6 Annual installations of the proposed European 500 MW grid connect programme



The 10 year enablement programme is appropriate in that it would result in a total of 500 MWp installed by the year 2005 thereby meeting the existing Altener 2005 PV target. It would also enable 25% of the PV2010 goal to be reached.

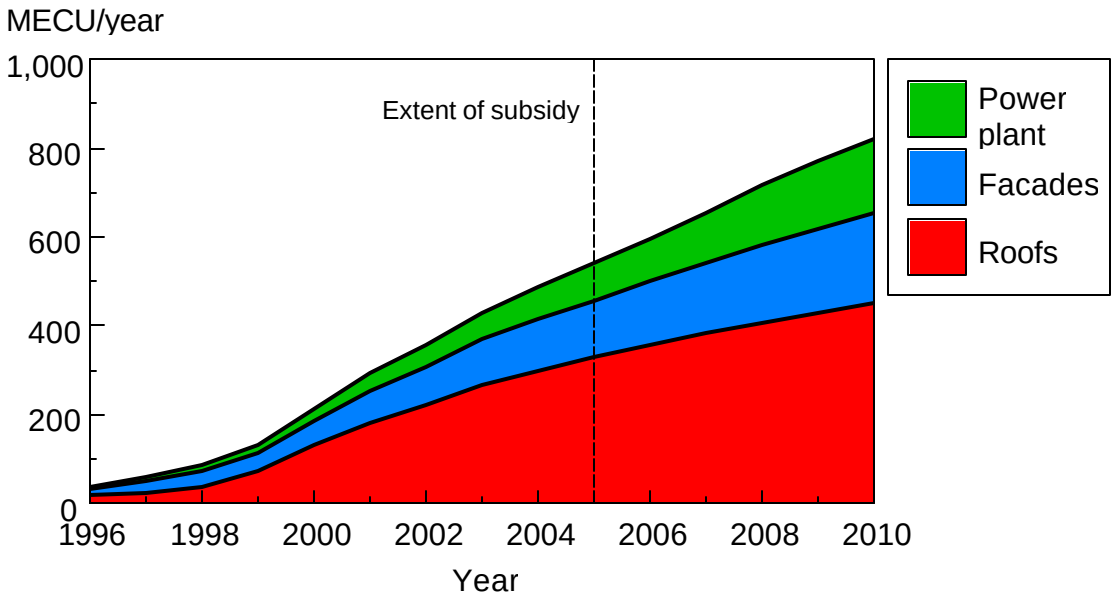
Importantly, the programme will assist in taking PV from the stage where only the "innovators" - those willing to take a risk with a comparatively new technology - will buy such systems, to the stage where the market is more mature, system costs have decreased and there is no longer a perceived risk in accepting the technology.

The proposed public funding support would be a relatively large component of the cost, initially (49%) dropping off linearly to zero in 2006.The expected annual investment costs for each of the three sectors (Roofs, Facades and Power plants) during the period of transitional support are defined in Table 8. The total cost of the programme is shown in Figure 7

Table 8 Annual investment costs by sector of the EU 500 MW grid connect project

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Annual roof costs	(MWp)	19.0	26.0	39.7	72.6	133.1	183.2	224.3	268.2	299.2	328.5
Annual facade costs	(MWp)	14.0	2.1	33.7	40.2	53.8	71.9	85.4	101.1	117.5	128.5
Annual plant costs	(MWp)	6.0	11.1	15.5	19.2	26.8	37.5	46.8	58.6	72.3	84.3
Support level	(%)	49	45	40	35	30	25	20	15	10	5
Roof subsidy	(MECU)	9.3	11.7	15.9	25.4	39.9	45.8	44.9	40.2	29.9	16.4
Facade subsidy	(MECU)	6.9	11.3	13.5	14.1	16.1	18.0	17.1	15.2	11.7	6.4
Plant subsidy	(MECU)	2.9	5.0	6.2	6.7	8.0	9.4	9.4	8.8	7.2	4.2
Programme cost	(MECU)	19.1	28.0	35.5	46.2	64.1	73.2	71.3	64.2	48.9	27.1

Figure 7 Overall cost of the EU 500 MW grid connect project



The proposed contribution from public funds would be at three levels:

- European 60%
- National 30%
- Local 10%

The public funding required for transitional support over the proposed 10 year programme is shown in Figure 8 where it is assumed the support falls linearly from 49% in 1996 to zero in 2006. This is summarised in Table 9.

Figure 8 Transitional support contributions to the proposed EU 500 MW grid connect project

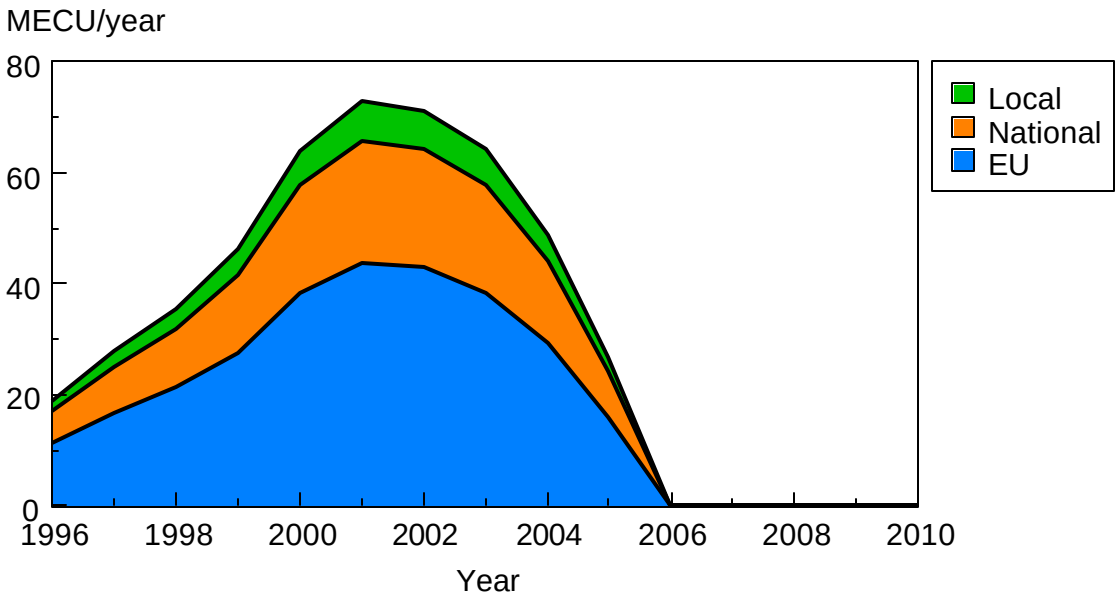
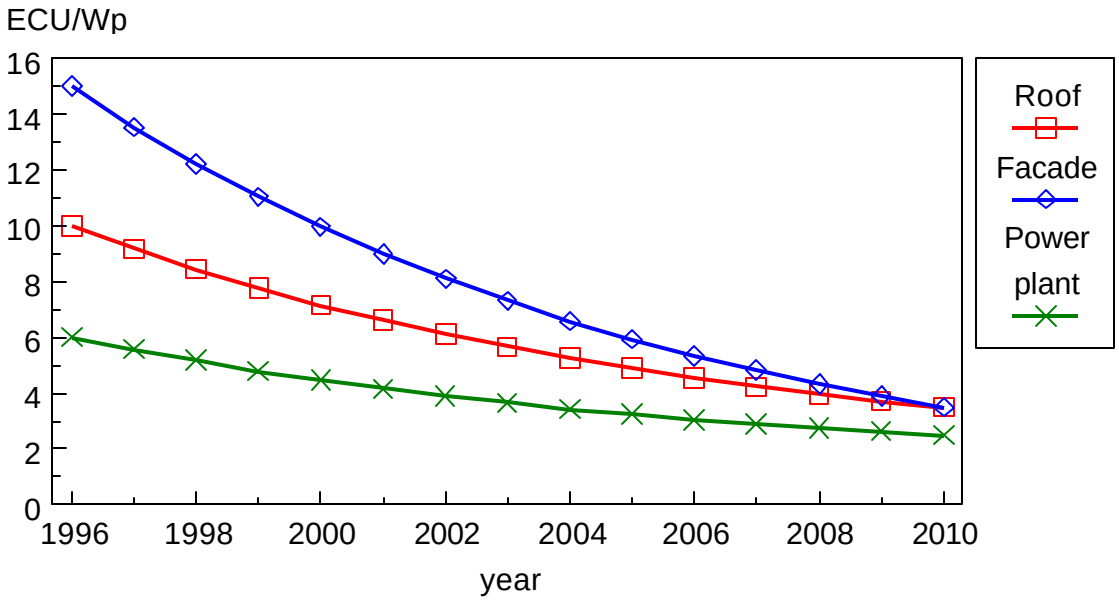


Table 9 Costs of the 500 MW grid connect programme

	MILLION ECU
Total costs PV roofs	3617
Total costs PV facades	1545
Total costs other grid connect	1038
Total programme costs	6200
Local contribution	48
National contribution	143
EU contribution	287

At the end of the 10 year programme, PV module costs are expected to have decreased to around 2.50 ECU/Wp. The practical experience gained in producing, selling, installing, operating and maintaining an ever increasing number of systems will move the technology from a specialist field to a more customary one which will help to reduce overall system costs significantly. The system price predictions are illustrated in Figure 9.

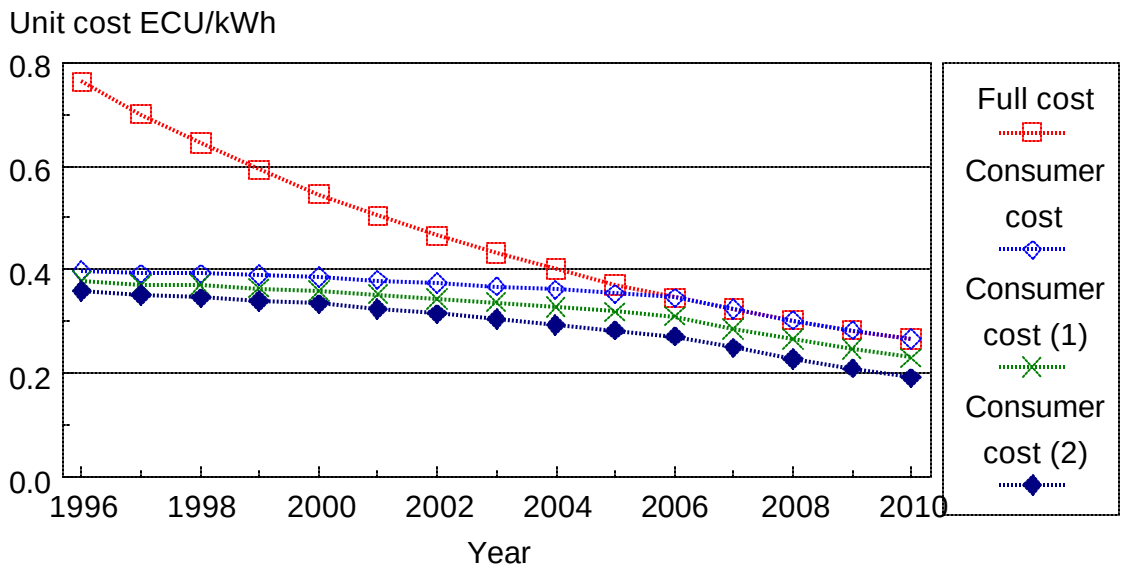
Figure 9 Price predictions for grid connect systems



When the transitional support programme ends, it is expected that the grid-connect PV industry will have reached a suitable stage of maturity and will have achieved the cost reductions needed to enable it to sustain further market growth without external support. Continuation of the growth after 2005 together with non publicly supported installations would account for the other 75% of the proposed 2000 MWp installed in Europe by 2010.

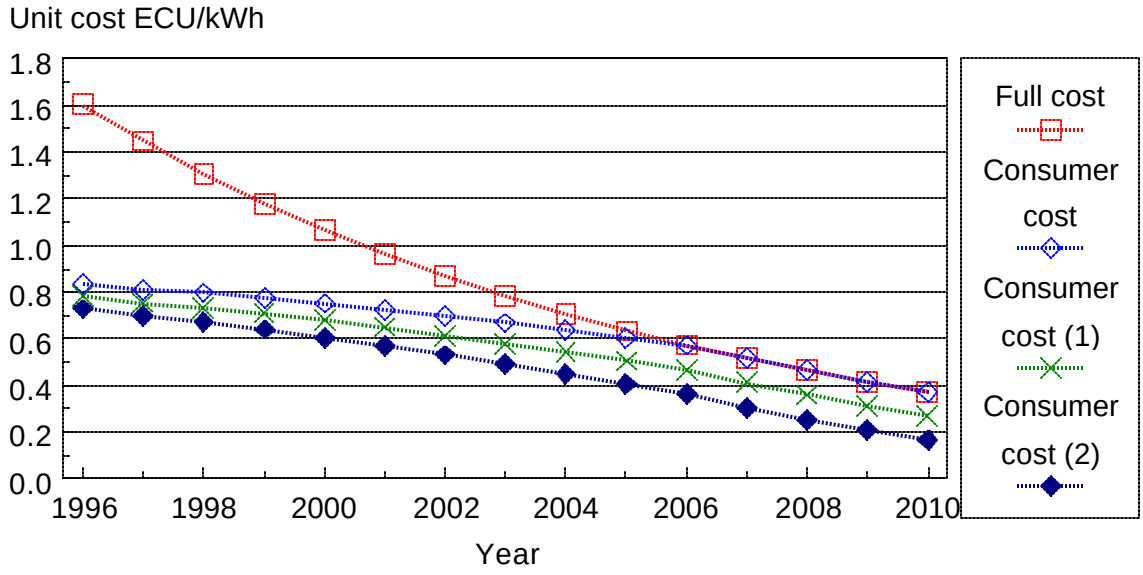
Figure 10 and Figure 11 illustrate the unit energy costs from roof mounted grid connected PV systems in southern Europe and facade systems in central Europe. The beneficial effect of the transitional support for the consumer is clear. The final resulting unit energy costs in the year 2010 are competitive with conventional energy costs if external environmental and social costs are taken into consideration for conventional fossil fuelled electricity.

Figure 10 Unit Energy Costs: roof integrated systems in southern Europe



Note: (1) Avoided roofing costs at 50 ECU/m2
(2) Avoided roofing costs at 100 ECU/m2

Figure 11 Unit energy costs: building facades in central Europe



Note: (1) Avoided cladding costs at 100 ECU/m2
(2) Avoided cladding costs at 200 ECU/m2

It is proposed that many of the building mounted installations would be high profile buildings and innovative installations attracting public attention and support and encompassing urban development and renovation.

It is proposed that the 500 MW grid-connect project also be supported by a programme of enabling and market development measures notably:

for building mounted grid connected systems

- country by country review and recommendations on utility legal constraints
- promotion to architects and planners (which is already being done as part of the ALTENER in some countries
- provide product development support (continuation of JOULE programmes in this area)
- guarantee of performance for customer
- guarantee of electricity buy-back at selling price
- tax incentives (such as accelerated depreciation)

for grid-connected PV plant generally

- a non fossil fuel obligation on utilities to generate a proportion of output with specified new renewable energies
- standardisation and certification of utility connected equipment
- a levy on fossil fuel electricity as currently applied by some regions in Europe

6.2.2 European 100,000 Isolated building project

One area of activity in the EU APAS programme is a survey of non-electrified houses in Southern Europe. It is proposed that this activity be followed with a target electrification with PV of 100,000 isolated buildings throughout the EU but mainly in Southern Europe. The barriers to widespread dissemination of stand alone PV in Europe have been outlined earlier in this report. To counter these barriers it is proposed that a series of enablement measures be introduced under Altener or regional EU programmes. The proposed measures are:

- Promotion of PV to potential users
- financial incentives at the regional or national level

In addition it is proposed that the PV industry seek to establish methods of guaranteeing the performance of systems to build up user confidence in the systems.

6.2.3 Developing World Programme

The EU *Power for the World* Initiative, the *Solar Energy Initiative* of the World Bank and Global Environment Facility (GEF) programmes in India and Zimbabwe demonstrate the growing support for the use of PV in developing countries to meet basic and development needs.

EPIA fully supports these initiatives and recommends that a 2010 target of 20 million European enabled (supplied or funded) solar lanterns or rural household (solar home systems) are installed by 2010 with an approximate installed PV capacity of 1000 MWp.

The key elements recommended for the developing world programme are:

- co-operation between the EU, World Bank, UN, GEF, ADB and others in financing and implementing the major development programmes

- Establishment of regional revolving funds and appropriate financing schemes supported by industry, NGO's and international development agencies to operate in co-operation with developing country organisations. An EPIA lead organisation to develop projects should be considered

- The European industry should play or more active role in formulating World Bank, ADB, UNDP, GEF PV developing country projects by providing advice and seconding personnel to major programmes

- Enhanced infrastructure support to PV programmes in developing countries (training, project management, support centres)

The European PV industry is experiencing aggressive competition at present in the developing world market, particularly from the US PV industry. The US industry has established close links with USAID and US DoE to develop the market in key areas such as India, Indonesia, Mexico and Southern Africa. The US DoE has also sponsored seconded positions in World Bank departments. In Indonesia for example the market was developed by Europe but is now being commercialised by the US industry through US supported programmes.

A temporary transitional support programme is thus recommended to counter the US industry market initiatives as summarised in Table 10.

Table 10 Elements of the proposed developing world market development programme

ACTIVITIES RECOMMENDED
Establishment of a European Renewable Energies Export Council to facilitate export promotion missions
Support and secondments to GEF, World Bank, ADB, IADB
Project identification missions

6.2.4 Low cost manufacturing partnership investment programme

The study team supports the proposal of the Madrid Conference for a partnership investment programme for new large scale manufacturing plant. This should be achieved as follows:

- a CEC invitation to the PV industry, electricity utilities, and European investment funds to participate in the development of large 50 MWp+) PV manufacturing plant
- long term contracts from the utilities for PV at agreed prices and quantities
- guaranteed number of PV procurements for developing world projects
- committed enhanced support for ALTENER, THERMIE, ERDF, Cohesion Fund, and other EU programmes to support the introduction of PV
- incentives for the industry for existing production processes which could for example be linked to achievements in developing the process and overcoming bottlenecks
- incentives for balance of system suppliers for improved equipment
- support for companies to provide all necessary assistance to potential users

6.2.5 Increased R&D support for new PV technologies

The benefits of JOULE programmes in the development of new PV technologies such as PV cladding and new manufacturing techniques are well recognised. It is recommended that such support should be continued and enhanced up to the year 2005 and prioritise on:

- new low cost manufacturing techniques

- standardisation and certification of products for
  - utility connection
  - isolated dwellings
  - developing country solar home systems

6.3 Benefits to the European Union of the proposed programmes

Various detailed computer models are available for the purpose of analysing the market potential for new energy technologies and assessing the associated costs and benefits of policies to encourage market penetration.

An integrated computer based world PV market model has been developed for the purpose of this study, incorporating the correlations between interdependent market parameters, such as shipments and manufacturing capacities, installed PV generation capacities, market shares, investments required for manufacturing capacity increases, generated employment, etc. This model checks for and detects inconsistencies between available market figures and estimates given in literature. This provides a sound base for the estimate of unknown market parameters and for the development of market scenarios and extrapolations to the year 2010.

6.3.1 Employment

The employment generated by the PV sector has been estimated separately for the areas of origin of PV equipment (PV+BOS manufacturing, services and wholesales) and for the areas of destination (local retailers, installation, maintenance) and, assuming the *Business as Usual* Scenario, will total in year 2010 more than 150.000 employed (of which 32.000 in Europe).

The employment model has clearly made evident, how PV technology will produce in time a marked multiplicator effect on employment, since the large majority of PV employment will be generated in the areas of destination of PV equipment, and mostly by the demand for maintenance and servicing activities arising from the accumulation in time of long-lasting small-scale PV installations. Furthermore, PV employment will be particularly beneficial to the European economy since:

- it is entirely additional, no employment in other sectors is substituted, since PV technology does not replace other conventional technologies;

- it is distributed over the territory, since linked to the diffusion of PV systems, and not to some concentrated power generation facility;
- ensures continuity in time and presents no seasonality;
- employment is created precisely in those areas, which mostly need economic development stimulation, i.e. the remote rural areas in the developing world as well as in less developed areas of the industrialised world.

If the proposed programmes are supported and the target of 2000 MWp of PV installed in Europe is achieved it is estimated that a minimum 58,000 additional jobs would be created in Europe. This is shown in Table 11 for the various enhanced market growth scenarios over the *business as usual* case. The breakdown of employment for the *business as usual* scenario is presented in Figure 12.

Table 11 Scenarios for annual market growth rate, investment requirements and employment generation to 2010.

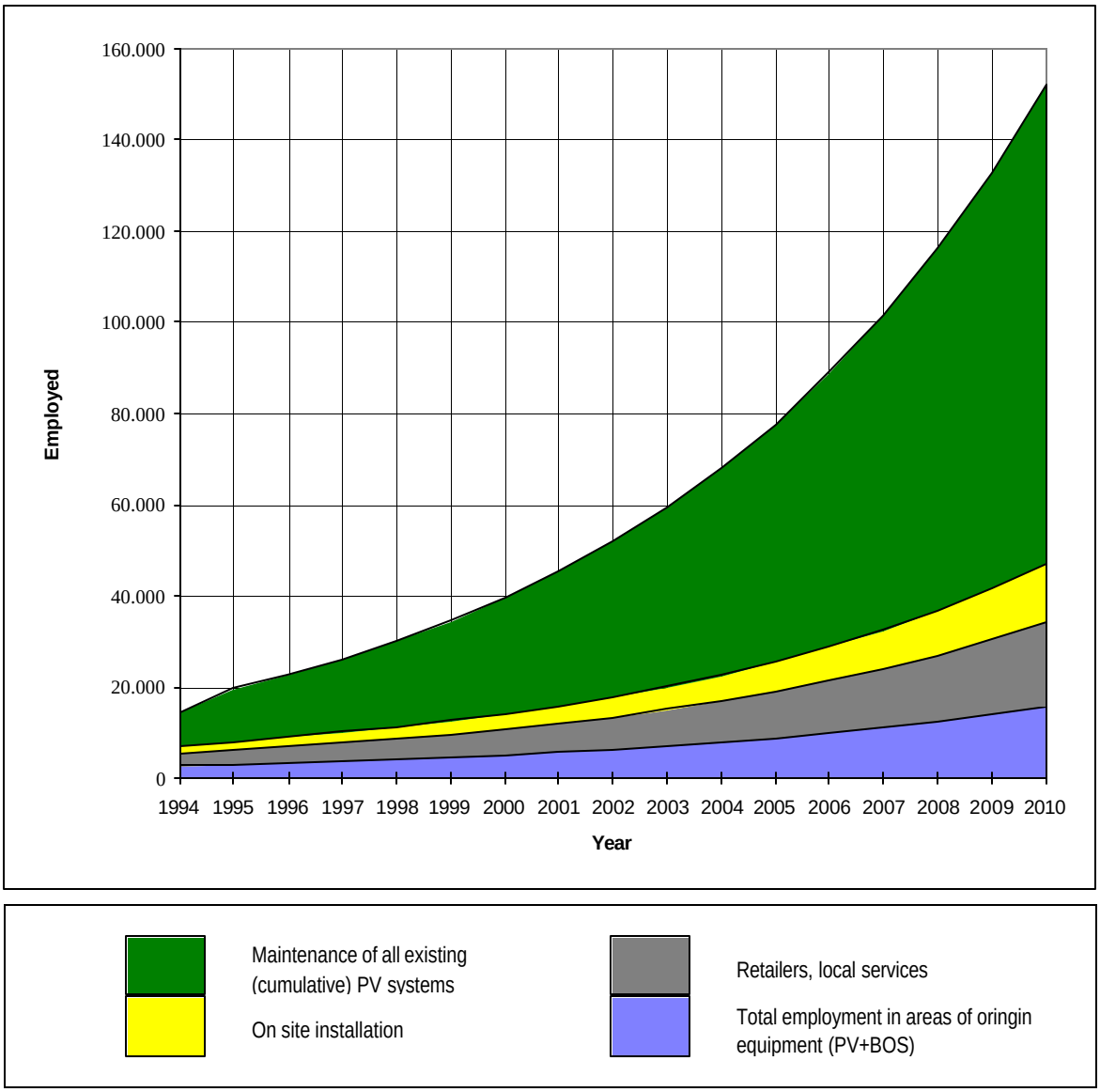
What is required		**to reach in year 2010 a whole world PV market scenario of:**				**Europe (assuming 32% of capacity installed in EU)**	
World PV market growth rate	Investment for manufacturing capacity increase	Annual shipments	Cumulative installed capacity	PV sector Employement	Remarks	Cumulative installed capacity	PV sector Employment
% year	% of sales	MWp/year	MWp	Employed		MWp	Employed
15%	7,2%	630	3.900	152.000	Business as usual, will develope spontaneously	1.200	32.000
20%	9,3%	1.240	6.300	261.000	Achievable by eliminating market barriers	2.000	56.000
25%	11,1%	2.380	10.200	453.000	Requires consistent market stimulation	3.300	98.000
30%	12,8%	4.460	16.700	783.000	Requires breakthrough in technology and costs	5.300	170.000
35%	14,4%	8.160	27.300	1.345.000	Extreme scenario	8.700	294.000

6.3.2 CO_2 Emissions Reductions

The savings in carbon dioxide emissions resulting from the displacement of coal fired electricity generation plant with an energy technology that does not emit CO_2 during the generation process would be approximately 2 million tonnes per year. Even assuming that PV was displacing power plant representative of the average European electricity generating plant with

associated CO_2 emissions of 0.55 tonnes/MWh, (rather than dirty coal power plant), annual savings in CO_2 would amount to approximately 1.1 million tonnes per year.

Figure 12 Employment forecast in the PV sector to 2010 - business as usual case



6.3.3 Security of Supply

One of the important objectives of the ALTENER Programme is to reduce Europe's dependence on imported energy. Energy dependence is undesirable as supplies from external sources are vulnerable to major disruption, whether this be caused by war or political upheaval, as the recent gulf crises demonstrated, or embargoes, as the two oil crises of the 1970s highlighted. Energy dependence can also contribute to national debt and has implications for trade balances with many nations struggling to pay for imported energy.

Photovoltaics and other renewable energy technologies provide energy independence by allowing countries to utilise their sustainable indigenous energy sources. This consideration is likely to increase in importance as many European countries' reserves of fossil fuels (eg. North

Sea oil and gas) gradually diminish. It is already of major importance to many developing countries that have no readily accessible conventional energy resources, and are forced towards crippling national debts resulting from fuel imports, particularly as many of these areas are especially well blessed with natural solar resources.

6.3.4 Rural Water Supply, Health Care and Education

Particularly in rural areas, PV can make a significant contribution to the quality of life of innumerable small communities. PV pumping systems are already in evidence, for instance, in many small villages in West Africa, helping to meet demands for drinking and irrigation water when hand pumps have proved inadequate. In such cases this is an invaluable utility which not only helps to meet basic potable water needs, but which also leaves local inhabitants free to tend crops or establish small business for trading.

Health care and education needs can be similarly enhanced. PV provides the opportunity to meet essential lighting, water pumping, refrigeration and communications requirements. This can have a significant impact on the success of education schemes and regional health care programmes.

6.3.5 Model Comparisons

An alternative model, SAFIRE[†], which performs a similar function to the integrated computer based PV market model mentioned above (although it is not dedicated to the PV market alone) was also used to analyse the associated costs and benefits of the proposed programmes for comparison purposes.

The forecasts from SAFIRE, indicate that if the proposed programmes are supported and the target of 2000 MWp of PV installed in Europe is achieved a minimum of 23,000 jobs would be created, and a net saving of approximately 650 thousand tonnes of CO_2 emissions would be realised by 2010 compared to 1995 figures. The prediction for carbon dioxide emissions savings takes into account all CO_2 released during the PV production process.

[†] SAFIRE was financed under the JOULE Programme by the EU's DGXII and developed by a consortium comprising ESD Ltd (UK), ZEW (Germany), FhG-ISI (Germany), IER (Germany), IARE (France) and Coherence (Belgium)

PHOTOVOLTAICS IN 2010

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A STRATEGIC PLAN FOR EUROPE

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SUMMARY

This report presents a strategic plan to the year 2010 for the sustainable growth of the European Photovoltaic Industry in partnership with the increased production of electricity in Europe (and the developing world) from photovoltaics and increased international trade in European photovoltaic products.

The plan has been developed as part of a European Commission Directorate General for Energy (DGXVII) ALTENER supported study undertaken by the European Photovoltaic Industry Association (EPIA).

The strategic plan calls for the following targets

PARAMETER	YEAR 2010 TARGET
Cumulative installed PV capacity in Europe	2000 MW - PV roofs 900 MW - PV facades 400 MW - PV grid plant 400 MW - Isolated homes 100 MW - Other 200 MW
Manufacturing capacity	1000 MW/yr
European share of international PV trade	>40%
Solar homes supplied to the developing world	20 million

To meet these targets the plan recommends the following programmes:

- A European 500 MW grid connect programme comprising:
  - 100,000 PV roof project
  - 2,000 PV building facade project and
  - 100 MW power plant project
- European 100,000 isolated building project
- 20million Solar Home System Developing World Programme

- Manufacturing partnership investment programme
- Increased R&D support programme