IEA INTERNATIONAL ENERGY AGENCY

Market deployment strategies for PV systems in the built environment –

An evaluation of Incentives, Support Programmes and Marketing Activities

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Task 7
Report IEA-PVPS T7-06:2002
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IEA PVPS

International Energy Agency

Implementing Agreement on Photovoltaic Power Systems

TASK 7

Photovoltaic Power Systems in the Built Environment

REPORT IEA PVPS T7-06: 2002

MARKET DEPLOYMENT STRATEGIES FOR PV SYSTEMS IN THE BUILT ENVIRONMENT

An evaluation of Incentives, Support Programmes and Marketing Activities

September 2002

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FOREWORD

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic co-Operation and Development (OECD) which carries out a comprehensive programme of energy co-operation amongst its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (PVPS) is one of the collaborative R&D agreements established within the IEA and since 1993 its participants have been conducting a variety of joint projects concerned with the application of photovoltaic conversion of solar energy into electricity. The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (Tasks) is the responsibility of Operating Agents. Currently activities are underway in seven Tasks.

The twenty one members of IEA PVPS are: Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), European Commission, Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), United States (USA).

Within PVPS, Task 7 is the international collaborative effort focusing on building integrated PV, linking developments in IEA countries world-wide. The overall objective of Task 7 is to enhance the architectural quality, technical quality and economic viability of photovoltaic power systems in the built environment and to assess and remove non-technical barriers for their introduction as an energy-significant option. 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).

The primary focus of this Task is on the integration of PV into the architectural design of roofs and facades of all type buildings and other structures in the built environment (such as noise barriers). Task 7 motivates the collaboration between urban planners, architects, building engineers, PV system specialists, utility specialists, PV and building industry and other professionals involved in photovoltaics.

More information on the activities and results of the Task can be found on www.task7.org or www.iea-pvps.org.

This report has been prepared under the supervision of PVPS Task 7 by Reinhard Haas (Austria)

in co-operation with the following countries:

AUS, AUT, CAN, CHE, DNK, DEU, FIN, ITA, JPN, NLD, ESP, SWE, GBR, USA

and approved by the PVPS programme Executive Committee.

The report expresses, as nearly as possible, an international consensus of the opinions on the subject dealt with.

CONTENTS

EXECUTIVE SUMMARY

In the last decade of the 20th century the market penetration of decentralised grid-connected PV systems has increased tremendously world-wide. This development was brought about by means of a wide variety of promotion strategies and dissemination programmes. These initiatives were launched by quite different organizations and institutions. Governmental bodies on national and local levels have launched strategies, as have electric utilities and NGO´s. Examples are:

(i) rebate programmes (e.g. the German 1000 roofs program or the Japanese residential PV promotion programme),
(ii) regulated rates (e.g. enhanced feed-in tariffs or rate-based incentives);
(iii) green pricing models (e.g. green tariffs, solar stock exchange, contribution programmes, shareholder programmes);
(iv) NGO marketing (e.g. "SOLARIS" in The Netherlands, "SONNENSCHEIN" in Austria);
(v) public building programmes (e.g. "Sonne in der Schule" in Germany or SCOLAR in UK).

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. Derived from this core objective the intentions of this work in detail are:

- to determine the major barriers for the broader market penetration of PV systems;
- to identify the major areas of activity and target groups for the removal of barriers,
- to document and evaluate the most important past and current programmes;
- to identify the relevant criteria for successful market deployment strategies;
- to derive recommendations for further actions required with respect to different target groups.

The most important results and conclusions of this analysis are:

- Pure cost-effectiveness is not crucial for private customers. Affordability is rather what counts.
- Comprehensive accompanied information and education activities are also important along with financial incentives;
- High environmental credibility of the institution/company which launches a voluntary strategy based on customers willingness-to-pay (WTP) e.g. Green Pricing or a Solar Stock Exchange is a very important precondition;
- Moreover, with respect to financial incentives it is of tremendous importance that they show a decreasing characteristic over time and that they are designed dynamically;
- Promotion programs should take into account consumers' willingness to pay (WTP). **Optimal financial incentives would provide only the difference between the system costs and the WTP for PV.** Consumers WTP for PV appears to be higher than expected by most program designers.
- Predictability and continuity over time are important: Avoid “Stop and Go”- strategies!

Finally, eight key factors for successful dissemination strategies of small grid-connected PV systems have been identified:

1) Provide a minimum of a financial incentive that allows to fully exhaust customers WTP!

2) Improve the market: Ensure that the competitiveness and the transparency of the PV system market as well as of the market for electricity (e.g. by means of a power content label) is enhanced! Ensure continuity of the strategy over time and sustainable growth of the industry!

3) Strive for a guaranteed technical performance, an increase of standardisation and efficiency!

4) Try to make the programme a social event and to address the public as well as the mass-media!

5) Strive for setting the correct regulatory conditions from societies point-of-view! Remove barriers for access to the grid and introduce environmental pricing!

6) Minimise the costs for the public! Strive for low administration and transaction costs and minimize monetary financial support to reach a certain amount of PV capacity!

7) Provide comprehensive detailed and targeted information for potential programme participants!
8) Conduct marketing! Identify the potential customers and their needs!

All in all, to be successful, it is necessary to design strategies in a way where governments, the PV industry, utilities, NGO’s and potential investors co-operate closely.

1. INTRODUCTION

The decentralized use of PV is discussed as an important tool to cope with the current environmental problems associated with electricity generation and electricity use and to “provide clean energy now and for the future“ (Amory Lovins, RMI (1991)).

In the last decade of the 20th century the market penetration of PV has been increased tremendously world-wide, see Fig. 1.1. While in 1990 there were mainly stand-alone systems in remote areas and the application for communication and consumer products were prevailing at the end of the decade small decentralised grid-connected systems (SGCS) became dominant, see Fig. 1.2. Yet, as depicted in Fig. 1.3 by the end of 2001 more than 50% of the PV world production went to SGCS. This development was brought about by means of a wide variety of promotion strategies and dissemination programmes. Of special interest is that these initiatives were launched by quite different organizations and institutions. Governmental bodies on national and on local levels have launched strategies as well as electric utilities and NGO's.

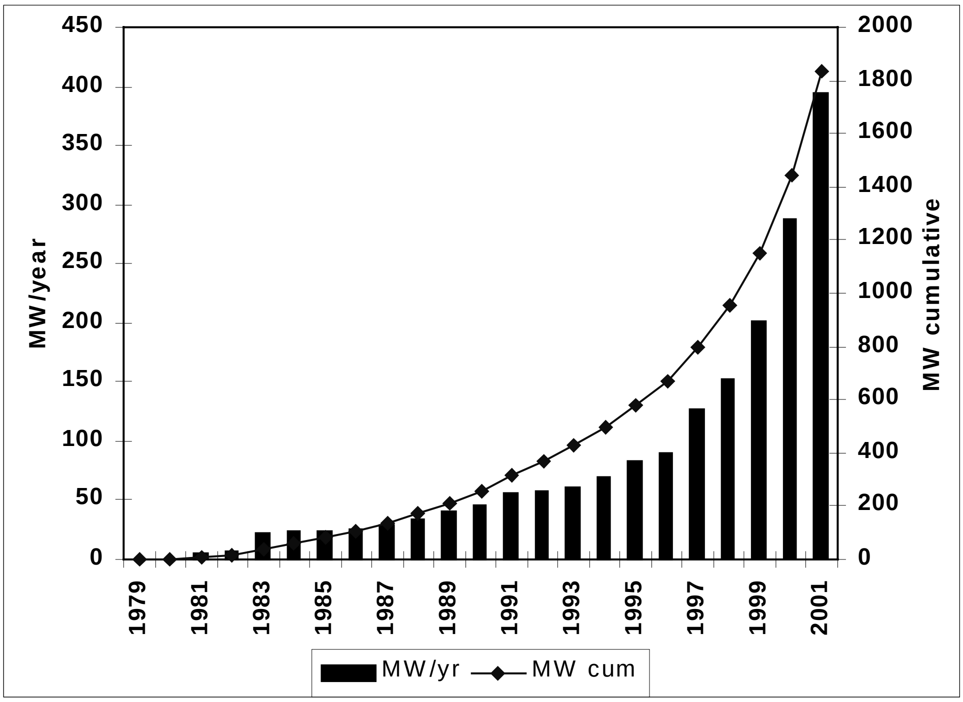

Figure 1.1 Development of the PV world market 1980 – 2001 (Reference: Maycock 2000, Maycock 2002)

Yet, there are still barriers for a broader market penetration of PV systems. To enhance the speed of market penetration of PV and to accelerate the achievement of the accompanied environmental benefits proper and optimised strategies have to be launched. The major open question is, what do efficient dissemination strategies look like. In recent years in various countries different types of financial incentives, regulatory measures, voluntary approaches, information and education programmes and demonstration projects as promotion programs for decentralised PV systems have been introduced.

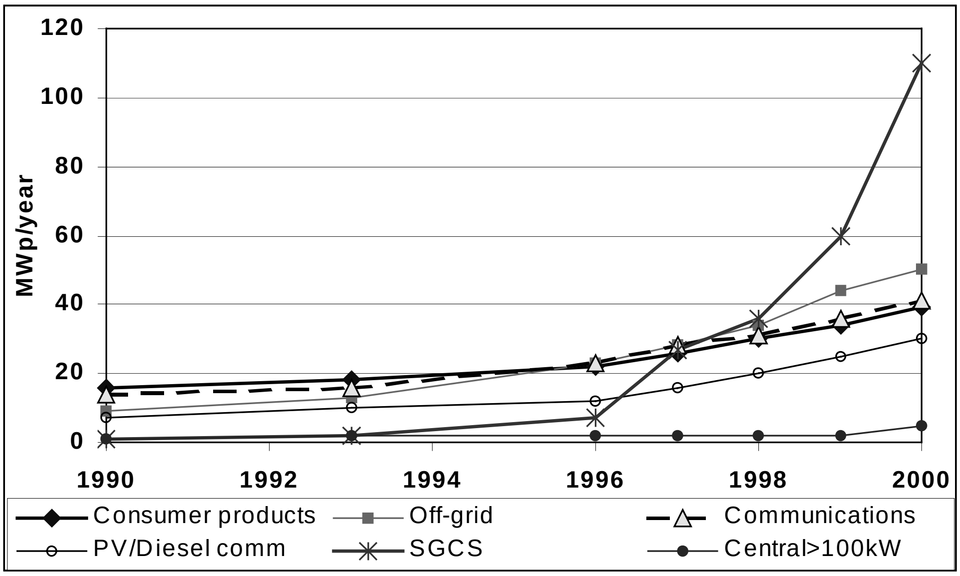

Figure 1.2 The development of the PV world market by product category and the relevance of small grid-connected PV systems (SGCS) 1990 – 2000 (Source: Maycock 2000)

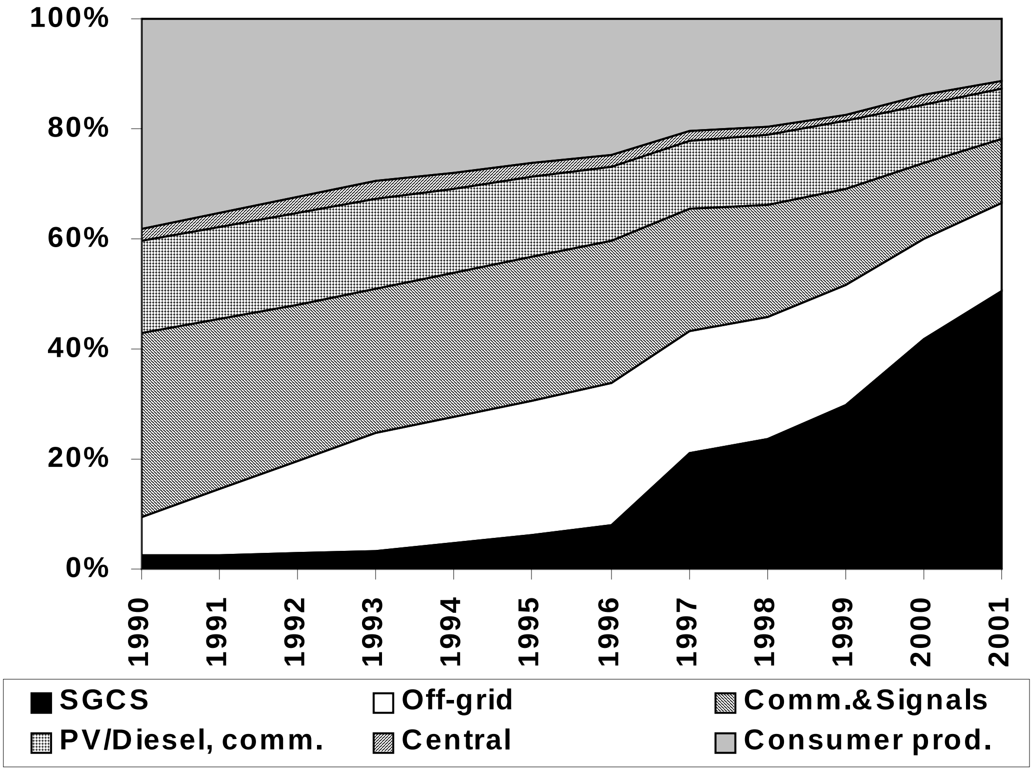

Figure 1.3 Shares of various product category on the PV world market and the relevance of small grid-connected PV systems (SGCS) 1990 – 2001 (Source: Maycock 2001)

1.1 Objectives of this work

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. Derived from this core objective the intentions of this work in detail are:

- to determine the major barriers for the broader market penetration of PV systems;
- to identify the major areas of activity and target groups for the removal of barriers,

- to document and evaluate the most important past and current programmes;
- to identify the relevant criteria for successful dissemination strategies;
- to derive recommendations for further actions required with respect to different target groups.

Of course, most interesting are programmes and projects from which some lessons learned are already available. Hence, in this report major emphasis is put on programmes from which experience is already available and minor focus is on programmes which have been announced only recently.

1.2 Definitions

In this report we focus on marketing strategies. Before going into further details it is useful to define this.

What are strategies?

In the mathematical literature they are defined as a series of policies which should lead to fulfilling a certain target. A major feature of strategies is, that they depend on time and are, hence, dynamic. Moreover, it is important to note that the target would (by far) not be reached without a proper strategy!

The literature on strategies for PV has increased in recent years. Hoffmann et al (1998) describe various market introduction strategies for grid-connected PV systems in Germany. Nordmann (1996) analyzes successful solar marketing and financing strategies. Rezzonico/Nowak (1997) compare buy-back rates and other promotional instruments for PV in 18 IEA countries. Haas (1998) analyzes the relevance of non-technical issues for a broader market penetration of residential PV systems. Watt (1999) discusses the prospects for Australia. Groenendal (2000) analyse critical success factors for a large-scale introduction of grid-connected PV systems.

Strategies for a broader market penetration of a technology usually focus on the following criteria:

- improvement of the economic viability (identifying added economic values, reducing system costs);
- information on the wider advantages of a product of its values added; e.g. environmental benignness;
- increasing the technical performance;
- enhancing the social acceptance.

A programme is the specific application of a strategy or a portfolio of strategies in a certain country or geographic region.

With respect to PV, in various countries different programmes have been introduced. The focus was weighted differently. To increase the technical reliability and performance was the major goal of the German 1000 roofs programme and the Austrian 200 kWp rooftop programme. A typical programme type with core focus on economics are rate-based incentives. Initiatives without substantial financial incentives, yet, with a strong focus on information are the Swiss ENERGIE 2000 programme and The Netherlands “Heading into the Solar age together” action plan.

1.3 Historical milestones

In the history of PV various types of dissemination strategies were launched. Already in 1982 in Massachusetts in the USA the first net metering program for PV (and other renewables) was introduced. While this program addressed only very few customers, in 1991 in Germany the first comprehensive dissemination strategy was launched, the German 1000 roofs program. In the early

1990s the Municipal utility of Sacramento in California SMUD introduced various new strategies. Most important were green pricing models – which furtheron attracted attention also in other countries – and the PV pioneer program in 1993, which was a kind of contracting model. At about the same time in Switzerland and Germany the first rate-based incentives programs were launched (Burgdorf and Aachen model).

Table 1.1. A history of the most important promotion strategies for grid-connected PV electricity

Year	Country	Type of strategy	Programme name	Remarks
1982	US	Net metering		
1987-present	DE	Rebate	"REN"	
1991-1995	DE	Rebate	"1000-Dächer-Programm"	
1991-2000	CH	Voluntary target programme	"ENERGIE 2000"	
1992-1994	AT	Rebate	"200 kW PV-Programm"	
1992-1999	DE, CH, AT	Regulated rates	"Kostendeckende Vergütung"	
1993-1997	US	Contracting	SMUD "PV pioneer I"	
1994-present	JP	Rebate	"Residential PV promotion programme"	revised 1998
1994-present	ES	Regulated rates	P.A.E.E.	revised 1998
1994-present	DE	Rebate, contribution	"Sonne in der Schule", "SONNEonline"	launched by various utilities and Governmental institutions
1996-present	DE	Green pricing	RWE "Umwelttarif"	
1996-present	CH	Bidding/Green Pricing	"Solarstrombörse"	
1997-present	NE	Voluntary target programme	"Heading into the Solar age together"	
1997-present	CH	Green Pricing	"Solarstrom vom E-Werk"	
1997-2001	DE	Bidding	"Solarbörse Berlin"	
1998-present	DE	Labelling	Golden and Silver label (EUROSOLAR)	
1999-present	AT	Shareholder	"Sonnenschein"	
1999- present	DE	Soft loans	"100,000 Dächer-Programm"	
1999- present	NE	NGO initiative	"SOLARIS"	
1999-present	US (CA)	Rebates	"California's emerging renewables buydown programme"	
1999 - present	AU	Rebates	“PV Rooftop Programme”	For grid and off-grid buildings. Revised 2000
2000 present	DE	Enhanced feed-in tariff	“Neues Einspeisegesetz (EEG)”	
2000-present	DE	Rebate, contribution	"Kirchengemeinden für die Sonnenenergie"	

Solar stock exchange models for PV electricity became popular in the city of Zurich in 1996. End 2000 more than half of the Swiss households have access to "Solarstrom". Since about 1998 programs for the promotion of renewables focus on liberalized electricity markets. Examples are public purpose programs as e.g. introduced in California followed by other states in the USA and tradable certificates.. The most recent development are soft loans introduced in the German 100000 roofs programme, Green Pricing programmes with labels and NGO initiatives.

As can be seen very clearly from Table 1.1 the widest variety of different types of strategies exists undoubtedly in Germany.

1.4 Current state-of-the-art: an international comparison

Figure 1.4 depicts the total currently installed PV capacity per capita in various OECD countries. It can clearly be seen that the most successful countries are those with the most ambitious programmes: Switzerland, Japan and Germany, or where off-grid PV is cost-effective: Australia. With respect to SGCS it can clearly be seen from Fig. 1.4 that there are tremendous differences between countries with a high density of population and/or grid-connection (e.g. NE, DE, CH, JP) and countries with a low density (e.g. SE, AU, FI). Of course in the latter autonomous systems play a much more important role than in countries with a tight grid.

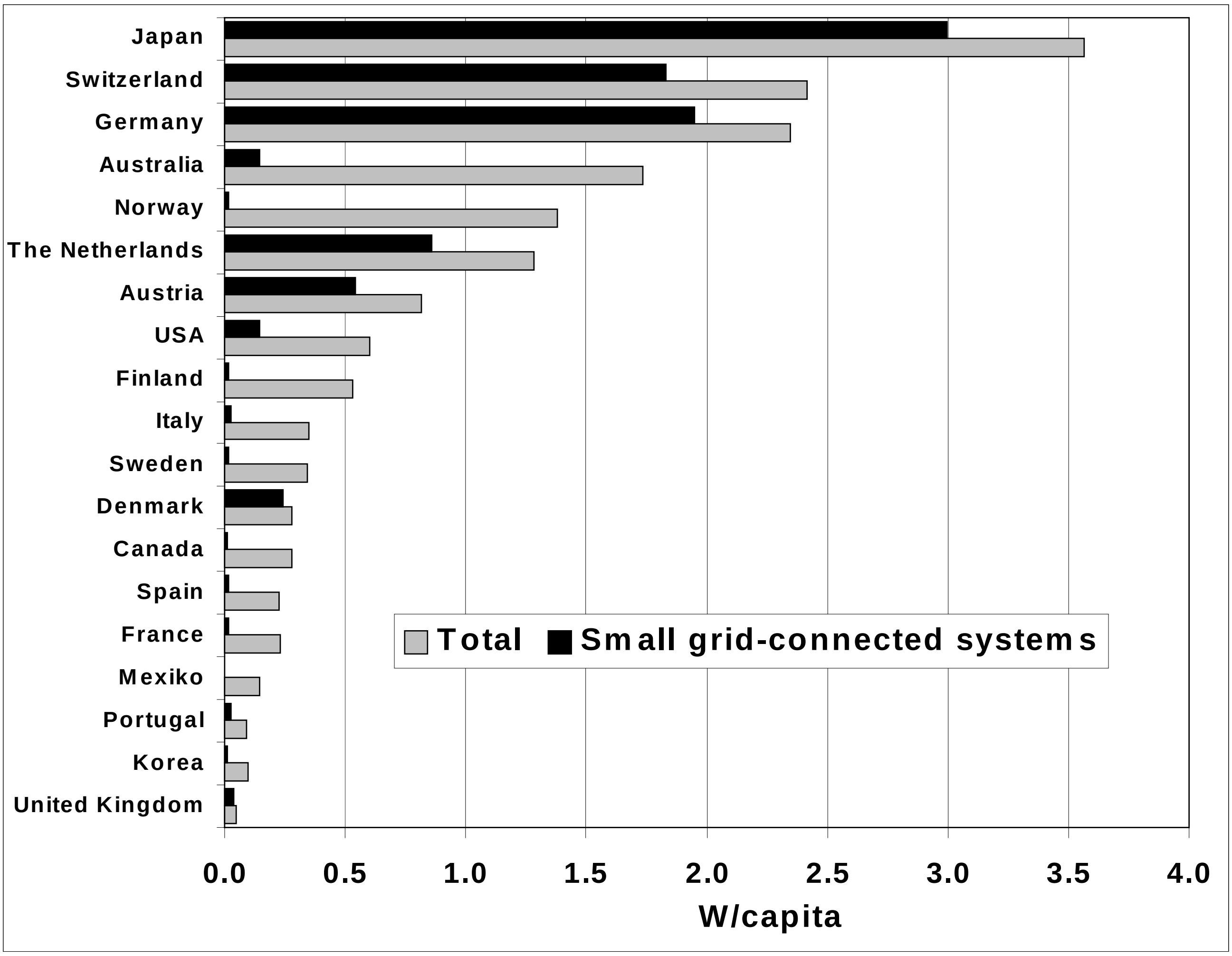

Figure 1.4 Comparison of total installed PV capacity per capita and SGCS capacity in various OECD countries by the end of 2001 (Source: PVPS homepage and own investigations).

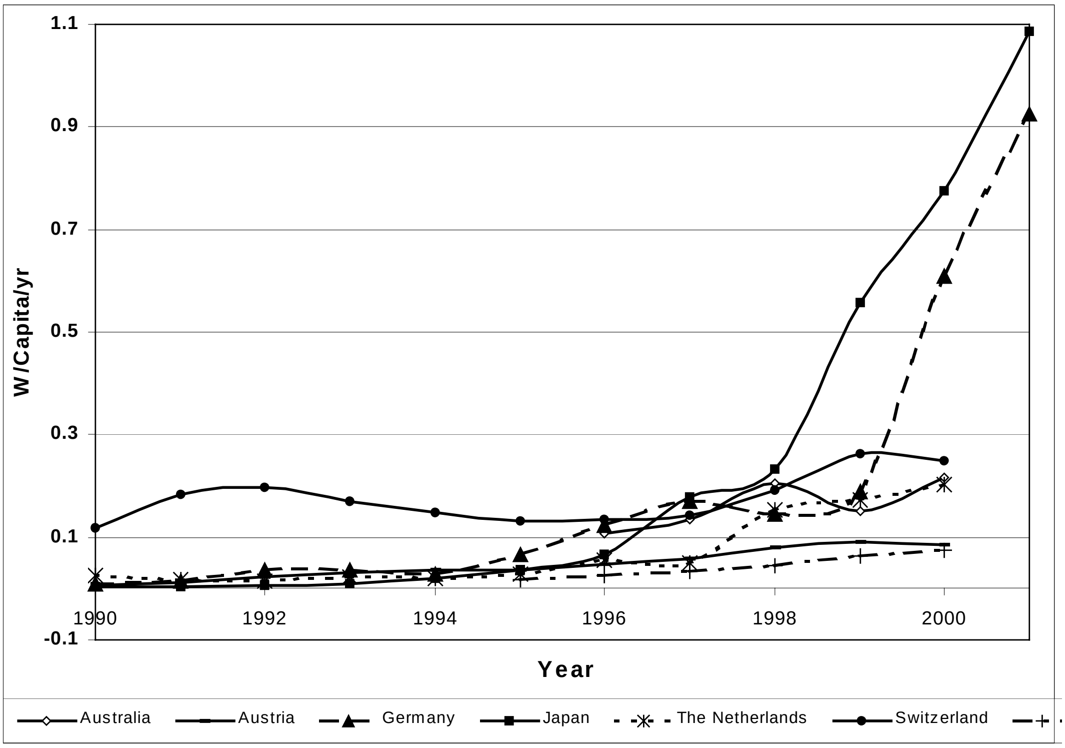

Figure 1.5 Yearly installed PV capacity per capita over time in various countries

1.5 Organisation of this report

In the next section the basic methodology for deriving successful marketing strategies is described. In section 3 the most important added values are explored, the relevant areas of activity are defined and the main barriers for a broader market penetration of PV are identified. In the sections 4 and 5 these target areas are analysed in detail and the major barriers in these target areas are documented. A survey on various types of strategies, is provided in section 6. Moreover, their major features and the suitability of various strategies with respect to removing different barriers addressing various target groups are described.

In the chapters 7 to 11 for the most important types of strategies examples are documented with respect to programmes which are currently or have in the past been implemented in different countries. As stated before, **major emphasis is put on programmes from which lessons learned are available and less focus is on programmes which have been announced only recently.**

Finally, in Section 12 the different strategies are evaluated and in section 13 the most important conclusions are derived.

2. HOW TO PROCEED FOR DERIVING SUCCESSFUL MARKETING STRATEGIES

For deriving the criteria for successful marketing strategies for PV from societies point-of-view we proceed in the following way, see also Fig. 2.1.

- Investigate the **benefits** of a technology:

  First, it is of course necessary to identify the benefits, the added values of PV (e.g. environmental benignity, load-shaving, modularity...) for society from a qualitative point-of-view.

- Estimate **potentials**:

  Next it is of relevance to investigate the quantitative potential the technology can contribute to solving a problem and/or to meet a certain societal objective, e.g. providing energy services for private households.

- Separate **areas of activity**:

  After having estimated the potential benefits it is necessary to identify the relevant areas of activities (e.g. the customer, the market, the technology) to identify barriers and to be addressed by a strategy where action has to be undertaken.

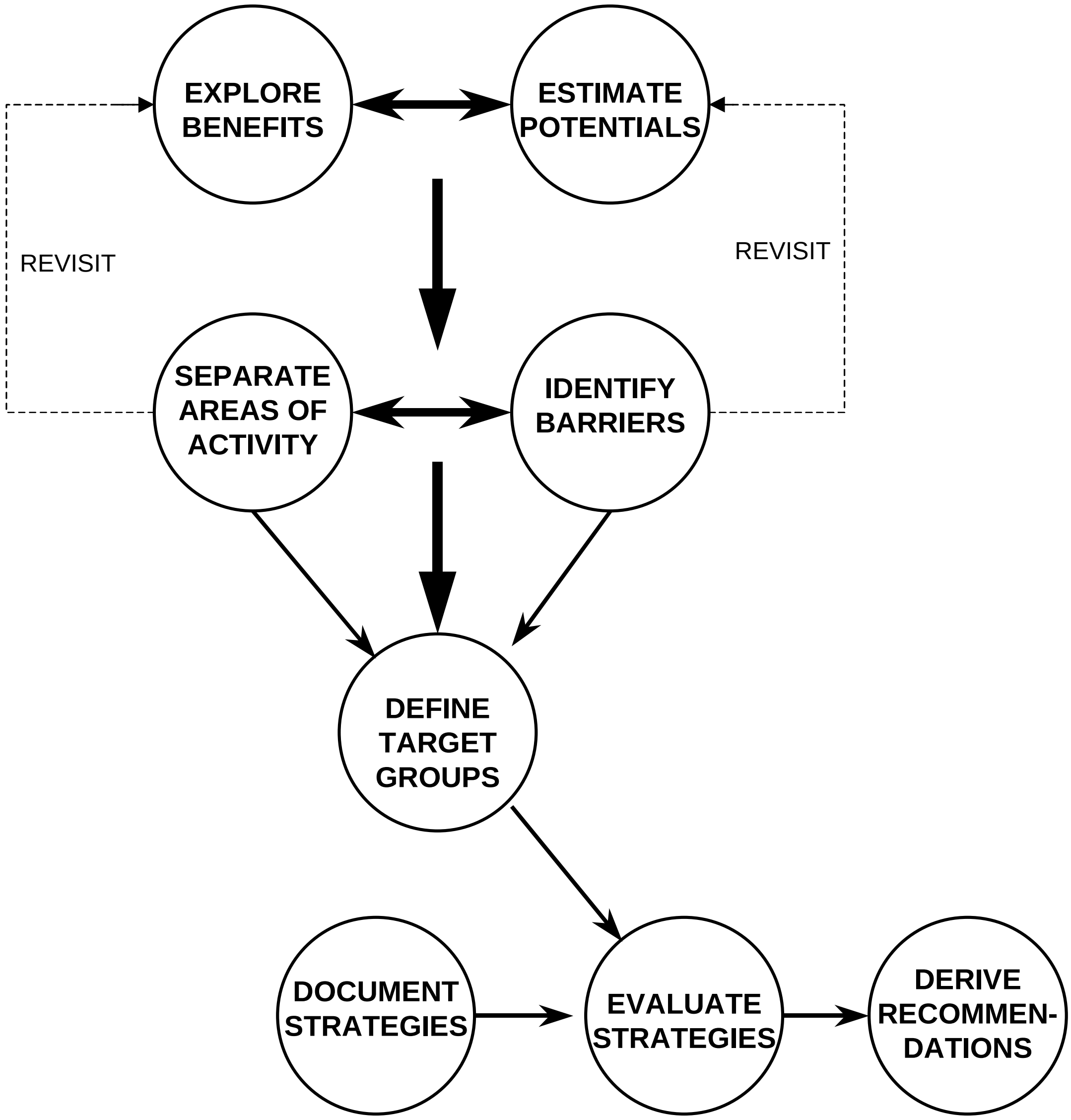

Figure 2.1 Steps for deriving a marketing strategy for a technology

- Identify **barriers**:

  Furthermore, in each of this areas of activity the major barriers (e.g. lack of technical reliability, high investment costs, no social acceptance) which impede a broader market penetration has to be investigated.

- Define **target groups** (e.g. private individuals, PV industry, architects, governments)

  ...for actions to be undertaken;

- Derive and assess possible **strategies**

  to overcome the barriers, e.g. financial incentives, information and education campaigns...

Of course, some iteration is necessary. After having identified areas of activity and the corresponding barriers it may be necessary to revisit and reaffirm added values as well as potentials.

Finally, it is of interest to look at the interactions between potentials, barriers and strategies. Fig. 2.2 depicts how potentials, barriers and strategies are linked in principle. The electricity generated is shown depending on the time. We start with the historical development of PV in a certain country and identify different potentials. Various barriers I, II, III ... exist which impede the practical achievement of the potentials. If no policy strategies are implemented, the lower broken line will be achieved, the so-called *business-as-usual* scenario. If an ambitious policy launches the proper strategies the upper broken line will be achieved.

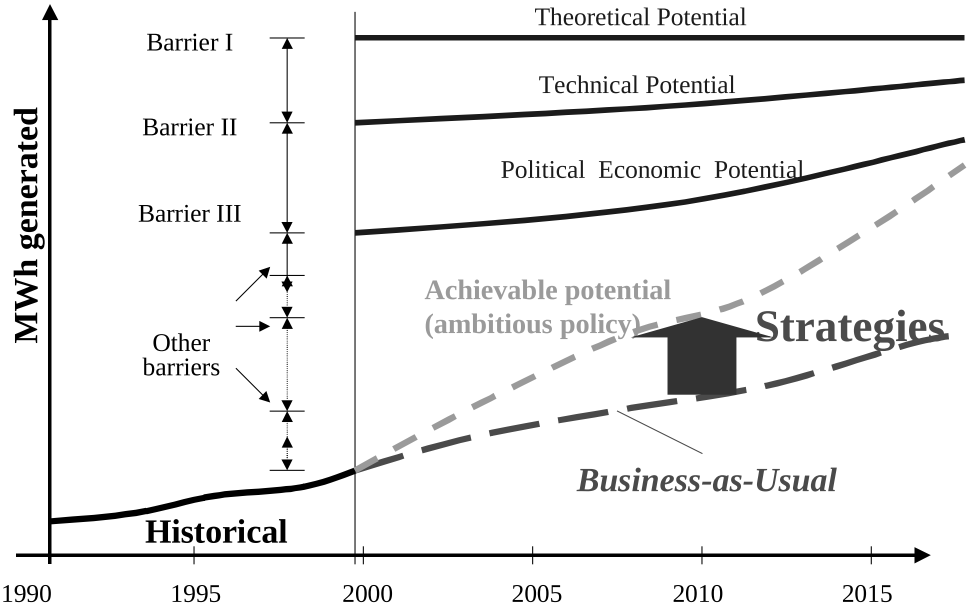

Figure 2.2. Interaction between potentials, barriers and strategies

3. BENEFITS, BARRIERS AND TARGET GROUPS

Following the procedure described in Section 2 we now first summarise the most important benefits of PV. Then we define the relevant areas of activity and identify the existing barriers for a broader dissemination.

Note that the potentials, economics, and barriers have been analysed in detail in separate activities of Task 7. Corresponding reports are published by the IEA (Eiffert 2001, Gutschner 2001, van Mierlo/Oudshoff 1999). Moreover, added values have been explored comprehensively in a report of Task 1 of the PVPS on " Added values of PV Power systems", see Watt (2001).

3.1 Exploring Added Values

The decentralized use of PV is considered to be an important tool to cope with the current environmental problems associated with electricity generation and electricity use. PV is unique amongst new renewables for the wide range of benefits which can be combined, while the use of PV as an integral part of a building provides the greatest opportunity for exploiting non-energy benefits and for adding value to the PV system (Watt 2001). Moreover, various other values added have been identified from different points-of-view, see Haas (1995) and Watt (2001).

From a PV customers point-of-view the most important values are that PV systems are available in every size (modularity) and that they are fast and relatively easy to install (this issue is subject to further improvements). Furthermore, PV systems with storages increase consumers independence from central supply by utilities.

From societies point-of-view the already mentioned environmental benignity – no emissions, no pollution in operation – is the most important added value along with its decentralised applicability and the virtually completely absence of acceptance problems. Further socio-economic values are that decentralised PV systems foster employment in general as well as gradually enhance local employment in rural areas. Decentralised PV applications could impact both supply-side and demand-side issues. That is to say PV may also serve as a vehicle for triggering energy conservation by influencing consumers' awareness of electricity consumption ("The value of meter reading") and may trigger additional fossile fuel energy saving measures, e.g. energy conservation and the purchase of other renewable energy using equipment. Finally, an increased supply security due to decentralised generation may in some countries also be considered to be of substantial value.

The values of PV for utilities are that transaction costs and lead times for building a PV power station are low (this may become important especially in liberalised electricity markets!) and that in some countries with on-peak electricity in summer at noon PV may contribute substantially to "peak-shaving". Due to Watt (2001) the effective load carrying capacity (ELCC) of PV can be especially high for commercial customers with typically good matching between peak PV output and daytime air-conditioning load.

Moreover, PV may also provide values for other branches in the market. Architects may benefit from PV as a new and innovative multi-functional building construction element. It also allows the designer to create environmentally benign and energy efficient buildings, without sacrificing comfort, aesthetics or economy, and offers a new and versatile building material (Watt 2001).

Table 3.1 summarises the most important values added by PV systems for different groups in society and weighs the values. For further indepth reading the report by Watt (2001) is recommended.

Table 3.1. Survey on values added by PV systems (Watt (2001), Haas (1995))

	BENEFIT/VALUE	REMARKS	WEIGHT
PV CUSTOMERS:			
	• **Modularity**	PV systems are available in every size	+ + +
	• **Fast and easy to install**	This value is subject to further improvements!	+ + (+)
	• **Increases independance (w/ battery)**		+ + +
SOCIETY:			
	• **Environmental Benignity**	no emissions, no pollution in operation	+ + +
	• **No acceptance problems**		+ + +
	• **Decentralised generation facility**		+ + +
	• **Enhances general and local employment**		+ +
	• **Indirect effect: Trigger energy conservation**		+
	• **Increase supply security**	In some countries with a low developed grid PV may contribute to increase supply security	+
	• **Local and community choice and control**		+
	• **Educational device**	PV is probably the best example for teaching energy supply and electricity generation	+
UTILITIES:			
	• **Peak shaving**		+
	• **Low transaction costs and short lead-time with respect to building a power station**	especially important in a liberalised electricity market!	+
OTHER BRANCHES:			
	• **For architects:** **Innovative multi-functional building construction element**		+ +

3.2 Separating areas of activity

Next the most important areas of activity which have to be addressed for identifying barriers and deriving strategies to remove these barriers are identified.

To identify the areas activity it is of core relevance to find out who is involved in spreading a technology? Who is interested in the dissemination of a technology?

Fig. 3.1 depicts the most important areas of activity which are explained in detail in the following:

In principle, dissemination of PV systems means to increase the number of purchasers of PV systems. Straightforwardly, the crucial aspect for the dissemination of PV is of course to motivate people to purchase this technology or at least to purchase the electricity generated by a PV system. Hence, first of all the possible purchasers of the technology are involved. That is to say, the potential PV customers are the core target group when deriving marketing strategies (see Fig. 3.1) and are – hence – the first important target group.

In the following **we define the group of people who purchase a PV system or buy PV electricity as the PV customer**. There are the following major different types of customers:

- private individuals;
- commercial companies using a PV system or a "Green Label" on their electricity as a symbol for the greenness of their company;
- traditional electricity suppliers;
- green utilities or Green Power Marketeers;
- building construction companies

With respect to the potential PV customers, their individual preferences and their WTP plays a very important role.

Moreover, society must be interested in spreading a technology. In this context, the status and the acceptance of the technology in society has to be considered. Society encompasses local, national and international governments, NGO's as well as politicians, education and the public.

Most important with respect to society as an action field is that it provide the right incentives for the purchase of PV systems and the correct boundary conditions e.g. with respect to feeding PV electricity into the grid! This encompasses R&D activities, financial incentives, taxes, information and education with respect to electricity generation in general and with respect to PV in detail.

The next important area of activity is the market. If the PV industry, the retailers and manufacturers want to sell their product they have to make sure that sufficient and targeted information is provided and that also other diffusion agents ("Catalysts") are addressed adequately, e.g. architects, teachers, mass-media. Financing companies also play an important role in this context. For the customer, market aspects such as competition, low transaction costs, and market transparency are very important.

Furthermore, the agents in the market have to communicate with the developers, researchers of the technology. That is to say, an important area of activity is the technology itself. Technical issues such as standardization and reliability are of high relevance in a successful dissemination strategy. Moreover, an important role especially in a liberalised market is played by utilities (e.g. the grid company in times of unbundling).

These target areas can also be classified as follows regarding their impact on a broader market penetration of PV systems:

- Setting up the conditions for a correct market: Society
- Improving the technology: Producers, Researchers
- Selling the technology: Manufacturers and retailers at competitive prices in a transparent market
- Buying the technology: PV customers

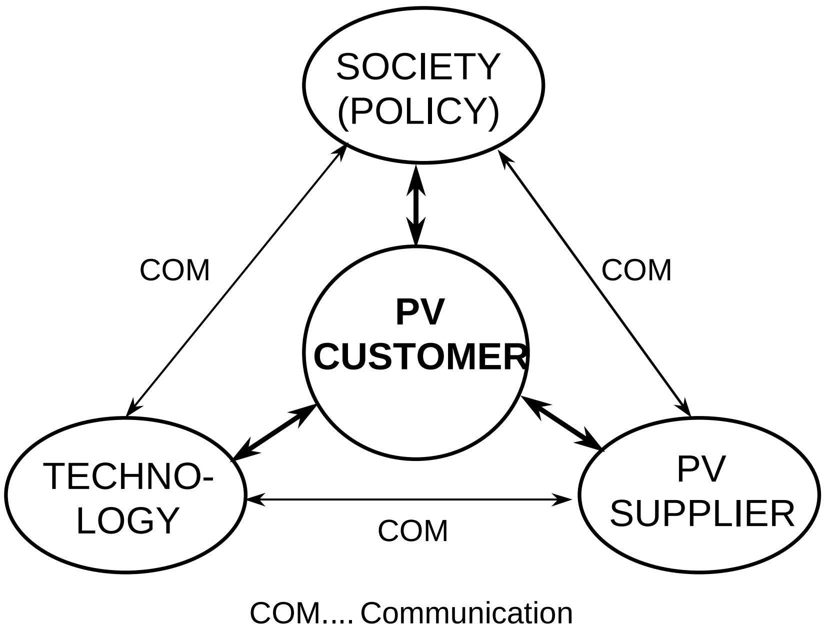

Figure 3.1 Relevant target areas for successful marketing strategies

Note that we always have to bear in mind that the final target of successful strategies is to convince people to purchase PV systems! This can of course also be brought about in an indirect way!

3.3 Identifying barriers for the broader dissemination of PV systems

In a study of Task 7 (activity 3.1) the major barriers and problem categories for the dissemination of PV have been identified, see van Mierlo/Oudshoff 1999. Watt (2001), Groenendal (2000), and Painuly (2001) are other references that provide comprehensive surveys on barriers. In the following the most important barriers are summarised for the target areas defined above. Of course, the barriers cited do not apply uniformly in all countries but in principle there are no big differences.

- <u>Customers (Generators/Users):</u>

The major barriers for various types of potential PV customers are:

- Bad economic performance: High investment costs are the most visible barrier to PV
- High transaction costs: It is hard for customers to get fast and easy access to information!
- There is a lack of proper financing opportunities;
- Architectural design and simple standardised systems are not available:
- Uncertainty on the technical performance: Many potential customers do not purchase a PV system because there are no guarantees with respect to the technical performance
- Lack of information on the benefits of PV

- Society:

Barriers which address local and national governments, politicians, education and the public are:

- Environmental benefits are not rewarded
- Lack of awareness with respect to scarce fossil and nuclear resources
- Customers WTP is not exhausted
- Low social acceptance
- Distortions in public education

- PV suppliers:

The major current barriers and problem categories for the dissemination of PV in the target area “market” are (see also van Mierlo/Oudshoff 1999):

- The PV markets in most countries are still non-competitive and non transparent which leads to high transaction costs for the potential customer
- the PV suppliers do not know the potential market and they do not know how to reach the market
- there still exists a wide range of immature products and immature service delivery chains;
- There is lack of proper marketing strategies and a lack of adequate infrastructure for successfully marketing PV systems;
- Communication problems between different actors in the market (e.g. between architects, building companies and PV retailers) do still widely exist;
- Back-up service delivery and maintenance is still very poor in most areas;
- Low level of marketing and information;

- Technology:

There are still major problems related to technical issues which strongly influence marketing strategies and, hence, are described briefly in this section. The most important barriers are:

- a poor system efficiency and low technical performance;
- the design of the system is not optimised;
- Safety is still a problem;
- Utility interfaces are not standardised;
- Almost no compact “plug and play” systems are available;
- Low flexibility in size, design and colours
- lack of system standardization and low system reliability

- Communication problems:

Finally, there may exist a series of communication problems between various actors in the different areas of activity. Some examples are

- The developers and designers do not consider the needs of the customers;
- The manufacturers and retailers do not provide sufficient information for customers;

- Various groups of potential customer are not addressed at all by marketing strategies from retailers;
- Many companies are not able to transmit the problems they have with the technology to the R&D area;

4. THE PV CUSTOMERS

In Section 3 we have identified the PV customer as the crucial target group. Most important for the successful marketing of any product is knowing the interests, needs and wishes of potential customers, the different types of customers and the factors influencing the customers decision-making process to buy a product.

4.1 Which types of PV customers exist? The market for PV systems vs the market for PV electricity

We have defined the PV customers as the group of people who purchase a PV system and/or purchase PV electricity. Hence there are two markets: A market for PV and a market for PV electricity. Fig. 4.1 depicts the relationship between these two markets. They are linked by the PV customer who on the one hand buys the system on the PV market and on the other hand may sell electricity to users via the public grid. A PV generator may be a traditional utility, a new green utility or an Independent PV power producer. Of course the user may also be the generator and/or the investor.

The market for PV electricity is in principle mainly influenced by the PV generator and the utility[1] (respectively the grid company in a liberalised market).

Yet, in the market for PV systems a lot of different transmitters (or "diffusion agents" as Rogers (1983) calls them) may interfere and influence the decision-making process of a potential PV generator. Aside from governmental institutions and NGO's the most important are: architects, housing companies, schools, banks and other private financing companies.

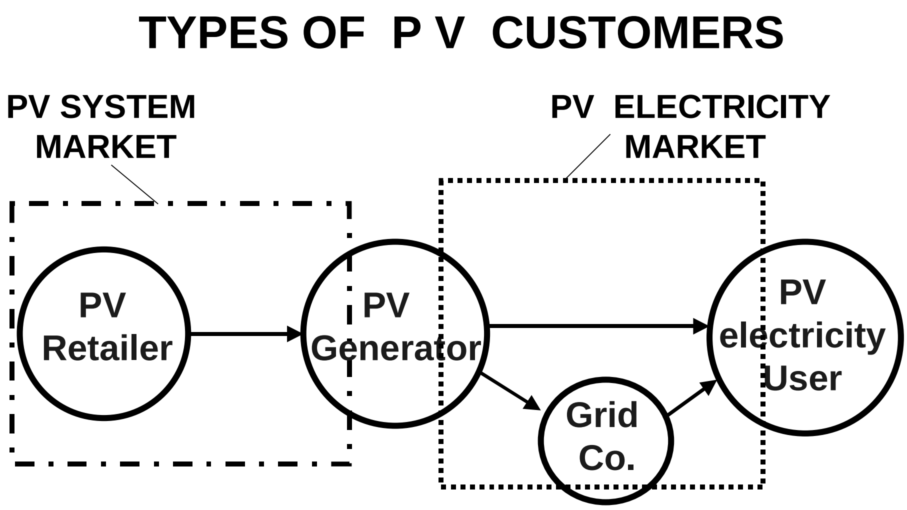

Figure 4.1. Types of PV customers: Purchase of PV systems vs purchase of PV electricity

Figure 4.2 depicts the three cases possible in principle. A PV generator may use the generated electricity to a large extent himself and feed only excess capacity into the grid, Fig 4.2a. Or he feeds all electricity into the grid and on the other hand draws all electricity used from the grid or in the case of the PV electricity customer all PV electricity is purchased from the utility.

Of course to reap the whole benefits from the values added – see section 3.1 –a decentralised use of PV should be striven for, to avoid the use of the electric grid as far as possible. Hence, the first case in Fig. 4.2 is in principle preferable.

[1] For a detailed analysis of a national PV electricity market see Weller (2000) on Germany

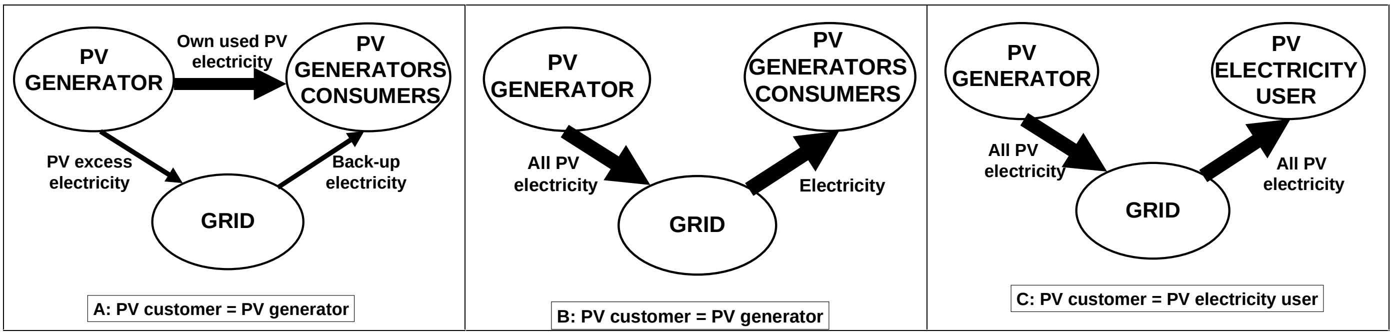

Figure 4.2. Types of customers: own use of PV electricity vs full feed-in of PV electricity

If we differ between different types of customers with respect to their financial decision-making criteria, in principle we have two different groups:

- Private customers (e.g. households): The most important feature of this group is that the purchase of a PV system depends on customers WTP and affordability and other relevant values added (visual, architectural, individual values...) rather than on cost-effectiveness. An important issue is whether equity is available for the purchase of a PV system or a loan has to be taken;
- Commercial customers: are in principle interested in PV systems if they are cost-effective – that is to say if they can make money with PV – or if PV systems or PV electricity provide other relevant values added; Examples for commercial customers and their interest are:
  - commercial companies may use an own PV system or a "Green Label" on their electricity as a symbol for the greenness of their company;
  - green electricity suppliers conducting Green Power Marketing;
  - traditional electricity suppliers may offer Green Pricing;
  - building construction companies may increase the value of their product by means of adding a PV system;

Between these two groups of customers differences in decision-making criteria exist. These differences in decision-making criteria are of principal relevance for an assessment of dissemination strategies. The most important ones are, see also Eiffert (2001):

- Individual WTP, taking into account all added values
- Affordability;
- Cost-effectiveness;

Table 4.1 depicts which decision-making criteria apply for the different groups of customers depending on whether they are PV generators and/or PV electricity users.

Table 4.1. Decision-making criteria for different groups of customers depending on whether they are PV generators and/or PV electricity users

	PV customer = PV generator	**PV customer = PV electricity user**
Private customer	Affordability, WTP, Cost-effectiveness	WTP, Cost-effectiveness
Commercial customer	Cost-effectiveness	WTP, Cost-effectiveness

Depending on these decision-making criteria in Fig. 4.1 different ways for customers to promote PV are depicted. It is possible to invest into a system e.g. by means of becoming a shareholder, to operate an own system, to donate e.g. for a school project or just to purchase PV electricity. The chosen way of promotion depends on the individual decision-making criteria.

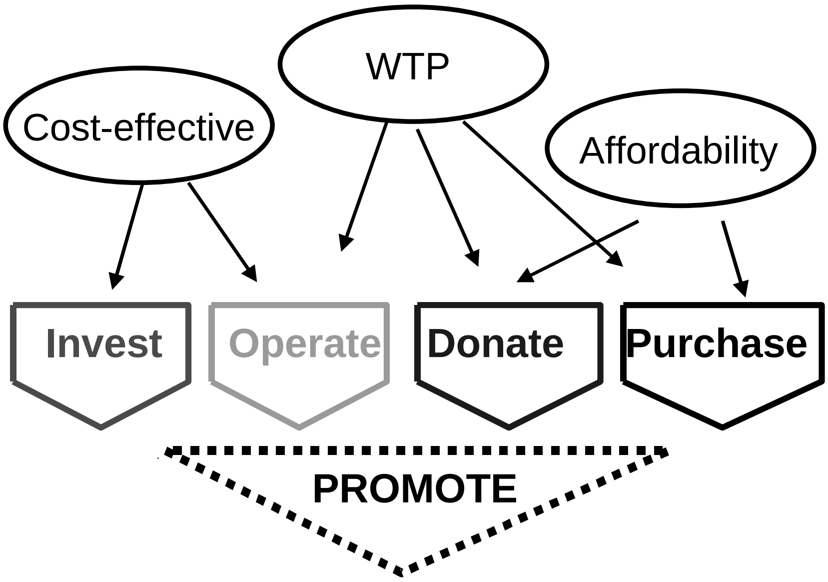

Figure 4.3. Different ways for customers to promote PV

Especially with respect to the individual decision-making criteria (WTP), the following question is of core interest for successful marketing activities:

"What are the needs of potential PV customers?"

As for any other product, also for PV, the most important prerequisite for successful marketing is knowing the interests, wishes and needs of the customers. In other words, the basis for a successful strategy is a good insight into the consumers wishes and needs and the factors influencing the consumers. Knowing this, the wanted product can be developed and a marketing strategy can be derived to provide the right price, promotion and distribution of the product.

The development of proper marketing strategies will create insight into the possibilities for PV and the possible market for PV among the various groups of potential customers.

4.2 What are potential PV customers willing to pay for?

It is important to investigate what things customers worry about. What are values for different groups of customers? What are customers willing to pay for? How does the decision-making processes of PV customers look and how are they influenced?

First of all, we have to think about what customers – e.g. individual households – worry about. They worry about comfortable homes, about technologies which increase their quality of life, they are interested in technologies that work, products that have a nice coloured surface, products they can afford to purchase. They are interested in technologies which ensure a life-worth future for them and their children. But in many cases they do not primarily look at technical details and they do not calculate interest rates. Hence, also with respect to the consumers' assessment of economics, some more impacts have to be taken into account:

(i) available income;
(ii) magnitude of electricity prices;
(iii) affordability.

What does affordability mean in practice? It means that, in principle, not only the pure cost-effectiveness has to be taken into account, but rather whether money is available to afford it (e.g.

instead of a new expensive car). That is to say, if the price of a good, a car or a PV system is some $20,000.- a household may purchase it even if it is not cost-effective. On the other hand, if the price of a good is $1 million most households will not purchase it even if it proves to be cost-effective. The reason is, that they cannot afford it (and that they have another risk appraisal than the large banks).

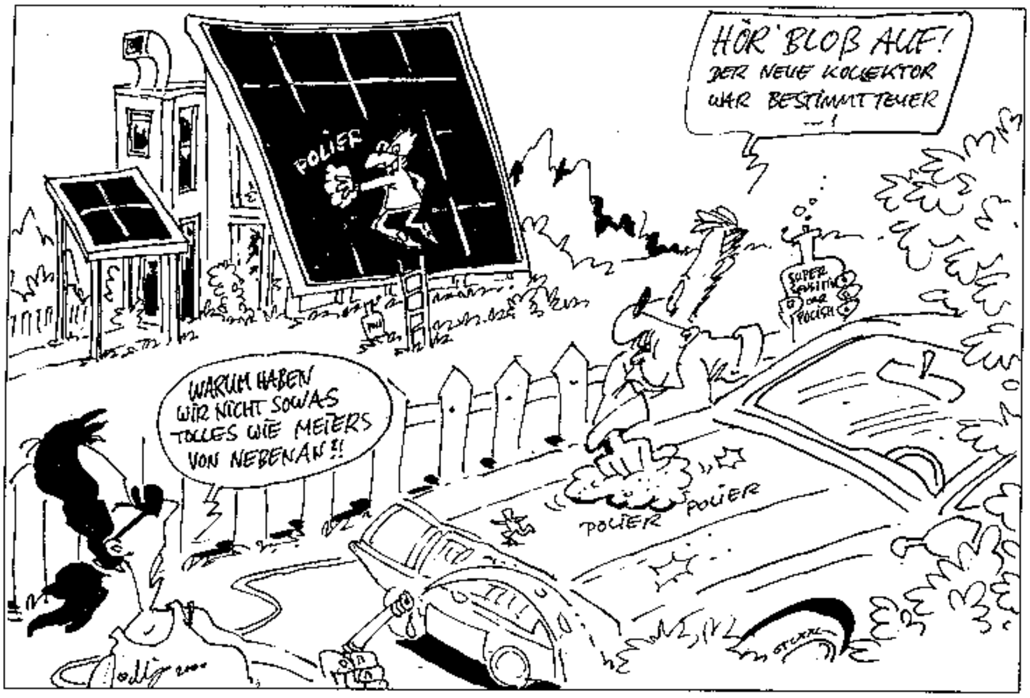

Fig. 4.4: "Why don't **we** have such a nice solar system?" "Oh dear, it must have been much more expensive than our new car!"

Of core relevance for deriving successful strategies is to find out what are the most important features to influence various types of customers' willingness-to-pay (WTP) for PV systems? The following parameters are of major relevance for customer decision-making processes and affect their WTP:

- Pure investment costs
- Affordability
- Transaction costs/efforts: information on system components, on system optimisation, on investment costs, on technical installment conditions
- technical performance (kWh per year generated) and technical reliability (How often is it likely that a part of the system breaks, that repairs have to be conducted?)
- Environmental benignity
- Social acceptance of PV

This argues that technical reliability, environmental benignity, affordability, and other non-technical issues are at least to the same extent important as simplified economic assessments using "artificial" interest rates.

Based on these reflections we define consumers' willingness-to-pay (WTP) as:

WTP=f(Income/affordability, investment costs, information, environmental benignity, reliability, technical efficiency, autonomous electricity supply, acceptance) (1)

Now it is of interest how these WTP may be interpreted by a demand curve. As already mentioned it describes the WTP of different consumers and, hence, consists of the value of the different impact parameters for single households. By conducting an empirical investigation on the weight of these parameters and the maximum of money consumers are ready to pay for a PV system, the shares of these parameters may be identified. The basic principle (with random numbers) is depicted in Fig. 4.5. It shows in principle how customers WTP depends on various impact categories. This concept may be helpful for deriving an appraisal of the future strategies and potentials. An example: if the weight of technical reliability is substantial (e.g. 20% impact weight) a 10% increase in this feature would shift the demand curve by 2% upwards.

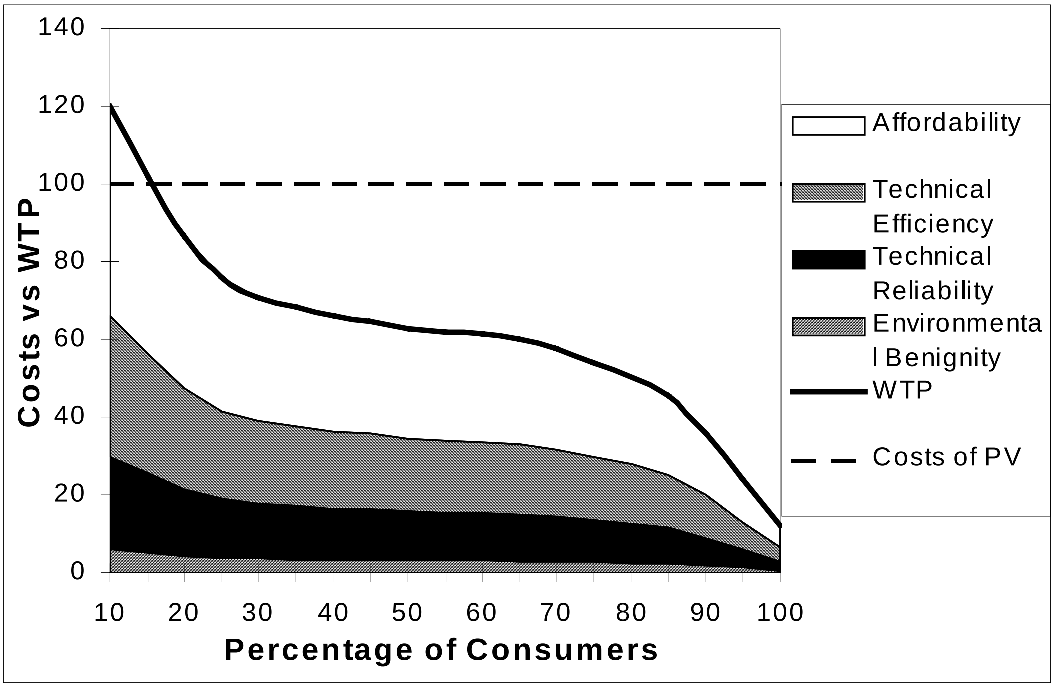

Figure 4.5. Willingness-to-pay for PV systems depending on various features

These impact parameters have also been identified in various WTP studies. The most important studies with respect to PV or renewables in general have been conducted by Farhar B. and Roper A. (USA) (1998), Farhar B. and Houston (1996), INFAS (1997), Haas et al (1998), Fouquet (1999), ISMA in Austria (2000) and Datamonitor, see Petrovic (2000). Of special interest is the work by Farhar because she summarises various utility studies in the U.S.

Surprisingly the results of these different studies are very similar.

All studies come to the conclusion that the vast majority of the population in different countries – between 55 and 75% – state that they would in principle be ready to pay a higher price for electricity if it would be generated by environmentally benign sources. In detail upt to 10 % of residential customers are very willing to pay a higher price (20% premium and more). The majority of 40 to 50% are fairly willing to pay a higher price (10 to 15% premium) and only 10 to 25% are not at all willing to pay a higher price, see Fig. 4.6.

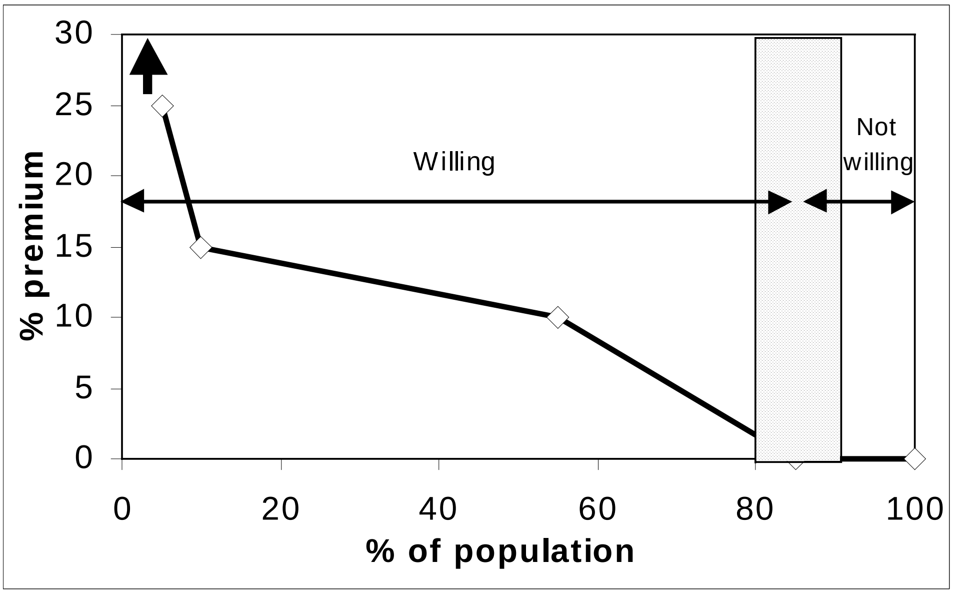

Figure 4.6. Willingness-to-pay for Green electricity due to different surveys

Most of these analyses mainly refer to Green Electricity in general. Hence if we look at PV in Fig 4.6 only the very left part of the curve is relevant.

Another interesting result is that in those studies where the question was asked: “who should provide this more expensive Green electricity?” the majority of 70 to 80% stated it should not be the "old" incumbent private-owned utility but rather a municipal utility, a Green company or a cooperative.

Moreover, of special interest is also the following result of the survey by Datamonitor, see Petrovic (2000). They found that in Germany "a large proportion of domestic customers are totally unaware that Green energy exists". This confirms that suppliers must devote a share of their budget towards aggressively marketing and advertising their green products (Petrovic 2000)..

Of course, the results of these studies refer to customers reported WTP. Given that there is a difference between stated and demonstrated WTP the actual numbers will be lower.

4.3 Diffusion of technologies

The WTP of a certain population for any product as depicted in Fig. 4.5 goes hand in hand with the theory of diffusion. This theory is very helpful to understand how the individual decision-making processes influence the over-all market penetration.

The fundamental theory of the diffusion of technologies was developed and is described comprehensively by Rogers (1983). He describes the innovation process by means of a cumulative S-shaped curve – see Fig. 4.7 – with the following typical categories of adopters (see also Gregory et al (1994)): (i) innovators, (ii) early adopters; (iii) early majority; (iv) late majority; (v) laggards. Of course, the customers with the higher WTP – left hand-side in Fig. 4.6 – are the innovators in the theory of diffusion.

Regarding the individual decision-making processes with respect to the innovation and market penetration respectively adoption or rejection of a technology by customers Rogers (1983) defines five different stages: (i) Knowledge; (ii) Persuasion; (iii) Decision; (iv) Implementation; (v) confirmation. In the third stage – decision – consumers will either adopt or reject the technology, yet, it is possible that they will revise this decision later.

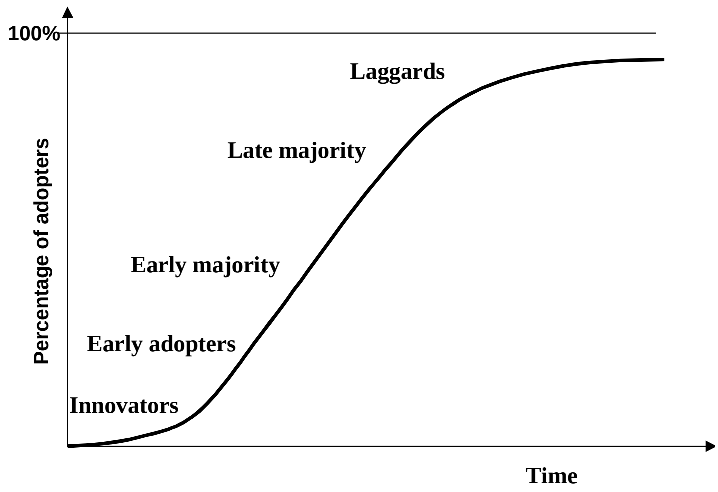

Figure 4.7 Diffusion theory – various stages

4.4 Market theory: short-term vs long term development of the supply curve

Although (conventional) economics are not the only assessment criteria it is important to be taken into account because the high (monetary) investment costs of PV systems are the major impediment to wider market penetration, see also Eiffert (2001). The (conceivable) environmental benefits of residential PV electricity will, in principle, always be compared with the production costs of PV electricity.

First it is of interest how the costs develop depending on quantity and time. This development is described by a supply curve. Fig. 4.8 depicts the long term and short term development of the supply curve. The short term development in an imperfect market – as it usually exists for an emerging new technology – is that prices increase if demand increases. Yet, this leads to the emergence of new companies, competition increases and prices drop.

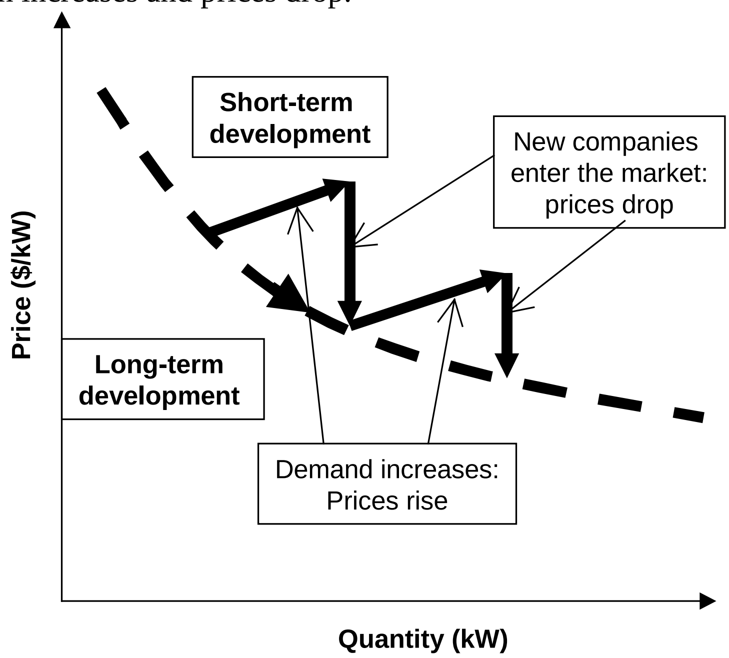

Figure 4.8 Short-term vs. long-term development of prices for PV systems in the early market introduction phase

The long-term curve may also be interpreted as a learning curve (see e.g. Grübler/Messner 1998 and Nej 1997)

Hence, in the long run prices will decrease till a perfect competitive market is reached, see Fig. 4.9 Then no further price decreases can be expected if demand continues to increase.

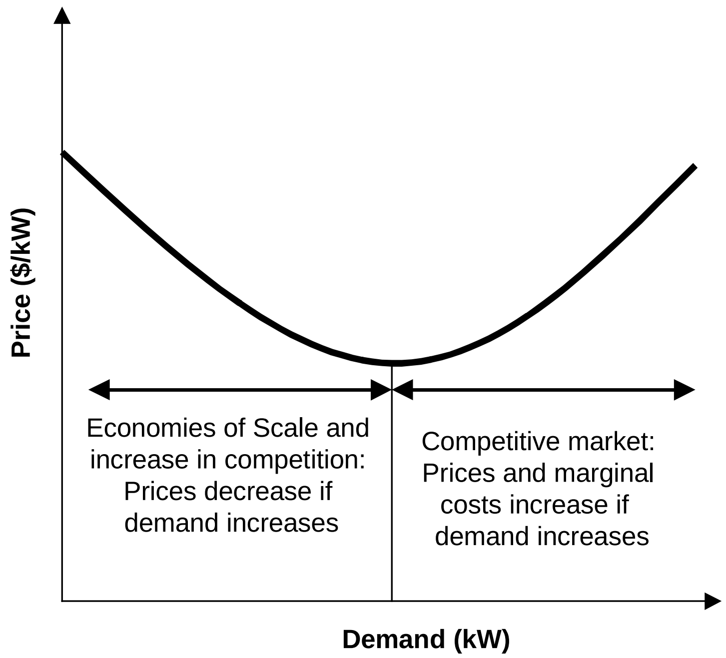

Figure 4.9 Supply curve: Cost development depending on quantity

4.5 Development of costs over time

Most interesting is how the costs will develop in the future. Therefore, it is important to know the past development of investment costs by component.

The development of the costs for small grid-connected PV systems with a capacity of 3 kWp in some of the countries where comprehensive promotion activities took place is depicted in Fig 4.10. It is of interest that system prices dropped substantially from 1990 till 1996. Yet, since 1996, with the exemption of Japan, no remarkable price reductions have been achieved.

In Fig. 4.11a the share of module costs is presented. It can be seen that in recent years the non-module costs, e.g. of inverters, design and planning, assembling, construction work, installation, were reduced to a larger extent than module costs. This shows the importance of pursueing both, a further reduction in module prices as well as in the design and installation costs. Although, there are cost reductions also for conventionally manufactured modules, this effect may die out in the near future. This argument is supported by the fact, that in recent years module costs decreased at a rather low rate (see Fig. 4.11a). The major cost reductions were achieved due to a reduction in costs of other components. PV module manufacture now must go to the next stage of development for further cost reductions to occur – larger manufacturing facilities to achieve better economies of scale and higher automation, as well as manufacture of the lower cost PV types, especially thin film products.

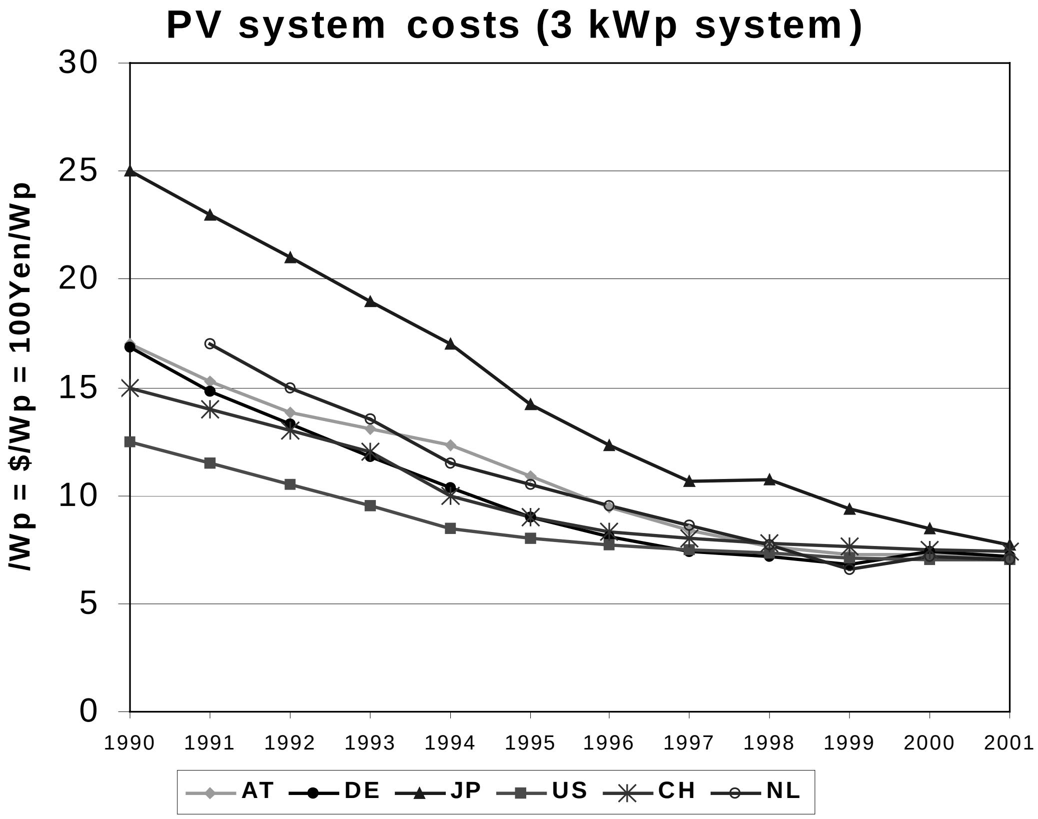

Figure 4.10 Development of PV system prices in Germany, Austria, USA, The Netherlands, Switzerland and Japan 1990-2000 excl. VAT

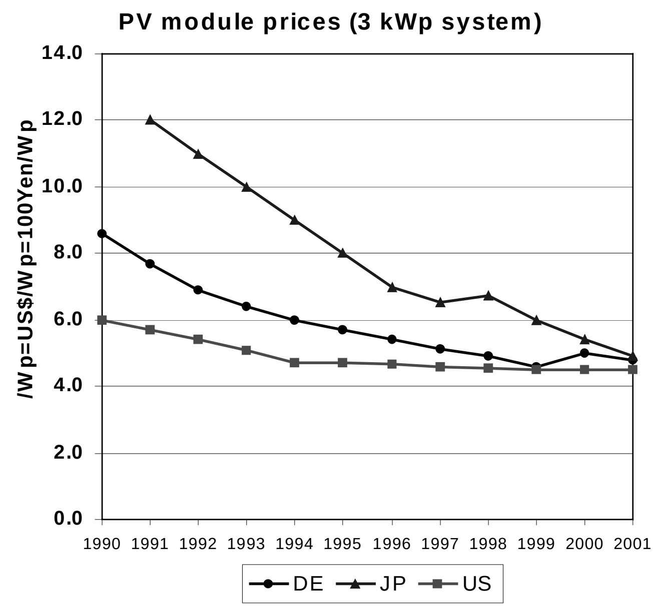

Figure 4.11a Development of the share of modules on PV system prices 1990-2000 excl. VAT

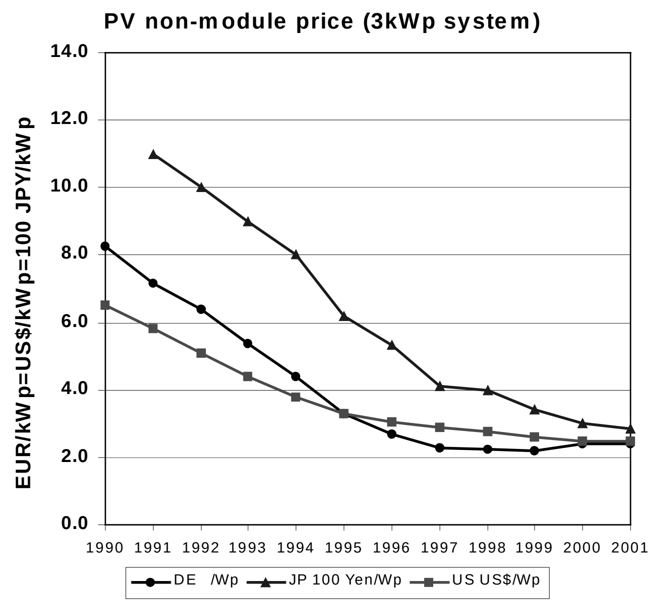

Figure 4.11b Development of PV non-module prices 1990-2000 excl. VAT

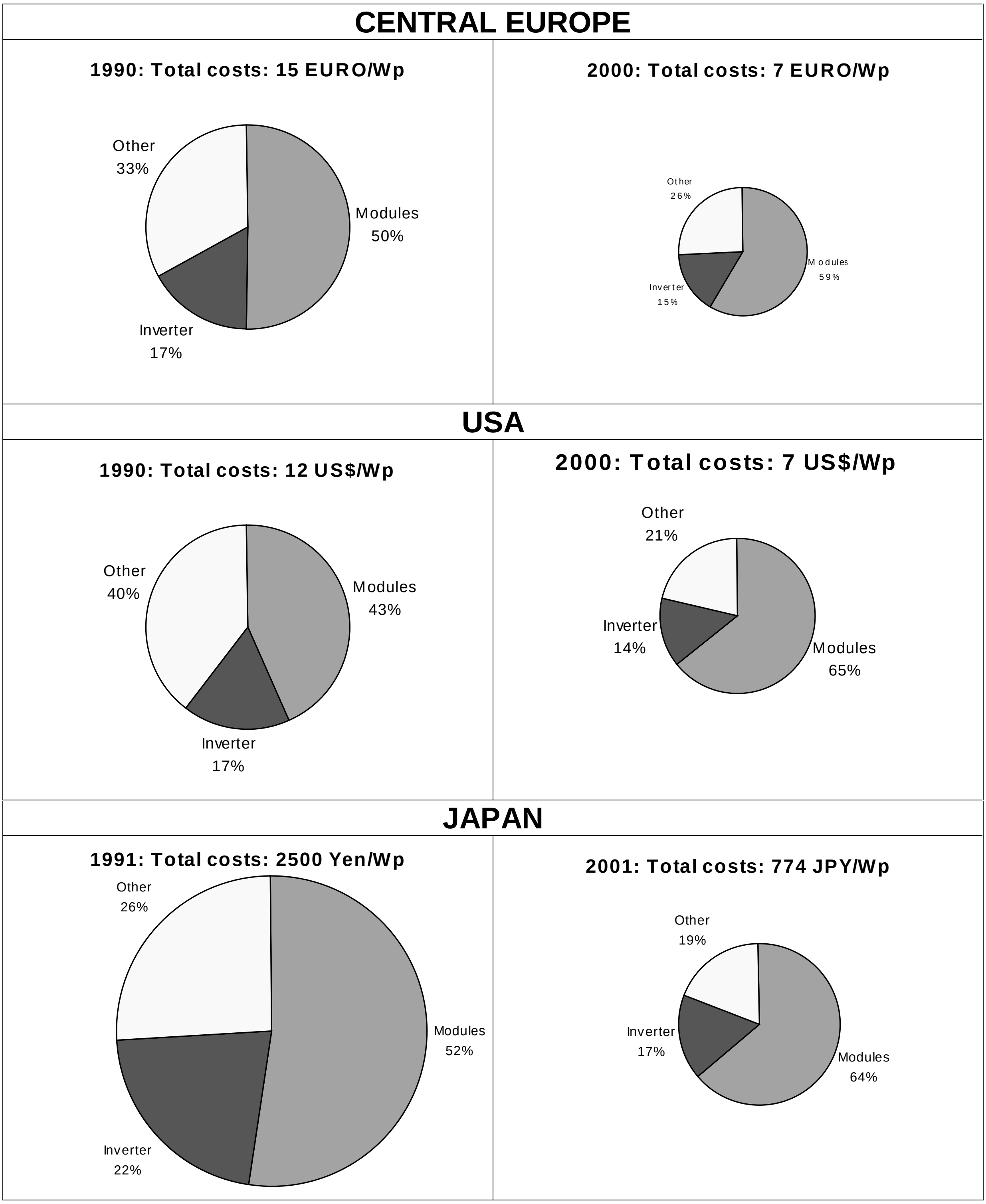

Figure 4.12 Share of modules, inverters and others on total PV system prices in 1990 and 2000 in Central Europe, USA, and Japan (excl. VAT)

4.6 A pure economic assessment: On the way to cost-effectiveness?

The bad current economic performance of PV systems has been identified as the most important barrier. Yet, how bad is this economic performance? How far away from cost-effectiveness is decentralised grid-connected PV? And how does it differ between countries?

In this context it is of course of relevance to take into account electricity purchase prices of households and companies and the difference in solar insolation. Moreover, differences in income and risk may also play an important role. An interesting investigation on the future prospects of the economics of PV systems has been conducted by Maycock (2000). Moreover, a very comprehensive survey on assessing the economics of PV systems is provided by Eiffert (2001).

In the following we use a traditional industrial economic approach to extract the costs of a kWh of PV electricity in different countries. The costs are calculated by considering the investment costs $IC_{PV\ per\ kWp}$, the capital recovery factor CRF, the yearly solar insolation per m² Q_{sol}, the ratio of total radiation on the optimal tilted plane to that on the horizontal surface R[2], the performance factor φ[3], the efficiency of the PV system η_{PV}, and the specific area needed per kWp installed A_{sp} as described in equ. (1):

$$p_{PV} = \frac{IC_{PV}\ CRF(r,LT)}{Q_{sol}\ R\ \eta_{PV}\ \varphi\ A_{sp}} \qquad (1)$$

<u>Example:</u>

For Australia the average investment costs are 12500A$/kWp (of 2000). This is 7500 U$/kWp. The insolation is between *1600* and *2200* kWh/m² horizontal surface. The CRF is 0.1 for an interest rate of 5% and a depreciation time of 15 years. The performance factor γ is 0.85, the efficiency η is 0.15, the R-value is 1.18 and the specific area is 10m²/kWp.
This leads to the equation:

$$P_{PV} = \frac{7500 \times 0.1}{2200 \times 0.85 \times 0.15 \times 1.18 \times 10} \approx 0.22\ \frac{US\$}{kWh}$$

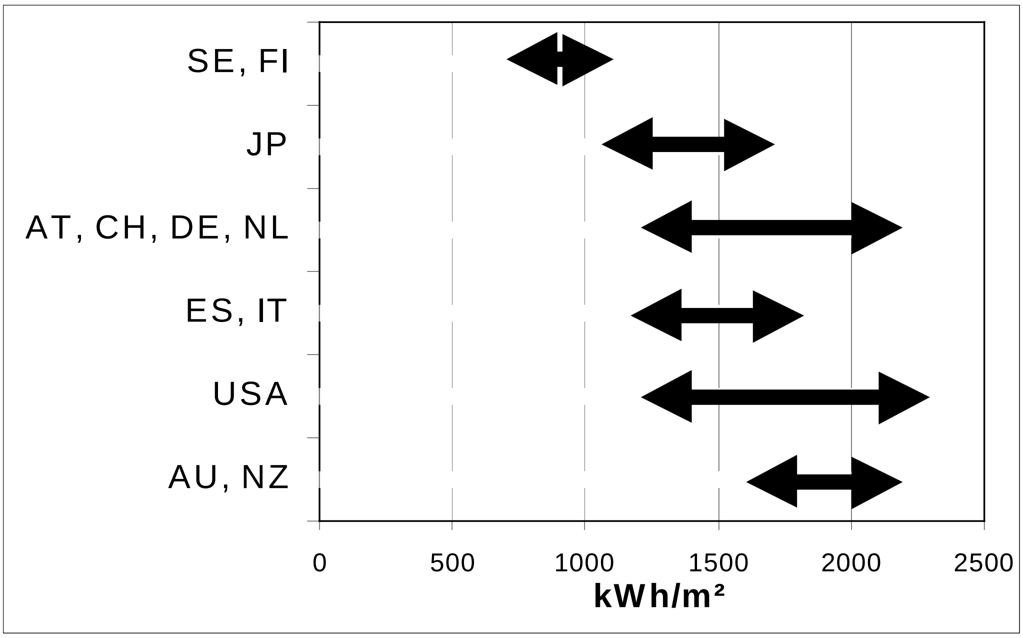

Figure 4.13 Solar insolation vs investment costs of PV systems in 2000 US$/kWp (related to small grid-connected systems of 3 kW_p) in six OECD countries

[2] An R value of 1.18 is used for all countries.
[3] An efficiency of 0.15 a performance factor of 0.85, and a specific area A_{sp} of 10m² per kWp are applied for all countries

Currently, the efficiency η_{PV} is by and large the same all over the world whereas the investment costs and the solar insolation may vary tremendously between different countries and locations, see Fig. 4.13. Hence, these are the most important terms in equation (1). Table 4.2 depicts the data for six OECD countries. We see the broad range that even exists within a single country. This leads to the fact, that production costs in 2000 varied between an average of 0.2 US$/kWh$_{PV}$ in some areas of the U.S. (e.g. New Mexico, Hawaii) and about 0.8 US$/kWh$_{PV}$ in Northern European countries, see Fig. 4.14.

Table 4.2. Investment costs of small grid-connected PV systems, range of solar insolation and resulting generation prices

	Investm.costs average (EURO/kWp or US$/kWp or 100 YEN/kWp)	Insolation max	Insolation min	Price (Insol. max) EURO/kWh	Price (Insol.-min) EURO/kWh
AU	7500	2200	1600	0.22	0.30
US	6500	2300	1200	0.18	0.35
ES, IT	8080	1900	1300	0.27	0.40
AT, CH, DE, NL	7200	1200	1000	0.38	0.46
JP	9300	1500	1100	0.36	0.58
SE, FI, UK	8800	1050	700	0.54	0.80

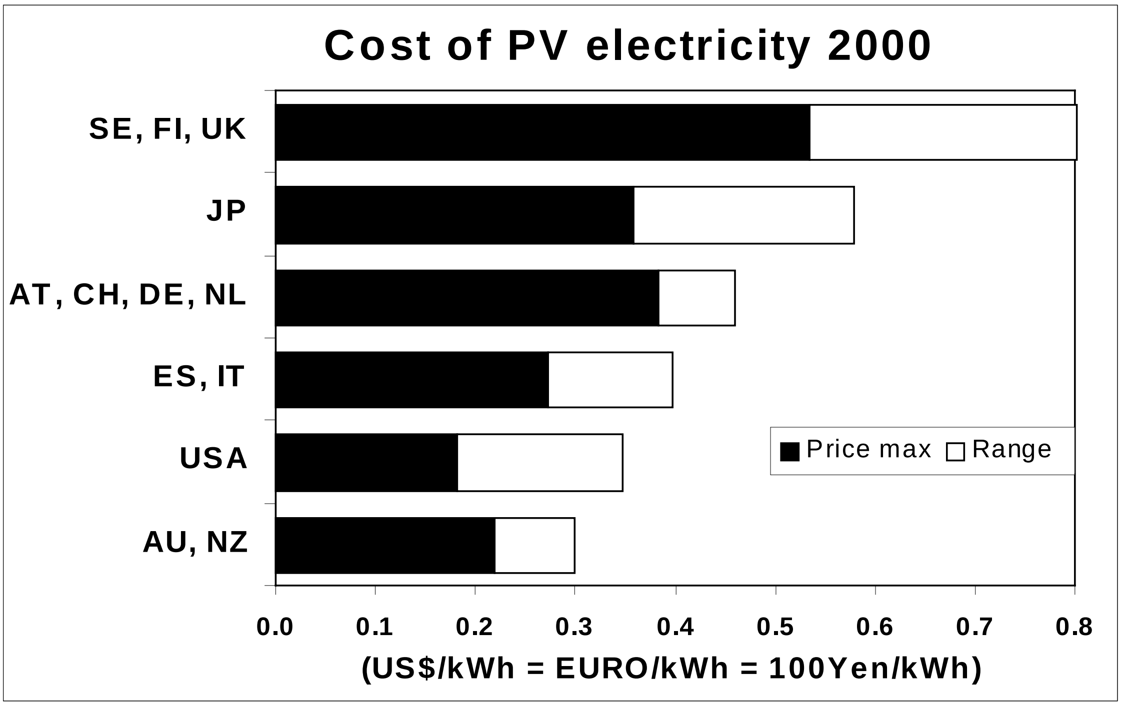

Figure 4.14 Range of costs per kWh of PV electricity in different OECD countries in 2000 (related to small systems of 3 kW$_p$)

It is obvious, that the costs vary tremendously. Most interesting is a comparison with household electricity prices. Fig. 4.15 depicts the range of household electricity prices in selected OECD countries in 2000. From Fig. 4.16 it can be seen that in the best areas of Australia and the USA the generation costs are closer to the household electricity prices. In Central and Northern Europe the prices are still around half a EURO/US$ which is far away from cost-effectiveness. If we look at the ratio R of costs per kWh PV electricity divided by electricity prices (with R=1 means cost-effectiveness) we see in Fig. 4.16 that in parts of the USA, Japan and Australia it is at least smaller than 2 while in Northern Europe it is still more than 4.

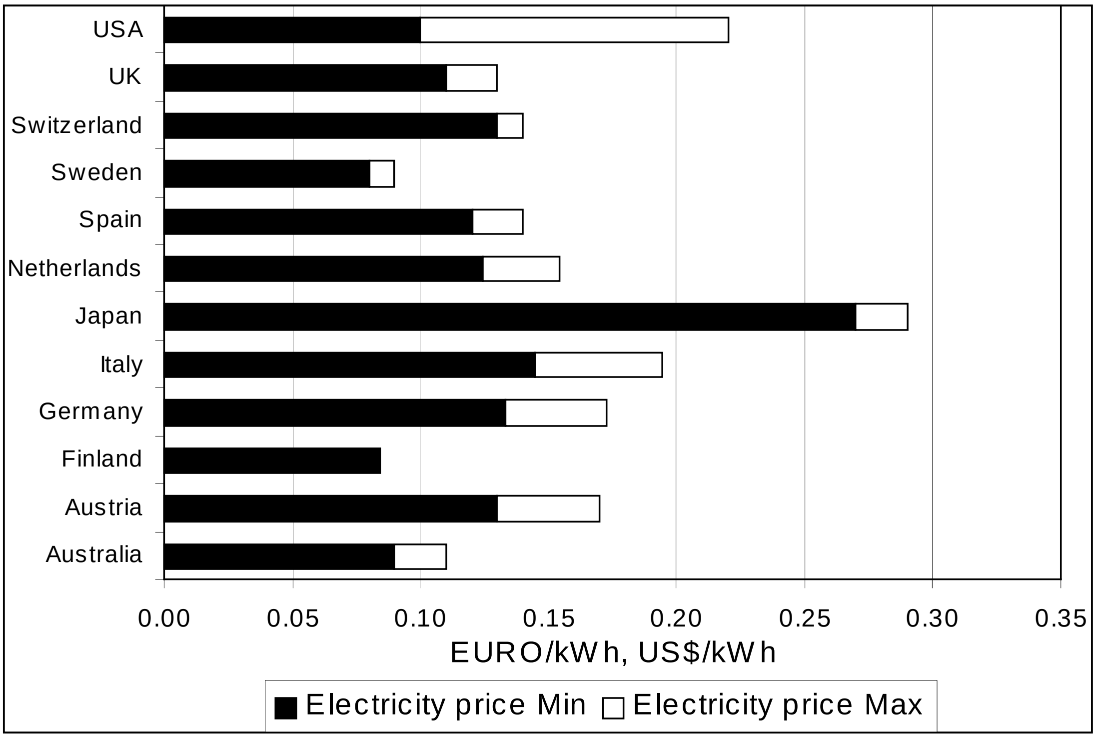

Figure 4.15 Range of household electricity prices in selected OECD countries in 2000

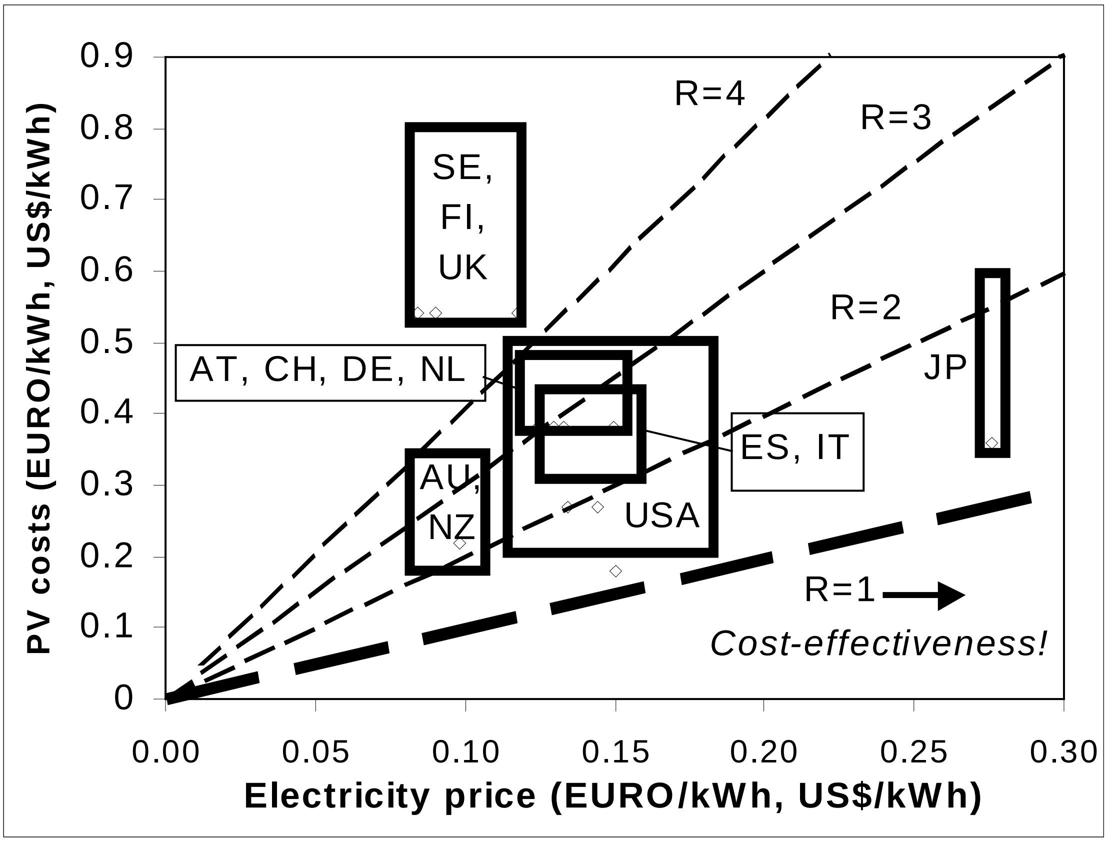

Figure 4.16 Range of electricity prices and costs per kWh PV electricity in different OECD countries in 2000 (R= ratio of PV generation costs/electricity price)

4.7 Other (hidden) costs for customers

Finally, it is important to analyse how the market looks from the customers' point-of-view. So far we have only considered pure monetary out-of-pocket costs for the PV system. Yet as e.g. Wenger (1998) reports there may also be other "hidden" monetary and non-monetary costs, so-called transaction costs. Typical "hidden" costs are due to Wenger (1998) insurances, utility metering, interconnection fees, minimum charges etc. Typical non-monetary costs are time needed to get information, time needed to find the product, negotiations with the utility, to compare prices etc.

Fig. 4.17 depicts the effect of these costs over time.

This leads straight to the requirements of perfect markets.

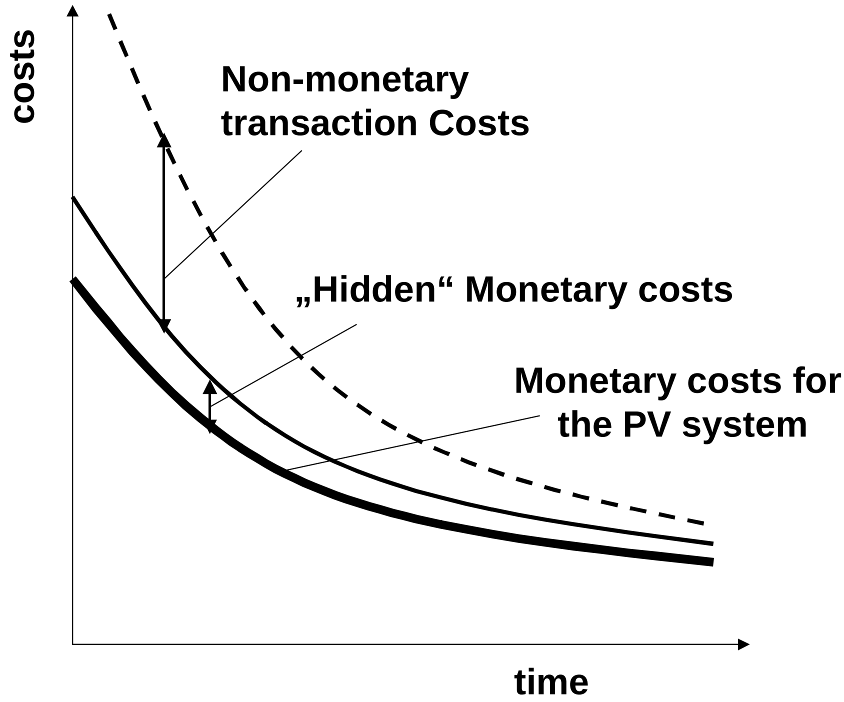

Figure 4.17 The market price for PV and the "hidden" transaction costs for customers

5. TYPES AND FEATURES OF DISSEMINATION STRATEGIES

In the sections above we have identified the most important barriers and the relevant areas of activity and target groups. Building on the theory of diffusion, it is now of interest whether and how the speed of market penetration of PV can be accelerated. This is done by applying proper dissemination strategies.

5.1 Objectives of strategies

The major objectives of strategies are:

- to remove the barriers for a broader market penetration (as summarised in Section 3);
- to increase the capacity installed and the market penetration of PV and
- to enjoy the corresponding environmental benefits.

Derived from these fundamental objectives related targets of strategies are:

- to exhaust customers WTP
- to increase social acceptance and public awareness
- to reduce costs per kWh generated
- to improve technical reliability, technical performance and standardization
- to remove obstacles with respect to grid-connection
- minimise costs to the public, e.g. strive for low administration costs, low transaction costs and minimise public financial support to reach a certain amount of PV capacity installed;
- lead to sustainable growth of the PV industry;

In recent years a wide variety of dissemination strategies have been implemented in various OECD countries. In the following the major features/dimensions of dissemination strategies are described. Next, a survey on which types of promotion strategies exist in principle and how they work is provided.

How these strategies are put into real life by means of specific programmes in certain areas or countries is depicted in the following chapters. Different types of programmes in these various strategy categories which are currently or have in the past been implemented in different countries are described in chapters 7 to 11.

5.2 Features/components of strategies

The investigations conducted so far lead to the result that there are six important **possible** features of successful dissemination strategies for decentralised PV systems, see Fig. 5.1. These features are:

1. Financial incentives:

A financial incentive may be important to improve the economic performance of PV systems.. As described above this may be on a regulated or on a voluntary basis. Moreover, there are three principal possibilities for a financial incentive it might: (i) be a subsidy on the capacity or the electricity generated or (ii) be an attractive financing offer; (iii) offer a standardised system at a low price; (“discount”).

2. Marketing and information

A successful strategy has to identify who are the potential participants of a programme and what are their needs. Moreover, it has to provide detailed and targeted technical and practical information for the potential customer on how and where to install the PV system. Further information is required on the conditions for installing a PV system, the cost of a system and its components.

3. Improve technical performance

The technical reliability, the conversion efficiency and the simplicity of installing the system are important criteria for customers. This should be addressed in a strategy by means of guaranteed yields, labelled products and technical monitoring. Moreover, technical performance can also be improved in a strategy promoting and financing standards development and technology R&D.

4. Set Regulatory conditions

Especially in liberalised markets it is important that distortions e.g. due to environmental effects, or not including external costs, are corrected by the governments. This can be done e.g. by regulatory rates, national quotas, or governmental rebates.

5. Address public awareness

Next it is important to address the social component. While the public acceptance for PV is in general no problem, the state of knowledge and public awareness is. This can be improved by means of launching general information on environmental problems and values added by PV, such as local job creation. Moreover, it is often important to make the programme a social event. Of tremendous importance in this context is to address the mass-media in a proper way.

6. Create Market Transparency

Finally, an important feature of a strategy may be to enhance the transparency of the market. This applies to the PV system market as well as the general market for electricity. With respect to the market for PV systems a market and product survey may be conducted. This may help substantially to reduce transaction costs for the customer. Regarding the electricity market it may be important to enhance transparency on current fuel mix of electricity supply e.g. by means of an energy source label.

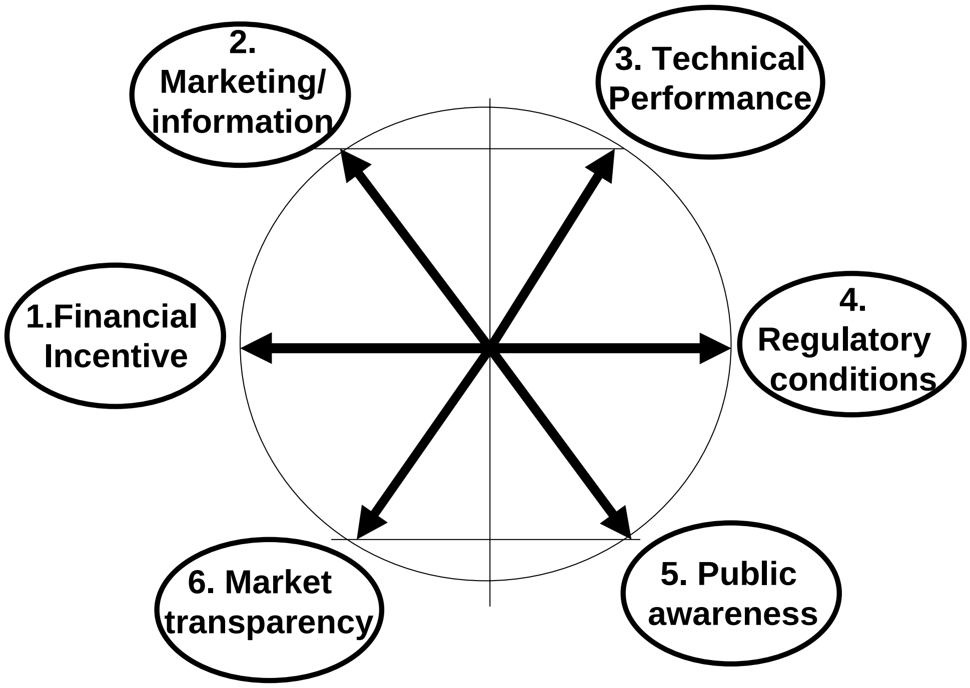

Figure 5.1. Features/components of dissemination strategies

The following matrix in Table 5.1 provides a survey of which features/components of strategies to remove specific types of barriers are listed as well as the target groups addressed.

Table 5.1. Barriers, features of strategies, and target groups (in *Italics*) to be addressed to remove various barriers

FEATURE OF STRATEGY → **TARGET GROUP ↘** **↓ BARRIER**	**1 Financial incentives**	**2 Marketing and informatio n**	**3 Technical Standardi-sation**	**4 Regulatory require-ments**	**5 Public awareness/ Social acceptance**	**6 Market Improve-ment**
A. Bad Economic performance	• *Private customers*		• *PV industry*	• *National and local govern-ments*		• *PV industry*
B. High trans-action costs for customers		• *(local) govern-ments and utilities*	• *PV industry*	• *government*	• *Local government, electrical and building industries*	• *Private customers*
C. Low private WTP	• *Financing sector*	• *private customer*			• *Community ; private customers*	• *community; private customers*
D. Lack of architectural acceptance		• *Architects*	• *PV industry*	• *Building industry, local government*	• *PV industry*	• *PV industry*
E. Lack of financing strategies	• *Financing sector*	• *Finance sector*				• *PV industry*
F. Imperfect non-transparent markets, low competition	• *government*	• *Private customers*		• *PV industry, electricity industry, government*	• *Community, government*	• *Governmen t, utilities*
G. Lack of technical reliability	• *PV industry, government, PV customers*		• *PV industry* • *R&D*	• *PV industry*		• *PV industry, government*
H. Lack of system standardisation	• *Government , PV industry, building industry*		• *PV industry* • *R&D*	• *National and local govern-ments*		• *PV industry,* • *Building industry*
I. Environmental benefits not rewarded		• *Private customers*		• *Governmen t, utilities*	• *National and local govern-ments*	• *electricity industry*
J. Low public awareness		• *customers (local)*			• *PV industry*	• *PV industry*

		govern-ments				

5.3 Survey: Which strategies exist in principle?

Next it is analysed which strategies exist in principle and how these strategies can be classified systematically. In this context the following questions are of interest:

- Who launches a strategy? Governments? NGO's? Commercial companies, e.g. "Green" utilities?
- Is it a voluntary strategy or based on regulation?
- Are financial incentives provided or not?
- Is the investment influenced, e.g. subsidized or the kWh generated by a PV system?
- Who is addressed by the strategy? PV generators? PV electricity users? Or a specific target group? E.g. architects, teachers, schools, building construction companies?

In the following it is described which fundamental types of strategies exist. Table 5.2 provides an overview. **Of course, a specific programme put into practice may always consist of a mix of different strategies!**

Table 5.2. Categories of strategies: Voluntary vs regulatory, capacity targets vs financial incentives, investment focussed vs generation-based

		Regulatory	**Voluntary**
Target programmes		• RPS • Bidding/Tendering • Quotas, TGCs	• National installment or capacity targets
Financial incentives	Generation-based	• feed-in tariffs, • rate-based incentives • Net metering	• Green Power Marketing • Green tariffs • Solar stock exchange
	Investment focused	• Rebates • Soft loans • Tax incentives	• Contracting • Shareholder progr. • Contribution • Bidding
Other		–	• NGO-marketing • Selling green buildings • Retailer progr. • Financing • Public building prog.

5.3.1. Governmental target programmes:

In this case the strategy is based on a government decision on the desired level of generation or market penetration of electricity from different RES. The price is in principle set through competition between generators. Financial incentives may support this type of a strategy but they are not compulsory.

National targets

Non-mandatory capacity targets or number of systems installed

Mandatory targets:

Renewable portfolio standards / quotas, tradable green certificates (TGC), renewable energy or CO_2 based certificates.

5.3.2. Financial incentives

In Fig. 5.2 various strategies based on financial incentives are categorized with respect to the flow of money and regulatory interferences between various players in the market.

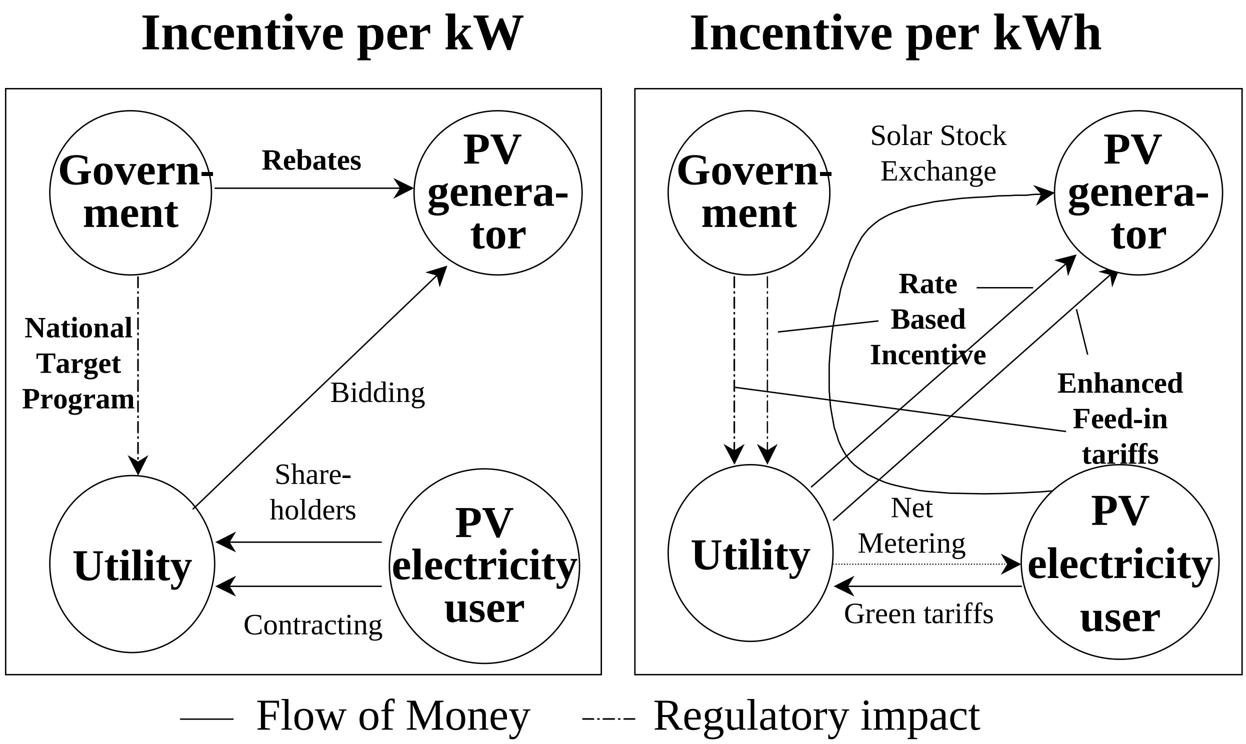

Figure 5.2. A representation of financial incentives and accompanied regulatory requirements of various dissemination strategies

These players are: governments, electric utilities, independent PV power producers (IPP), and the consumers. E.g. in the case of rate-based incentives, the money goes from the utility to the PV producer as a payment for every kWh. In the case of a public purpose program the utility collects money from the customers, hands it over to the government and the government's fund supports independent PV generators.

5.3.2.1. Regulated financial incentives:

Generators of electricity from RES receive financial support in terms of a subsidy per kWp capacity installed or a payment per kWh produced and sold.

Investment focused:

Rebates, income tax incentives, soft loans

Generation based:

This type of strategy is typically based on regulated rates. Examples are:_Net metering, enhanced feed-in tariffs, rate-based incentives (= "Kostendeckende Vergütung" for PV in Germany, Austria and Switzerland); Environmental pricing.

5.3.2.2. Voluntary approaches with financial incentives:

This type of strategy is mainly based on the WTP (Willingness to pay) of different categories of customers. The strategy is usually launched by an electric utility. The financial incentive is provided by a PV electricity user with a corresponding WTP. This type of strategy can be split into two categories:

Investment focused:

shareholder programmes, contribution programmes, voluntary bidding/tendering.

Generation based

Green tariffs, w/ or w/o labelling, "Solarastrombörse", Green power marketing (in liberalised electricity markets)

5.3.2.3. Indirect financial incentives:

PV electricity can also be promoted by means of indirect strategies, as e.g. CO_2 taxes, penalties for not meeting mandatory targets or removal of subsidies for fossil fuel and nuclear generation.

5.3.3. Other strategies:

Other programmes encompass marketing programmes by NGO's or by commercial companies (e.g. selling Green buildings), retailer programmes (e.g. franchising, guaranteed yield), programmes for public buildings (schools, townhalls, churches), and voluntary financing programmes by private companies (general information campaigns and education programmes, programmes for specific target groups e.g. architects?)

Table 5.3 gives an overview on the most important strategies categorised by the criteria described above with their core features.

5.4 The impact of financial incentives

In section 4 we have identified costs and the bad economic performance as very important barriers for a widespread use of PV. Financial incentives are undoubtedly the most important single feature of dissemination strategies for PV. In the following is explained in more detail how financial incentives impact the decision-making process of various groups of customers.

With respect to financial incentives as a promotion strategy for a technology, it is of principal relevance to take into account the following two major features:

- The dynamics of the investment costs;
- The WTP of private or commercial investors;

Most important is how the dynamics of investment costs and the WTP influence the magnitude of optimal dynamic incentives?

Moreover, Fig. 5.3 shows how different market equilibria with and without subsidies may look like for a certain point-of-time.

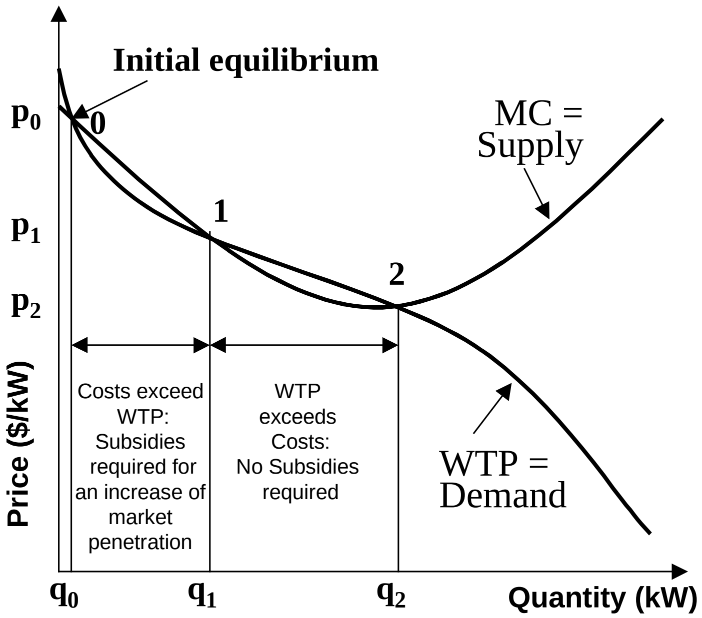

Figure 5.3 Price vs. customers WTP and the relevance of subsidies

From Fig. 5.3 it can be seen that there may exist a possible long term equilibrium w/o subsidies where a by far higher quantity of the technology is installed as at the current equilibrium. Yet to reach this equilibrium rebates are required to move from q0 to q1. This item is depicted in detail in Figure 5.4 The maximum rebate is given from the difference between supply and demand curve at qx. Of course an increase of subsidies to enhance the quantity sold is not possible because nobody would purchase a system if he knows that he gets more subsidies next year.

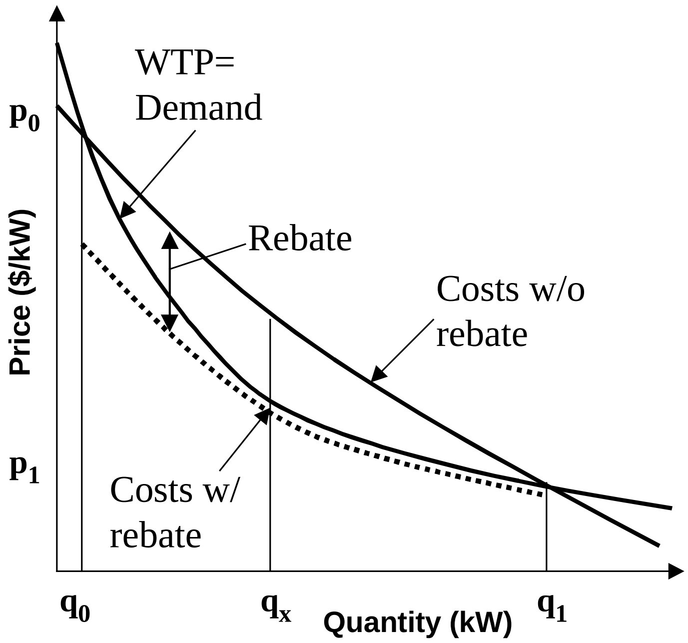

Figure 5.4 Rebates required to increase market penetration

Furthermore, it can be argued that subsidies are justified as long as they reflect the societal benefit.

6. GOVERNMENTAL TARGET PROGRAMMES

In some countries programs have been introduced or are intended to be launched which focus on a certain target for a market share or installed capacity of PV or renewables in general.

In principle, both, voluntary and mandatory strategies are possible.

6.1 Voluntary capacity targets or number of installations targets

Such programs has been introduced in Switzerland (ENERGIE 2000), The Netherlands (NOVEM program), the USA (Presidents' million solar roofs program) and by the EC (1 000 000 roofs programme)

6.1.1 The 1 000 000 roofs programme of the European Commission

Generating electricity from Renewable Energy Sources (RES) currently has a high priority in the energy policy strategies of the European Commission. Since 1979 the EC supports the dissemination of PV by means of various programmes (e.g. THERMIE and ALTENER).

A milestone for the political promotion of PV in Europe was the EC's *White Paper on Renewable Sources of Energy* (EC 1997). In 1999 the *Campaign for take-off (CTO)* was launched. A comprehensive range of measures is proposed to overcome barriers to the development of renewables and to redress imbalances. Within the CTO it is intended to promote 1 000 000 PV systems until 2003. It is aimed for installing 500 000 PV systems on roofs and facades within the domestic European market and an export initiative for another 500 000 PV village systems to start the decentralised electrification in developing countries. Furthermore, the proposal (common position) for a directive of the European Parliament and the council *On the promotion of electricity from renewable energy sources in the internal electricity market* (Council of the European Union, 2001) set the challenging goal to substantially increase the share of renewables in the electricity mix of EU countries from 13.9% in 1997 to 22% in 2010. This should also contribute to meeting the objective of the CTO and to promote PV.

6.1.2 The Swiss "ENERGIE 2000" programme

In Switzerland in the early 1990s the so – called "ENERGIE 2000" program – has been launched by governmental institutions. Within this program the promotion of various energy conserving and solar energy converting technologies is planned and specific goals of market penetration should be reached by the year 2000. The "ENERGIE 2000" program is obviously over. The follow-up programme started in 2000 and is called "EnergieSchweiz".

For PV a capacity of 50 MWp was planned. At the end of 1999 about 14 MWp were installed. Until 1999 the PV systems were subsidised by around 1700 EURO/kWp (3000 SFr/kWp). Currently (2001) no government rebates are available anymore. This has been transferred to the individual Cantons and is being regulated differently. In some Cantons subsidies are available, in others none.

The major current strategy initiated under the "ENERGIE 2000" program is the campaign "Solarstrom vom E-Werk"" It has been started in 1996 and since then attracted 23 000 customers until the end of 2000. More than 100 utilities are currently (2001) offering "Solarstrom" compared to 6 in 1996. The installed capacity grew from 3.4 MWp in 1999 to about 5 MWp at the end of 2000, see Fig 6.1. Source: Frauenfelder 2000, and Frauenfelder (personal information).

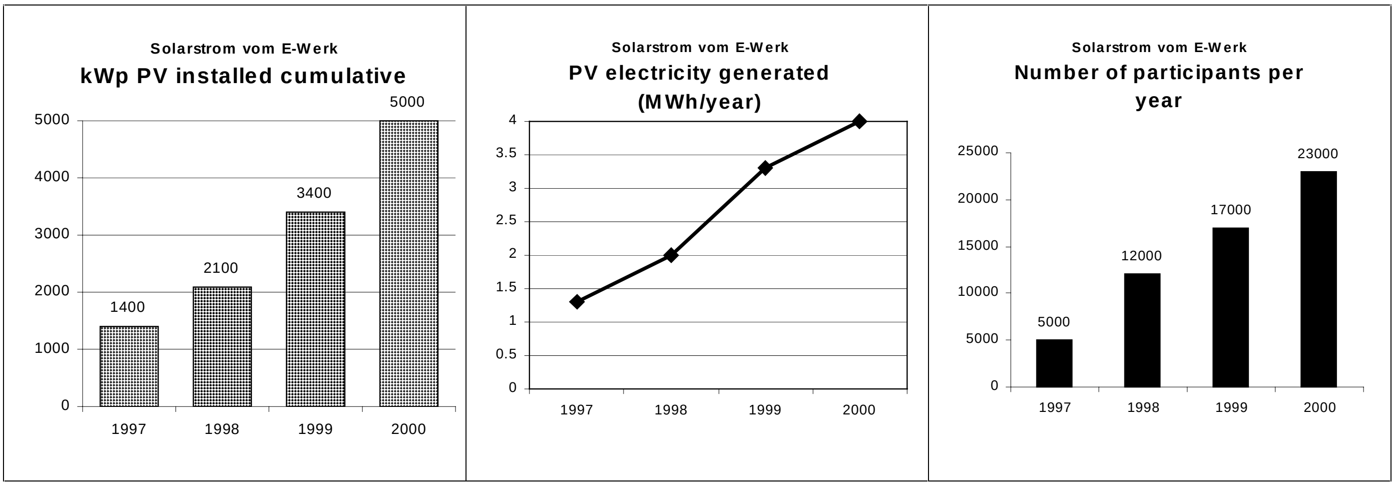

Figure 6.1. Installed PV capacity, electricity generated and number of participants in the Swiss campaign "Solarstrom vom E-Werk" 1997-2000

6.1.3 The Dutch "NOZ-PV" programme

In 1994 in The Netherlands various organisations under the leadership of the ministry for energy and environment (represented by NOVEM) launched a cooperation for a broader market dissemination of decentralised PV systems, the so-called NOZ-pv programme. Due to the Dutch “PV introduction plan“ (NOVEM 1997) it was planned to install 7.7 MWp of PV capacity till the year 2000 respectively 500 MW till 2010 (see Schoen 2000). The first target of 7.7 MWp was surpassed with 9.2 MWp installed already by the end of 1999 and 12.5 MW installed by the end of 2000.

The new PV covenant is anticipated to aim at a target of 300 MW by 2010 and 1400 MW by 2020, see Fig. 6.2. Moreover it is intended to reduce the investment costs to 2.75 NLG/kW in 2010 (Source: Wouters 2001

Within this programme to some extent strongly reduced rebates are foreseen.

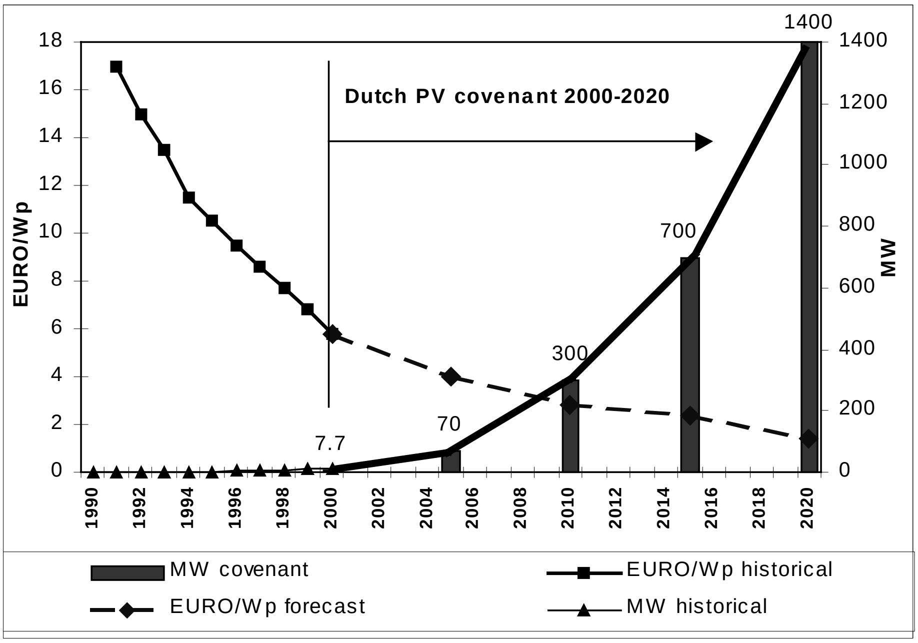

Figure 6.2. Installed PV capacity and cost development in the Netherlands: Historical numbers and planned development due to the Dutch PV covenant programme 2000-2020

6.1.4 German target programmes

In Germany the first national target programme took place from 1991 till 1995, the "German 1000 roofs programme". In 1999 another PV target programme has been launched, the "100 000 roofs programme". For further details of these programmes see sections 8.1.1 and 8.2.1.

6.1.5 Japanese targets

Within the New Sunshine project in 1996 the Japanese government announced targets of 400 MWp by 2000 and 4600 MWp by 2010. For details of the residential rebate programme see section 7.1.2.

6.1.6 USA: The President's Million Solar Roofs Initiative

In 1997 the former American president Clinton announced the so-called "Million Solar Roofs Initiative". Within this program a million roofs in the USA should be equipped with a PV system and/or a solar thermal system for water heating, pool heating, or space heating. With respect to PV the ***Team-Up initiative*** with its "friendly PV programs" is of special relevance. In this programme eight utilities have joined and market green electricity differently. Moreover, tax credits up to 2000 US$ are possible for individual systems.

6.1.7 Italy's "Fonti rinnovabili" programme

In Italy since 1998 a 10,000 roofs programme was announced. The programme was aiming at installing 50 MWp of small PV systems over five years.

Now it is obvious that this programme will never be put into practice. Instead in 2001 the "Programmi Fonti rinnovabili 2001 was announced with a special sub-programme on PV called "Tetti fotovoltaici". This programme intends to install 7 MW of PV.

6.1.8 Spanish targets

The Spanish government has already conducted a renewable energy programme from 1991 to 2000. Within this programme 5 MW of PV has been installed. In order to continue with the dissemination of RES a new plan for the period of 2000 – 2010 has been approved. Due to the "Plan de Fomento de las Energias Renovables" launched in 1999 a target of 135 MW of PV capacity is set for 2010. Most important is the Royal Decree which requires utilities to pay an economic incentive for PV electricity fed into the grid, see section 8.1, Fig. 8.1.

6.1.9 Finnish targets

The National Climate Change Programme intends to install 40 MW by 2010. It will be subsidized with 35 Mill. Euro.

6.1.10 Thailand: 20 MWp target till 2002

In 1997, the National Energy Policy Office (NEPO) of Thailand has introduced policy to support widespread use of PV applications and has set a goal to install 20 MWp between 1998 to 2002 (within the `8th National Social and Economic Development Plan). NEPO is encouraging measures to attract the use of photovoltaic energy by providing subsidies up to 50% for grid-connected systems and stand alone systems. The grid connected photovoltaic systems proposed can be either a roof-top programme (6 MWp) and/or utility supplied applications (4 MWp); the Electricity Generating Authority of Thailand (EGAT) will be the responsible implementing agency. (Source: Rakwichian et al (1998)).

6.2 Mandatory targets

In some countries mandatory targets – e.g. quotas or Renewable portfolio standards – have been introduced. Yet, so far it is not possible to provide lessons learned for this programmes. In the following the most important ones which at least include PV are shortly described.

6.2.1 Renewable portfolio standards (RPS) in the USA

The basic idea of the so called Renewable portfolio standards (RPS) is to ensure that a certain minimum percentage of electricity is generated by renewables but to encourage maximum efficiency by allowing the market to determine the most cost-effective solution for each electricity retailer.

Under a Renewables Portfolio Standard (RPS), all retail electricity suppliers are required to obtain a certain minimum percentage of their electricity from RES, in the form of "renewable energy credits" (RECs). Electricity retailers can obtain RECs in three ways. They can own their own renewable energy generation, and each kWh generated by these plants would represent one REC. They can purchase renewable energy from a separate renewable energy generator, hence obtaining one REC for each kWh of renewable electricity they purchase. Or, they can purchase RECs, without purchasing the actual power, from a broker who facilitates trades between various buyers and sellers. RECs are, therefore, certificates of proof that one kWh of electricity has been generated by renewables, and these RECs can be traded independently of the power itself.

RPS have been implemented in some federal states of the United States (e.g. Arizona, Connecticut, Iowa, Maine, Massachusetts and Nevada). Table 6.1 list the programmes which include PV..

Table 6.1: Renewable Portfolio Standards in the USA which include PV

State	Requirement	Energy sources
Arizona	0.5% of sales in 1999 rising to 1% in 2002	Solar PV and Solar-thermal electric
Connecticut	Class I technologies 0.5% in 2000, +0.25%/yr. to 1% by 2002	Solar, Wind, Hydro Biomass, landfill gas, fuel cells
Iowa	105 average MW minus 2.5% of sales	Solar, Wind, methane recovery, Biomass,
Maine	30% of sales in 2000	Solar, wind, fuel cells tidal power, geothermal, biomass, MSW and Cogen (under 100 MW)
Massachusetts	+1% from new renewables by 2003, +0.5%/yr to 4% by 2009, +1%/yr thereafter until date to be determined	Solar, Wind, Ocean, clean biomass,
Nevada	0.2% in 2001, rising 0.2% biannualy to 1% in 2009	50% from Solar, 50% from Wind

6.2.2 Australia's 2% additional RES target till 2010

The Australian government has recently required electricity retailers and large purchasers to meet a target of 9 500 GWh (approximately an additional 2%) of their electricity from RES by 2010. The measure is implemented by RECs trading, as described, however, each REC is worth 1 MWh. A penalty of AUD 40 per MWh will apply for non-compliance. Yet, there is no special commitment to PV.

6.2.3 Austria's 4% target program till 2007

In July 2000, the Austrian Parliament adopted a new Electricity Act, reflecting the proposal for a directive of the European Parliament and the council *On the promotion of electricity from renewable energy sources in the internal electricity market* (Council of the European Union, 2001) The Act requires that by 2007 "new renewables" account for 4% of the electricity sold to the final users. The provincial governors have fixed minimum feed-in tariffs for different technologies of this green electricity. This will bring about a change in the existing regulations. Extra costs incurred by the distribution companies will be compensated for by an additional tariff. Furthermore, the Act provides for the possibility of selling green electricity directly to customers, i.e. enterprises producing electricity from RES may conclude delivery contracts not only with eligible customers, but with any customer.

6.2.4 Upper Austria's bidding programme

The first governmental bidding programme for decentralised grid-connected PV so far has been launched In Upper Austria in 2000. It sets targets and financial incentives for different types of RES-E. There is a special obligation for PV of 220 kW/year. To meet this target a budget of 1 Mio EURO per year is available.

In the first year (2000) this programme has been successful. Further information is not yet available. (Source: Personal information Heinrich Wilk).

6.3 Public purpose programs in the USA

In the light of the looming restructuring of the ESI, various states of the USA intend to implement different types of *Public Purpose Programs*. These programmes are based on charges on transmission fees (*system benefit charges*). The most important ones are listed in Table 6.2. Yet, so far it is not possible to assess the effect of this programme type on the dissemination of PV. With respect to California see also section 7.1.5.

Table 6.2: Public Purpose Programs/System benefit charges in the USA

State	Description
California	$ 540 million per year over four years where from $54 are dedicated to Emerging Renewables
Illinois	5.0 c/month surcharge on residential customers for 10 years
Massachusettes	A yearly increasing charge starting at 0.075 c/kWh from all customers will provide $ 150 over the period 1998-2002
Montana	2.4% of total revenues
Rhode Island	0.23 c/kWh for next five years, all customers

7. CAPACITY-BASED GOVERNMENTAL FINANCIAL INCENTIVES (REBATE PROGRAMS, SOFT LOANS, TAX INCENTIVES)

The following describes the most important governmental financial incentives programmes world-wide, focusing on the capacity of PV installed and introduced so far. This category emcompasses mainly governmental rebates, governmental financing programs (e.g. soft loans) and tax incentives on investment.

7.1 Rebate programmes

MW Total	Number of systems	kW/ capita	MWh/ year	kW average	Status
6.15	**2250**	**0.12**	**4200**	**2.6**	**OFF 1995**

7.1.1 The German 1000 roofs program

The first comprehensive international dissemination program was the "1000 roofs program" launched in Germany in 1989. This program was completed in 1994. Some 2250 German roofs were equipped with PV systems of an average size of 2.6 kWp and a total capacity of about 6 MWp. Average system costs were 15000 US$/kWp, average subsidies 70% of the investment costs. During this dissemination program and also in the aftermath comprehensive investigations on technical and sociological aspects of this program took place. The major results of this programme were that PV systems reached a certain standard of technical reliability, that PV system costs dropped, and that the acceptance of this technology increased considerably. Moreover, experiences gained in this program were also used for similar activities in Austria and Japan. The major references for the German 1000 roofs program are Genennig/Hoffmann (1996), Hoffmann (1995), and ISE (1994).

7.1.2 The Austrian 200 kW rooftop program

In 1991 the Austrian Ministry for Economic Affairs launched a promotion program for small decentralized PV systems, the 200 kWp PV-rooftop program. It took place between 1992 and 1994. Within this program about 100 small residential grid-connected systems were subsidized by utilities and governmental authorities. The total installed capacity was 203.6 kWp. The average capacity was 2.28 kWp. Average system costs were about US$ 16,000. About 58% of the investment costs were subsidized by authorities and electric utilities. For further details see e.g. Haas et al (1997), Wilk et al (1993), and Wilk (1994).

The major targets of the 200 kWp rooftop program were: (i) collecting comprehensive operation data as a basis for further R&D activities on various components of PV systems; (ii) testing and assessing the long-term performance of small decentralized PV systems; (iii) investigating the maintenance efforts for small PV systems; (iv) optimizing the system design of grid-connected systems; (v) acceleration of the market penetration of PV.

7.1.3 The Japanese "Residential PV System Dissemination Programme"

The largest dissemination program so far world-wide was launched in Japan in 1994. In the following years the number of small grid-connected systems skyrocketed, see Fig. 7.1.

This programme was and is to some extent combined with low-interest consumer loans and comprehensive education and awareness activities for PV. The programme makes blocks of funds available to PV system retailers in a competitive bid programme.

This program is still ongoing and expected to expire in 2002.

In 1997 the "New Energy Promotion Law" was introduced as part of the New Sunshine project. It ensured subsidies for PV and it announced targets of 400 MWp by 2000 and 4800 MWp by 2010 (Ikki/Ohigashi, 2001).

While in 1994 "only" about 540 systems has been installed up to the end of FY2001 about 75 000 small grid-connected systems with an average capacity of about 3,6 kWp has been installed. In FY 2000 and 2001 alone more than 20000 systems were installed. It is expected that this number will increase to about 29000 in FY 2002 (Ikki 2002). This led to around 88 MW installed in FY2001 and to a cumulated installed capacity of 270 MW in Japan by the end of FY2000. The most important details are summarized in Table 7.1. To put these figures in perspective: world-wide PV production in 2001 was about 400 MW.

Table 7.1. Number of installations/applications and capacity installed in the Japanese Residential PV dissemination programme (Source: Ikki 2002)

		FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001*)
Number of installations	Total per year	539	1065	1986	5654	6352	15879	20877	22600*)
	Cumulative	539	1604	3590	9244	15596	31475	52352	75000*)
Generation capacity	MW/year	1.9	3.9	7.5	19.5	24.1	57.7	74.4	88.0*)
	Cumulative	1.9	5.8	13.3	32.8	56.9	114.6	189.0	277*)
Budget	M¥/year	2.0	3.3	4.0	11.1	14.7	16.0	14.5	23.5*)

*) The numbers for FY 2001 are estimated by means of multiplying the number of applications in 2001 (29 400 systems with an overall capacity of 114.7 MW due to Ikki, PV Activities in Japan May 2002) with the achievement percentage of 2000 (77%).

In the Japanese programme rebates decreased continuously over time. From 1994 to 1996 the subsidies were 50% of the total investment costs. They were reduced from 50% of the total investment costs in 1994 to about 30% in 1999. In 1998 about 8000 systems were subsidized. The upper limit for rebates has been reduced from 900 000 ¥ in FY1994 to 500 000 ¥ in FY1996 and 329 000 ¥ in FY1999, see Fig. 7.1. For the FY 2000 it was decided to switch to a fixed amount of subsidies per kW of 270 000 ¥/kW in the first half of the year and to 180 000 ¥/kW in the second half.

A major question is whether the Japanese programme has brought down the PV price substantially. Currently, it appears that is has. Yet, from 1996 to 1999 the decline has been very moderate. The average price of a residential PV system decreased from 939 000 ¥/kW in FY1999 to 774 000 ¥/kW in FY2001. Fig. 7.2 depicts the development of investment costs and subsidies in Japanese Yen over the time period of the promotion programme.

A result of these efforts is that Japan is now the world leader in the development of grid-connected systems. This success is the direct result of a conscious policy to promote PV technology, both for reasons of national energy security (Japan imports most of its fuels) and for reasons of economic development (Japan aims to dominate PV manufacturing to the same extent as it dominates the production of electronic equipment).

Major references: Ikki O., 1998, 1999, 2000, 2001.

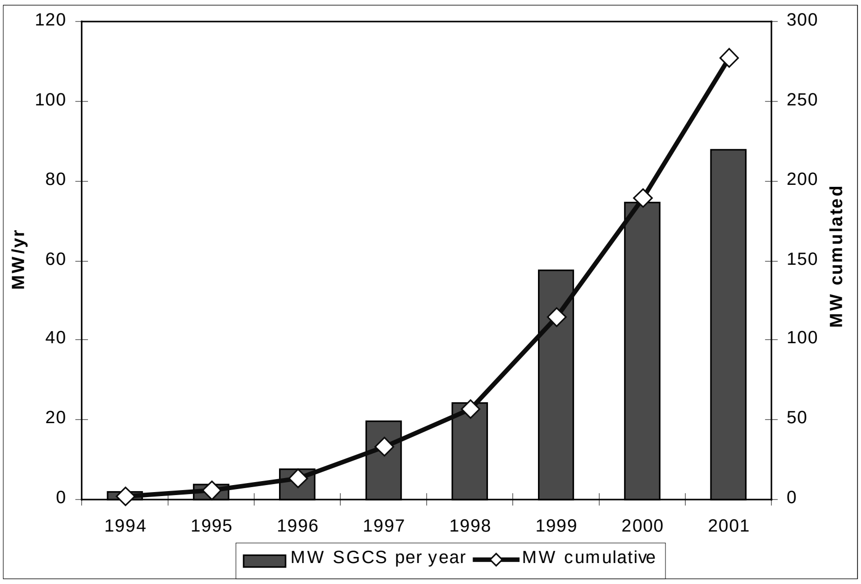

Figure 7.1 Japanese residential PV promotion programme: development of installed capacity and average capacity

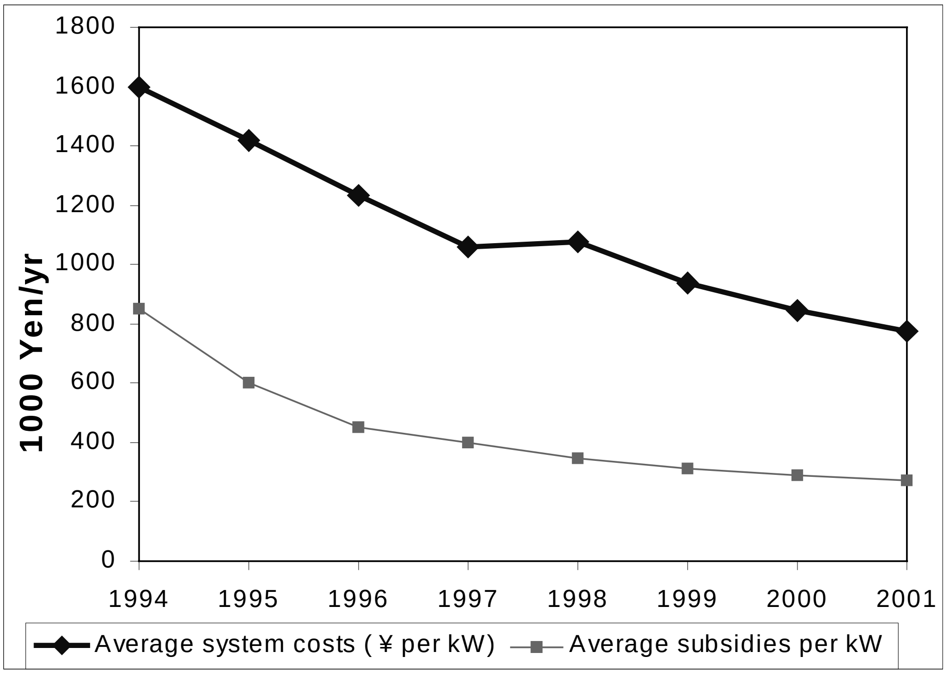

Figure 7.2 Japanese residential PV promotion programme: development of investment costs and rebates 1994-2000

7.1.4 The REN programme in NRW in Germany

The first and the longest PV rebate programme that has been launched world-wide was the REN programme in North-Rhine-Westfalia in Germany. Over the period 1988 until 2000 an overall capacity of about 25 MW of PV has been installed. These installations has been funded with about 150 million Deutsche Mark (about 75 million EURO). As can be seen from Figure 7.3 the number of systems has been increasing tremendously in the last three years. In the year 2000 alone about 9 MWp has been installed.

In February 2001 the new REN programme, which can be combined with the 100 000 roofs programme started. It offers 1500 € (3000 DM) per kW to private households for building-integrated PV systems and 750 € (1500 DM) for systems larger than 5 kWp without building integration. Moreover, there is a special rebate for "multipliers" like schools of 1000 € (2000 DM)/kWp.

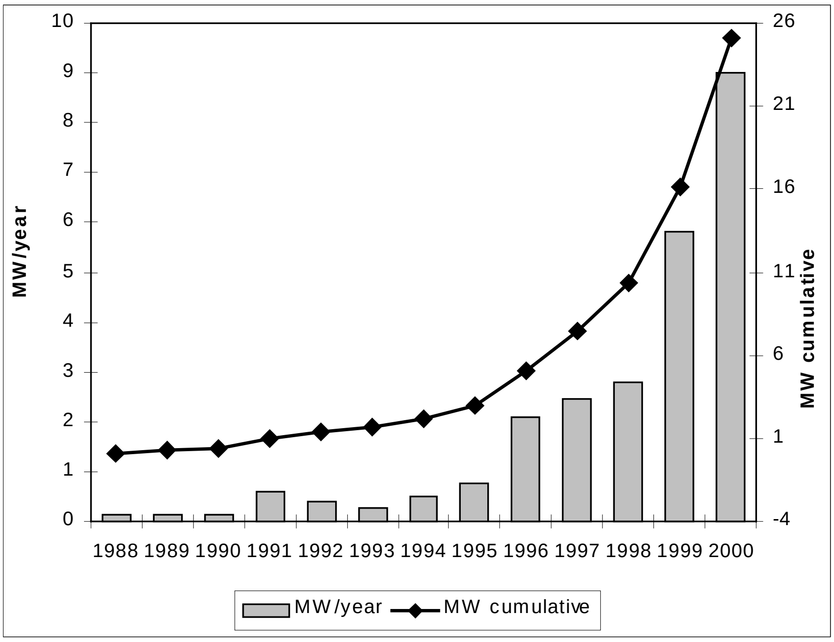

Figure 7.3. Development of installed capacities in the REN programme of North-Rhine-Westfalia in Germany

7.1.5 California's Emerging Renewables Buydown Programme (CERBP)

In September 1996, the California legislature passed Assembly Bill No. 1890 (AB 1890). This law requires California´s three largest investor-owned utilities to collect $540 million from their customers over 4 years to support electricity generation from renewable technologies. 10% or $54 million was approved for a multi-year rebate program for selected emerging technologies, including PV, small wind (10 kW or less, fuel cells using renewable fuels and solar thermal electric generation. Additional funding has since brought the total to $92 million. The program began accepting applications on March 20, 1998.

The program guidelines for CERBP required all retailers receiving a buydown payment to provide a "full 5-year warranty" to the purchaser against breakdown or degradation of output.

Five tiers with $10.5 million in each of the first four tiers and $12.0 million in the fifth were planned. It set the maximum buydown per Watt of system output at $3/Watt in the first tier, declining $0.50 per tier to $1/Watt in the final tier. The tiers are not tied to a calendar year or any other specific time frame. Instead, each block of funds would be made available until exhausted.

Yet until 2000 the number of applications was rather disappointing. By the end of 2000 only about 3 MW of PV have been installed due to the CERBP in California. (http://www.energy.ca.gov/renewables/emerging_summary.html). In 2001, when the combination of high natural gas prices and a flawed deregulation structure sent electricity prices soaring, the tiered rebate was abandoned and rebates were increased to $4.50/watt for all sizes of systems (see Fig. 7.4d). Along with the high electricity prices this led to a sharp increase in the number of applications in 2001 see Fig. 7.4a (Source: Brasil (2002)). While from 1998 to 2002 the number of applications was around 30 per month in 2001 it increased to around 300 per month. Yet, as Bolinger/Wiser (2002) argue the surge in activity in 2001 started already in the first quarter while the rebate was raised only in the second quarter.

Yet, as Fig. 7.4a depicts since the peak in the third quarter of 2001 the number of applications declines continously. By June 2002 around 24 MW of PV have been installed or reserved under California's buy-down programme.

Moreover, anticipated cost reductions have not materialised. An investigation on the cost development from 1998 to 2000 found virtually no cost reductions (Bollinger/Wiser). Since then the costs slightly decreased, see Fig. 7.4c and Fig. 7.4d.

The proposed program from 2002-2007, which would provide about $25 million per year in rebates, will require legislative approval. As of October 2001 almost $65 million of funding had been encumbered or paid-out for 17MW, primarily for solar.

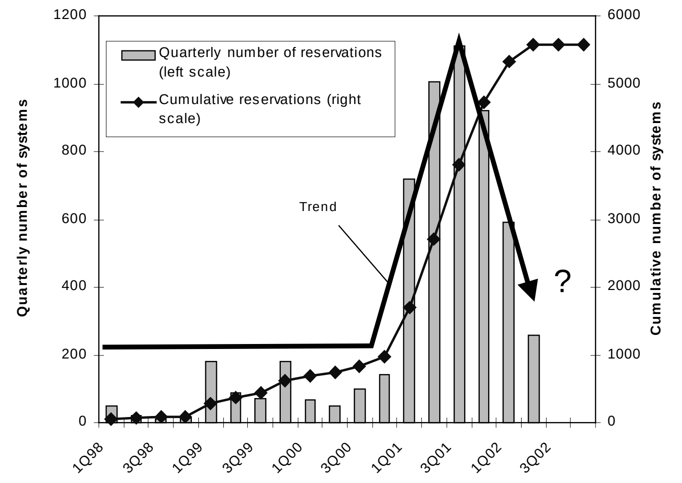

Figure 7.4a. Development of applications from 1998 to 2002

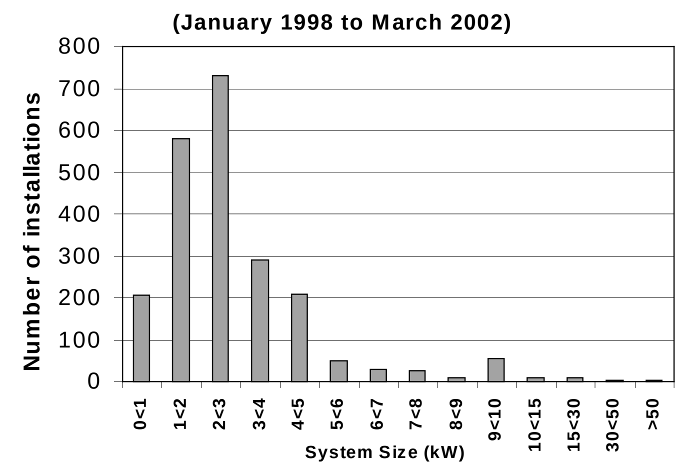

Figure 7.4b. Number of installations by size (January 1998 to March 2002)

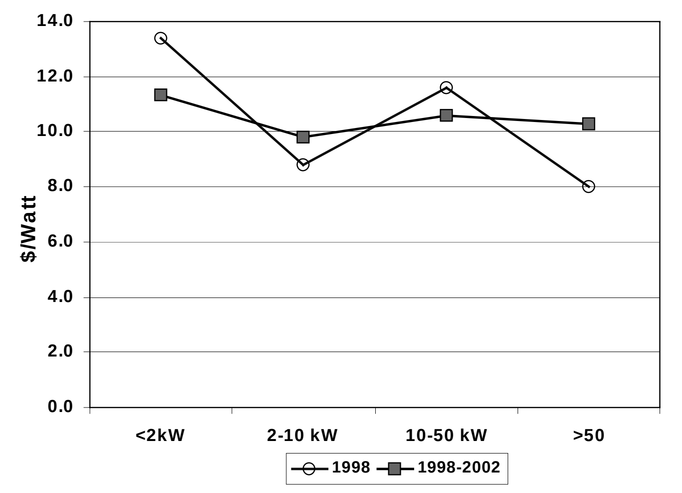

Figure 7.4c. System Cost Versus System Size

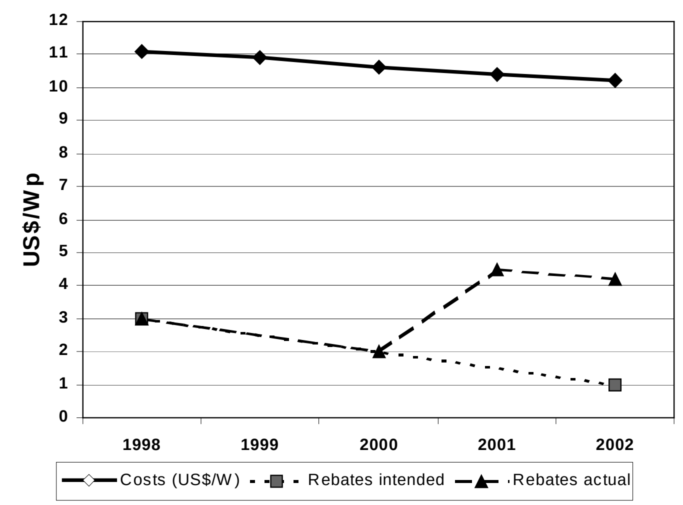

Figure 7.4d. System Cost and rebates from 1998 to 2002

7.1.6 Spain: PAEE

The P.A.E.E. ("Plan de Ahorro y Eficiencia Energética") is run by different regions in Spain. It subsidizes PV installations to a maximum of 4.1 EURO/Wp (600 PTA/Wp) for on-grid and 8.2 EURO/Wp (1200 PTA/Wp) for off-grid systems. The PAEE started in 1991 and ended in 2000. The public resources to promote PV was 2950 millions of pesetas what would imply the 50% of the associated investments. Currently it is estimated that due to the P.A.E.E. about 7000 MWp of PV (including stand-alone systems, grid-connected systems and demonstration projects) has been installed by the end of 2000.

7.1.7 The Australian rebate programmes

7.1.7.1 The SEDA programme

The Sustainable Energy Development Authority (SEDA) launched its BIPV programme in August 1998 in the state of NSW. Since then it has approved over 200 applications with an average capacity of 1.3 kWp. Over AUS$ 500000 in cash rebates were provided for BIPV systems.

In the first year until the end of 1999 more than two thirds of the applications were in the residential sector. 60% of all systems were grid-connected systems. When in June 1999 the Commonwealth government announced its new PV rebate program the number of applications dropped considerably. The offer of 5500 AUS$/kWp was enough to persuade people to postpone their purchases until the new year. (Williamson 2000)

Currently, in 2001 SEDA, offers a rebate of AUS$ 2400 per kWp for non – residential buildings (small business and commercial buildings) and a rebate of AUS$ 4800 per kWp for installations on community use buildings such as schools, town halls and other public buildings

7.1.6.2 The governmental PV rebate programme (PVRP)

In January 2000 the Australian government launched the PVRP with a budget of AUS$ 31 million. The programme is operated by the Australian Greenhouse Office (AGO). In the beginning a rebate of AUS$ 5500 per kW was provided with a cap of AUS$ 8250 or 1.5 kWp. This rebate was offered for small rooftop and building-integrated PV systems until September 2000. In October 2000 the rebate was reduced to AUS$ 5000 per kW and capped at AUS$ 7500 for new systems and AUS$ 2500 per kW for upgrades on existing systems with a 2500 AUS$ cap. The reason was that the budget planned for four years was used up nearly twice as fast as expected and planned. (Hirshman 2001). By the end of Dec. 2000 about 2600 applications has been pre-approved, averaging at about 1 kW per system.

Another important reason for the revision of the rebate was that the original rebate of AUS$ 5500 per kW was only on solar panels. Hence, investors who had already put in PV installations were taking advantage of the PV rebate to boost the power of their systems while first-time purchasers still needed to buy equipment such as inverters and batteries, which at that time were not covered by the rebate.

Fig 7.5 depicts the development of the PVPR in the first 27 months. The first spike in approvals in June 2000 was caused by the introduction of 10% GST (VAT) on 1 July 2000. The second spike in September was caused by the announcement of the reduction of the rebate in October. Of interest is also that more than 70% of all systems installed are stand-alone systems. By the end of March 2002 almost 3000 stand-alone systems were promoted vs 970 grid-connected systems.

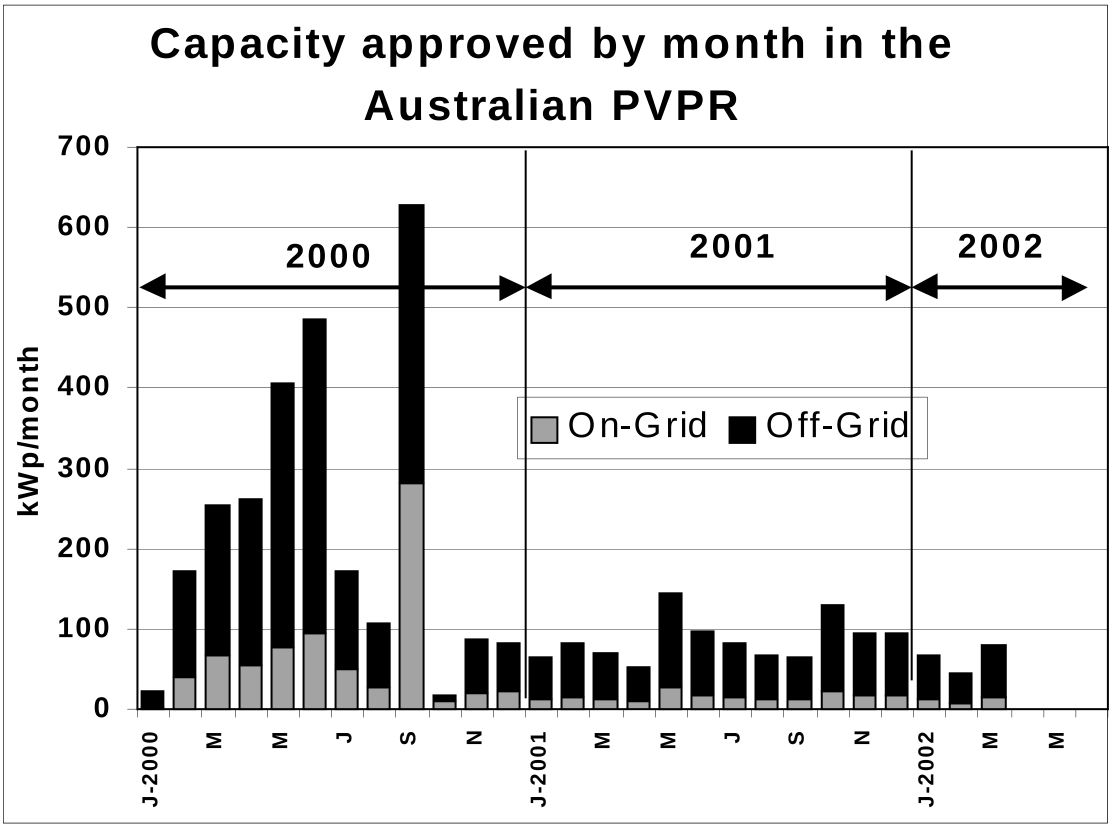

Figure 7.5. kWp approved in the first two years of the Australian PVRP

Finally, it has to be stated that industry representatives are unhappy that the PVPR has been so heavily weighted towards off-grid installations. They argue that the PVPR has provided a windfall profit for the off-grid installations at the expense of the far more difficult market of grid-connected PV where it must compete against electricity prices of around AUS$ 0.12 per kWh.

7.1.8 The Dutch "PV GO!" tendering programme

In 2000 NOVEM launched the PV-GO! rebate programme (ECOFYS, 2000). PV-GO! is a tender programme for specific grid-connected PV applications with sufficient marketing potential. PV-GO! contributes up to 25% of the system costs. Offers are ranked according to the required subsidy per Watt-Peak. The total budget in 2000 was 7.2 MEuro intended to support 6 MW additional PV capacity. In the first round in Spring 2000, proposals for a total of 1.7 MWp were submitted (total requested subsidy 2.4 M Euro). Results of the second round (November 2000) are not yet known. To date, approximately 900 kWp of systems as been realized under the pv-GO! tender.

In 2001, pv-GO! was replaced by a new mechanism, providing individual PV system owners with a rebate of 3.4 Euro/Wp (the Energy Premium Scheme, EPR). This is a traditional rebate programme, in which individual system owners have to apply for subsidies through their utilities. Funds for the rebate programme come from the energy tax.

The quick move from Novem R&D programme to pv-GO! to EPR has given industry little security to build up capacity and marketing schemes. Market growth seems to have slowed down.

7.2 Financing programmes

7.2.1. The German 100 000 roofs programme

Since 1999 a new financial approach is being pursued in Germany with the 100 000 roofs programme. Within this programme very attractive credits (soft loans) are provided to the public. Initially the interest rate was 0% (in 1999) for 10 years payback time. The loan is to be repaid in 8 instalments from years 3 to 10, and the last instalment in year 10 is cancelled if the system is still operating. The response to this programme in the first year (1999) was disappointing. Only about 3000 new projects (about 9 MWp) were approved. This was only half of the planned capacity of 18 MWp. In March 2000 the German Law for the priority of renewable energy came into force with the accompanied introduction of a substantial feed-in tariff of 99 Pfennig/kWh (0.5 EURO/kWh) for PV in March 2000. This was a major reason for the boost in April 2000 – see Fig. 7.7. Then the programme was stopped for almost half a year and the initial plan was revised, see fig. 7.6. The interest rate was raised from 0% in 1999 to 1.8% in June 2000. The target for 2000 was raised to 50 MW/year increasing to 95 MW/year in the year 2003 when the programme is expected to be terminated. But the second target in the year 2000 was also missed see Fig. 7.6b. In 2000 41.7 MW were installed instead of the target of 50 MW. For 2001 65 MW were planned in addition to the 9 MW missing from the first two years. This target was was met with a total capacity of applications of 126 MW cumulated. In the first half of 2002 the growth was beyond the planned target see Fig. 7.7.

It can be seen that, a lot of "Stop and Go" took place since the start of this programme. It is not yet possible to determine which instrument had more influence on increasing the rate of installations: the loan or the feed-in tariff.

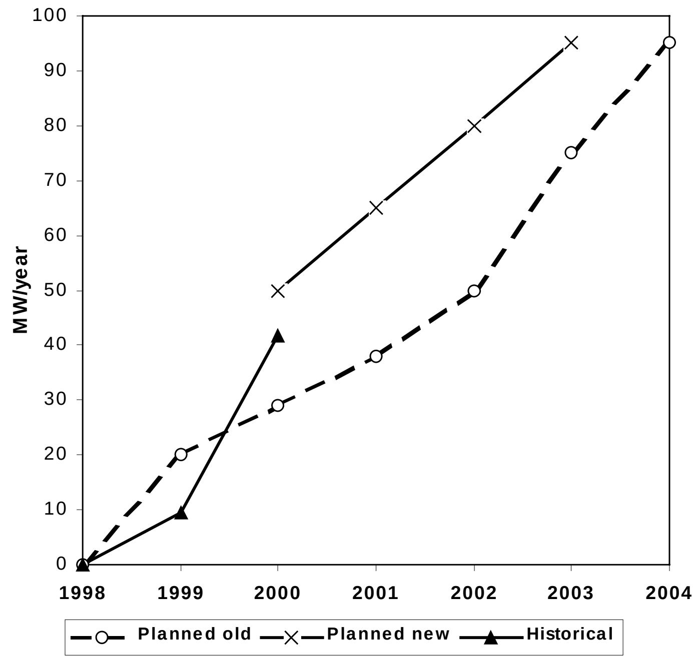

Figure 7.6 The German 100 000 roofs programme: original and revised plan and historical installments in MW/year

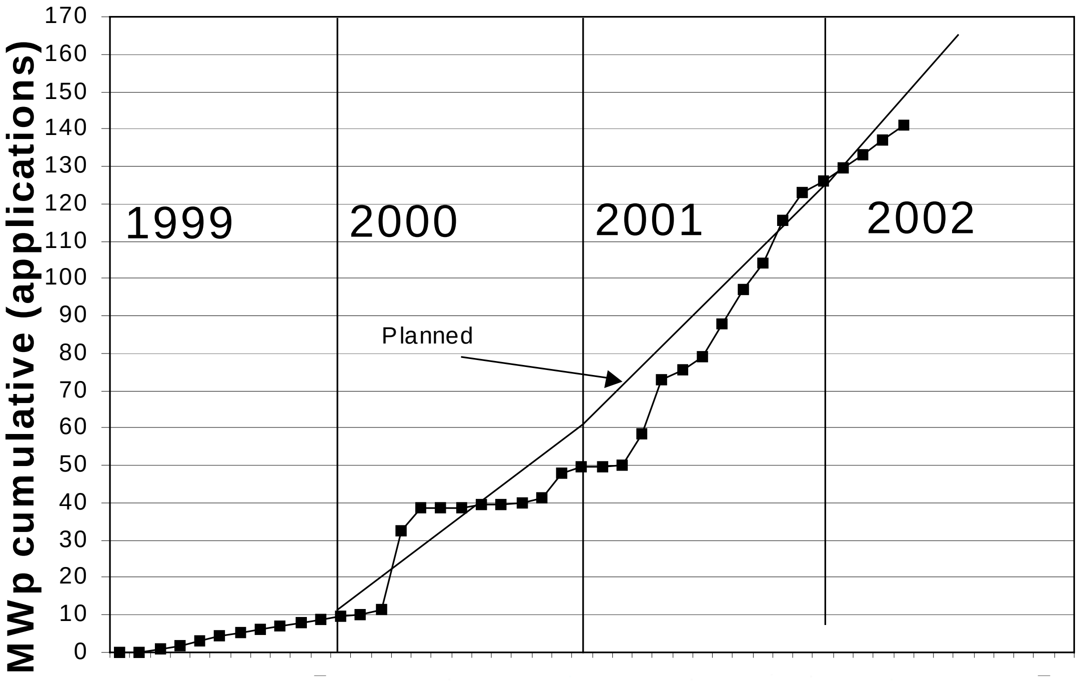

Figure 7.7 The German 100 000 roofs programme: cumulative installments of the first two years

7.2.2. The Dutch Green Funds

In The Netherlands, 'Green Funds' money is made available at a lower interest rate (about 1%) for so-called 'green projects'. PV projects are seen as "green projects'. Green Funds are under the supervision of the Dutch Central Bank. However as reported by ECOFYS (2000) few PV systems have actually been supported. Most likely this has only occurred through green mortgages which are a part of the green funds programme (ECOFYS 2000). No detailed information on the dissemination effect of 'green funds" for PV systems is available.

7.3 Tax incentives on investments

In various countries it is possible to deduct the investment in PV systems (or in renewable energy technologies in general) completely or partly from income tax.

Several different options have been used to promote the generation of electricity from RES with fiscal instruments:

- lower VAT-rate applied for RES-E systems;
- dividends from RES-Investment made exempt from income taxes.

Both options have similar impact, acting as moderate investment subsidies for new installations.

In table 7.2 an overview of existing investment-based tax incentives and how they are implemented in different countries is given. Further details for PV systems in the U.S. are described by Eiffert et al (2001).

Table 7.2. Tax incentives on investments in PV in various countries

Country	Investment-based tax incentives
Austria	Private investors get tax credits for investments in renewable energies (personal income tax)
Belgium	13.5 – 14% of RES-investments deductible from company profits, regressive depreciation of investments
Greece	Up to 75% of RES-investments can be deducted
Ireland	Tax relief for certain RES-investments
Italy	Up to 36% tax reductions of the investment costs of a PV system are available and a VAT reduction from 20% to 10%.
Japan	The taxable amount of fixed property is reduced to 5/6 for 3 years if a PV system is installed
The Netherlands	• VAMIL scheme: RES-investors (specific renewable technologies) are allowed to offset depreciation of their investments against taxable profits • EIA scheme: RES-investors (same technologies as VAMIL) are eligible for an additional tax deduction against their profits (from 52.5% to 40% depending on sum of the investment)
UK	Reduction of VAT (5% rather than 17.5%) on domestic PV and wind generating capacity cost
US/New York	• 25 % of RES-investments deductible from private income tax • a tax deduction of 2000 US$/kWp is possible for individual PV systems within the *Team-Up initiative* with its "friendly PV programs"

So far no clear dissemination effect for PV has been identified due to this promotion instrument.

8. REGULATED RATES

In recent years in various countries other types of financing models have been introduced which are based on regulated rates. In the following the most important models are described briefly.

8.1 Net Metering

Since the early 1980s especially in the U.S. the financing model "Net metering" has gained attention for PV (and other renewable and CHP electricity). Within this approach the *Net Excess Generated Electricity* (NEG) is refunded by the utility at by and large the same price as the retail price of electricity. Examples of Net Metering in the USA are listed in Table 8.1.

Table 8.1 Net Metering in the USA and Australia

State	Enacted	Capacity	Energy sources
Massachusetts	~1982	<30 kW	REN&COG
Minnesota	~1983	≤40 kW	QF
Indiana	~1985	≤1,000 kWh/month	QF
Rhode Island	~1985	≤25 kW	REN&COG
Idaho	~1986	≤100 kW	All
Texas	~1986	≤ 50 kW	REN only
Maine	~1987	≤100 kW	QF
New Mexico	~1988	≤100 kW	QF
Oklahoma	~1988	≤100 kW	REN&COG
Connecticut	~1990	≤100 kW	REN&COG
North Dakota	~1991	≤100 kW	REN&COG
Arizona	~1993	≤ 10 kW	REN only
Wisconsin	~1993	≤ 20 kW	All
Iowa	~1993	No limit	REN
New Hampshire	~1994	≤25 kW	REN
Colorado	~1994	≤ 10 kW	QF
California	~1995	≤ 10 kW	Solar Only
REN&COG...Renewables & Cogeneration			
QF ....Qualifying facilities			
All ... All technologies			

In Japan net-metering has been available since 1992. In Denmark net-metering was established mid-1998 for a pilot period of four years. In most states of Australia net-metering is applied for residential customers by some utilities since the mid-1990s.

So far no lessons learned from these countries are available.

8.2 Enhanced feed-in tariffs

With enhanced feed-in tariffs electricity from renewables is purchased at a higher price than the electricity retail price. These tariffs have attracted attention since the late 1980s. Currently the highest general "feed-in"-prices in Europe are in force in Spain, Germany, and Austria, see Fig. 8.1.

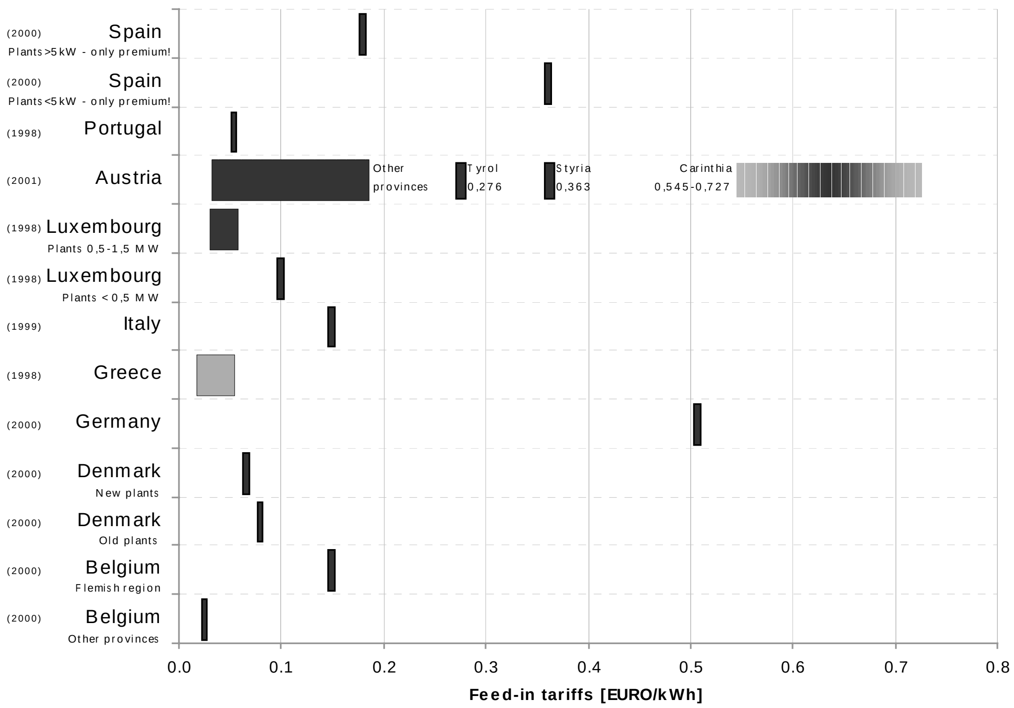

Figure 8.1 Feed-in tariffs for PV in various countries in 2000.

8.3 Rate-based incentives (RBI)

In the early 1990s, at almost the same time in Burgdorf in Switzerland and in Aachen in Germany, the idea of „Full cost rates“ (Kostendeckende Vergütung) was launched. This means that the public utility has to buy back PV electricity at (almost) the full production costs. The Aachen Model was first proposed in 1992, and was implemented September 1, 1994. Individuals or businesses who invest in photovoltaics are paid for every kilowatt hour of solar energy the PV system feeds back to the grid. In the early phase of RBI PV investors in Germany received two Deutsche Mark per kilowatt hour (≈ 1 US$/kWh or 1 € /kWh). In the course of the time this rate has been reduced. The rate is guaranteed for a time frame of between 10 and 20 years. Hence, the generators can fully recover their cost of purchasing and installing the PV system.

Cost recovery is funded through a surcharge on electric utility bills paid by the public “rate-base” of the utility. Usually a programme ceiling limits the number of installations which obtain the RBI. Examples are a limited surcharge on the electric bill of all customers or a limit with respect to the overall promoted capacity. The limit of this surcharge is still in discussion and varies from state to state between 0,6 % (Bavaria) and 1 %. Mostly 1 % is accepted by the ministers of economy.

This idea has gained attention mainly in cities where municipal utilities are responsible for power supply and where local politicians have the power to put these full cost rates into practice. The program has been implemented in cities where the public and the politicians support the idea of a utility bill surcharge to encourage the installation of photovoltaics. They have gained special attention mainly in Germany and in some cities in Switzerland and Austria. They vary currently between about US$ 0.7 and US$ 1.0. Figure 8.2 shows the installed PV capacity per capita in those cities where rate-based incentives were most successful.

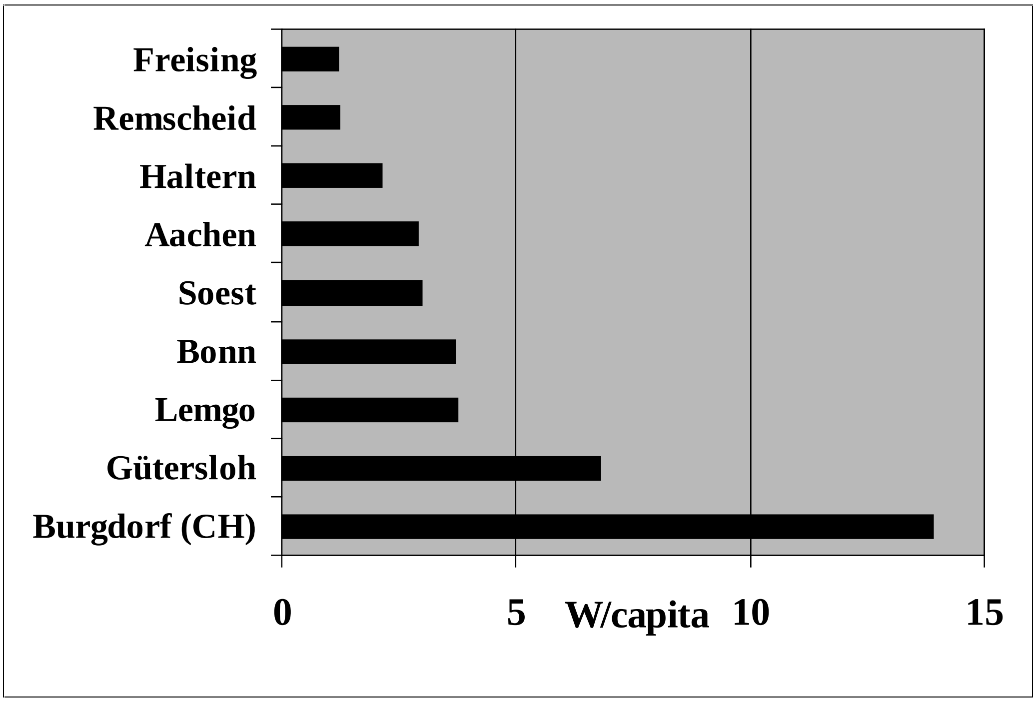

Figure 8.2 Installed PV-capacity per capita in German cities with rate-based incentives ([13], [14]) Note that in some cities the limit of the cap of price increases has already been reached.

9. VOLUNTARY INVESTMENT-FOCUSED FINANCIAL INCENTIVE PROGRAMS

Under this type of programme utilities, NGOs or other companies do usually provide financial incentives for a PV generator. The financial incentive is tied to generation capacity and is paid e.g. per kW. The financial incentives may be collected from private individuals or a utilities' electricity consumers. Of course, it is also possible, that the utility itself is the generator.

9.1 Contracting

Under "Contracting" an organisation e.g. a utility pre-finances the investment for the customer and the customer pays back a certain amount per month or per year. Finally, the customer owns the PV system.

9.1.1 SMUD's "PV pioneer I programme"

The first and so far most popular contracting programme world-wide for PV was launched in 1993 by SMUD in California. It was the so-called "PV pioneer I program". Under this programme the system was purchased, installed, owned, and operated by SMUD, see Osborn (2000). It feeds its power directly into the SMUD electric grid. SMUD residential customers volunteer to share in this effort through a form of "green pricing" and by providing the roof area to place the SMUD "PV power plants", each about 4 kWp. The PV Pioneer I customer pays a $4 per month "green" premium in addition to their normal utility bill to participate.

This program is aimed at developing the experience needed to successfully integrate PV as distributed generation into the utility system, developing long-term market and business strategies and stimulating the collaborative processes needed to accelerate the cost-reductions necessary for PV to be cost-competitive in these applications by about the year 2003.

This effort has resulted in about 8 MWp of PV systems installed in Sacramento, distributed over some 700 installations by the end of 2000.

SMUD gains experience in the installation, operation, maintenance, pricing strategies and other aspects of residential PV systems and obtain low-cost "power plant sites". With little marketing undertaken SMUD has been adding about 100 PV Pioneer I systems each year.

Finding customers willing to pay has not been difficult for SMUD. PV Pioneer marketing normally consists of just one or two bill stuffers a year, door hangers in neighbourhoods with a predominance of "good roofs", and as a result free media coverage.

9.1.2 The 200 roofs programme of HEW in Hamburg

Within the "Hamburger Solarkonzept" in 1997 in total 200 PV systems with an overall capacity of 350 kWp has been installed on private roofs (Haberland/Stuhlweissenburg, 2000). In this programme the municipal utility of Hamburg HEW has rented 200 roofs to install these systems. Over ten years the roof owner gets 10% additional ownership of the PV system every year. This is the rent the utility pays for the roof. The total project costs were 5.5 Mill DM (2.25 Mill €).

An additional feature of interest within this programme was the fact that HEW launched an EU-wide call for tenders to purchase these 200 PV systems. Finally, four PV suppliers delivered these 200 systems.

9.2 Shareholder programmes

Another concept that has attracted attention mainly in Germany is to sell shares of a PV plant to private customers in blocks of e.g. 100 W. Within this type of programme the customer becomes a shareholder in a renewable power station. At the end of every year he gets back the money generated due to his share. Such programmes have been conducted by utilities, others by other entities (e.g. Salvamoser in Freiburg, IBC/Möhrstedt in Staffelstein, and the so-called PV-associations in the Netherlands. An early example for this programme type is the “Bürger für Solarstrom” – Model of the “Bayernwerke”. Table 9.2 provides some features of some programmes.

Table 9.2. PV Shareholder programmes

Utility	Programme name	Time period	Costs (EURO /W_p)	Total number of participants	particip a-tion rate (%)	PV capacity installed (kW)	Money raised per participant (EURO)	Status
Bayern-werk	“Bürger für Solarstrom"	1994-96	6.63	101	0.01	50	3290	OFF
Konstanz	No	1995-97	7.29	200	0.57	63	2300	OFF
München	"Pasinger Fabrik"	1997/1998	6.76	70	0.01	37	3573	OFF
Freiburg	"REGIO"	1994-current	n.a	278	N.A.	208.1	N.A.	ON
Detroit Edison	SolarCurrents	1996-2000	6.59	<300	0.3	55	110 US$/yr	ON
Vorarl-berg	"Sonnen-schein"	1997	N.A.	2300	N.A.	100	150	ON

Source: Own investigations, Taus 2001

An example for a successful privately organised shareholder programme is the "SONNENSCHEIN" campaign launched in the Austrian province of Vorarlberg in 1997. The German word "SONNENSCHEIN" has two meanings: it means sunshine and solar bill. Up to now about 100 kW of decentralised systems has been installed. About 2300 shareholders have raised around 5 Mio. ATS (≈ 400.000 EURO). This programme is still ongoing.

The programme is coordinated by the “Energieinstitut Vorarlberg”.

- Within this programme private individuals and local governments are encouraged to purchase “Sonnenscheine” (= “Sun bill”)
- The price of a share is 1000 ATS (≈ 70 US$, ≈ 70 EURO)
- The systems are operated either by private persons or communities. One of the systems is in Belarus.
- Comprehensive information campaigns, technical tours, and education activities accompany the programme. Moreover, frequent meetings of shareholders and operators ensure that the campaign is kind of a public event.
- The shareholders may cash the money earned from electricity generation at the end of every year or they may donate it into a fund for further PV investments in the education sector.

The installations are supported by means of 30 % to 35 % rebates from the province of Vorarlberg.

9.3 Contribution Programmes

Within contribution or donation programmes customers can donate to a fund for renewable energy projects. On contrary to shareholder programmes within this type of programme the consumers do not get any money back! Most often these funds are managed by electric utilities. It is an approach which focuses mainly on the promotion of PV systems in public places e.g. schools. The projects developed are unrelated to the customers electricity usage. Usually school projects (see section 12.4.1) rely fully or for a certain percentage on contribution. An example for such a project has been achieved by WPSC in Wisconsin (USA) for schools. The major features of some programme are depicted in Table 9.3. Note, school programmes are listed in Table 12.1 later.

Table 9.3. Contribution/donation projects

Utility (country)	programme name	Time period	Status	Number of parti-cipants	partici-pation rate (%)	Money raised per partici-pant	PV capacity installed (kW), number	Total electricity generated (MWh)
Bayernwerke (E.ON, DE)	"Aktion Zukunfts-pfennig"	1998-2000	ON	800	n.a.	60 DM	86 (19)	75
SCHLESWAG (DE)		1995-12/96	OFF	1000	0.17	45 DM		
FÜW Nürnberg (DE)		1995-12/96	ON	197	0.07	25 DM		

9.4 Utility bidding

To ensure that the most efficient and cheapest PV systems are promoted some utilities have launched a bidding procedure for PV electricity from private generators. This approach has been applied by the utility BEWAG in Berlin in Germany. Every three months from April 1997 until December 2000 there had been a call for tender of PV systems of different size categories.

Table 9.4. The bidding programme of the BEWAG (Germany)

Utility (country)	Time period	Price per kWh	Total average rebate:	Total PV capacity installed (kW)	PV electricity generated (MWh/yr)	Status
BEWAG (D)	1996-12/2000	36 ct/ kWh (0.72 DM/kWh)	6375 DM/kWp	2275	1850	OFF

By December 2000 a total of 635 systems, with an overall capacity of 3345 kWp, had been approved (see Fig. 9.1). Yet, only 1063 kW has been installed. The average rebate provided by BEWAG was about 3200 Euro/kWp (6375 DM/kWp). Moreover, an additional feed-in tariff of 36¢/kWh (0,72 DM/kWh) was paid. (Source: BEWAG, Photon 3/2001).

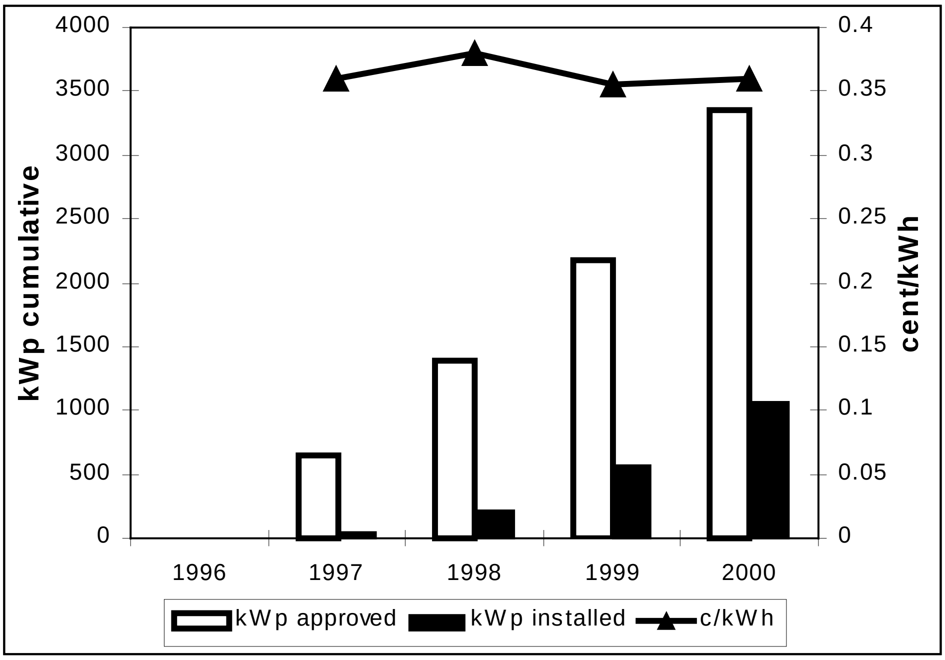

Figure 9.1. PV approvals and installments within the PV bidding programme of the BEWAG in Berlin (Germany)

9.5 Bulk purchases

In a bulk purchase programme an organisation e.g. a municipal utility purchases a large amount of PV system at a cheaper per kWp price if every single system would be purchased individually. Two programmes has so far becom popular: The programme of the Stadtwerke Munich in Germany and the PV pioneer II programme of SMUD in California.

9.5.1 Stadtwerke Munich (Germany)

The first bulk purchase programme of PV systems has been launched in Munich in Germany in 1996. The Stadtwerke Munich purchased about 200 do-it-yourself kits for PV systems with a capacity of 1.1. kWp. and sold it at the same prices to interested programme participants. In total within the promotion programme of the Stadtwerke Munich about 520 kWp were installed on 225 single systems. The average price was about 14 800 DM/kWp (7 300 EURO/kWp) which was very cheap at that time.

Moreover, the programme consisted of a mix of very different strategies. Over the first two years accompanied rate-based incentives of about 2 DM/kWh were available. Another initiative was the shareholder programme "Pasinger Fabrik" (see Section 9.2)

9.5.2 SMUD’s PV Pioneer II Program

Under the slogan "Own a piece of the sun and watch your meter turn backwards!" SMUD has launched its PV Pioneer II Program in 1999. It started offering customers a way to own their rooftop solar power plants. The PV Pioneer II systems are owned by the customer, and SMUD “buys down” the cost of the systems bringing the cost to the customer down to where it can compete in the retail market. By bringing down the cost of the PV system to about $2.50 to $3.00/W the resulting effective cost of PV electricity is in the competitive range in the California residential electric market when financed in a home mortgage.

The customer´s cost in 1999 to buy a typical 2000 W system is under $5000 ($2.37/W). This system would provide a little over half on the annual energy needs of an average SMUD customer. The full turnkey cost, including utility transactional costs and overhead, of the system to SMUD in 1999 was under $10,000, so the SMUD buydown in 1999 was about 50%.

The second phase of SMUD´s PV Program will bring the fully installed cost to below $3 per installed watt ($3/W) in 2003, placing PV at a point where it can start to become economically interesting. By 2003, the customer cost for a new system will rise to $2.80/W while the cost to SMUD reduces to under $3/W, resulting in a buydown of less than 20¢/W and leading to a sustainable, unsubsidized residential market.

10. GREEN PRICING – VOLUNTARY GENERATION-BASED FINANCIAL INCENTIVES

Under this type of programme usually called "Green Pricing" utilities or other companies sell electricity generated from renewables at a higher price and take this premium to provide financial incentives for a PV generator. The incentive is paid by the green customer per kWh. Of course, it is also possible, that the utility itself is the generator.

10.1 Green tariffs

The major feature of this type of financing program is that participants pay a special price premium per kWh over regular rates. This type of financing program has gained attention up to now in Switzerland, Germany, Australia, the USA, Austria, and The Netherlands. Within this program type utilities offer „green“ electricity – that is to say, electricity generated by wind turbines, biomass, small-scale hydro, and PV – at a price that by and large meets the generation costs.

Table 10.1. Green tariff schemes

Utility (country)	Star tyea r	Product/ Label (PV share)	premium/ price ()	number of parti-cipants (year)	partici-pation rate	PV capacity installed (kW)	PV electricity generated (MWh/yr)	kWh per participan t per year	Stat us
RWE (D)	6/19 96-	Umwelttarif (26% PV)	10.22 ct/ kWh (Mix)	15800 (1998) 12500 (2000)	0.5 %	1050	800		ON
ENBW (D)	2/19 97	Umwelttarif grün (1 % PV)	4.1 ct/ kWh (Mix)	2070 (2000)	0,12	?	?		ON
	2/19 97	Umwelttarif solar (100% PV)	81.8 ct/ kWh	230 (2000)	0.013	62	59		ON
Elektra Basel Liestal (CH)	1992	"Solar-strom für alle!"	1.40 (1998) 1.30 (2000) sFr/kWh	333 (2000)	n.a.	104	84	252	ON
Elektra Birseck München-stein (CH)	1994	"EBM-Solar"	1.40 sFr/kWh	440 (2000)	n.a.	71	85	180	ON
Göteborg Energi(S)	1997		1 öre/ kWh	2400 (2000)	n.a.	40	28		ON
NUON (NL)	1996	Natuurstroom (0,5% PV)	0.09 NLG/kWh	52000 (2000)	n.a.	1000	702	n.a.	ON
Energy Australia	1997	"Pure Energy"/ GreenPower	13.7 A$c /kWh (40% premium for 100% greenpower)	15500 (2000)	n.a.	600	877	56	ON
Arizona Public Service (USA)	1997	"Solar Partner"	17.6 US$ cent/kWh	1600 (2000)	n.a.	500			ON
Salt River project (USA)	1998 - 2000	n.a.	20 US$ cent/kWh	n.a.	n.a.	200			OFF

Source: Own investigations, Sweden: Mats Andersson

In recent years, labels have become more and more important to prove the content of the product. Green tariffs with respect to PV are most important in Germany, Switzerland and the US. In Australia a wide variety of Green tariffs exist and most utilities have installed some PV, although it is typically a very small portion of total green power requirements (see e.g. Weller 2000).

With respect to the promotion of BIPV systems it has to be stated that mostly larger plants are built from the revenues of the "Green tariff" programmes.

Table 10.1 describes the major features of the so far most popular world-wide green tariffs in different countries. Only those programmes which contain a substantial amount of PV are listed.

One of the most famous world-wide Green tariffs including PV is the "Umwelttarif" of RWE in Germany. As can be seen from Fig. 10.1a until 1999 about 1 MW of PV capacity has been installed. Yet, since 1998 there is a deadlock. No more capacities were triggered and the number of participants went back from 15800 in 1998 to 12500 in 2000, see Fig. 10.1b.

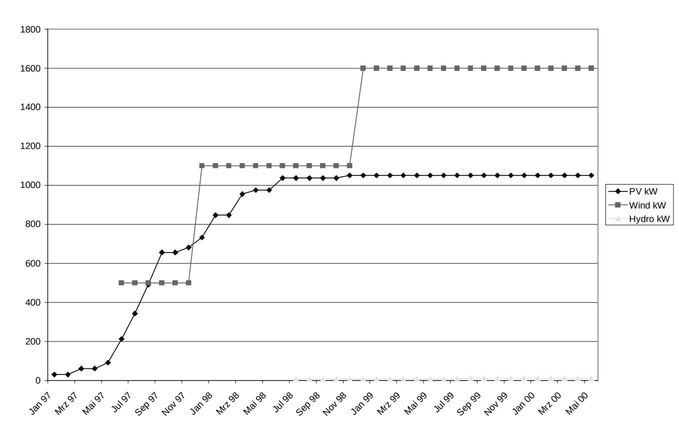

Figure 10.1a Installed PV, wind and hydro capacity due to the RWE "Umwelttarif"- programme

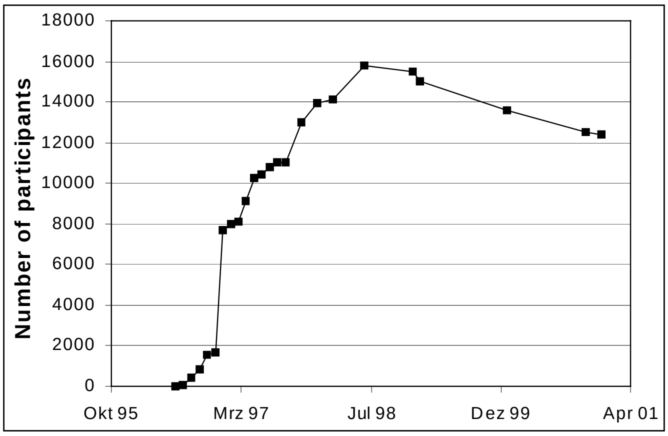

Figure 10.1b Number of participants in the German RWE "Umwelttarif"- programme

10.2 Solar stock exchange

Another idea of providing financial incentives for the construction of PV systems is the so-called “Solar stock exchange”. The idea is that electricity is generated by privately-owned PV systems and fed into the public grid. Other customers may buy this electricity and pay rates corresponding to the PV production costs. On the supply-side only the most cost-effective projects are selected by a bidding process.

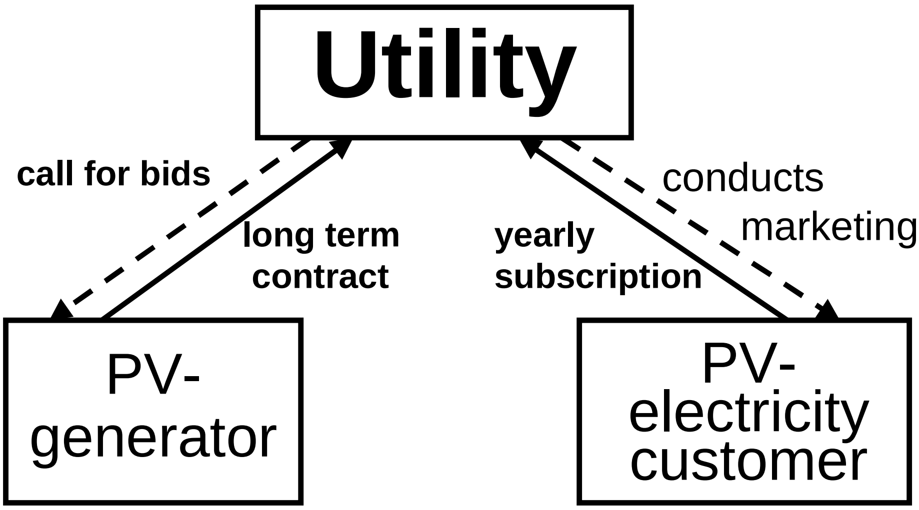

Figure 10.2. The principle of the "Solarstrombörse" applied by various utilities in Switzerland

The utility acts as a "power exchange". That is to say it organises the balance between supply and demand. It launches calls for tenders for new PV capacities and signs long-term contracts with the generator. On the demand-side marketing activities are conducted and the customer may subscribe on a yearly base or longer, see Fig. 10.2. Usually, the utility bears the administration costs but has no other expenses. The customers choose how much solar electricity they want to buy. The minimum order is usually 100 kWh/year. The price is around 60 to 65 c/kWh (0.95 and 1.15 sFr/kWh) in 2001. It has to be recognised that the system costs and the price for customers has decreased continously since 1996 (From about 1.40 in 1996 to 1 sFr/kWh).

The advantages of this strategy are:

- Customers WTP is fully exhausted;

- efficient operation is ensured
- private "green" PV owners ensure that only the best examples for PV will be constructed;
- kind of a “Green label” with high credit ("Pure solar electricity") may be associated with this type of strategy;

This idea was first developed for the city of Zurich in Switzerland by the municipal utility ewz. At the end of 2000 about 1.7 MW had been installed, see Fig. 10.4. The target was to reach 2.4 MW by the end of the year 2000. (Ref.: Ruoss (2000) and Homepage **ewz**)

Of special interest is also the marketing strategy applied by **ewz** . The single solar systems were named by famous stars and a so-called "Züricher Sonnensystem" was created, see Fig. 10.3.

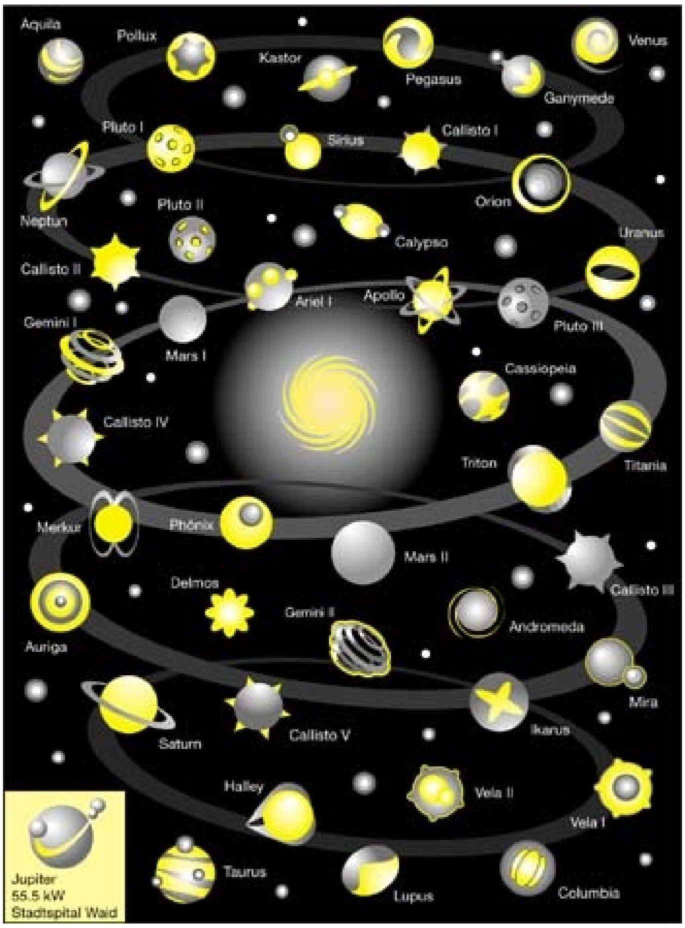

Figure 10.3. Marketing approach of "Solarstrombörse" programme of the **ewz**: "Creating a "Zuericher Sonnensystem"

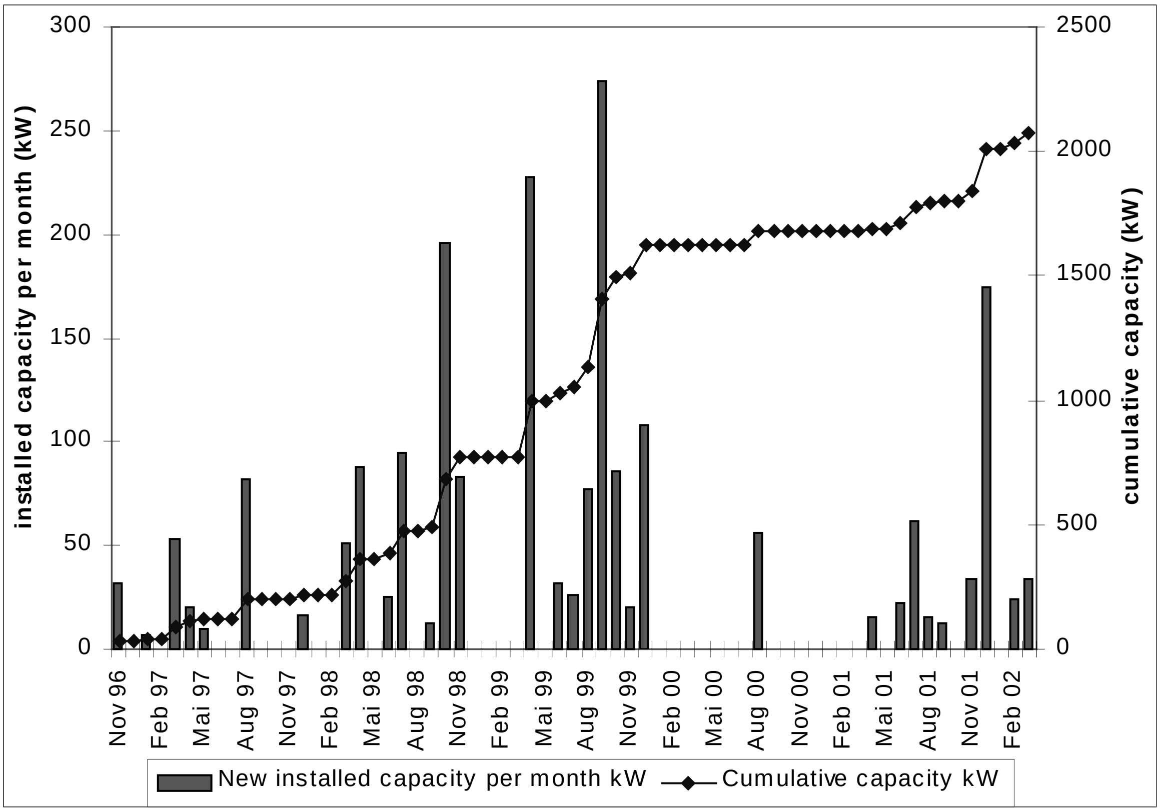

Figure 10.4. PV installations within the "Solarstrombörse" programme of the ewz in Zuerich (Switzerland)

The programme has also attracted attention in other cities. More than half of the Swiss population has access to "Solarstrom". Some examples and their major features are described in Table 10.2.

A remark with respect to the system size: It has to be stated that mostly larger plants are built from the revenues of the "Solarstrombörse".

Table 10.2. Some examples for Solar Stock Exchange models

Utility (country)	Start date	Price for customers sFr/ kWh	Number of participants (year)	Participation rate	Total PV capacity installed (kW)	PV electricity delivered (MWh/yr)	Money raised per participant	Status
EWZ (CH)	1996	1.20 (1996) 0.95 (2000)	5 700 (2000)	3.2	1680	1021	120 sFr	ON
EKZ (CH)	1997	1.20 (1997) 1.05 (2000)	2 600 (2000)	1.4	281	477	140 sFr	ON
EWB (CH)	1997	1.20 (1997) 0.88 (2000)	3 200 (2000)	2.5	723	630	150 sFr	ON
CKW (CH)	1998	1.0 sFr/ kWh	176 (2000)	n.a.	n.a.	40	180 sFr	ON
FÜW (D)	1998	1.40 DM/ kWh	240 (2000)	n.a.	29	23	134 DM	ON

Source: Daniel Ruoss, personal information and Internet-Homepages of the companies

10.3 Green Power Marketing

In the age of fully liberalised electricity markets in many countries Green electricity suppliers have emerged. That is to say, under Green Power Marketing a private or commercial or industrial customer may change their supplier and switch to a company which provides a certain brand of Green electricity. In different mixes a certain amount of PV is required.

Of course this approach is potentially interesting for development of PV. There are some German ones (Naturstrom, Unit[e]), *Green Mountain* in the US, "Echte Energie" in the Netherlands.

According to Swezey/Bird (2000) in the U.S. by the end of 1999 a PV capacity of 268 kWp has been added due to Green Power Marketing in states with fully liberalised electricity markets.

10.4 The Dutch green label proposal

A tradable “green labels” market has already started as of January 1998. Under current laws, local energy distribution companies (LEDCs) must purchase renewable electricity from independent power generators at a price determined based on the current market price of electricity and the Regulating Energy Tax refund. However, under the new programme, in addition, the LEDCs must issue green labels to the renewable generator based on the number of renewable kWh sold to the grid (one green label represents 10 000 kWh of renewable electricity). The renewable generator can then sell these green labels on an open market to distribution utilities who will all be required to own a certain quota of green labels as part of their agreement with the government. With wind energy, for example, given current production costs of approximately 0.16 NLG/kWh and current payments from utilities of approximately 0.11 NLG/kWh, the renewable generator would have to sell its green labels for at least 0.05 NLG/kWh to realise a profit.

This mechanism is similar to the RPS mechanism proposed in the USA and essentially reserves a certain percentage of the electricity market for renewable energy within an otherwise liberalised market. However, unlike the RPS, the Dutch green labels scheme guarantees that all renewable generators can sell power to the grid at an assured price, thus removing some of the market uncertainty of the RPS but simultaneously perhaps reducing the economic incentive to reduce renewable energy costs.

11 OTHER STRATEGIES

As well as the important strategies and corresponding programmes described in previous sections various other types of strategies have also been applied. Despite tthe fact that there are no clear lessons yet learnt from these strategies they are documented in the following to complete the picture.

First it is analysed, which other players play an important role and how they influence the markets for PV systems.

There are a lot of different transmitters (or "diffusion agents" as Rogers calls them) in the market for PV systems who may influence the decision-making process of a potential PV generator. Aside from governmental institutions and NGO’s the most important are: architects, housing companies, schools, banks and other private financing companies, see Fig 11.1.

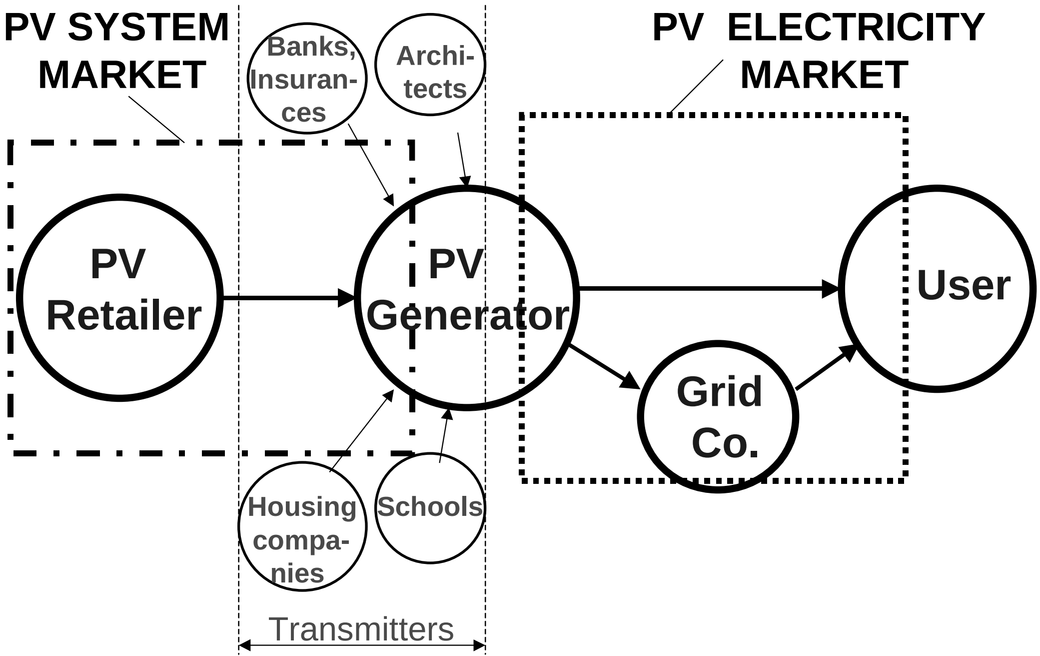

Figure 11.1 Transmitters in the market for PV systems

In the following the most interesting programmes which involve these transmitters are described.

11.1 NGO initiatives

Aside from green tariffs private shareholder and donation projects have been launched by different other types of organisations e.g. NGO’s. The most important programmes are summarised in this chapter.

11.1.1 The SOLARIS programme

A successful example is the SOLARIS programme launched by GREENPEACE in 1997 in The Netherlands. The overall objective of Solaris is to realise 20,000 AC-modules on residential houses. The first phase of 5,000 AC-modules started in August 1999. Within this programme by the end of 1999, about 3000 AC-modules had been installed and about 15000 applicants has registered (Major references: Schoen, 2000; de Wit et al 2000).

The AC-modules (100 Wp modules) are offered as Do-It-Yourself packages for € 442,50 (975 NLG) with a maximum of 4 AC-modules per address. This low price, which is about half the normal price, can be realised by purchasing the modules on a large-scale and by using subsidies from both the Dutch government and utilities and by applying favourable tax regulations. Within this programme no financial incentives are provided for residential customers! Only for commercial companies subsidies were available (25% by the Dutch government). As a consequence of the use of these tax regulations, the AC-modules are offered for (operational) lease and not for sale.

The prices mentioned are net prices, in which subsidies and tax benefits have already been discounted.

The Solaris-project is the first large-scale marketing campaign on the consumer market in Europe, carried out by commercial partners. It is therefore a unique project to gain experiences with marketing concepts for renewable energy.

The use of an (operational) lease construction is very new for The Netherlands and unique for Europe. An advantage of the lease construction is access to favourable tax regulations. Lease constructions therefore offer great possibilities for the financing of PV-systems, not only for private consumers, but also for e.g. public institutions.

11.2 Commercial Financing programmes

Here Financing programmes launched by commercial companies are summarised. So far world-wide it is not possible to attribute specific PV installations to this type of strategy. Hence, the initiatives/programmes described in the following should mainly serve to provide ideas of what might be possible in the future and to complete the documentation of possible strategies.

The most important countries with respect to private financing are the USA, Japan, the UK, Switzerland, Germany and The Netherlands.

The USA is undoubtedly the country with the largest number of private financing models. For details see *The borrower’s guide toFinancing Solar Systems* (DOE (1998)) and Eiffert et al 2001.

In Japan some financing institutes such as banks provide preferential financing at low interest rates for residential PV systems for private use.

Insurance companies are involved increasingly in Switzerland, Germany and the UK, e.g. Swiss RE, Münchner RE and suppliers like Solar Century in the UK.

So far it is not possible to appraise the effects of these financing activities on the dissemination of PV systems.

11.3 Retailer alliances

As has been mentioned under barriers there are a lot of problems with respect to providing an adequate infrastructure and a guaranteed technical reliabilty as well as service level on the PV retailer side.

Two types of strategies are currently applied to cope with these problems: Franchising and guaranteed yields programmes.

In Germany, franchising for PV systems has attracted attention in four retailer groups: Sunlive, SunTechnics, Solar Direct and Solarvent. More than 100 PV retail companies have been involved by the end of 2000, see Iken (2000).

Another idea is to provide a guaranteed yield.

Yet, so far for both types of strategies no performance data are available.

11.4 Public building programmes

If the added values of a technology like PV are recognised by society – that is to say by local or national governments or NGOs – it is very important that their relevance is emphasised by integrating them in public buildings. Indeed, various programmes focussing on different types of public buildings such as schools, town halls and churches have been conducted in various countries, mainly in Germany.

11.4.1 School programmes

In various countries strategies have been launched by governments or electric utilities to provide PV for schools. Especially in Germany a wide range of activities has taken place. Utilities like Bayernwerke (now E.ON), BEWAG, HEW, Preussen-Elektra (now E.ON) have promoted more than 1000 PV systems on schools. Also the German ministery for Economic affairs has launched a large programme supporting more than 200 schools.

In the UK the ETSU supports a similar school programme called SCOLAR. The programme was for a maximum of 100 schools, 95 applications were approved before the closing date, but a number of these failed to be implemented for one reason or another (matching funding, timing, etc.) so the final count is expected to be 73 systems. All but 7 are now installed and the programme closes soon[4].

In the USA school programmes are mainly funded by contribution funds. In the USA the UPVG is monitoring solar initiatives of schools nationwide through its 'Schools going Solar' campaign supported by the DOE. So far 'Schools going Solar' encompasses around 50 projects.

As an example the German project *SONNEonline* is described in more detail. The project was launched in 1997 by Preussen-Elektra (Now: E.ON) and 31 local energy utilities in Northern Germany. Its intention was to introduce PV to schools. Standardised construction kits of 1 kWp were installed in about 400 participating schools in Northern Germany up to the end of 2000. The schools were responsible for a financial contribution, the assembling and operation of the PV system and the monitoring and data transfer via internet to FhG/ISE in Freiburg. The ISE organised the storage and the evaluation of the data. In addition to the PV system the schools received a PC and internet access. So the pupils are able to communicate with all other SONNEonline operators allowing a detailed exchange of their system results and general experience with PV.

The programme is completed. It was limited to these 400 schools. The interest was by far higher. More than 1000 applications were received. A major reference is Skorka (1998). More information is available at the Hompage: www.sonneonline.de.

A summary on some important schools programmes world-wide is provided in Table 11.1. Further reading: Hoffmann (2000), Kiefer et al (2000).

Table 11.1. Some examples for promoting PV in schools (Source: Kiefer et al 2000, Swezey/Bird (2001))

Project name	**Time period**	**Number of systems**	**Average system size (Total)**	**Average yield**	**Financial support**	**Supported by**	**Status**
Sonne in der Schule	1994-1997	544	1.1 kWp (610 kWp)	n.a.	60 %	Bayernwerk (DE)	OFF
SONNEonline	1997-2000	405	1.1 kWp (500 kWp)	693 kWh /kWp	60 %	Preussen-Elektra (DE)	OFF
Sonne in der Schule	1998-2001	320	1 kWp (350 kWp)	763 kWh /kWp	3000 EURO/system (6000 DM/system)	BMWi (DE)	ON

[4] Reference: Donna Munro, personal information

SCOLAR (UK)	1998-2001	73	1.1 kWp (80 kWp)	n.a.	60 %	ETSU (UK)	OFF
PSCO	1998-2000	30	1.8 kWp (52.8 kWp)	n.a.	Contribution programme	PSCO Colorado, USA)	ON
SolarWise for Schools	1996-2000	10	4.8 kWp (50 kWp)	n.a.	Contribution programme	Wisconsin Public service (USA)	ON

11.5 Promoting green buildings

Finally, an important group which may act as a transmitter are building construction companies. They may support PV if the system is integrated in a "green" building. There are some nice examples from the Netherlands and Germany.

In the Netherlands WWF-buildings, which asked for a limited amount of PV on green buildings, have raised attention.

In Austria and Germany some prefabricating home manufacturers (e.g. "Hartl"-Haus) offer buildings with PV integrated.

In Australia, 640 energy efficient houses near the Year 2000 Olympic venue were constructed with building integrated PV.

In Japan housing companies make use of the residential rebate programme. They are promoting the sales of products with the PV system as standard equipment (Ikki, 2000).

Summing up there are various intiatives which support green buildings, "Passivhäuser", etc, which have a positive impact on the market for PV.

11.4.1 "50 Solar energy housing estates in NRW"

A special project of interest is currently under way in in North-Rhine-Westfalia (NRW) in Germany. In 1997 the state initiative on future energies NRW launched the "50 Solar energy housing estates in NRW" concept. The objective of this programme is to support and supervise the construction of solar houses[5]. The buildings within this programme has to meet two of the following three requirements:

- very high thermal insulation standards;
- integration of a PV system;
- integration of solar thermal systems.

Some projects are already completed others are still under construction. So far especially the following three projects have attracted attention with respect to the role PV plays:

- a new built settlement in the city of Gelsenkirchen where two building construction companies has contructed and sold solar houses;
- retrofit of 548 dwellings in multi-family-houses in Köln-Bocklemünd. All of these buildings were also equipped with PV systems;

[5] for updated information visit: http://www.50-solarsiedlungen.de

- a settlement in Bielefeld where houses were marketed individually. Yet, PV systems were required to be integrated in the buildings envelope.

12. AN EVALUATION AND REVIEW OF VARIOUS STRATEGIES

Table 12.1 provides an overview on the major strategies currently implemented in various OECD countries and also on additional instruments applied.

Table 12.1: Prevailing dissemination strategies for PV electricity in selected OECD countries

Country	Current major strategy	Additional programmes
Australia	Rebates	Green tariffs, green electricity targets
Austria	Rebates and feed-in tariffs	RPS (4% “new” renewables by 2007)
Belgium	No	
Denmark	No	
Finland	No	
France	Grants for PV, rural areas (stand alone systems)	
Germany	Regulated rates, Soft loans	Green Power marketing, public building programmes
Italy	Rebates	Net metering
Japan	Rebates	Green Pricing (intended)
Netherlands	National target programme for PV	Green tariff, Financing
Norway	No	
Portugal	Regulated rates	
Spain	Regulated rates (Royal Decree)	Funds (P.A.E.E.)
Sweden	Rebates and tax reliefs	Regulated rates for small generators
Switzerland	Solar stock exchange, "Solarstrom vom E-Werk"	Green tariffs
UK	No	School programme
USA	Buy-downs (Rebates) (CA)	RPS's, Net metering, Green Pricing, Green Power marketing

Source: Own investigations

It can be seen from this table that enhanced feed-in tariffs are currently the most popular dissemination strategy, followed by rebates, and green tariffs.

The core question of our analysis is: Which of the programme types presented above were successful and which strategies are most promising for the future? In the following the programmes described above are evaluated and critically reviewed.

Of special interest is the difference between regulatory and voluntary strategies on the one hand and between strategies focussing on investments and strategies focusing on payments per kWh (“regulated rates”) on the other hand.

12.1 National target programmes

Both voluntary national target programmes launched so far without substantial financial incentives has been successful. The Dutch programme surpassed its first goal of 7.7 MW in the year 2000 and in Switzerland about 15 MW of the goal of 50 MW was attained by the end of 2000.

With respect to the Swiss PV programme it must be stated that it is really a success story because with a minimum of public money the largest capacity per capita world-wide (until 1999) was installed see Fig 1.5.

National target programmes (“Covenants”) work if they are pursued seriously accompanied by information and education activities and if clearly defined and achievable targets per year exists. Specific technology portfolios are required if PV is to benefit from general renewable energy targets. Moreover, it is of high relevance that carefully conducted progress reports are provided;

With respect to mandatory target programmes for PV so far it is not possible to assess their success because not enough experience is available.

12.2 Rebate programs

Rebates are in general an effective tool to enhance the market penetration of PV in a nascent market. Moreover, rebates are an important instrument to ensure a maximum of own use of decentralised PV electricity.

Investigations about the effects of rebate programs in various countries are still ongoing. Yet, the following conclusions may already be drawn:

- Different subsidy strategies led to different effects of cost reduction. In the German 1000 roofs programme (1991-1995) subsidies were a constant share of the investment costs (about 70%). This led to almost no cost reduction within the duration of the program. After the programme was terminated investment costs dropped. A similar effect happened in Austria where the overall investment costs during the programme decreased only slightly and dropped after the programme was terminated. The most advanced strategy so far was pursued in Japan. Over the period 1994 till 2000 the rebates (in 1994 about 50% of the overall investment costs) are cut every year by about 10-15%. This type of dynamic strategy led to considerable cost reductions in the first years and to some stagnation in the last years;
- Reliability and technical performance parameters were improved considerably;
- System design was established and electricians became familiar with PV technology;
- Within the Austrian program (as well as in the German) households with a high initial consumption reduced their electricity demand whereas households with a low initial electricity demand increased their electricity consumption (Haas, 1999);
- The rebates in virtually all programmes where too high. This can be seen from the fact that in all of these (limited) programs there were far more applications than approvals. This was true in the German, the Austrian and the Japanese programme.

  That is to say, the ignorance of consumers‘ W T P led to a smaller total capacity installed than what would have been possible to be achieved with the same amount of money. A recent example is the Australian NGO programme that has been revised substantially because otherwise the budget foreseen would have been exhausted too fast;
- Furthermore, to accelerate the cost reduction of PV systems it is important that rebates are a fixed amount per kW capacity and not a percentage of the investment costs.
- Rebates as percentage of total cost are the wrong incentives because they do not provide a sufficient incentive for the customer to look for the cheapest or most efficient system; E.g. if the rebate share is 50% or higher deals between customer and the PV retailer may take place so that the objective is to maximise the amount of the rebate and not to look for the best system.
- Rebates on investments do not ensure an optimal performance of the RES over its lifetime due to the lack of incentive to run the installation properly after the subsidy has been paid. Hence rebate programmes have to be accompanied by monitoring programmes and supervision ensuring system performance stays as high as possible. There is also a risk of “boom and bust” cycles destabilising the market and destroying reputable companies.
- All in all, rebates do work as a dissemination policy in an early stage of market diffusion. Yet, rebates cannot be considered to be a sustainable promotion instrument. They are useful to support an emerging technology. Yet, as soon as possible performance should become part of the incentive scheme.

Rebates have to decline continuously over time. Otherwise the suppliers (retailers) would not reduce the system costs to the same extent but rather earn an extra profit;

12.3 Financing/Soft loans

This type of instrument works similar to rebates. Up to now the experience available is rather limited. The lessons learned so far from the German 100000 roofs programme are rather ambiguous.

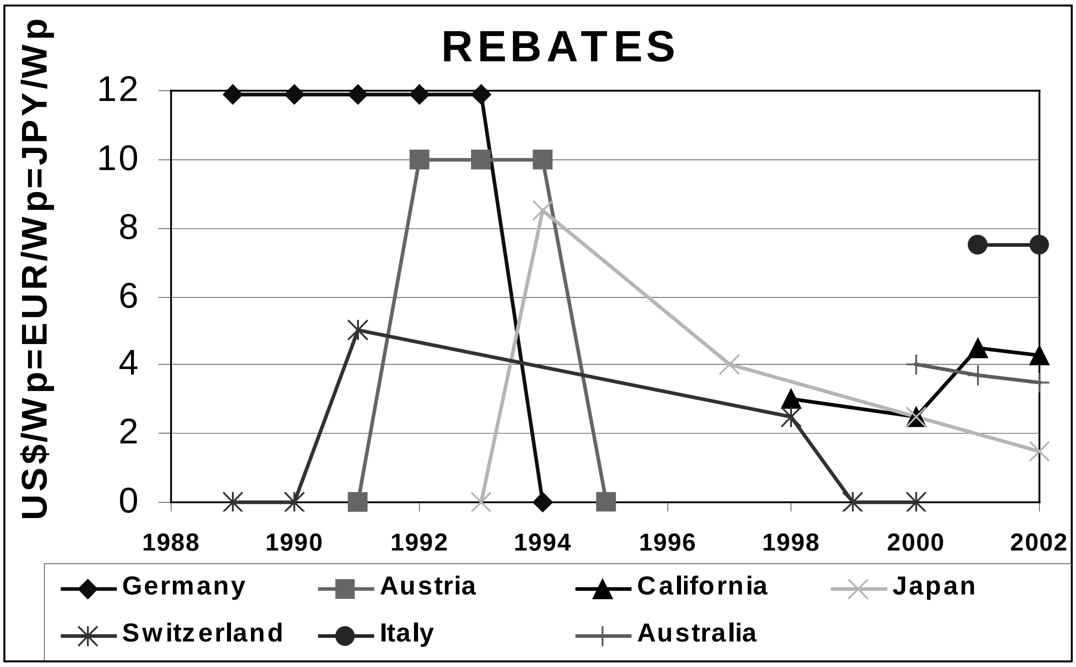

Figure 12.1. Development of rebates over time and in various countries

12.4 Tax incentives

Tax incentives in both forms – deduction of income tax and relief from electricity generation - based tax – may be an instrument that supports and completes especially rebates and soft loans. Yet, so far they have not been of relevance for a substantial increase in the market penetration of PV.

12.5 Regulated rates

Of the three types of regulated rates applied in various countries in recent years rate-based incentives (e. g. enhanced feed-in tariffs) turned out to be the most successful tool for achieving a significant increase in market penetration. Virtually all programmes based on regulated rates close to the production costs and guaranteed over a period of about 15 years were successful. Yet there are advantages and disadvantages.

The major advantages of rate-based incentives are:

- They are effective in the sense that they trigger substantial installations of new PV systems;
- They ensure technically efficient operation of the plants;
- Regulated rates are preferable to rebates with respect to system performance and lower transaction costs and bureaucracy;

The major points of criticism with respect to rate-based incentives are:

- RBI neither fully exhaust customers' WTP nor do they minimize costs to the public;
- They lead to cost reductions only if they decrease strongly over time;
- They provide subsidies and hence lead to new distortions in markets;
- They do not encourage competition between generators.
- They do not encourage the own use of PV electricity and hence do not allow to reap the full added values

Generally enhanced feed-in tariffs not specified for PV do not play a role.

On Net Metering no sound results regarding their effect on increasing the market share of PV are available. Net metering may be considered as a minimum condition for the acceptance of PV in a utilities network and it is a correct instrument to encourage a maximum of own-use of PV electricity. Net metering is a successful strategy if it is accompanied by financial incentives on the investment and comprehensive marketing activities Yet, if net metering is not accompanied by other financial incentives in general it does not really foster the market penetration of PV.

12.5 Voluntary capacity-based programmes

The most promising strategy under the voluntary capacity-based programmes are Green Shareholder programmes. These are usually very successful as a first step of market introduction in a local area. The installed capacity is limited by the WTP to buy shares.If such a strategy was to be launched in every village or neighbourhood in a country it would lead to a substantial increase in PV capacity. The programmes implemented so far havebeen especially successful if they were accompanied by social events e.g. shareholder meetings, solar parties and follow-up activities like striving for installations on all local public building, schools and kindergardens.

12.6 Voluntary generation-based Green Pricing models by utilities

Green tariffs and Solar stock exchanges are based on a high consumers’ willingness to pay for “green electricity” and trust in the seriousness of the "old" incumbent utility. Hence, they depend very strongly on the credibility of the organisation that offers it. Effective green pricing programmes have to exhaust electricity consumers’ willingness to pay for “green electricity” as far as possible. In general green tariff programmes need a lot of public relations work from the utility to make them work (See e.g. the RWE programme in Germany or the ewz “Solarstrombörse” in Switzerland). Most important is that they are accompanied by a credible green label. Moreover, if there was a label on all electricity the attractiveness of Green Pricing programmes might be even higher.If they are not accompanied by an attractive Green label in many cases they lose attraction and after some time no more additional systems are installed, see Fig. 12.2. Some programmes in Austria and Germany have been terminated, because of a lack of participants.

Anyway, GP is based on private customers WTP and, hence, especially for PV is a rather limited dissemination strategy. But it is an important instrument for complementing governmental programmes.

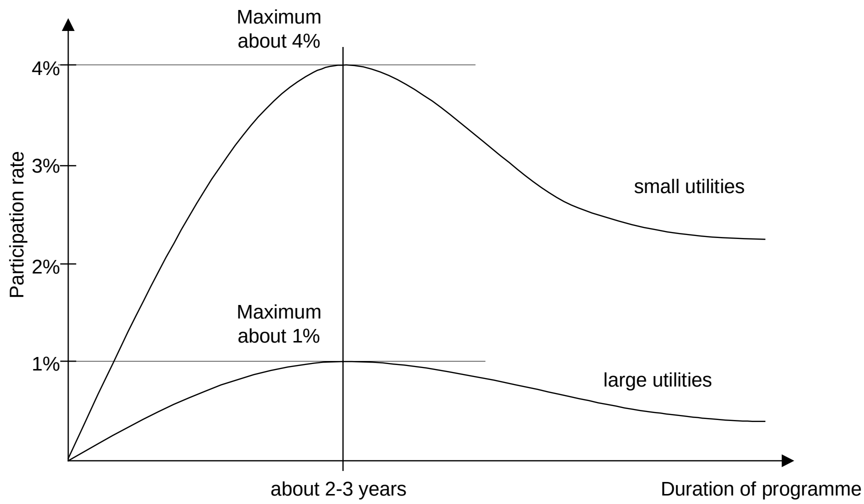

Figure 12.2 Possible saturation and backlashes of green pricing programs

12.7 Green Power Marketing

Green Power Marketing is a new strategy in a liberalised market. Experience so far tells us that, as with Green Pricing for PV, it is only promising if it is accompanied by an attractive and credible Green Label. This means the label must guarantee a certain amount of PV from new installations. Moreover, a major precondition for the success of Green Power Marketing is that all barriers for potential green electricity users should be removed, e.g. no fees for changing the supplier, no additional metering charges.

Successful GPM would furthermore be supported by the introduction of a general "Power content label" to distinguish all sources of electricity (see e.g. Green, 2001).

12.8 Voluntary programmes by NGO´S

Recently launched NGO initiatives have been surprisingly successful. They proved that there is a high WTP of private customers if a strategy is launched by an organisation with high environmental credit.

Table 12.2 gives an overview of the most important strategies categorised by the criteria described above with their core features.

Table 12.2. Suitability of major strategies for removal of various barriers for PV systems

REQUIREMENT → ↓ STRATEGY	QUANTITATIVE:		QUALTITATIVE:			
	Dissemination effectiveness	Costs to the public	Increase technical Performance	Cost reduction	Increase social acceptance	Exhaust customers WTP
I. GOVERNMENT. TARGET PROG.						
1. Voluntary national targets	High	Medium	N	Y/N	Y/N	Y/N
2. Mandatory national targets	High	Medium	N	Y/N	Y/N	Y/N
II. REGUL. FINANC. INCENT. INVESTMENT FOCUSED						
3. Governmental rebates	High	High	N	Y*)	N	Y*)
4. Financing, soft loans	High	High	N	Y*)	N	Y*)
5. Tax incentives	Low	Low	N	Y*)	N	Y*)
III. REGUL. FINANC. INCENT. GENERATION-BASED						
6. Net metering	Low	Low	Y	Y#/N*)	Y/N	Y
7. Enhanced Feed-in tariffs	High	Low	Y	Y*)	N	Y*)
8. Rate-based incentives	High	Medium	Y	Y*)	N	Y*)
9. Environm. pricing (e.g. CO2-taxes)	Low	Low	N	Y+)	N	N
IV. VOLUNT. FINANC. INCENT. INVESTMENT FOCUSED						
10. Contracting	High*)	Low	N	N	N	Y
11. Green Shareholder	High*)	Low	N	N	Y	Y
12. Contribution	High*)	Low	N	N	Y	Y
13. Bidding	High*)	Low	Y	Y	N	Y
V. VOLUNT. FINANC. INCENT. GENERATION-BASED						
14. Green tariffs	Low	Low	-	N	N	Y
15. Green Power Marketing	Low	Low	Y	N	Y*)	Y
16. Solar stock exchange	Medium	Low	Y	N	Y*)	Y
VI. OTHERS						
17. NGO marketing	High*)	Low	Y	Y*)	Y	Y
18. Selling green buildings	Low	Low	Y	N	Y	Y
19. Retailer alliances	Medium	Low	Y	-	-	Y
20. Commerc. Financing progr.	Low	Low	N	-	Y/N	-
21. Public building progr. (Schools...)	Medium	Medium	Y	-	Y	N

*) if designed properly; +) relatively; #) if interconnection and metering costs are reduced

13. CONCLUSIONS AND OUTLOOK

This review of market deployment strategies for small grid-connected PV systems shows that there is a wide range of possibilities to increase their market penetration and that there are real success stories. Yet, there are considerable differences in these strategies with respect to technical and economic efficiency as well as with respect to their success in triggering a substantial number of new installments. In the following the most important conclusions of this analysis are reported split up into four major categories:

- ➢ What are the core issues for successful dissemination strategies regardless which strategy is chosen?
- ➢ Does the type of optimal strategy depend on the stage of market penetration of PV?
- ➢ Which activities are required now with respect to different target groups?
- ➢ What are the key final messages?

13.1 What are the relevant criteria for successful dissemination strategies?

There are basic requirements for strategies that apply regardless which strategy is chosen. The most important are:

- Comprehensive accompanied information and education activities are important;
- Pure cost-effectiveness is not crucial for private customers. Affordability is rather what counts. BUT: Over the next five to ten years the costs have to come down substantially, at least close to the residential final electricity prices !
- High environmental credibility of the institution/company which launches a voluntary strategy based on customers WTP (e.g. Green Pricing or a Solar Stock Exchange) is a very important precondition;
- Predictability and continuity over time is of tremendous importance. Avoid “Stop and Go”-strategies! It has to be clear how long a policy will last to provide confidence among customers and the PV industry!
- It has to be ensured that after the programme is terminated a sustainable development of the PV industry is likely and that the market does not collapse;
- Minimise administrative and transaction costs!
- The design of a PV strategy should allow the rejection of projects that are unlikely to be good examples and encourage suppliers to improve the operational performance and technology efficiency ;
- It is important to note that efficient promotion programs take into account consumers' willingness to pay (WTP). **Optimal financial incentives would provide only the difference between the system costs and the WTP for PV.** The incentives in most programs up to now were not optimally designed. Consumers WTP for PV is higher than expected by program designers. With the same amount of total subsidies it would have been possible to promote more PV systems.
- With respect to financial incentives **it is of tremendous importance that they show a decreasing characteristics over time and** that they are designed dynamically**.** That is to say financial incentives have to be reduced over time to an extent which is justified by societal benefits;
- When designing a programme it should be borne in mind that there are the following important areas of activity: the PV customer, the PV market, the technology, society and communication between the former;

- An important issue in this context is also international dissemination and international learning. In some countries more progress has been made than in others. The maturity of markets is different in different regions.

13.2 Does the type of optimal strategy depend on the stage of market penetration of PV?

Figure 13.1 depicts the effectiveness of various promotion strategies depending on the stage of market penetration of PV. In an early stage of market introduction it is most important to trigger some practical examples to get some first experience. Moreover, it is important to provide demonstration projects in this early phase. This is done best by means of rebates (for small-scale systems and mass applications like decentralised PV systems) or bidding strategies (for large systems and individual applications like large PV power plants).

After PV has reached a certain maturity and a reliable performance standard in a special region – that is to say after a critical threshold of performance φ times efficiency η is surpassed – it makes sense to tie part of the financial incentive to the system performance e.g. to kWhs generated or kWhs fed into the grid. This can be done by means of rate-based incentives or feed-in tariffs. And finally, after the technology reaches a level where customers WTP can reach a substantial influence on the dispersion of the technology voluntary strategies, e.g. Green Pricing could become a proper complementary instrument.

There are two important arguments, why a rebate (or other adequate financial incentive on the investment) is important regardless of the stage of market penetration:

1) It has to be borne in mind, that an important added value is that decentral generated electricity is used as far as possible at the place where it is generated. Hence, it makes sense that only excess electricity is fed into the grid. The own-used amount of electricity has to be subsidized by a rebate;

2) Of course, most important with respect to building integration is that the PV system is integrated in the envelope of the building at the time the building is constructed. Yet, at this point-of-time money is usually scarce and, hence, a proper financing incentive, e.g. a rebate, is of high relevance.

Therefore, efficient promotion strategies should focus on incentives per kWh generated as well as to some extent on rebates on the investment in generating capacity (kW).

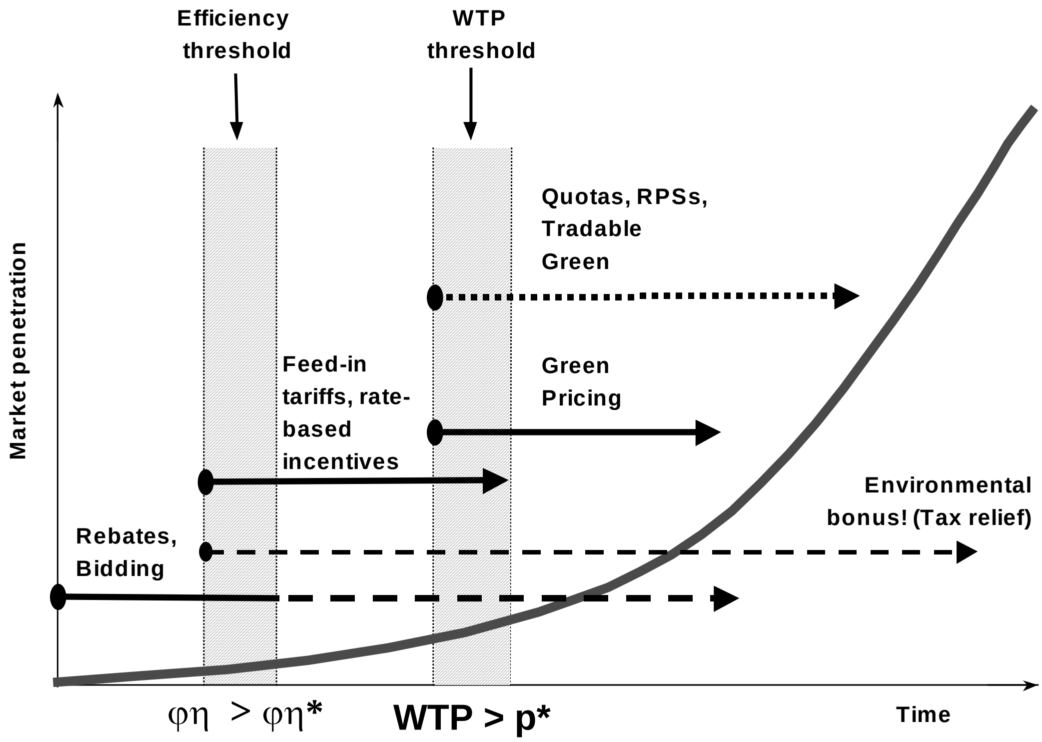

Figure 13.1 Effectiveness of various promotion strategies depending on the stage of market penetration of PV

13.2 Which activities are required NOW with respect to different target groups?

The actions required now with respect to different target groups in the relevant areas of activity are:

1. Customers

There are different groups of potential PV customers which have to be addressed differently:

- With respect to private households most important is to increase their WTP. This can be increased by:
  - providing proof of environmental benignity;
  - personal identification with the technology;
  - credible labelling of green power
  - simple purchase conditions;
  - simple technical installation;
  - affordable systems at reasonable prices.
- For architects and housing companies: introduce targeted education programmes
- For commercial companies: provide financing programmes

2. Solve the technical problems

Technical barriers still exist. A lot of technical issues are not solved satisfactory. The most pressing problems are:

- Ensure standardised system optimisation and performance
- Increase compactness/standardisation and simplicity with respect to system installation! ("black box", "plug and ...")
- Enhance/Standardise Safety

- Simplify/Standardise Utility interface
- Simplicity

Note, that it is of high relevance to solve these problems or at least to address them before any wide-spread dissemination strategy is triggered.

3. Improve the markets:

To make any programme work and to reduce the subsidies or the premium paid it is very important to have a good infrastructure with respect to PV suppliers and a competitive market. In principle we have to differentiate between countries and regions where there is already a mature market and where there is not. Currently in most countries - except maybe Germany and Japan – no competitive and transparent market exists. Important measures are:

- Use the internet to increase transparency and competition;
- The PV industry should put emphasis on the investigation of desirable product developments for integrating PV in the buildings' envelopes;
- Provide an infrastructure network;
- A possible action could be benchmarking of system costs on the internet;
- Building-integrated PV is just hitting the market, and, hence many subjects have to be investigated further;
- Finally the PV industry must continue the development of the technology by improving efficiencies, increasing production levels and providing reliable, easy to install and aesthetically pleasing products (Watt, 2001);
- For Green Utilities it is important to create reliable labels which clearly distinct between existing and newly installed capacities!
- The diversity of PV applications has made it difficult for different market participants to achieve market presence and to provide adequate product support (Watt 2001). Until each sector of industry and each market participant reaches maturity it is of tremendous importance to forming partnerships and/or to pool resources between the industry groups, governments, electricity suppliers and installation, operation and maintenance services.

4. Society:

Most important is that national and local governments as well as the public are both convinced of the added values of PV and set the correct conditions for the deployment of renewables in general.

The requirements for national and local governments in detail are:

- They must be convinced, that PV technologies bring about societal benefit by means of:
  - mitigating the environmental burden;
  - increasing local employment;
  - enhancing supply security;
- A means to achieve this could be the setting up of information centers for environmentally benign technologies;
- a range of education programmes is necessary, aiming at the increase of awareness and understanding of customers, planners, regulators, electricity suppliers and the building industry (Watt, 2001);
- Encourage and support NGO marketing activities!

- with respect to embedded energy and environmental issues research and demonstration towards safer materials and recycling should be emphasized;
- introducing environmental pricing, e.g. CO_2- taxes;
- in the age of the liberalisation of electricity markets an important role for policymakers is to design conditions for various players in ways that minimise the transaction costs for new players, avoids market power, and minimises barriers to entry;
- The liberalisation of electricity supply should ensure that it is soon possible to have green suppliers comprehensively across Europe. Moreover, barriers for potential green electricity suppliers have to be removed by the government, e.g. no connection fees for access to the grid, no discrimination by incumbent utilities and providing fair network access;
- For Green Power Marketing (including Green Pricing models) we conclude that no further government support should be needed. This is because the Green Power Market depends on the willingness to pay of private customers. The market will determine the demand. Yet, barriers for potential green electricity users have to be removed consequently, e.g. no fees for changing the supplier, no additional metering charges etc;
- Nevertheless, an international mandatory 'power Content Label' is of high priority to distinguish all sources of electricity. It is in principle not necessary to harmonise the different individual Green Labels, which could remain alongside the 'power content label'. Of course, a reduction in the number of labels would make the voluntary purchase of Green Electricity much more attractive for customers (Green, 2001).
- If these conditions are fullfilled in some years a real market for green electricity could develop, where the transmission grid would serve both Green Power marketers and the independent PV generator as a vehicle to bring PV electricity to "green" customers.

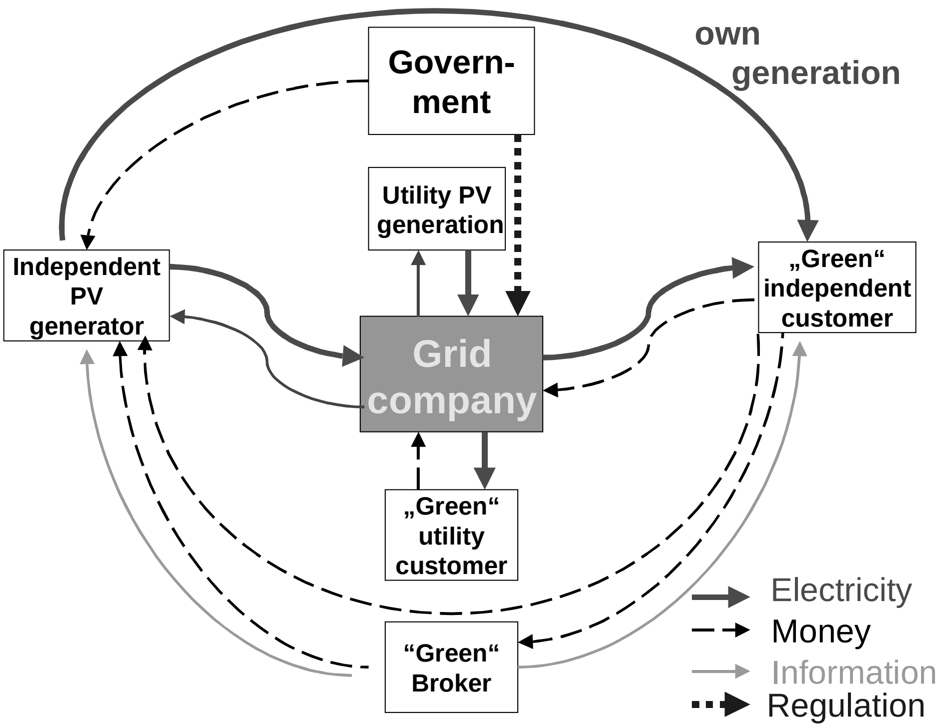

Figure 13.2 Interactions between various participants in possible "Green" electricity markets

13.4 Final key messages - Perspectives

Finally it is analysed how possible different developments may look like.

It is of principal relevance to take into account the dynamic development of two major features:

- of the costs to customers (monetary and "hidden" transaction costs) and ;
- the WTP of private or commercial investors;

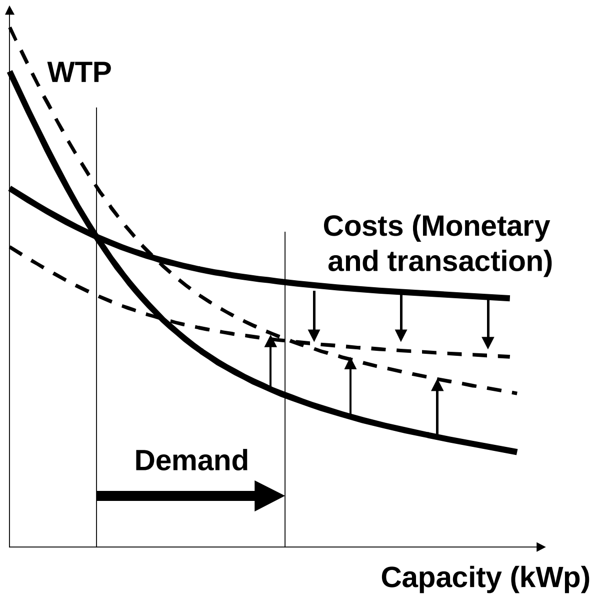

Figure 13.3 How enhancements in customers WTP and decreases in costs influence the demand for PV

Most important is that measures contribute to increases in customers WTP on the one hand and to reduce the (monetary and transaction) costs for customers on the other hand. Fig. 13.3 depicts these effects in a traditional supply and demand diagram.

Summing up there are eight key factors for successful dissemination strategies of small grid-connected PV systems, see Fig. 13.4:

1) Provide a minimum of a financial incentive that allows to fully exhaust customers WTP!
2) Improve the market: Ensure that the competitiveness and the transparency of the PV system market as well as of the market for electricity (e.g. by means of a power content label) is enhanced! Moreover, ensure continuity of the strategy over time and sustainable growth of the industry!
3) Strive for a guaranteed technical performance, an increase of standardisation and efficiency!
4) Try to make the programme a social event and to address the public as well as the mass-media!
5) Strive for setting the correct regulatory conditions from societies point-of-view! Remove barriers for access to the grid and introduce environmental pricing!
6) Minimise the costs for the public! Strive for low administration and transaction costs and minimize monetary financial support to reach a certain amount of PV capacity!
7) Provide comprehensive detailed and targeted information for the potential programme participants!
8) Conduct marketing! What are the potential customers and what are their needs?

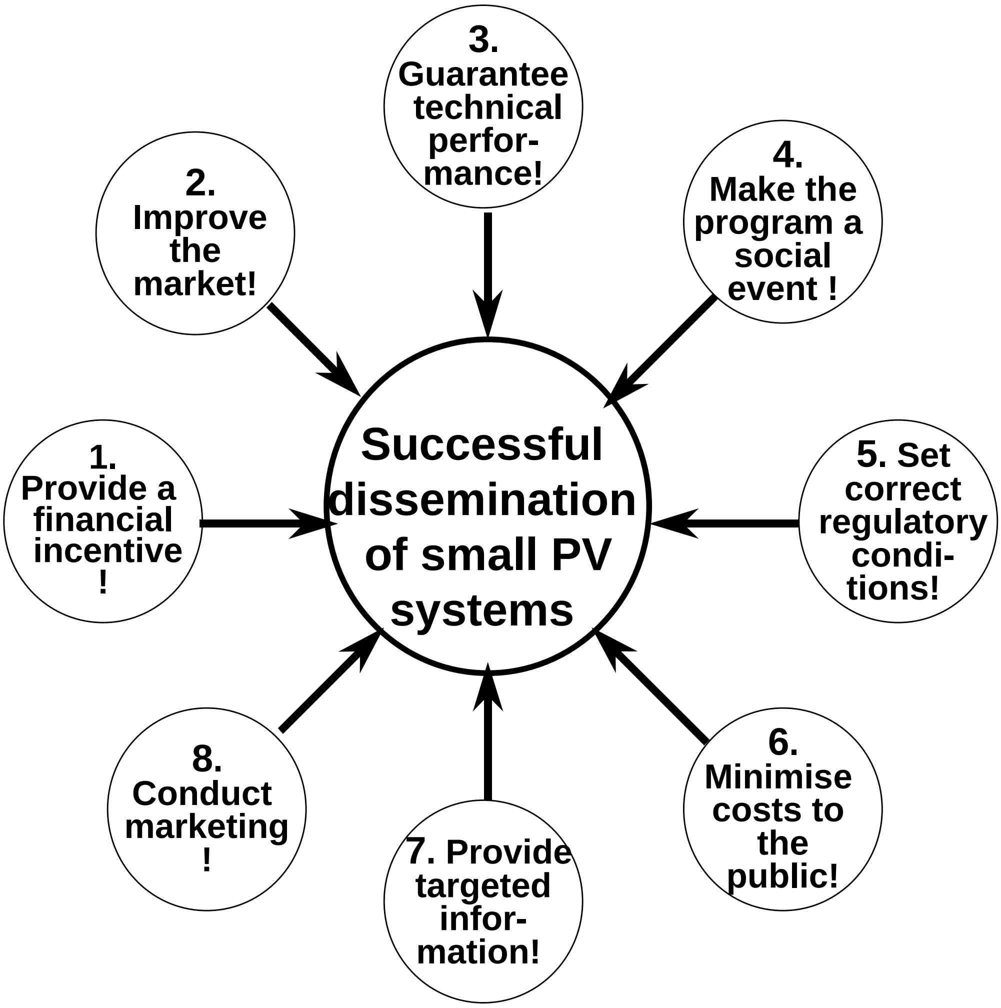

Figure 13.4 Key factors for successful dissemination strategies of small grid-connected PV systems

As has been shown in this report there is a tremendous variety in strategies, programmes and dissemination ideas. If the most valuable lessons learned from these wide-spread activities are summarised and extracted the ground is provided for a continuously increasing further dissemination of BIPV systems. Yet, it is of core relevance that the market transforms in ways to reach new customers with well-performing, affordable systems.

Finally, it is stated that to be successful, it is of paramount importance to design strategies in a way where governments, the PV industry, utilities, NGO's and potential investors co-operate. If this cooperation takes place in a constructive way with goodwill from all participating parties it may in some years lead to the vision of electricity supply where the added values of all renewables for electricity generation are fully reaped and provides the utmost benefits for society.

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APPENDIX A: SYSTEM COSTS, MODULE AND NON-MODULE COSTS

Total system costs:

Year	AT €/Wp	DE €/Wp	JP 100 Yen/Wp	US US$/Wp	CH €/Wp	NL €/Wp
1990	17.01	16.9	N.A.	12.5	15.0	
1991	15.26	14.8	23.0	11.5	14.0	17
1992	13.81	13.3	21.0	10.5	13.0	15
1993	13.08	11.8	19.0	9.5	12.0	13.5
1994	12.35	10.4	17.0	8.5	10.0	11.5
1995	10.90	9.0	14.2	8.0	9.0	10.5
1996	9.45	8.1	12.3	7.7	8.3	9.5
1997	8.36	7.4	10.62	7.5	8.0	8.6
1998	7.63	7.2	10.74	7.3	7.8	7.7
1999	7.27	6.8	9.39	7.1	7.6	6.6
2000	7.23	7.4	8.44	7.0	7.5	7.2
2001	7.20	7.2	7.74	7.0	7.4	7

Modules:

Year	AT €/Wp	DE €/Wp	JP 100 Yen/Wp	US US$/Wp	CH €/Wp	NL €/Wp
1990	8.80	8.60	N.A.	6.00	N.A.	N.A.
1991	7.85	7.67	12.00	5.70	N.A.	N.A.
1992	7.10	6.90	11.00	5.40	N.A.	N.A.
1993	6.70	6.39	10.00	5.10	N.A.	N.A.
1994	6.40	6.00	9.00	4.70	N.A.	N.A.
1995	5.80	5.70	8.00	4.70	N.A.	N.A.
1996	5.40	5.40	7.00	4.65	N.A.	N.A.
1997	5.10	5.1	6.52	4.6	N.A.	N.A.
1998	5.00	4.90	6.74	4.55	N.A.	N.A.
1999	5.00	4.6	5.98	4.5	N.A.	N.A.
2000	5.00	5.0	5.42	4.50	N.A.	N.A.
2001	5.00	4.8	4.90	4.5	N.A.	N.A.

Non-Modules:

Year	AT €/Wp	DE €/Wp	JP 100 Yen/Wp	US US$/Wp	CH €/Wp	NL €/Wp
1990	8.21	8.27	N.A.	6.5	N.A.	N.A.
1991	7.41	7.16	11.00	5.8	N.A.	N.A.
1992	6.71	6.39	10.00	5.1	N.A.	N.A.
1993	6.38	5.37	9.00	4.4	N.A.	N.A.
1994	5.95	4.38	8.00	3.8	N.A.	N.A.
1995	5.10	3.30	6.20	3.3	N.A.	N.A.
1996	4.05	2.70	5.33	3.1	N.A.	N.A.
1997	3.26	2.29	4.10	2.9	N.A.	N.A.
1998	2.63	2.26	4.00	2.8	N.A.	N.A.
1999	2.27	2.20	3.41	2.6	N.A.	N.A.
2000	2.23	2.40	3.02	2.5	N.A.	N.A.
2001	2.20	2.40	2.84	2.5	N.A.	N.A.