International Energy Agency

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task 1

Exchange and Dissemination of Information on PV power systems

National Survey Report of PV Power Applications in The Netherlands

2002

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I 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 among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-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 in the applications of photovoltaic conversion of solar energy into electricity.

The twenty participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA). The European Commission is also a member.

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. Eight tasks have been established, and currently five are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning urban-scale deployment of PV systems is being developed.

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

II INTRODUCTION

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems. An important deliverable of Task 1 is the annual International Survey Report on PV power applications. This report gives information on trends in PV power applications in the twenty member countries and is based on the information provided in the National Survey Reports which are produced annually by each Task 1 participant.

This National Survey Report has been written in the context of Task 1 of the designated tasks of the International Energy Agency. It provides an overview of the projects on Photovoltaic energy projects that were executed in the Netherlands in 2002. The information in this report will be used by the IEA in order to generate global figures on the number, characteristics and trends in the implementation of Photovoltaic Power Systems.

The information displayed in this report is given by the participants on a confidential basis and is therefore not suitable for general use. In the global report of the IEA figures should be given on an aggregated level, without providing any insight in the share or turnkeys of the individual organisations on the Photovoltaic market in The Netherlands.

III DEFINITIONS, SYMBOLS AND ABBREVIATIONS

For the purposes of this report, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W_p or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m2, cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see 'Peak power').

Peak power: Amount of power produced by a PV module or array under STC, written as W_p.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W_p or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed in households and villages that are not connected to the utility grid. Usually a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Off-grid non-domestic PV power system: System used for a variety of applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed on consumers' premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers. etc. These may be used for support of the utility distribution grid.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication systems in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

NC: National Currency

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

1 Executive summary

This report provides an overview of Photovoltaic energy projects executed in The Netherlands in the year 2002. These projects have been characterised by on-grid distributed applications (small systems connected to the grid), on-grid centralised applications (projects connected to the grid with the characteristics of a Photovoltaic power plant) and off-grid applications.

- Installed PV power

The PV projects executed in The Netherlands have resulted in the total cumulative installed PV power (in kW_p) on 31st of December of each year, as stated in the table below.

Table 1: The cumulative installed PV Power.

Sub-market application	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TOTAL	1 270	1 641	1 963	2 400	3 257	4 036	6 480	9 195	12 759	20 509	26 326
On-grid distributed								5 309	8 499	13 699	19 214
On-grid Centralised								0	180	2 480	2 480
Off-grid								3 886	4 080	4 330	4 632

From the table above, it can be concluded that the total growth of installed power of on-grid PV-applications has increased from an estimated 5 817 kW_p in 2002. In 2002 a total of 5 515 kW_p on-grid PV-applications were installed. The growth of on-grid PV-applications is decreasing compared to the year 2001. This can be explained by one giant project in 2001 named The Floriade. The growth of autonomous PV-applications is considered as slightly increasing.

- Budgets for PV.

Budgets for market-stimulation, demonstration/field test programmes and R&D have been investigated. National subsidies (total amount of € 2 221 340) are mainly provided by Novem. Exact budgets from others like EET (programme Economy, Ecology and Technology) and EC 'Fifth framework' programs are not available. The budget from ECN[1] for R&D is approximately EUR 8 000 000. Within the budget of ECN are also subsidies from Novem, the European Commission and money from manufacturers.

For PV-projects on the industrial and utility market the tax-regulations of EIA and VAMIL are still applicable and even improved so that it is easier for companies to make use of these tax-regulations. These tax measures account for governmental support of EUR 1 500 000. The "Energy Premium Regulation" (EPR) supports consumers financially in various sustainable,

[1] ECN is a research institute and isn't engaged in implementation projects. ECN has assignments from the government, the European committee and companies. The research at ECN concerns: crystalline Silicium, thin film and PV-applications.

such as PV-projects, and energy-consumption reducing projects. In 2002 the EPR contains a total amount of
EUR 4 342 573. In 2003 a part of the payments regarding projects in 2002 will be done. The budget will probably be higher then shown above because of obligations concerning the last quarter of 2002. The budget shown above is based on a subsidy of EUR 3,50 per W_p. In 2002 approximately 634 400 W_p was installed on new buildings and approximately 606 350 W_p was installed on existing buildings. This means that a total of 1 240 kWp was installed in 2002 with the use of EPR.
In 2001 a total amount of EUR 2 608 602 was assumed. After all obligations concerning the last quarter of 2001 were complied with, finally this amount was
EUR 8 037 831. When this given is applied to 2002 it means that the EPR contains a total amount of EUR 13 027 719, this should mean that a total of approximately 3 725 kW_p was installed with the use of EPR in 2002.

Other generic subsidies are applicable to PV-projects as well, but it has become clear that allocation of exact figures of these funds to PV-projects is difficult, since these funds have been applicable to the stimulation of other sustainable and energy-consumption reducing projects as well.

In 2001 a new subsidy of the "Decision Subsidies of Energy Programs" (BSE), was introduced by the Dutch Enterprise for Energy and Environment (Novem). This subsidy is also available for other sustainable techniques. In 2002 the subsidy contains a total amount of € 2 221 340.

In most subsidies nowadays everything is based on a CO2-reduction ratio. So PV must compete with other renewable energy options. In competition with other Renewable Energy options, PV does not perform well. An important aspect is the balance between the investment / PJ natural gas reduction ration. PV has a poor performance when compared to other Renewable Energy options like wind and bio-mass due to the low output and relatively high cost for production and installation.

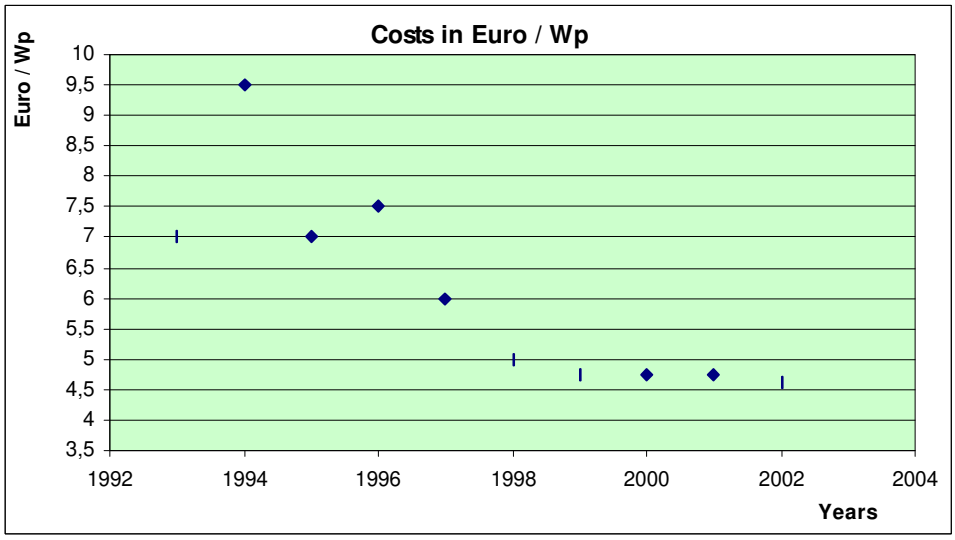
- PV production

In 2002 Shell Solar was one of the two manufacturers of PV-cells and modules in The Netherlands. In 2003 Shell Solar decided to leave The Netherlands. The production site in Helmond (and Munich) will be closed. Four other factories will stay open. The production site in Helmond is closed due to a larger supply than the demand on the PV-application market.
In 2002 Philips Solar Energy entered the PV-market. Philips offers polycrystalline solar modules of 125Wp and 165Wp with conversion efficiency rates of respectively 13% and 12,7%.
Logic Electronics planned its market introduction in 2002[2] and it's still uncertain when AKZO-Nobel will start the production of PV-systems, probably before 2005. They are now busy with the development of flexible amorphous silicium solar cell foil (thin film). This development is supported by Novem, EET and the European Union. Another party is Becarius, this party is developing thin film and is ready to produce this thin film. This application is more expensive and has a low return.

- Costs & prices

[2] At the time of writing this report no information about Logic Electronics was available

The current development of the prices of PV-systems is stated in the following figure. The prices mentioned in this graph concern the lowest PV-project prices per year, stated in Euro per W_p. The graph indicates a downward trend in the development of the price (see trend-line) for the past ten years, but indicates that prices have almost been stabilised for the last five years as well.



Employment

The current number of employees in the market for PV-applications is estimated at 670 fte. There are many new parties that are participating in the market during the year 2002. This year a total of 50 parties were approached within the framework of this market research, in 2001 this number was 31. It is expected that this is an important trend and that the number of people working in the market for PV-applications is still slightly increasing.

Influences on PV-applications in future

Issues that will influence the market for PV-applications in future are expected to be:

- The current economical recession in the Netherlands has a negative influence on the PV-application market. Consumers may be less willingly to invest in sustainable energy, unless the price of these applications is decreasing.
- New promotional activities, like EPR, will create a large new market segment for PV-systems, i.e. existing and new dwellings. There is already a trend in increasing usage during the start up in 2001 and in 2002 this trend has continued.
- Regulating Energy Tax (REB) puts taxes on conventional energy, which results in a promotion of sustainable energy. This regulation will change, the advantages and the negative side-effects will disappear and instead of the REB the new MEP-regulation will introduced. This regulation is specific and non-fiscal for stimulation of the environmental quality of the electricity production. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production. For PV the support will be EUR 0.069 per kWh.
- Liberalisation of energy-markets will influence the energy-price of conventional energy, which could have an impact on the market potential and the penetration of sustainable energy. It could have a negative impact.

- Public perception towards PV-energy is still positive and the general knowledge of the general public is increasing rapidly.
- Many energy companies had there own subsidies (B-map) during the years laying behind. But this subsidy will end in December 2003. For future projects in the years in 2004 and 2005 it is possible to use B-MAP support, provided that in 2003 commitment for these projects was gained.
- The installation of several major projects in 2003 (a 500 kW_p power production system on the roof of the Oceanium at Rotterdam Zoo (Diergaarde Blijdorp) and the 351 kWp at WL Delft Hydraulics) Photovoltaic power in 2003.

2 The implementation of PV systems

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 Wp or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Applications for photovoltaics

The Photovoltaic projects in The Netherlands can be characterised into two main groups of applications: on-grid and off-grid applications.

The on-grid applications can be differentiated in distributed applications and centralised applications. On-grid distributed applications are defined as the smaller application projects that are connected to the grid, with an installed power up to 10 kW_p. Centralised, grid connected applications are defined as the larger projects, with the characteristics of a Photovoltaic power plant and an installed power over 10 kW_p. Most of the grid-connected projects are applied to roofs of utility buildings and dwellings.

The number of applications of autonomous systems has been stable for several years already, in 2002 it has just a slight increase compared to the year 2001. The majority of the autonomous systems that have been realised are applied to**:**

- Public Lighting,
- Road signs,
- Holiday homes,
- Cooling systems,
- Electric boat engines,
- Caravans and campers,
- Water management systems,
- Trough for live stock.

Picture 1: Trough for live stock on solar power

2.2 Total photovoltaic power installed

The PV projects executed in The Netherlands have resulted in the total cumulative installed PV power on 31st of December of each year from 1992 onwards, as stated in table 2 on the next page.

Table 2: The cumulative installed PV Power in 4 sub-markets.

Sub-market/ application	31 Dec. 1992 kWp	31 Dec. 1993 kWp	31 Dec. 1994 kWp	31 Dec. 1995 kWp	31 Dec. 1996 kWp	31 Dec. 1997 kWp	31 Dec. 1998 kWp	31 Dec. 1999 kWp	31 Dec. 2000 kWp	31 Dec. 2001 kWp	31 Dec 2002 kWp
off-grid domestic											
off-grid non-domestic	1 240 (total off-grid)	1 594 (total off-grid)	1 849 (total off-grid)	2 133 (total off-grid)	2 554 (total off-grid)	3 002 (total off-grid)		3 886 (total off-grid)	4 080 (total off-grid)	4 330 (total off-grid)	4 632 (total off-grid)
grid-connected distributed	30 (total grid-connected)	47 (total grid-connected)	114 (total grid-connected)	267 (total grid-connected)	703 (total grid-connected)	1034 (total grid-connected)		5309	8499	13699	19 214
grid-connected centralized								0	180	2480	*2 480*
TOTAL	1 270	1 641	1 963	2 400	3 257	4 036	6 480	9 195	12 759	20 509	26 326

2.3 Major projects, demonstration and field test programmes

Table 3 (next pages) states some characteristic projects that have been realised in 2002. Associated promoters (e.g. national governments, government agencies, local authorities, electric utilities, and industry) are indicated as well.

Table 3: Summary of major projects, demonstration and field test programmes.

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002/problems and lessons learned	Funding	Project management	Remarks
Madurodam - the first entire city on solar power – two pictures are shown below this table **Start up of PV realisation: May 2001** **March 2002 the system was put in to use.**	Grid-connected system Total power: 3,8 kWp and 38,3 kWp Total area: 53 m2 and 319 m2 Orientation: S and SW	Madurodam is the theme park that shows the Netherlands miniaturized. The intention of this project was to be the first city which would be entirely self sufficient in its energy consumption. To show how solar power works with a demonstration wall. To use a special roof integration system: Powerguard.	Installation of a demonstration wall for the public with 40 m2 (3,8 kWp) solar modules. In this wall the words Solar City are written and seven miniature houses are created. The more energy is produced with the solar cells, the more lights in these miniature houses start burning. Next to the wall a table of solar modules explains in four languages how the solar cells work. Furthermore 319 m2 solar modules are installed on the roof of the painting studio and the production area of Madurodam. To place these modules on the flat roof of the painting studio and the production area a special roof integration system Powerguard was used. It was the first time this system was used in the Netherlands.	Madurodam BV, Energy-company ENECO, Municipality the Hague and Novem.	Energy-company ENECO	With this idea of 'Bureau Wilders', Madurodam became the first city which is entirely self supporting in it's energy needs.
Housing association St. Joseph renovates dwellings in the districts 'De Mheen' and 'Sluisoord' in Apeldoorn with 1 MWp solar	Grid-connected system Total power: 1 MWp Total area: 20 m2 at each dwelling, in total 364 dwellings Orientation: several	During the renovation of 364 dwellings housing association St Joseph wanted to use the possibilities to install solar modules when renovating the roofs.	In the districts 'De Mheen' and 'Sluisoord' 364 dwellings where renovated. When the roofs where under renovation, 20 m2 solar modules were installed at each roof. The PV systems (BP Solarex) cover the entire roof of a dwelling. With the PV systems the dwellings produce 750.000 kWh solar power, this is sufficient to comply with the energy need of the	Fiscal incentives: EPR and EPA Novem Energy-company NUON	Projectbureau MEGA PV / Lafarge	At this moment this project is the world's greatest renovation project where solar power was applied. Housing association St. Joseph made use of the very positive situation for housing associations when renovating existing dwellings. In this

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002/problems and lessons learned	Funding	Project management	Remarks
power. **Realisation in 2002 (250 kWp) and 2003 (750 kWp)** **– two pictures are shown below this table**			dwellings. Besides the solar modules a central heating boiler and a heatpump boiler where installed.			situation fiscal incentives as EPR and EPA can be used to achieve a price of a kWh solar power which is half the usual price of solar power. In spite of the rice of the rent the occupants each month gain a small amount of money with the delivery of solar energy to the energynet.

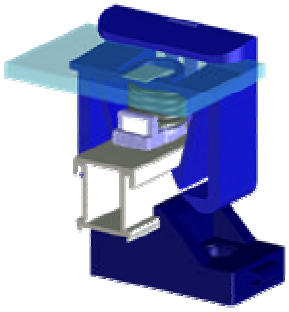
Pictures 2 and 3: Madurodam – the first Solar city in the world

Pictures 4 and 5: St. Joseph – Apeldoorn – renovation of roofs and application of solar power

2.4 Highlights of R&D

In this paragraph a brief overview of key R&D activities related to PV power systems within the Netherlands is given.

A new development in the year 2002 is a wire free PV-system. This system is developed by a consortium of ECN[3], NKF, OKE-services and Oskomera as a result of the NEO-programme of Novem[4] . With this technique the installation of solar power on roofs is much simpler and much cheaper. Because of this system it's not necessary to connect the modules with wires, it's a safe system and with fewer components a larger energy power and reliability can be gained. This PV-system is more tolerant when partly being in the shade. in the shade shady. With this application very simple installations and a reduction of system design costs with 20% can be achieved. More detailed information can be found on the website: www.pv-wirefree.nl .



Pictures 6: PV-wirefree module connector

In the field of cell research, the following developments are worth mentioning:

As a cost-effective alternative for crystalline silicon solar cells, various thin-film solar cells are under development at ECN Solar Energy. The thin-film activities are carried out within the laboratory for Thin Film PV Technology. ECN´s goal is to create conditions for a lower price. Silicium modules must have a price under EUR 1.00 per Wp in 2010. At this moment the price is EUR 3.50 per W_p. Also for the other components a lower price must be achieved. R&D activities of ECN are focussed on:

- Microcrystalline thin-film silicon by plasma-enhanced chemical vapour deposition (PECVD).
- Advanced substrates for thin-film silicon solar cells.
- Development of CIS solar cells & modules by electrochemical deposition methods and by using innovative interconnection technologies.
- Semi-automated manufacturing of large area dye-sensitised solar cells ("Grätzel" cell).
- New concepts for solar cells based on sensitised oxides (ETA solar cell).
- Polymer-based solar cells.

- A new method to produce silicium wavers has been developed by ECN. It is no longer necessary to cut slices from a silicium block. It's now possible to pour down the silicium on a line. A saving of 60% on the current cutting losses is possible with this technique. With the same return the costs are decreased half.
- In the field of thin film ECN developed a solar cell with a colouring agent on basis of titan dioxide. At this moment ECN has an operational, partially automatically baseline and is

[3] ECN is a research institute and isn't engaged in implementation projects. ECN has assignments from the government, the European Committee and companies. The research at ECN concerns: crystalline Silicium, thin film and PV-applications.

[4] NEO-programme – this programme encourages parties to search for and develop new energy techniques and applications.

searching for parties to sell this product. Because of cheaper materials thin film will be the solar cell of the future. Until 2010 this type of cell will not compete with the crystalline cells. Probably in 2020 the thin film will be determinative on the PV-market.

- ECN has, in association with Novem, organised a workshop to generate pioneering high efficiency ideas for PV. The workshop resulted in a lot of ideas. One of these ideas was to make better use of the total spectrum of the sun by upgrading less useful wavelength
- Dutch Space is manufacturer of solar arrays for spacecraft. The solar array programme ranges from telecom and science, to earth and observation applications. The experiences and achievements of Dutch Space are used in the development of PV-applications which are applied on earth so the efficiency of silicium cells can be improved. Compared to the PV-applications which stay on earth the prices of space PV-applications is sky high. At this moment one square feet PV cost a quarter of a million Euro.

- Corus Iron investigated how PV foil can be glued down to fronts and roofs.
- Several R&D investigations are done by Ecofys for parties as well in the Netherlands as abroad. One of these investigations has resulted in a network of PV-knowledge (Zenith) that pays a lot of attention to PV-applications.
- The company Poly-Duurzaam has developed a PV-system with two functions, the main goal is the production of solar power and the second goal is to collect rainwater that can be used.
- The Dutch company Davinason has been developing a new autonomous PV-application. This application is the result of a project from the municipality Tiel, the goal of this project was to gather ideas for a better a better living environment. Davinason developed a traffic sign with flashing lights which can be used to warn motorists for a pedestrian crossing. In 2003 the first systems will be placed in the municipality Tiel.

- Another positive influence for autonomous PV-applications could be the development of thin film solar cells. These cells have little weight and are very flexible. Next to that these cells are relatively cheap because for the production few Silicium is needed. Also the development of cooled PV and a combination of micro-crystalline with amorphous technology can raise the profits of autonomous PV-applications.
- Shell Solar reported that within the framework of the EET-project Sunovation R&D activities were developed in the field of mc-Si Solar power technology, alternative concepts for modules and alternative materials for modules. Besides that development activities were undertaken in the field of a new module product portfolio.

Research and development activities regarding inverters their sustainability and reliability has been carried out by Exendis. Another party, Electron, has been studying the possibilities of connecting several inverters and how to construct such an option.

2.5 Public budgets for market stimulation, demonstration/field test programmes and R&D

In table 4 the budgets from the public authorities for R&D, demonstration/field test programmes and market incentives (public subsidies, fiscal incentives, and amounts collected) on the national/federal level, and on the state/regional level are stated.

Table 4: Public budgets (in NC) for R&D, demonstration/field test programmes and market incentives.

	R & D	**Demo/ Field test**	**Market Incentives**
National/federal:			
Decision Subsidies of Energy Programs – BSE	EUR 1 662 044	EUR 182 026	EUR 377 270
Others :			
ECN	EUR 8 000 000	-	-
(EE, EC 'Fifth framework, and others)	Unknown	Unknown	Unknown
Tax:			
EIA/VAMIL	-	EIA and VAMIL; see next column	EIA and VAMIL EUR 1 500 000
EPR	-	-	EUR 4 342 573[5]
State/regional	Unknown	Unknown	Unknown
Total	**EUR 9 662 044**	**EUR 182 026**	**EUR 6 219 843**

Several tax-measures are applicable to Photovoltaic investment projects besides national subsidies. The most important regulations on this issue are EIA and VAMIL. With EIA a company that invests in renewable energy or energy saving measures can deduct a percentage (55%) of its taxable profit. This results in a real reduction of the total investment costs by almost 20%.

[5] In 2003 a part of the payments regarding projects in 2002 will be done. The budget will probably be higher then shown above because of obligations concerning the last quarter of 2002. The budget shown above is based on a subsidy of EUR 3.50 per W_p. In 2001 a total amount of EUR 2 608 602 was assumed. After all obligations concerning the last quarter of 2001 were complied with, finally this amount was EUR 8 037 831. When this given is applied to 2002 it means that the EPR contains a total amount of EUR 13 027 719.

EIA thus acts as a subsidy. VAMIL is a measure with which a company can freely determine the depreciation period of the investment, which leads to an interest benefit of approx. 6 - 7% when the investment is depreciated in 1 year (compared to 10 or 15 years). For the subsidy of Photovoltaic power projects EIA-subsidy has been applied for to the amount of approximately € 1 140 000 in 2002 (97 requests). This implies total investments of the projects that have been subsidized by EIA of approximately € 6 000 000 (equivalent to the installation of approximately 1 000 kW_p of PV-cells) in 2002. In the year 2001 a total of approximately € 15 700 000 had been subsidized by EIA, this is two and a half times more then in the year 2002. This can be explained by the fact that at the end of September 2002 EIA was frozen because of an insufficient budget. Therefore companies couldn't apply for support for PV-applications and initiatives and because of that the PV-market slowed down.

EIA and VAMIL are two separate subsidies, but VAMIL was in 2002 applicable in the majority of the cases that EIA-subsidy has been applied for as well. Hence, EIA and VAMIL result in a total extra subsidy of approximately 25 % of the investment-cost.

In 2001 a new subsidy of the "Decision Subsidies of Energy Programs" (BSE), was started by the Ministry of Economic Affairs and executed by the Dutch Enterprise for Energy and Environment (Novem). This subsidy is also available for other sustainable techniques. This subsidy has the aim to contribute to the goal of the Dutch government to generate 10% of its energy consumption from sustainable sources in 2020. Within this subsidy it is possible to realize PV-projects. In competition with other Renewable Energy options, PV does not perform well. An import aspect is the balance between the investment / PJ natural gas reduction ration. PV has a poor performance when compared to other Renewable Energy options like wind and bio-mass due to the low output and relatively high cost for production and installation.

In 2002 the "Decision Subsidies of Energy Programs" supported mainly research and development projects. This is in line with the other stimulation programs (like e.g. EPR) for application. Only genuine innovative projects (important selection criteria for DEN) in solar energy have been rewarded with subsidies. In 2002 the subsidy contains a total amount of € 2 221 340. The costs of project investments are 1.4 to 2.0 times higher than the subsidy amount. From January 1, 2001, the Dutch government has decided to introduce a new tax refund for PV in order to increase the implementation of PV systems on houses in the Netherlands. A tax refund of € 3.50/W_p is provided for each PV system installed on the house and bought by the house owner or the dweller. The tax refund for PV is incorporated in the EPR, the Energy Premium Regulation. The EPR stimulates several kinds of domestic energy saving measures like low-energy refrigerators, washing machines, high efficiency heating systems and all kinds of insulation measures. After an Energy Performance Advice (EPA) 25% extra tax refund is provided which makes a total of benefit of approximately € 4.38 per W_p PV-solar energy installed. In 2002 the EPR contains a total amount of EUR 4 342 573. This amount is paid out for existing buildings as well for newly developed buildings. In 2002 approximately 634 400 Wp was installed on new buildings and approximately 606 350 Wp was installed on existing buildings. This means that a total of 1 240 kWp was installed in 2002 with the use of EPR. In 2003 a part of the payments regarding projects in 2002 will be done. The budget will probably be higher then shown above because of obligations concerning the last quarter of 2002. The budget shown above is base on a subsidy of EUR 3,50 per W_p. In 2001 a total amount of EUR 2 608 602 was assumed. After all obligations concerning the last quarter of 2001 were complied with, finally this amount was EUR 8 037 831. When this given is applied to 2002 it means that the EPR contains a total amount of EUR 13 027 719. This should mean that a total of approximately 3 725 kWp was installed with the use of EPR in 2002.

Another programme of Novem, the so called NEO-programme encourages parties to search for and develop new energy techniques and applications. In relation to this programme the year 2002 can be called a productive year full of ideas. This programme covers nineteen different topics. At least 155 ideas for new energy research were submitted. 9% of these new ideas were related tot Solar-PV. A relevant market party or a support regulation will be searched for ideas that are tested positive within the NEO-programme.
NEO is focused on energy research without a sharp delineation in areas. Ideas must be innovative and (if possible) must be leading to an enlargement of the Dutch energy supply. In 2003 this programme will be continued.

Other budgets are regional budgets. Most provinces have budgets to stimulate municipalities and private (market-) parties to carry out projects to increase the use of sustainable energy applications like solar power. For instance, the province Noord-Holland has a budget of EUR 13.5 million and the province Zuid-Holland has a budget of EUR 2 million available until June 1, 2004. Projects must be carried out within the borders of the concerning province. Other provinces with a budget for sustainable energy are the provinces Noord-Brabant and Utrecht.

Finally, support can be obtained from private/public energy companies. These companies provide so called B-MAP-support on Photovoltaic Power projects. The MAP-support can aggregate to approximately € 1.34 per W_p installed. This subsidy will end in December 2003. For future projects in the years in 2004 and 2005 it is possible to use B-MAP support, provided that in 2003 commitment for these projects was gained.
Several energy companies (e.g. Nuon, Eneco) are planning special supportive activities for companies; these actions will be announced when the spending of B-MAP support is given.

3 Industry and growth

3.1 Production of photovoltaic cells en modules

A module manufacturer is defined as an organisation carrying out the encapsulation in the process of the production of PV modules. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only count to the Netherlands if the encapsulation takes place in that country. Some details of the production process and the share of Photovoltaic cells that have been produced outside the Netherlands have been stated in the accompanying text and in the footnotes of Table 5. In 2001 only two manufacturers were located in The Netherlands. Other companies are currently planning their market-introduction. It is expected that one company would be active on the market in 2002[6] the other will probably be active on the market before 2005.

Table 5: Production and production capacity information for 2002 for each manufacturer.

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW_p) Cell	Module	Maximum production capacity (MW_p) Cell	Module
1 Shell Solar Energy	mc-Si	900 kW_p	7 300 kW_p	Between 3 000 and 4 000 kW_p	Between 8 000 and 10 000 kW_p
2 Philips Solar Energy	Mono-crystalline Poly-crystalline Amorphous silicon	Started production in 2002 – no data available yet			
3 AKZO Nobel	Planning production still in R&D stage				
4 Logic Electronics	Starts production in 2002 – no data available yet	-	-	-	-
Thin film manufacturers					
1					
TOTALS		900	7 300	3 000 – 4 000	8 000 10 000

More information about Shell and its production of modules is given in the next paragraphs. Also the available information about Philips Solar Energy is given.

In 2002 Shell had two offices in The Netherlands. The office in Helmond has the production facilities for Photovoltaic products. The office in Amsterdam has a managerial function. Marketing and Sales take place from both offices. Details about differentiation of the production by steps of the process have not been provided.

[6] At the time of writing this report no information about Logic Electronics was available

The production of cells

100% of the modules produced in 2002 at the Dutch Solar Energy Plant of Shell has been generated with Photovoltaic cells from Shell Solar Energy. The most of the 900 kW_p Photovoltaic cells has been produced for the Dutch market. The production of Photovoltaic modules is much larger, because the Photovoltaic cells that have been produced in the production plant in Germany have been assembled into modules in The Netherlands. No Photovoltaic cells have been purchased from other parties. The total production of modules sums up to 7 300 kW_p, whereas only 900 kW_p Photovoltaic cells are actually produced by Shell Solar Energy BV in The Netherlands.

No export of Photovoltaic cells takes place to other module manufacturers, neither to international nor to national competitors.

In 2002 Philips Solar Energy entered the PV-market. Philips offers polycrystalline solar modules of 125Wp and 165Wp with conversion efficiency rates of respectively 13% and 12,7%. Lifetime is expected to be longer than 20 years in view of MTTF calculations and the durability experience of the main materials that constitute the solar module. Modules have standard Multi-Contact or Tyco connectors for an easy installation.

Characteristics of the standard and special products are indicated in the table below.

Table 6: Characteristics of standard en special products

Product	Cell Material	Typical Module Output Power Range	Type of encapsulation	Certification of modules	Length of typical warranty
Standard: Commercial modules (Shell)	mc-Si	10-115 W_p	Glass EVA Polyester-aluminium-tedlar	IEC 61215 ISO 9000 Tüv Isolation class II KEMA Certification for RSM 95 AC module	unknown
Special: explosion-safe Photovoltaic module (Shell)	mc-Si	Unknown No complementary information considering this special product has been given			
Standard: Commercial modules (Philips)	Mono-crystalline Poly-crystalline Amorphous silicon	125Wp and 165Wp	Unknown	Unknown	Lifetime is expected to be longer than 20 years in view of MTTF calculations and the durability experience of the main materials that constitute the solar module.

Shell Solar reported that within the framework of the EET-project Sunovation R&D activities were developed in the field of mc-Si Solar power technology, alternative concepts for modules and alternative materials for modules. Besides that development activities were undertaken in the field of a new module product portfolio.

In 2003 Shell Solar decided to leave The Netherlands. The production site in Helmond (and Munich) will be closed. Four other factories will stay open. The production site in Helmond is closed due to a larger supply than the demand on the PV-application market.

Other Manufacturers

At this stage one manufacturer of modules is active on the market for Photovoltaic energy in The Netherlands. Furthermore two companies are planning their introduction on the market soon (2002 - 2005). It concerns Logic Electronics and AKZO-Nobel.

Logic Electronics planned to start manufacturing PV-modules in 2002[7]. This company is located in Barneveld, employs 15 fte. and has done several feasibility-studies on the issue of Photovoltaic energy in order to introduce Logic solar systems on the Photovoltaic market. Logic is currently participating in autonomous projects mainly. Logic will become a manufacturer of multi-crystalline synthetic solar modules, with various outputs.

AKZO-Nobel has been running Research & Development programs for a couple of years now. AKZO-Nobel is planning market introduction before 2005.

A lot of production companies have a focus on certain alternatives for PV-modules, like poly and mono crystalline modules. For example Paneka only focuses on amorphous modules, but in the mean time BP rejected this type of modules. Shell Solar and Scheuten Solar have a new alternative with CIS modules. This looks alike to amorphous modules, but is inexpensive, although at this moment the profits are low.

Shell Solar has indicated that selling prices of modules produced cannot be given on an aggregated level. The selling prices are to a high extent dependent of the content of the contract with customers, the amount and characteristics of the delivery, the size of the modules and the specific characteristics of the modules. However, parties involved in the market for PV-modules indicate unanimously that prices are expected to decrease in the longer term. In table 7 module prices for a number of years are stated. This concerns the lowest market sales prices.

[7] At the time of writing this report no information about Logic Electronics was available

Table 7: Typical module prices (NC) for a number of years

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002
Price EUR/W_p	9.5	7	7.5	6	5	4.75	4.73	4.73	4.62

3.2 Manufacturers and suppliers of other components

Inverters

NKF, Solar Philips, Mastervolt and Exendis Renewable Energy, the main manufacturers of inverters located in The Netherlands, have been contacted for this inventory. NKF and Exendis Renewable Energy both produce small-sized inverters up to 0.5 kVA. The maximum production capacity is approximately 130.000 pieces per year. Mastervolt produces medium-sized inverters of approx. 3 kVA. At the time of writing this report Mastervolt and Solar Philips had not delivered us any information.

NKF shows a decrease in production of inverters and number of people who are employed. Exendis has an increasing production and more people employed in comparison with the year 2001. Both companies deliver inverters to PV-module factories and to PV-application suppliers and installation companies. The inverters from NKF and Exendis are used in both small and big PV-applications.

Looking at the market of inverters, both companies have an increasing market potential outside the Netherlands. Within the Netherlands a slight increase on the market is made. Several other manufacturers are investing in inverter production and are planning market introduction soon.

The price of inverters is shown in Table 8. Compared to the year 2001 the price increased with EUR 0.48.

Table 8: Price of inverters for grid-connected PV applications

Size of Inverter	< 0,5 KVA	<1 KVA	1-10 KVA	10-100 KVA	>100 KVA
Average Price per kVA (NC)	EUR 1,50 / W_p	-	-	-	-

It's expected that the prices of inverters will decrease in the next years and that because of that more inverters will be sold and the market potential will increase.

Information regarding business activities, trends and strategies concerning other component products[8] can't be provide, because no information is available from the approached parties. Considering the developments in the off-grid market it's expected that no significant developments and activities occurred. The PV-market is mainly focused on the on-grid PV- applications and the reduction of the cost price.

3.3 System prices

In the table 9 below an outline of the turnkey (system) prices (excluding VAT/TVA/sales tax national taxes) in National Currency per Wp for the various categories of installation has been given. These figures are average figures, because price is significantly dependent of scale, output, characteristics of the application, etc. The average price is based on the figures provided by several Dutch suppliers and installation firms. The average price is based on the system price including installation and excluding system maintenance, repairs and support.

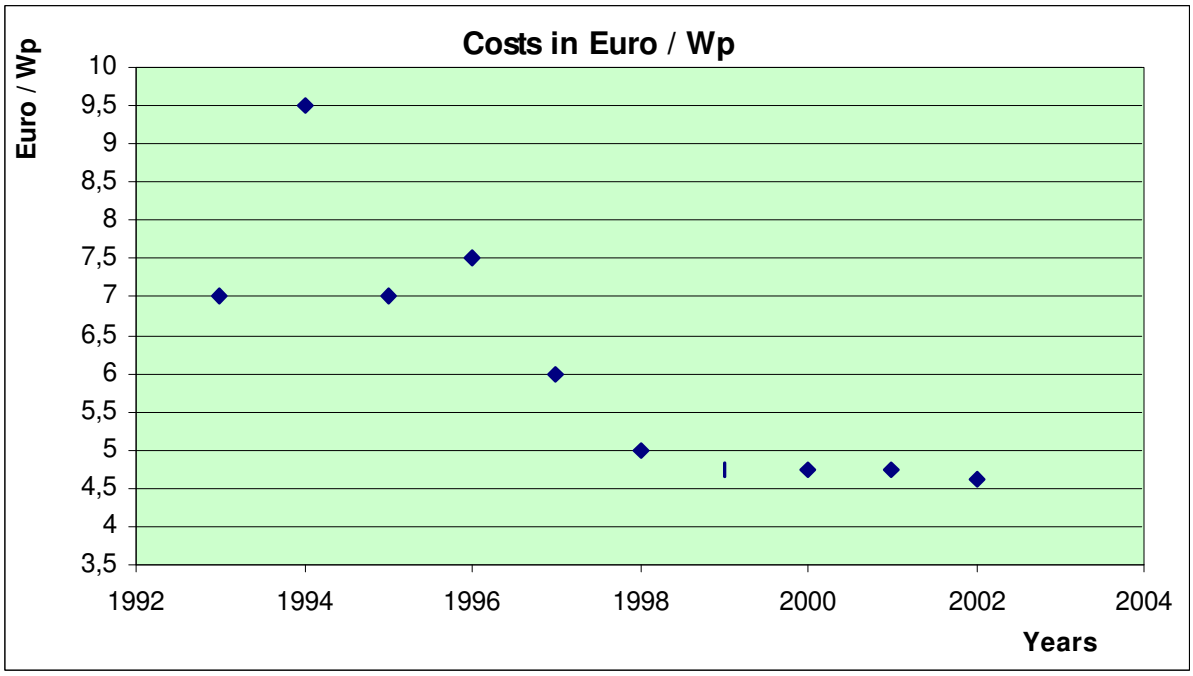
[8] • Components like: Storage batteries, Battery charge controllers, DC switchgear and Supporting structures

Table 9: Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Current prices per Wp in NC
OFF-GRID Up to 1 kWp	No information available	EUR 5.70
OFF-GRID >1 kWp	No information available	EUR 5.00
GRID-CONNECTED Specific case	1-3 kWp roof-mounted system No information available	EUR 6.04
GRID-CONNECTED Up to 10 kWp	No information available	EUR 6.16
GRID-CONNECTED >10 kWp	No information available	EUR 5.69

Regarding national trends in the turnkey prices of applications (in Table 9), it has been chosen to display general figures only, because exact insight in type and size of a majority of the applications realized in 2002, prevent distinguishing various applications and, as a result, various system prices.

In the figure below, the current trend in price development of PV-systems has been stated. The prices mentioned in this graph, concern the lowest PV-project prices per year, stated in Euro per W_p. These prices give an indication of the lowest possible prices for PV-applications in a certain year. The graph indicates a down-ward trend in the development of the price (see trend-line), but indicates that prices have almost been stabilised for the last five years as well.



The last years the prices of PV-applications decreased with an average of 7%. Because of shortage on the market the prices increased in the first months of 2002. Later on the prices dropped again. In 2003 this trend will continue because of overcapacity in the market. This is caused by newcomers on the European market because of disappointing markets in Italy, Spain and Japan.
It is expected that the prices of PV-applications will decrease (5% to 10%) in the next years, but support must be continued otherwise the prices will increase and therefore the market of PV will decrease.
The technology for poly- and mono crystalline PV is almost completely developed, but alternative technologies are not or barely available. When available these alternative technologies are expensive. It is expected that the cost price of crystalline PV will be slightly increasing and become stable in the next years. In the future the thin film technology will probably price breakthrough.

Home PV systems kits mostly contain: 4 AC-panels, the supporting structure, wires for direct current (DC), an inverter and wires for alternating current (AC). The DC-wires are used for a connection between the panels and the inverter. The inverter is placed inside the dwelling and converts direct current into alternating current. With the AC-wires and a plug the solar panels are connected electricity network. Prices are depending on the type of situation where PV is applied, such as a flat roof, front and a slanted roof. The prices vary from EUR 6.60 to EUR 8.60. Information about prices from the years 1992 until 2002 are not available.

3.3 Labour places

In the following table the labour places within the solar-energy sector are given, with small characteristics of the companies that are involved in certain areas of PV-technology and application.

Larger companies often have particular PV-divisions. The number of employees as stated in the table below, indicate the number of people who are mainly involved in PV issues.

Table 10: Employment in the PV-industry per category in 2002

Category	Type of company	Number of Employees
Research and Development	Universities and private-public research institutions	150
Manufacturing of PV system components, incl. company R&D	Both manufacturers of PV cells and modules as other applications like inverters, batteries etc. This number includes R&D of Dutch that tend to manufacture and sell PV-cells and modules in future	320
All other	Electricity companies, installation companies, consulting companies specialized in PV, local & regional authorities	200

These figures show that more people are employed in relation to PV-applications in 2002 compared by the year 2001. It is expected that this is an important trend and that the number of people working in the market for PV-applications is still increasing. When support will become less in the next years probably the smaller companies that entered the market in the last years will have a hard time.

3.4 Business value

The value of PV business in the Netherlands is estimated at a total amount of EUR 53 483 700. This amount is best on the following methodology and assumptions:

- A total of 5 817 kWp was installed in 2002. This represents a total investment of EUR 35 483 700. [9]
- A total of 200 persons are involved in areas of PV-technology for the category "All other" (see also table 10). It's assumed that every employee earns EUR 50.000 per year, this represents a total amount of EUR 10 000 000.
- Next to these amounts a R&D budget from ECN of EUR 8 000 000 is available
- Data about the exported systems isn't available.

[9] Per Wp average investment cost are EUR 6.10

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

By order of Novem a new schooling program has been started for installation companies. This schooling program focuses on transferring knowledge and on the broader application of sustainable energy-methods, among which PV-solar energy. These kinds of initiatives are creating conditions in order to obviate difficulties in the market, which should finally result in a broader application of PV-systems.

New promotional activities
Regulating Energy Tax (REB) puts taxes on conventional energy, which results in a promotion of sustainable energy. This regulation will change, the advantages and the negative side-effects will disappear and instead of the REB the new MEP-regulation will introduced. This regulation is specific and non-fiscal for stimulation of the environmental quality of the electricity production. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production.

From January 2001 onwards PV is part of Energy Premium Regulation (EPR), which is a regulation to stimulate energy saving measures and renewable energy options in dwellings. In 2003 house owners who install a PV system are entitled to obtain a premium of € 3.50/W_p. When the installation is the result of a so called Energy Performance Advice (EPA) the premium is increased with 10% (so € 3.85/W_p). These new regulation opened up a large new market segment for PV systems, i.e. existing and new dwellings.

PV is also part of a generic Renewable Energy R&D program, which started in Juni 2001. In this new Renewable Energy (RE) Program, PV proposals have to compete on aspects of innovation and size of market segment (in PJ) with other RE options for The Netherlands, like wind, bio-mass, solar thermal and so on. The focus on the reduction of PJ is not very positive for PV projects, because of the low reduction which is accomplished with this kind of projects in comparison with other RE-options like bio-mass and wind. This new program aims at the acceleration of the implementation of RE, in order to meet the Kyoto targets. This programme opened again in April 2003

Competition with other Sustainable energy resources is, based on the current available technology, is difficult. Therefore there is only a small number of research projects subsidised by NOVEM in 2002. This could lead to the situation of a slower development of the market and smaller numbers of producers in the Netherlands compared to Europe and the rest of the world.

Projectbureau MEGA-PV has developed a new financing system with Rabobank and Ecostream. With this system it is possible for private persons to get a bank- and subsidy guaranty.

Ekomation developed a special service for house owners. This service, EasySolar, takes care of the delivery, the installation and connection, the application for subsidy, the financing in advance, the system guaranty and power guaranty on the solar panels. It concerns the bigger systems with a

surface from 8.5, 17 or 25.5 m2. At www.easysolar.nl the house owner can calculate the costs by filling in some data.

Utility perception of PV
Because of the EPR regulation the ownership of the PV-systems will move to house owners and occupants. The last few years in many cases the ownership of the PV-systems stayed with the electricity company, at least for several (>10) years. Because of less support possibilities for energy companies (B-map disappears) it is uncertain which position the energy companies will have in the future regarding the stimulation of PV-systems.

With the liberalisation of the green power market (due July 2001) more green power is produced and used. Both the grey and the green power market became competitive price markets. These markets are mostly concerned about the favour of customers. Because of this PV hasn't become a marketing tool to sell green power. Green power is mostly produced with biomass, wind- and hydro-electric systems. The liberalisation isn't stimulating for solar power.

Changes in public perceptions of PV
Research has shown that the general knowledge of PV by the general public is increasing rapidly. The public is becoming more and more positive about PV and selling PV becomes easier. This is basically due to the increasing number of advertising activities of utility companies for green power. Also internet is a well known media where solar power is promoted. Solar energy is probably the best known renewable energy source.
Studies into the aesthetics of PV systems have shown that the general opinion favours integrated PV systems over non-integrated ones, and the invisible ones over the more prominent systems.

Surveys have pointed out that private owners of PV-systems generally have positive experiences with the functioning of the PV-system. Approximately 50% is planning expansion or willing to expand their PV-system in future.

The market for autonomous PV-applications does not seem to change rapidly and has been considered as stable for several years now.

Several parties indicated that the general public still must be informed about the goals, the existence and principals of solar power. The government must continue to put effort into the demand side of PV and must inform the general public to keep the attention on PV. The German solar power campaign "Solar-na-klar" [Solar – of course] was a great success. In 1999 until trough 2001 a great publication wave for solar power became the most successful government campaign in the solar power sector. In spite of a worsened economy the basis for a lasting solar power sector was created.

Because of a worsened economy the general public is reserved about buying alternative power systems.. Also the public deliberates the costs and profits of every investment. The public will be inclined to buy conventional systems. This has a negative effect on the PV-market.

Surveys on various fields of autonomous PV-application indicate a relatively large potential market for the application of PV-systems on the roofs of caravans and campers. At this moment the application of PV in the recreation sector is still small, but recent surveys indicated interest for these

applications of PV-systems. The experience of current users of PV-systems on the roofs of their caravan or camper is very positive.
Another positive influence for autonomous PV-applications could be the development of thin film solar cells. These cells have little weight and are very flexible. Next to that these cells are relatively cheap because for the production few Silicium is needed. Also the development of cooled PV and a combination of micro-crystalline with amorphous technology can raise the profits of autonomous PV-applications.

Major new projects or initiatives
For 2003 at least two major projects are planned. These projects will contribute significantly to the overall result of Photovoltaic power that will be installed in 2003. These two projects, a 500 kW_p power production system on the roof of the Oceanium at Rotterdam Zoo (Diergaarde Blijdorp) and the 351 kWp at WL Delft Hydraulics will result in a peak in the power installed so far. Another project in 2003 is the development and production of the Nuna II.

Power production system at the Oceanium
The power production system on the roof of the Oceanium, the so called Sunport Blijdorp will be the biggest solar power production system in The Netherlands within the build-up area. The system is initiated by ENECO Energie, the Municipality Rotterdam and Rotterdam Zoo. Sunport Blijdorp will produce 325 000 kWh electricity each year. This is enough to provide electricity to more than 100 households.

Pictures 5 and 6 – The Oceanium at Rotterdam Zoo

More than three thousand black en grey coloured solar panels will fill the 5 000 m2 surface of the Oceanium. The produced solar energy will be used at the Oceanium. Building of the power production system has started at the beginning of the year 2003 and at the end of the same year the system will be put into use.

The solar cells will be an eye-catcher on the ‘Stadhoudersweg’ (this is the access road from Kleinpolder (traffic interchange of state highways)) to the centre of Rotterdam. One of the goals of ENECO Energie, the municipality of Rotterdam and Rotterdam Zoo is to attract the attention of the public so that the get acquainted with this sustainable way of energy production. That’s why in the Zoo an educational programme on solar energy will be created and presented to the public of the Rotterdam Zoo.

World´s largest solar roof at WL Delft Hydraulics

While writing this report, a record-breaking photo-voltaic system with an electrical output of up to 351 kW has been completed in the Netherlands by BP Solar. The world's largest solar roof (at this moment) is accomplished by a PV-installation on an 11 000 m2 roof of a building at WL Delft Hydraulics. This is an independent international research institute dealing with water-related issues. This project demonstrates the potential of solar panels being used as a low-cost retrofit building product for commercial buildings.
The installation comprises 7272 amorphous modules mounted on an 11 000 m2 KalZip-Corus aluminium roof as part of WLD's renovation of the roof of its salt-water and fresh-water research hall.
The system will produce 230 000 kWh of electricity each year, enough for 75 households. The roof is connected to the public electrical power network. Dutch energy and water company Nuon built the solar-power roof as part of a green-electricity agreement with WL Delft Hydraulics, which buys 30% of the green electricity - a third of which is generated on site using the solar panels.

The project is said to be significant in terms of how a high-performance solar product can be easily adapted to a standard industrial-scale design at relatively low cost and without the need for special fittings or fixtures.

Mike Pitcher, BP Solar's regional manager for northern Europe, says, 'We believe this is the largest solar roof of its kind in the world, certainly the largest delivered by BP Solar over the last 20 years. The project demonstrates that solar modules can be scaled up successfully, in a reasonable time frame, using normal construction techniques.'

Nuna II

Better solar cells, an improved streamlined design and a higher weight must increase the speed of the Nuna II. The Nuna II will be faster than the Nuna, the solar car which won the World Solar Challenge in 2001.

Vegetable growing with PV

The application of PV to generate electricity within the vegetable growing industry will be profitable within a reasonable term. This is concluded from a research of TNO Delft and IMAG Wageningen. These institutes used a tomato company as an example for their research.

Other projects worth mentioning are:
- 300 kWp on a sporting complex in Wageningen in 2003;
- 600 kWp on 4 locations of the Dutch Bank in 2003;
- Energy economic new building of the NAM in Den Helder with a PV-application;
- 250 kWp at 42 dwellings and 60 kWp on a apartment house of Housing association "Nieuw wonen in Friesland" (2003);

- TNO Delft and Bear Architecten are looking for market parties to search universal applications to stimulate the use of PV on apartment houses. This experimental project is supported by Novem.
- At the Afsluitdijk (a dam) PV-applications will be installed. It concerns a test which must led to clean energy for at least 3 000 households. The department V&W has agreed with the test.

Technological developments

- At ECN an industrial technique was developed to roughen the surface of solar cells. Because of this the surface becomes less shining and smoother. More sunlight is absorbed and locked up in the cell with a higher power producing efficiency as a result. Because of the lower reflection these cells can be used in areas were less reflection is needed, for example by airports.
- BP Solar states that their so called Saturn solar cell has a efficiency of 18.3%. This is a world record on the electric return of solar cells. The electrical conductor isn't placed on the glass surface, but etched with a kind of laser technique. With this solar cell the costs of solar power are 0.70 to 0.90 euro per kWh.
- Shell increased her production capacity in Gelsenkirchen to 25 MW and at the same time they improved the return of the solar cells to 15.0%. Because of a new technique the anti-reflection coating absorbs more light, because of that more electrons are produced.
- Other important developments are the nano technology and the development of organically leds. It's expected that these technologies will have a big impact on the PV-market.
- A technique which can be a threat to PV is the fuel cell. These cells are now also used in housing constructions. In an apartment building in 's-Hertogenbosch the cells are integrated in a energy production installation in combination with heat pumps and solar collectors.
- Sustainability and reliability become more important than high efficiency. Technical aspects and developments from PV-applications are still regarded as positive and extending. It is expected that the production processes become more efficient and because of that the quality increases, the price decreases and guaranties go upwards.

Other new issues

The next paragraphs contain information providing the source data for Table 9 (Initiatives and perceptions) in the ISR. Only key facts and major new projects/initiatives/issues are described. Key matters that should be reported in the ISR are highlighted.

More and more municipalities and provinces become climate friendly. A large majority of these government departments are working on their climate policy. These activities are supported with the BANS-climate subsidy[10]. Since 2002 a national budget of EUR 37 million is available to undertake activities to reduce the emission of gasses which will reduce the green house effect. With BANS concrete projects concerning for example solar modules, biomass-installations and CO2-less public buildings are stimulated.

The REB-regulation will change, the advantages and the negative side-effects will disappear and instead of the REB the new MEP-regulation will introduced. This regulation is specific and non-fiscal for stimulation of the environmental quality of the electricity production. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production. For PV the support will be EUR 0.069 per kWh.

In 2003 a power production system (500 kWp) at the Oceanium of Rotterdam Zoo will be installed. This system can have a positive effect on the public perception and it has an educational function. It will attract the attention of the visiting public so that the get acquainted with this sustainable way of energy production. That's why in the Zoo an educational programme on solar energy will be created and presented to the public of the Rotterdam Zoo.

The contribution of domestic renewable energy sources to the Dutch energy supply is growing. Compared to 1990 the contribution of solar power showed the most increase. In 1990 0.31 GWh was produced and in 2001 the solar power production was increased more than 40 times to 13 GWh in 2001.

[10] BANS means administrative agreement new style [Bestuursakkoord Nieuwe Stijl]

4.2 Indirect policy issues

National policies affecting the use of PV Power Systems
The attention of politics regarding sustainable energy and PV-applications faded away as a result of a chance of cabinet in 2002 and this year. In the past years an environmental minister was present in the cabinet. In 2003 an Assistant Secretary will fulfil this function.
The Kyoto-protocol is still an issue of the government. But it has decided to focus on biomass and wind. PV-systems should contribute too little to the Kyoto goals. But actually a long term is necessary to compare PV-applications in support regulations with other sustainable techniques.

Another negative influence was the big variety in support regulations in 2002 and the past few years. In the past years in countries like England and Spain only one or two different regulations were used. In the Netherlands several regulations were used in the past few years. This creates instability in the PV-market.

Several parties indicated that support structures and the current policy are an obstruction for a healthy solar power market. Uncertainties about the EPR for next year and the unfair competition of energy companies because of the use of B-MAP in 2002 are creating a market which is out of balance. The possibilities for support became less positive. The situation concerning supports like EPR and EPA is uncertain. In the year 2002 the EPR was closed before the end of the year. VAMIL-support and the EINP-support were cancelled. And in 2003 the EPR is limited by a ceiling and has an increasing objective from 500 to 600 W_p.
Regulations can be changed on a daily basis, this happened in 2002 when it occurred that the EIA was frozen at the end of September because of insufficient budget. Therefore companies couldn't apply for support for PV-applications and initiatives and because of that the PV-market slowed down. Procedures for application seem to be simple but frequently the subsidies are not transparent and therefore sometimes procedures are stopped.
This must be improved and the accessibility must increase. The threshold to apply for subsidy must be lowered. This overall subsidy situation has to improve, it's necessary to have an unchanging regulation for five to ten years; this will have a positive effect on the application of PV.
An option for a better situation is a higher return supply rate in combination with the installation of a digital meter. The MEP-regulation is not easy approachable for private persons and companies. This regulation offers fewer possibilities to receive support. A possibility is to provide support in the same way as happens in Germany. There a fixed return supply rate of EUR 0.45 per kWh is given as subsidy. It is expected that this system of compensation on the middle-term will become widely accepted in Europe.

International policies affecting the use of PV Power Systems
At this moment it is not clear to what extent the European Union will obligated within the framework of the Kyoto-protocol. Perhaps certain PV-implementation systems, from for example Germany and Luxemburg will be obligated.

The development of European policy with regard to the return supply rate and an investment subsidy can have positive influence on the growth of the PV-market.

Due to world-wide liberalizing energy markets price-competition is expected. As a result of this liberalization modern conventional power plants (which have been placed in The Netherlands) and sustainable energy systems (solar- and wind-energy) have to compete on price-level with the cheapest

possibilities to produce electricity, such as nuclear power and coal, if intervention of authorities stays out. The return on investment will decrease and the relative prices of systems for the generation of sustainable energy, like PV-systems, will decrease, due to lower energy prices. This development could result in less interest in the application of PV-systems by the public and private organizations.

The introduction of favourable environmental regulations
The REB-regulation will change, the advantages and the negative side-effects will disappear and instead of the REB the new MEP-regulation will introduced. This regulation is specific and non-fiscal for stimulation of the environmental quality of the electricity production. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production.

As stated earlier in this Survey, the former BSE-regulations have partly been changed into EPR-regulations from 2001 onwards. EPR (Energy Premium Regulation) provides consumers the possibility to apply for subsidies for measures taken in order to reduce their energy-consumption or generate their energy in a sustainable way.
The department VROM[11] will be investigating the possibilities to make it possible to finance PV-projects before realisation. With the current EPR this isn't possible. Maybe this subsidy will be connected e.g. to urban renewal projects.

In 2002 the DEN-program supported R&D projects mainly. This is in line with the alternative funding (like e.g. EPR) available on the market for realisation. Only genuine innovative projects (selection criteria for DEN) in solar energy received a grant.

The energy policy does not mention PV as a separate category. More attention is given to the energy sources wind- and biomass. Without a PV policy the success of sustainable energy production using a mix of sources in undermined. Chances will be missed. The Netherlands will be taken over by other countries and the EU in the state of the technological development.

PV-systems can be installed without a permit. Installation of The application op PV-systems in housing construction has become easier. Only for monuments or protected urban and rural sights permitting will still be required.

Studies relating to externalities and hidden costs of conventional energy generation
No additional information has been found on this subject.

Taxes on pollution (e.g. carbon tax)
The Regulating Energy Tax (REB) put taxes on generating and consumption of conventional energy. Energy that has been generated in a sustainable way, such as PV, is exempted from REB. This regulation will change, the advantages and the negative side-effects will disappear and instead of the REB the new MEP-regulation will introduced. This regulation is specific and non-fiscal for stimulation of the environmental quality of the electricity production. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will

[11] VROM stands for Public housing, spatial organisation and environment

become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production. For PV the support will be EUR 0.069 per kWh.

National policies & programmes to promote use of PV in foreign non-IEA countries
SENTER provides, besides national subsidies like EIA and VAMIL, subsidies for projects abroad, executed by Dutch companies. Currently Dutch energy companies are active in various countries abroad, like South Africa and China, trying to establish sustainable projects.
Solar power is an item which reaches over the national borders and more and more parties focus on foreign countries.

4.3 Standards and codes

With the introduction of the new MEP-regulation it is not clear which demands the meters must comply with. The text of the regulation about this topic can be explained in several ways.

5 Highlights and prospects

The market for PV-systems was until 2001 still growing in The Netherlands. In 2001 the total amount of PV-systems (on-grid and off-grid) installed is estimated at 7 500 kW_p. The growth of autonomous PV-systems has been considered as relatively constant, due to a lack of data concerning autonomous systems and because no facts that could invalidate this assumption emerged during this research. The growth of grid-connected PV-applications has decreased from approx. 7 500 kW_p in 2001 to 5 770 kW_p in 2002.

Shell Solar decided to leave The Netherlands. The production site in Helmond (and Munich) will be closed. Four other factories will stay open. The production site in Helmond is closed due to a larger supply than the demand on the PV-application market. Therefore only smaller production companies are present in the Netherlands.

In the field of thin film ECN developed a solar cell with a colouring agent on basis of titan dioxide. At this moment ECN has an operational, partially automatically baseline and is searching for parties to sell this product. Because of cheaper materials thin film will be the solar cell of the future. Until 2010 this type of cell will not compete with the crystalline cells. Probably in 2020 the thin film will be determinative on the PV-market.

The amount of realised PV power is limited by the support available. When only MEP and EPR and EPA are available as support for PV the PV-market size is narrowed. It's expected that next year also project developers can use EPR. The size of the market is determined by the EPR-budget. Assumed that this budget is EUR 54 million, than EUR 18 million is available for PV and a maximum of 3 MW can be installed. This means stagnation in the development of the market. It would differ when the Dutch government would be more concerned about the MEP. It's expected that for especially smaller systems this regulation will have a negative impact and the investment possibilities will become smaller. Several smaller systems can't be combined and don't qualify for MEP because of high costs of determination of energy production.

At this moment The Dutch government doesn't obligated private persons and companies to contribute to their Kyoto goal. It is not clear how this will develop in the future. For example the municipality Harderwijk obligates project developers to install at least 4 m2 solar cells on new dwellings. Because of this obligation 125 dwellings will be supplied with at least 4 m2 PV.

Annex A – Method and accuracy of data

When preparing the ISR, it is necessary to know the accuracy of the data provided in the NSRs. Therefore a summary of the methods used to gather, process and analyse the data given in the NSR is given in this Annex. Also the accuracy of the data is estimated.

Methods used to gather, process and analyse data

This National Survey Report 2002 has been generated, using the following method:

- Parties that have been involved in this research have been identified by means of a database on PV-projects that is available at Novem. Out of this database and the internet list the most significant parties have been selected. Also the lists with parties on the internet site www.duurzame-energie.nl and the internet site www.pvportal.com are used to select parties for this research.

- Informing major parties active on the market of PV-systems, explaining the purposes of the research and emphasizing the confidentiality of the research. This letter has been sent by BECO on behalf of the Dutch Organisation of Energy and Environment (Novem), since this organisation has been the principal of this research and has a fairly objective status.

- The question list was sent to the parties involved as an attachment to the letter mentioned above. With this list as a guideline, several consultants of BECO Group BV, have called these parties in order to check whether they were willing to fill in this list. On the average parties have been contacted by telephone several times within April and May 2003, in order to remind them of completing and returning this list.

- Besides the question list, three parties [ECN, NUON and Ecofys] which are active on the market of PV-systems were interviewed to collect information.

- By handling a 'tree-structure', the inventory has been made by starting to investigate the number of cells that have been manufactured in 2002, either parties who import a specific brand of PV-systems (like BP Solar, Siemens, Kyocera etc.). Consequently, parties have been contacted who are involved in the installation or process co-ordination of various PV-projects. By means of this top-down approach double counts of projects in order to get the total amount of power installed in 2002 has been avoided as good as possible.

- At this moment 30 out of 50 parties (60% response) have given their market perspective and company information. Thirteen parties are at the time of writing this report still gathering information. The gathered information, together with overall market-information and various surveys done in 2002 on the PV-market, has resulted in this report.

- Several parties which were approached because of this research indicated that they are curious what happens with the outcome of this research and this report. They have the opinion that the gathered information is reported and that nothing else happens with the results. Because of that the response could be decreasing.

Herewith we would like to thank the companies stated in the table below, who have been willing to provide information and have contributed to the accomplishment of this survey.

Company / Organisation (in alphabetical order)	
Akzo Nobel Chemicals bv	Lafarge Dakproducten
Buro Wilders bv	Mega Pv
BP Solar	MtM
Croon	NKF Electronics
Davinason / Infrasign	NUON Internationaal / Duurzame Energie
Dutch Space	Oskomera Solar Power Solutions BV
ECN	Poly Duurzaam
Ecofys / E-concern / Ecostream / E-conergy	REMU
Electron	Scheuten Solar Systems
Eneco Energie Power Plus	Senter
Energie Service Delta BV	Shell Solar Energy BV
Essent Energie B.V.	Siemens Nederland N.V.
Exendis Renewable Energy	SolarNed
Fraxin Natuurenergie	The Sun Factory
Gramsbergen	Unica Installatietechnieken
Heijmans Stork Infratechniek BV	

Accuracy of the data

The data provided covers at least 90% of the PV-systems installed in 2002, because in a single PV-project many parties are involved.

The data provided by the companies and the administration of Novem as mentioned above covers 5 515 kW_p of the grid-connected PV-systems installed in 2002. In 90% of these projects at least one of the companies mentioned in the table above has been mentioned. This implies that the accuracy of the data is more than 90% and the error margin therefore presumably approximately 10%. This means that the expected number of PV-systems is assumed to be 5 817 $kW_p \pm 582$ kW_p, which implies a range between 5 235 kW_p and 6 399 kW_p of PV-power installed in 2002.

LITERATURE

Besides the parties that have been involved, the following articles / sources have been used in order to generate this report:

1 Site documentation from www.pde.nl, "Suppliers of grid-connected PV-applications", Suppliers of off-grid PV applications, August 2002

2 Site view, publication about the world's largest roof renovation project with solar cells, St. Joseph – Apeldoorn, www.dakmeester.nl/nieuws_01.htm and http://www.sja.nl/SJAktueel%20september%202002/4-1.html

3 Journal BG&W, issue 4, 2002, article "Housing association St. Joseph achieves 1 MWp [Corporatie Apeldoorn realiseert 1 MWp].

4 Site view, publication about power production system on the roof of the Oceanium, www.gw.rotterdam.nl/content/nieuws/cont_nieuws.asp.

5 Site view, publication about autonomous PV-applications, www.duurzame-energie.nl/zelf/consumenten/vt_standvzaken.html.

6 Site view, publication Company in Tiel develops solar powered road sign [Tiels bedrijf ontwikkelt verkeersbord op zonne-energie], www.energiewereld.nl

7 Journal "Nieuwsblad Stromen" issue 21, November 29 2002, "New, wire free solar power system [Nieuw: 'draadloos'zonnestroomsysteem]

8 Journal "Nieuwsblad Stromen" issue 5, March 2003, " More municipalities in the province Noord-Holland become climate friendly [Meer Noord-Hollandse gemeenten klimaatvriendelijk]

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10 Journal "Duurzaam Bouwen" issue February 2003, "PV-factory closing" [PV-fabriek dicht]

11 Journal "Energieconsulent" issue 4, May 2003, "BP establishes a PV-cell world record" [BP vestigt PV-cel wereldrecord]]

12 Journal "Energieconsulent" issue 1, January/February 2003, "Regulation green energy not final yet" [Regeling groene energie nog niet definitief]

13 Interview with mr. M. van Schalkwijk, May 15, 2003

14 Interview with mr. Wijers of ECN, May 26, 2003

15 Interview with mr. H.J. Marsman of NUON, May 26, 2003

16 Site views about realisation of 351 kWp at the installation on a building at WL Delft Hydraulics, http://www.bsee.co.uk/news/fullstory.php/aid/2302/Photo-voltaics_just_got_bigger.html and http://www.engineeringtalk.com/news/bso/bso102.html

17 Site view about Solar Philips Energy, www.solar.philips.com

18 Journal "Duurzaam Bouwen" issue February 2003, "PV on the dam" [PV op de afsluitdijk]

19 Journal "Energieconsulent" "Domestic sustainable energy contribution slowly increasing" [Aandeel binnenlands duurzaam groeit langzaam].

20 Journal "Energieconsulent" issue nr. 2 March 2003, "Fuel cells penetrate the housing construction" [Brandstofcellen dringen door in woningbouw]

21 Journal "Intech", issue September 2002, "Solar energy more or less obliged in Harderwijk" [Zonne-energie 'min of meer' verplicht in Harderwijk]