4. JAPAN 197

4.1 OBJECTIVES, STRATEGIES AND INCENTIVES CONTAINED IN NATIONAL PROGRAMMES AND ACTIONS 197

4.1.1 Objectives 197

4.1.2 Strategies 197

4.1.3 Funding and Incentives 201

4.2 OVERVIEW OF THE JAPANESE PV INDUSTRY 202

4.2.1 The Japanese Manufacturing Industry 205

4.3 MARKET OVERVIEW FOR MAIN APPLICATION SEGMENTS 207

4.3.1 Large and medium size PV power plants 207

4.3.1.1 Capacity installed 1980-1994 207

4.3.2 Grid-connected small-scale applications: Rooftops 211

4.3.2.1 Capacity installed 1980-1994 211

4.3.2.2 Grid-connected small-scale applications (rooftops) todays potential demand 212

4.3.2.3 Grid-connected diffused applications (rooftops) Japanese market forecast for year 2010 216

Table 4.1 - Total budget for the Japanese Solar Energy Program (1974-1989) 201

Table 4.2 - Number of producers and production lines for PV technology 202

Table 4.3 - Market trends, growth rates and market shares of the Japanese PV industry 203

Table 4.4 - Overview of main Japanese PV producers per technology 205

Table 4.5 - Estimated trends in market shares of main Japanese PV producers 206

Table 4.6 - Large-medium size PV power plants: capacity started-up per year in Japan (1982-1994) 207

Table 4.7 - List of main Large-Medium size PV power plant installed in Japan (1982-1994) 207

Table 4.8 - Capacity of large-medium size PV power plants installed in Japan as share of same type total world capacity 209

Table 4.9 - Large-medium size PV power plants: cumulative capacity per year in Japan (1982-1994) 210

Table 4.10 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan (1989-1994) 211

Table 4.11 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan as share of same type total world capacity 212

Table 4.12 - Estimate of Available Net Solar rooftop surfaces in Japan (1992) 213

Table 4.13- Estimated available net solar rooftops surface per capita in 1992 and 1990 213

Table 4.14 - Installable PV Rooftops Capacity in 1990 in Japan 214

Table 4.15 - Todays potential PV Rooftop share as compared to Final Electricity Consumption in Japan 214

Table 4.16 - Forecast of available net solar rooftop surfaces in Japan for year 2010 216

Table 4.17 - Forecast of Installable PV rooftop Capacity in 2010 in Japan 216

Table 4.18- Forecasted potential PV Rooftop energy contribution share in Japan as compared to Final Electricity Consumption for year 2010 216

Figure 4.1 - Distribution of number of Japanese PV manufacturers per technology (1994) 202

Figure 4.2 - Distribution of production capacity of Japanese PV manufacturers per technology (1994) 203

Figure 4.3 - Distribution of world market shares among Japanese PV manufacturers per technology (1994) 204

Figure 4.4 - Estimated world market shares of major Japanese PV suppliers (1994) 206

Figure 4.5 - Large-Medium size PV power plant capacity started-up per year in Japan in comparison with same type total world capacity (1982-1994) 208

Figure 4.6 - Large-Medium size PV power plants cumulative capacity installed in Japan in comparison with same type total world capacity (1982-1994) 210

Figure 4.7 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan per year in comparison with same type total world capacity (1989-1994) 211

Figure 4.8 - Cumulative capacity of grid-connected small-scale PV applications (rooftops) installed in Japan in comparison with same type total world capacity (1989-1994) 212

Figure 4.9 - Comparison between PV rooftop potential, final electricity consumption and hydropower share in Japan (year 1990) 215

Figure 4.10 - Comparison between PV rooftop potential energy contribution, final electricity consumption and hydropower share in Japan (year 2010 forecast) 217

1.
2.
3.

4. JAPAN

4.1 OBJECTIVES, STRATEGIES AND INCENTIVES CONTAINED IN NATIONAL PROGRAMMES AND ACTIONS

4.1.1 Objectives

The Japanese support programme for PV technology aims to reach cost levels able to compete with current commercial costs of the bulk power market and with electric utilities. The Japanese Ministry of International Trade and Industry (MITI) support these actions in the field of PV technology development taking into consideration also the outcomes of the world global environmental protection policy issues discussed and agreed at the end of the 1980s at the UNCED and at the Rio Conference on Environment in 1992. From the viewpoint of environmental protection, new energies such as photovoltaic systems are considered the most Earth Friendly energy resources.

The Governmental Committee on Energy and Environmental Technology Development has proposed therefor the establishment of the "**New Sunshine" programme**, which defines objectives and strategies for technology development policies for new energy, energy conservation and environmental protection. The development of solar energy technologies is one of major concerns from the viewpoint of both environmental protection and new energy development policies.

4.1.2 Strategies

The Japanese Sunshine Program is a long-term project scheduled to run from 1974 to year 2000. Its goals are to favour the development of sufficient alternative energy sources to supply a considerable portion of the Japanese total energy needs by year 2000. As regards specifically PV technology, the principal objectives are to continue PV material and cell development and to stimulate PV market expansion so that large-scale production benefits can be exploited.

The interim evaluation of research and development activities on photovoltaic power generation under the Sunshine Program[1] is carried out by a Policy Technological Subcommittee every four years, where results are evaluated and new targets are set for development during the next term. The last interim evaluation related to years 1989-1992 was the third one. As already during the preceding 4-year periods, priorities have been assigned to the following two major R&D issues:

- the development of manufacturing technologies for solar PV cells;
- PV system technology development.

Since during the previous 4-year period, both subjects basically achieved the foreseen target levels, the new targets for year 1996 aim towards technological developments able to realise PV power generation costs which within year 2000 will be competitive with the current power rate paid by Japanese households. The following provides an outline of the new targets.

On the base of the current R&D situation:

1. *Development of solar cell fabrication technologies:*

   * Studies on practical application of advanced solar cell fabrication technologies

     As regards the crystalline solar cell, the thin-layer cell and block-layer cell have developed, both are expected to realise drastic improvements in efficiency and substrate cost.

   * Development of technology for manufacturing amorphous solar cells

     Amorphous solar cells present marked economic advantages through their mass-production capability and due to their low consumption of silicon. On the other hand, this technology presents the disadvantages of lower conversion efficiency as a power supply source and its known photo-degradation tendency. To solve these problems, Japanese research concentrates on the enhancement of several technological elements including the development of high quality production, large surface area production and high reliability production technology.

   * Development of technologies for super-high efficiency solar cells

     Aiming at the widening of application fields after year 2000 on the basis of expected drastic improvements in efficiency, the research and development of super-high efficiency solar PV cell focuses on new materials and new manufacturing processes.

   * Research and development of solar cell evaluation system

     A method to evaluate performance and reliability of solar cells was developed, to improve the accuracy of evaluation.

2. *Technological development of photovoltaic power generation systems*

   * **R&D of peripheral technologies (BOS = Balance of System components):**

     Since year 1985, the performance improvement and cost reduction of inverters and storage batteries has been conducted according to a two step schedule. Furthermore, an investigation of effective measures and technological issues related to utility grid interfacing techniques of small scale dispersed PV systems was carried out during the period from year 1986 to 1991

   * **R&D of evaluation technologies for photovoltaic power generation system**

     The study group has been continuing the investigation of a standard test and evaluation method for the correct understanding of performance of peripheral equipment (BOS components) which differ depending on application, The research and development of a system evaluation technology for the establishment of design procedures has been conducting to improve total efficiency of PV systems and to realise an optimum system design method.

- **R&D of application system of photovoltaic power generation**

  During the past four years, the validation study of eight stand-alone systems was performed to establish the basic technology for practical application. The demonstration test facilities now continue their operations as practical installations.

- **Study of photovoltaic power generation systems**

  Aiming at the introduction of photovoltaic power generation system to isolated island, the validation operating study is continuing to establish the optimum operation, control technology, and optimisation system structure of a system using PV power generation as the main power source and diesel power generation as a subsidiary power source (hybrid system for remote islands).

3. *Electric power cost at the current state of research*

   The anticipated technology level achieved by the end of year 1992 in the Sunshine Program realises that the minimum electric power cost will not be lower than 40 yen/kWh (0,33 ECU/kWh) at a scale of 100 MWp/year mass-production. The basic assumptions which lead to this estimate are:

- Production scale: Approx. 100 MWp/year
- PV module efficiency: Approx. 15%
- PV system utilisation: Approx. 12%
- PV cell cost: Approx. 330 yen/Wp
- Peripheral (BOS) costs: Approx. 120 yen/Wp

Research and development executed under the Sunshine Program have shown steady achievements. In the future, however, it will be necessary to promote the formulation of concrete targets and schedules focusing on cost reductions and aiming at full-scale industrial introduction of developed technologies. A two step development plan is envisaged for the purpose:

1. *Medium to short term targets within year 2000:*

- to develop PV technology as to realise a PV power cost, which is competitive with the present household power rate;

- Further advancement of solar cell fabrication technology development, specifically:
  - **polycrystalline silicon**: advanced solar cell fabrication technology developments shall allow to reduce the cost of substrates and the final cell/module, while maintaining the present level of cell/module efficiencies;
  - **amorphous silicon**: technology development shall aim to reduce photo-degradation and to increase the efficiency level after degradation. Furthermore technology developments shall address PV module integration with building materials and large area cells to reduce module costs. In addition, high speed film formation techniques shall be developed to realise an effective mass-production process.

- **CdTe solar cell**: technology development aims to enlarge the PV module area and to develop high speed application patterning.

* further advancement of photovoltaic power generation system development
  - Simplification of peripheral (BOS) units shall be carried out, which includes the improvement of the total system efficiency, development of multi-functional units, and standardisation. Furthermore, through the technological development of a composite solar cell module integrated with building materials, the promotion toward the full scale use of PV systems in housing shall be performed as a functional building material and housing design.
  - To expand the fields of PV applications, optimised design procedures shall be developed, including the analysis of how to adapt to power variations due to incoming sunshine fluctuation. Further areas of investigation are identification of PV characteristics and reliable PV power supply systems, under widely different conditions and various types of photovoltaic power generation systems.

2. *Long term targets after year 2010*

* Technology developments shall be aimed **to reduce PV power costs** that far, that it can be adopted as a standard component of electric utility power generation facilities.
* Further advancement of **PV cell fabrication technology** development:
  - High quality technology development shall be continued for thin layer polycrystalline silicon solar cells and $CuInSe_2$ solar cells, which are expected to reach an efficiency of around 20%.
  - Development work aiming at the drastic improvement of conversion efficiencies (30 - 40%) shall focus on the single crystal silicon solar cell and compound semiconductor solar cell (III-V group).
  - In addition, new cells such as the organic semiconductor solar cell, which present materials and structure completely different from conventional cells, shall also be subjected to feasibility investigation.

* further advancement of **PV power generation system development**
  - Studies on the technological issues regarding different applications of PV power generation systems (for buildings or for urban integration) and the scale enlargement of power generation (oceans, deserts, universe environment) shall be started.
  - For the accelerated future market deployment of PV power generation, relevant organisations have started to prepare support actions to promote public awareness towards PV technology, and the preparation of a series of industrial systems, adding to the existing research and development work.

4.1.3 Funding and Incentives

The total budget[2] for the Japanese solar energy program is shown in the following table 4.1.

Table 4.1 - Total budget for the Japanese Solar Energy Program (1974-1989)

Year	*Total Amount (Mio US$)*	*of which for PV*	
		(Mio US$)	*%*
1974	6,7	1,0	14,9%
1975	6,7	1,7	25,4%
1976	5,8	2,3	39,7%
1977	8,7	1,7	19,5%
1978	11,6	5,8	50,0%
1979	25,2	5,8	23,0%
1980	63,5	13,5	21,3%
1981	53,9	40,4	75,0%
1982	54,9	41,4	75,4%
1983	54,9	40,4	73,6%
1984	55,8	52,9	94,8%
1985	57,8	54,9	95,0%
1986	55,8	53,9	96,6%
1987	50,1	47,2	94,2%
1988	48,1	45,2	94,0%
1989	43,3	41,4	95,6%
TOTAL	**602,8**	**449,5**	**74,6%**

- *Subsidy Program for Residential PV Systems*

  In 1994 MITI has launched a subsidy program for grid-connected residential PV system applications. Each private house-owner is obliged to report performance and operation data to the New Energy Foundation (NEF) for three years. The budget for 1994 accounts for 20 million US$. This program refers to applications under the following conditions:

  - the PV system must be installed at the applicants own house;
  - the PV system should be grid-connected;
  - the applicant must enter a reverse flow agreement with his utility;
  - the subsidy covers the costs of PV modules, peripheral (BOS) equipment, distribution line and installation;
  - the maximum subsidy amount is 50% of the system cost or 9.000 US$/kWp (max. 5 kWp).

4.2 OVERVIEW OF THE JAPANESE PV INDUSTRY

Table 4.2 - Number of producers and production lines for PV technology

Technology	*Manufacturing Facilities*	
	number	*capacity*
Crystall. silicon	9	10,2
Ribbon	1	-
A-Si	5	14,0
CdTe	1	1,0
CIS		-
Other	4	-
TOTAL PRODUCTION LINES	**20**	**25,2**
Only modules assembly	4	-
TOTAL PRODUCERS	**21**	

Figure 4.1 - Distribution of number of Japanese PV manufacturers per technology (1994)

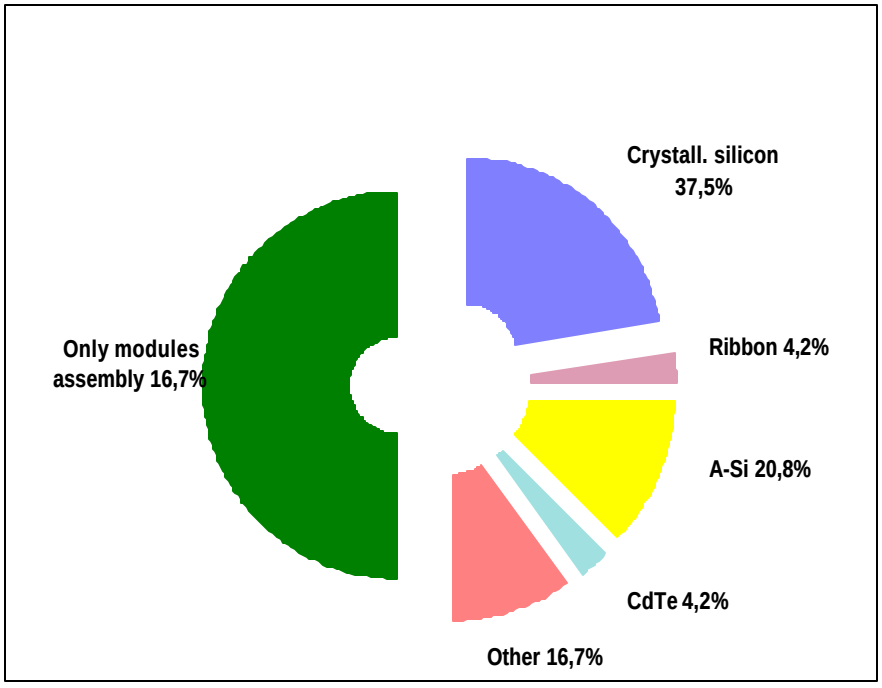


Figure 4.2 - Distribution of production capacity of Japanese PV manufacturers per technology (1994)

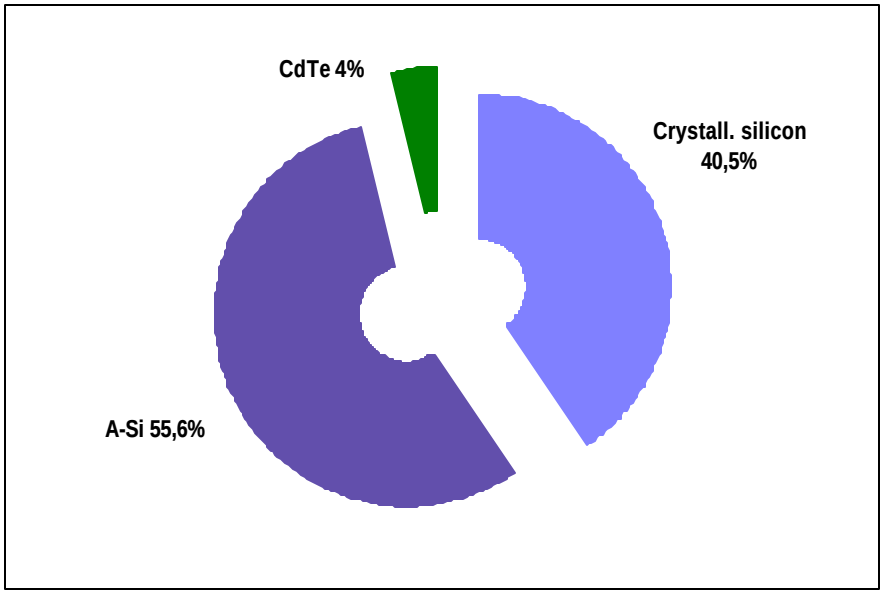
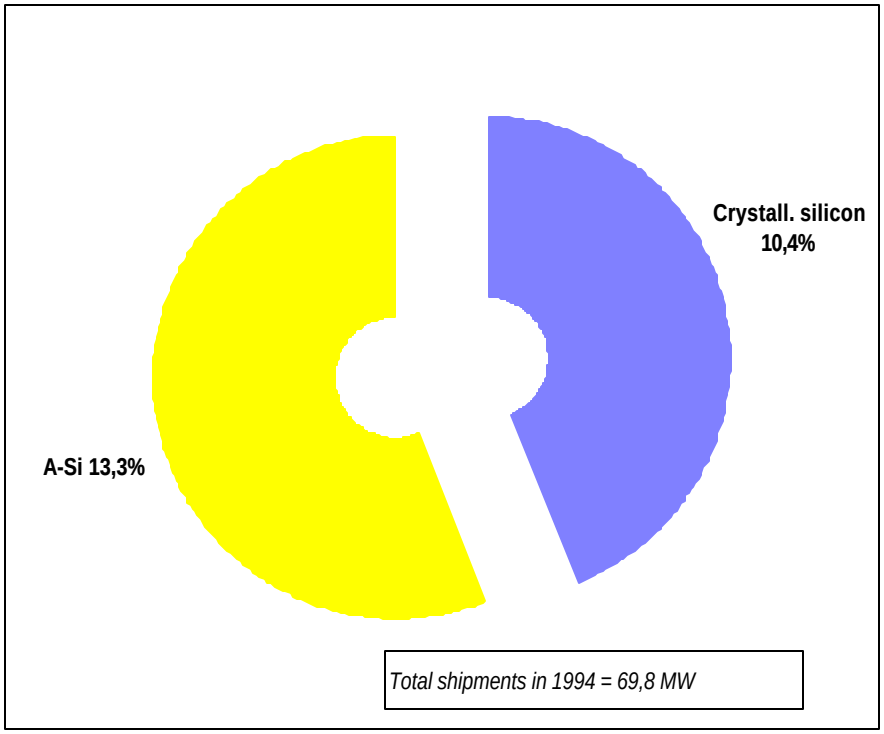


Table 4.3 - Market trends, growth rates and market shares of the Japanese PV industry

PERIOD	*SHIPMENTS*			*MARKET SHARE*
	Total	*Annual growth*		%
	kWp	*kWp*	*%*	
1987	10.950			39,4%
1987- 1988	10.800	-150	-1,4%	31,9%
1988- 1989	15.100	4.300	39,8%	36,9%
1989- 1990	17.700	2.600	17,2%	36,8%
1990- 1991	18.500	800	4,5%	34,7%
1991- 1992	17.300	-1.200	-6,5%	30,5%
1992- 1993	16.900	-400	-2,3%	27,6%
1993- 1994	16.500	-400	-2,4%	23,6%
AVERAGE PERIOD VALUES			**8,6%**	**31,6%**

Figure 4.3 - Distribution of world market shares among Japanese PV manufacturers per technology (1994)



Note: Given percentages do not sum up to 100% since the world market shares of only Japanese manufacturers are presented

4.2.1 The Japanese Manufacturing Industry

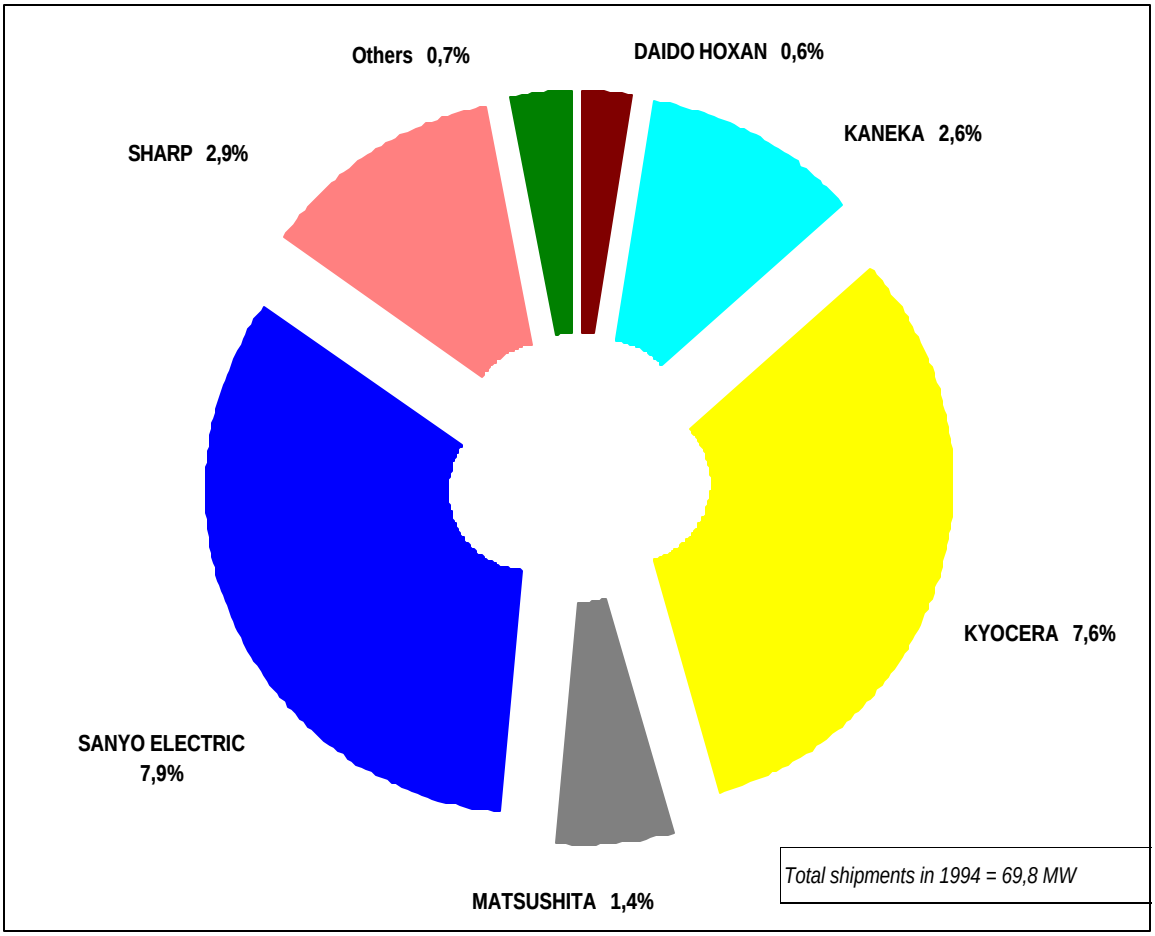
Table 4.4 - Overview of main Japanese PV producers per technology

PRODUCER	*CELLS AND MODULES*						*Only module assembly*	*Capacity 1994*
	Crystall. silicon	*Ribbon*	*A-Si*	*CdTe*	*CIS*	*Other*		*(in MWp/yr)*
DAIDO HOXAN	*							1,0
		*						
HITACHI	*							
KANEKA			*					4,0
KOMATSU	*							
KURIMOTO	*							
KYOCERA	*							7,0
			*					2,0
M. SETEK	*							
MATSUSHITA				*				1,0
MITSUBISHI	*					*		
MSK							*	
SANYO ELECTRIC	*							0,2
			*					6,0
SHARP	*							2,0
						*		
SHOWA SOLAR			*					1,0
SUMITOMO						*		
TAIYO YUDEN			*					1,0
TONEN						*		
TOTAL	**9**	**1**	**5**	**1**		**4**	**1**	**25,2**

Table 4.5 - Estimated trends in market shares of main Japanese PV producers

PRODUCER	*ESTIMATED MARKET SHARE*								
	1987	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*total*
DAIDO HOXAN	5,4%	2,4%	2,4%	1,7%	1,5%	1,1%	0,7%	0,6%	1,6%
KANEKA	5,9%	6,5%	5,9%	5,2%	3,0%	2,8%	2,8%	2,6%	3,9%
KOMATSU				0,2%	0,2%	0,2%	0,2%		0,1%
KYOCERA	5,0%	4,7%	6,6%	9,4%	11,4%	8,8%	7,8%	7,6%	8,0%
MATSUSHITA				1,2%	0,8%	1,1%	1,0%	1,4%	0,8%
SANYO ELECTRIC	11,8%	8,6%	11,7%	10,2%	11,3%	11,5%	10,1%	7,9%	10,2%
SHARP	1,8%	1,5%	1,0%	0,8%	1,1%	1,2%	1,6%	2,9%	1,6%
SHOWA SOLAR	2,5%	2,4%	3,4%	3,1%	2,3%	1,9%	1,6%		2,0%
TAIYO YUDEN	4,3%	3,8%	3,7%	3,3%	2,1%	1,6%	1,5%		2,2%
Others	2,5%	2,1%	2,2%	1,7%	1,1%	0,4%	0,3%	0,7%	1,2%
TOTAL	**39,2%**	**31,9%**	**36,9%**	**36,8%**	**34,7%**	**30,5%**	**27,6%**	**23,6%**	**31,6%**

Figure 4.4 - Estimated world market shares of major Japanese PV suppliers (1994)



4.3 MARKET OVERVIEW FOR MAIN APPLICATION SEGMENTS

4.3.1 Large and medium size PV power plants

4.3.1.1 Capacity installed 1980-1994

The total Large-medium size PV power plant capacity[3] installed in Japan is presented in table 4.6.

Table 4.6 - Large-medium size PV power plants: capacity started-up per year in Japan (1982-1994)

Year	*INSTALLED PEAK POWER (in kWp) PER YEAR*
1982	
1983	
1984	
1985	1.250
1986	
1987	
1988	
1989	
1990	
1991	
1992	
1993	
1994	500
TOTAL	**1.750**

Table 4.7 - List of main Large-Medium size PV power plant installed in Japan (1982-1994)

PLANT	*POWER INSTALLED (kWp)*	*YEAR*
1 MW PV Saijo Plant	1.250	1985
Rokko Island PV Test Centre	500	1994
Okinawa elect. utility	700	1995
TOTAL	**1.750**	

Figure 4.5 - Large-Medium size PV power plant capacity started-up per year in Japan in comparison with same type total world capacity (1982-1994)

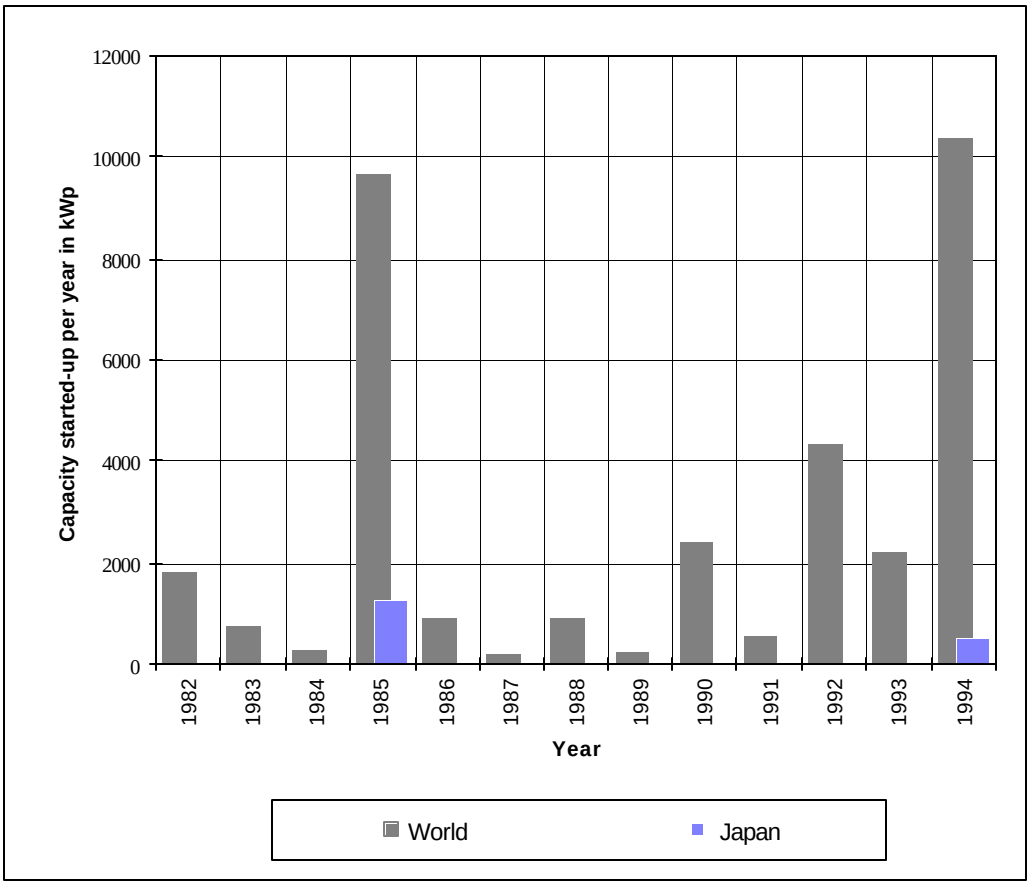


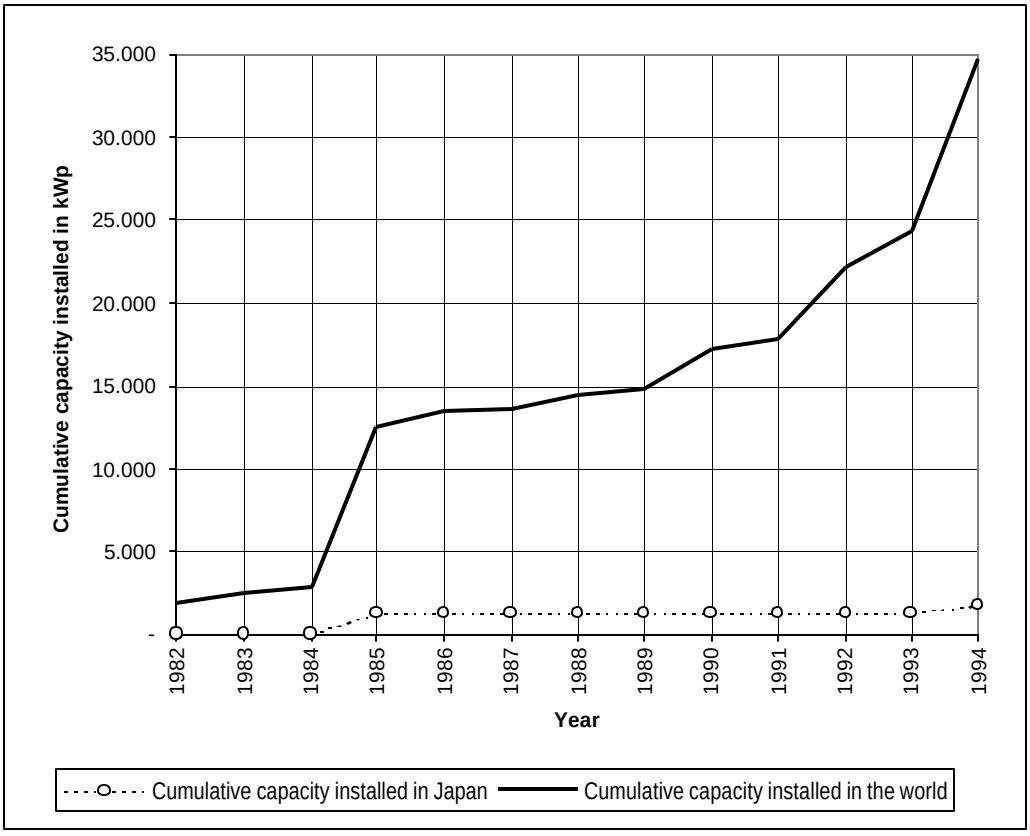
Table 4.8 - Capacity of large-medium size PV power plants installed in Japan as share of same type total world capacity

Year	*% of installed world capacity*	
	per year	*cumulative*
1982		
1983		
1984		
1985	13%	10%
1986		9%
1987		9%
1988		9%
1989		8%
1990		7%
1991		7%
1992		6%
1993		5%
1994	5%	5%

Table 4.9 - Large-medium size PV power plants: cumulative capacity per year in Japan (1982-1994)

Year	*CUMULATIVE INSTALLED PEAK POWER (in kWp)*
1982	
1983	
1984	
1985	1.250
1986	1.250
1987	1.250
1988	1.250
1989	1.250
1990	1.250
1991	1.250
1992	1.250
1993	1.250
1994	1.750

Figure 4.6 - Large-Medium size PV power plants cumulative capacity installed in Japan in comparison with same type total world capacity (1982-1994)



4.3.2 Grid-connected small-scale applications: Rooftops

4.3.2.1 Capacity installed 1980-1994

Table 4.10 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan (1989-1994)

Country	*CAPACITY INSTALLED (in kWp) PER YEAR*					
	1989	*1990*	*1991*	*1992*	*1993*	*1994*
Japan						2.100
TOTAL						**2.100**

Figure 4.7 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan per year in comparison with same type total world capacity (1989-1994)

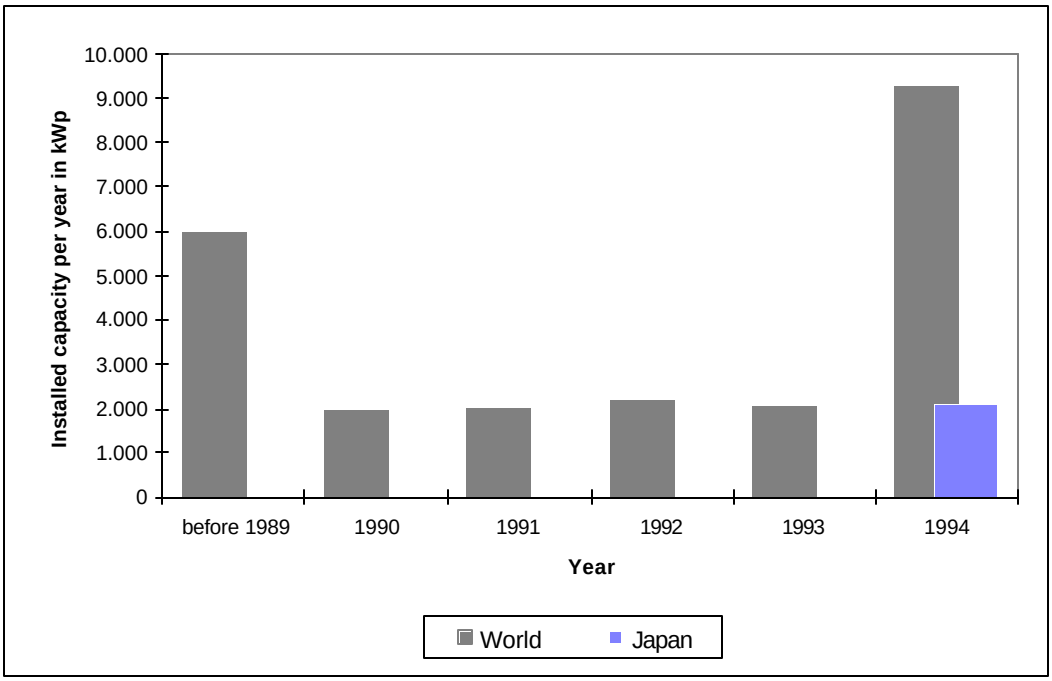
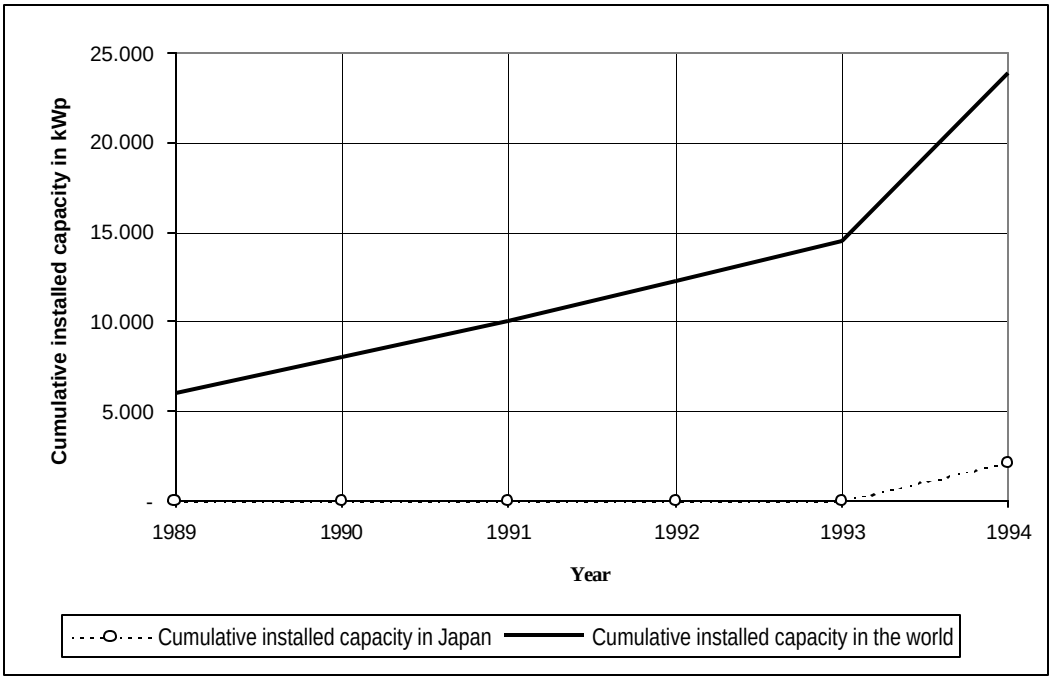


Table 4.11 - Capacity of grid-connected small-scale PV applications (rooftops) installed in Japan as share of same type total world capacity

Year	*% of world installed world capacity*	
	per year	*cumulative*
1989		
1990		
1991		
1992		
1993		
1994	22%	9%

Figure 4.8 - Cumulative capacity of grid-connected small-scale PV applications (rooftops) installed in Japan in comparison with same type total world capacity (1989-1994)



4.3.2.2 Grid-connected small-scale applications (rooftops) todays potential demand

The parameters adopted for the estimate calculations of the PV rooftop potential in Japan are presented by the following table 4.12.

Table 4.12 - Estimate of Available Net Solar rooftop surfaces in Japan (1992)

Countries	Irradiation	Net Available Solar Surface			
		houses	offices & services buildings	industrial buildings	TOTAL 1992
	kWh/ m2 year	km2	km2	km2	km2
Japan	1.300	486	289	264	1.039

The following table 4.13 gives instead the figures per inhabitant for available solar rooftop surfaces for year 1992 and interpolation results for year 1990 (required for further extrapolation calculations).

It must be emphasized, that **calculations do not take into consideration** that a consistent part of the available solar rooftop surfaces will be used for **concurrent thermal solar applications**, which obviously will have to be subtracted from the quantified rooftop surface potential.

Table 4.13- Estimated available net solar rooftops surface per capita in 1992 and 1990

Countries	Available net Solar surface pro capita					
	houses	offices & services buildings	industrial buildings	TOTAL 1992		TOTAL 1990
	m2/ inhabitant	m2/ inhabitant	m2/ inhabitant	km2	m2/ inhabitant	km2
Japan	3,9	2,3	2,1	1.039	8,3	1.031

According to the above mentioned assumptions (see for further details same PV rooftop potential calculation for whole world), the present (1990) potential for grid-connected (distributed) small-scale PV (rooftop) capacities has been calculated **for Japan** to be roughly **129.000 MWp (~ 1.000 Wp/inhabitant)** of installed PV capacity, whereas the producible PV energy has resulted to be roughly **117 TWh/year (~ 950 kWh/year per inhabitant)**.

Table 4.14 - Installable PV Rooftops Capacity in 1990 in Japan

Countries	Installable PV Capacity 1990		Producible PV Energy 1990	
	MWp	Wp/ inhabitant	MWh/year	kWh/year inhabitant
Japan	128.874	1.035	117.274.934	949

On the basis of the above results, the producible PV rooftop electric energy has then been compared with the overall final electricity consumption in Japan, to quantify the share of overall consumptions, which can be covered by PV rooftop power.

Table 4.15 - Todays potential PV Rooftop share as compared to Final Electricity Consumption in Japan

Countries	Final Consumption of Electricity 1990		PV Rooftop Potential Energy Share [*] 1990	Actual Hydro Energy Share [*] 1990
	MWh/year	kWh/year inhabitant	%	%
Japan	857.273.000	6.939	13,7%	11,5%

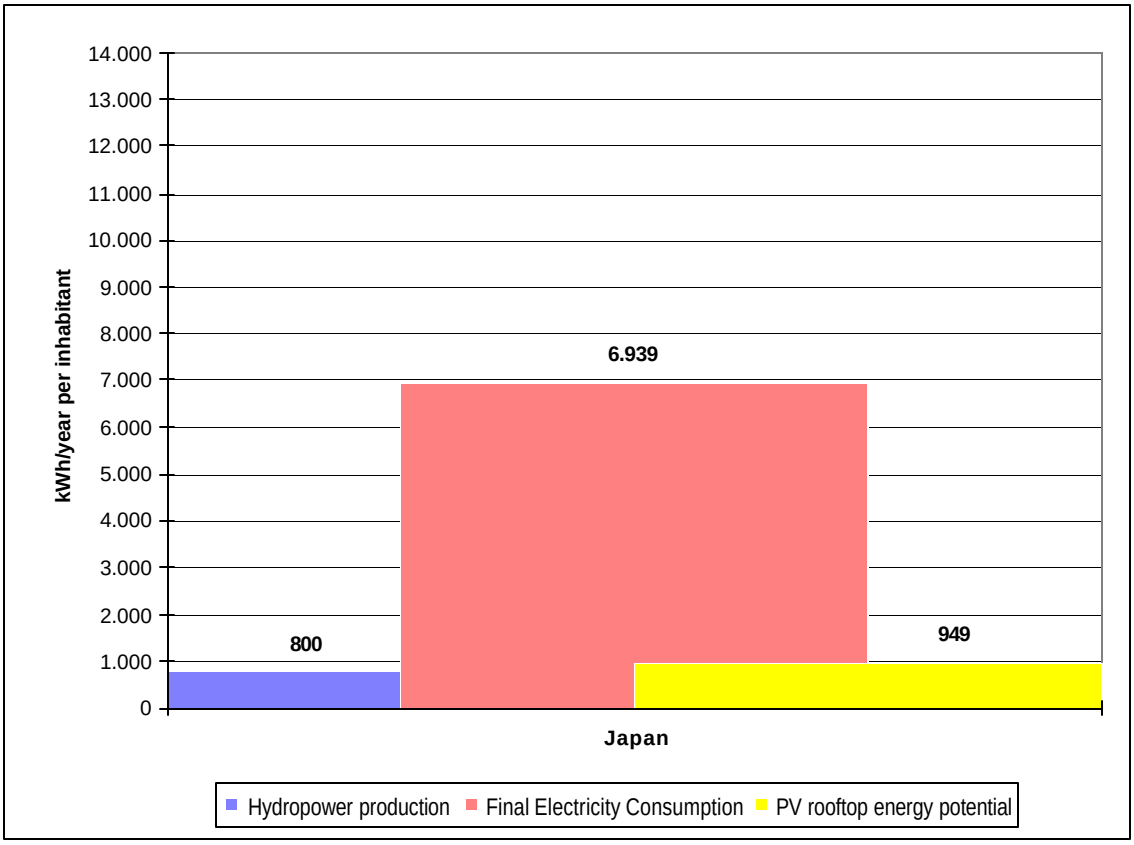
[*] as compared to total final electricity consumption

In JAPAN, the 1990 potential contribution of PV rooftop power would be roughly 950 kWh/year per inhabitant equalling nearly 14% of Japanese final electricity consumptions.

Table 4.15 and related figure 4.9 show in addition a comparison with the present **hydropower contribution** to electricity consumption. The purpose of this comparison is to provide a rough quantification means for the maximum Solar PV power contribution, which the utility network would be able to absorb without need for significant changes in present network management techniques (for more details see corresponding chapter for whole world potential calculation).

Actually, since the hydropower energy contribution share in Japan is smaller than the corresponding potential PV rooftop share, changes in the present utility network management system might be required to cope with a significant PV contribution.

Figure 4.9 - Comparison between PV rooftop potential, final electricity consumption and hydropower share in Japan (year 1990)



4.3.2.3 Grid-connected diffused applications (rooftops) Japanese market forecast for year 2010

The potential market forecast for year 2010 specifically for grid-connected small-scale PV systems (rooftops and similar) has been extrapolated for Japan following same assumptions and procedures as presented in the corresponding chapter for the whole world potential calculation.

The following Tables 4.16, 4.17 and 4.18 as well as figure 4.10 produce a synthetic overview of results for Japan.

Table 4.16 - Forecast of available net solar rooftop surfaces in Japan for year 2010

Countries	*Available net Solar surface year 2010*	
	TOTAL *km2*	*per capita* *m2/ inhabitant*
Japan	1.050	8,3

Table 4.17 - Forecast of Installable PV rooftop Capacity in 2010 in Japan

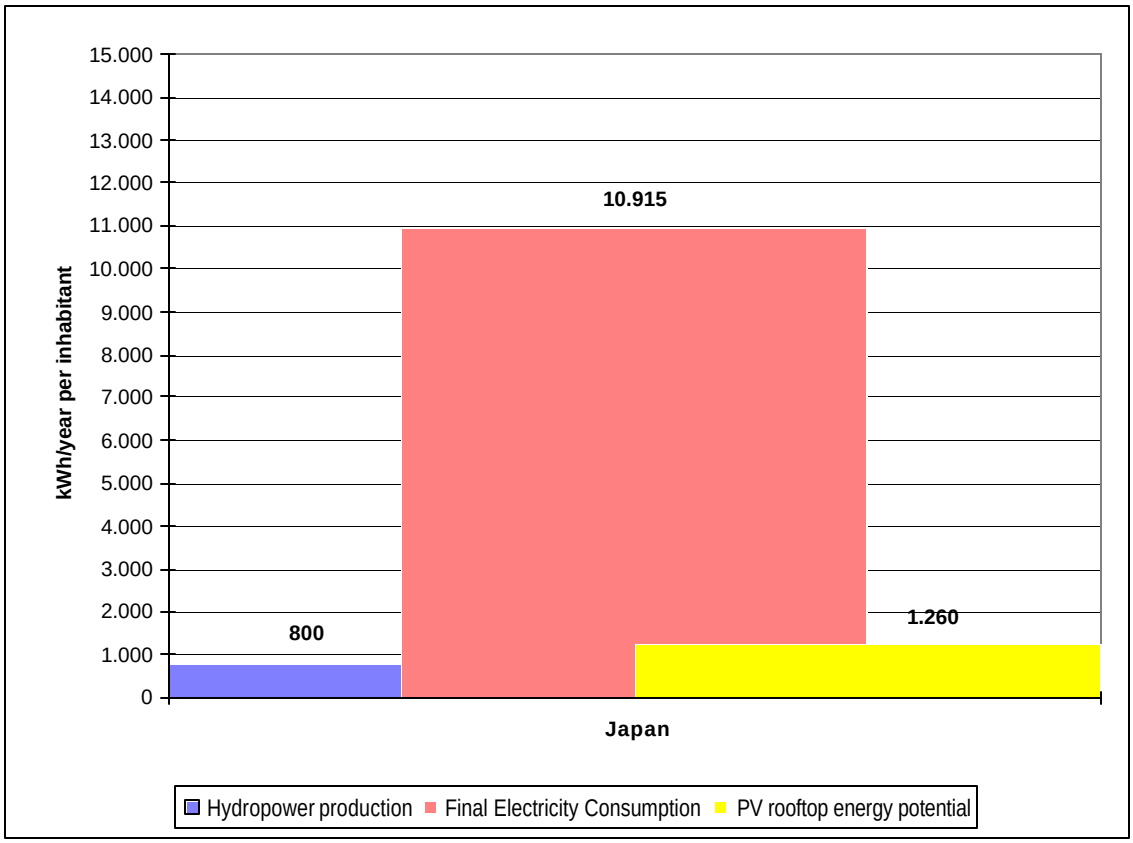
Countries	*Installable PV Capacity* *year 2010*		*Producible PV Energy* *year 2010*	
	MWp	*Wp/ inhabitant*	*MWh/year*	*kWh/year inhabitant*
Japan	174.179	1.385	158.503.338	1.260

Table 4.18- Forecasted potential PV Rooftop energy contribution share in Japan as compared to Final Electricity Consumption for year 2010

Countries	*Final Consumption of Electricity* *year 2010*		*PV Rooftop Energy Share [*]* *year 2010*	*Hydro Energy Share [*][**]* *year 2010*
	MWh/year	*kWh/year inhabitant*	*%*	*%*
Japan	1.373.048.233	10.915	11,5%	7,2%

[*] as compared to total final electricity consumption
[**] hydro energy production (in MWh/year) assumed equal to year 1990

Figure 4.10 - Comparison between PV rooftop potential energy contribution, final electricity consumption and hydropower share in Japan (year 2010 forecast)



CHAPTER 4 - NOTES

[1] K. Sahara, A. Ota, T. Tadokoro, N. Sano, T. Ohno, Solar Energy Department, New Energy and Industrial Technology Development Organization, *Technical Advances of PV Systems in the R&D Program of NEDO*, 11th E.C. Photovoltaic Solar Energy Conference, 12-16 October 1992 Montreux, Switzerland

[2] K. Toma, S. Wakamatsu, *The New Sunshine Programme in Japan*, 12th E.C. Photovoltaic Solar Energy Conference, 11-15 April 1994 Amsterdam, Netherlands

[3] International Energy Agency, *Workshop on Modular PV Plants for Multimegawatt Power Generation*, Proceedings, 7-9 July 1994 Paestum, Italy