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EUROSTAT

*“Collection of statistical data on Solar Energy Applications
in Greece”*

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Final Report

by

C.R.E.S - Department of Energy Information Systems

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CRES - Centre For Renewable Energy Sources

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Introduction

The application of active solar systems in Greece started in mid 70's. The use of electric heaters in almost every Greek household, in combination with the oil crisis, and the rising price of electricity during this period, provided the background for the solar market to develop (EBHE – the Greek Solar Industry Association- was created in 1978). The advertising campaigns of large firms, helped a lot in the initial phase of the establishment of the solar market.

Until 1987 the market was steadily rising. In 1984-1986 a large advertising campaign supported by the Greek government, combined with financial incentives, boosted the sales of glazed solar collectors up to 218,000 m². It was considered that there were about 300 “manufacturers” of solar systems at that time. All the systems were locally produced except from some imported, mainly from Israel.

Since 1987 the market's growth rate has stabilised mainly because:

- The financial constraints slowed down the rate of construction of new buildings
- The oil price started going down as the oil crisis ended
- The electricity tariffs remained low resulting in the decrease of the competitiveness of solar systems.

The campaign of 84-86 mentioned above, as well as a new one performed in cooperation with the Public Power Corporation in 1995, helped the solar systems to penetrate considerably in the residential sector.

Trying to support the application of central solar systems in the tertiary and the industrial sector which is still low, the Operational Programme for Energy (1996-2000) supported a significant number of solar systems in Hotels and Industry by financing up to 50% of the capital cost.

Nowadays, 45 manufacturers of solar collectors are active, producing more than 300,000 m² of collectors annually. 21 of them are members of the Greek Solar Industry Association and cover almost 54% of the domestic market calculated on the basis of annual turnover of the relevant activity.

Imports of solar collectors carried out by 3 companies, are limited to almost 5,000 m² annually.

Aim of the Project

Greece has a significant solar potential. The application of solar systems for satisfying needs in heating and cooling is a strategic option of great importance for the Greek energy system and for the electricity system in particular. It is also an important choice for the national economy in total, since a very dynamic and competitive industry concerning the manufacturing of solar systems has already been developed.

The assessment of new strategies and actions in order to reinforce the solar systems market, taking into consideration the new situation, and needs of the Greek energy system, require accurate and up-to-date data, concerning solar systems and their environmental and energy benefits.

The information collected so far by CRES, concerns annual data of the production of solar collectors in Greece, the exports and the imports, while the energy gain was estimated through the use of an average annual energy production per m². From a careful evaluation, of the existing kind of data collected until now, it is concluded that:

- Sales of non - EBHE members were underestimated
- There is a lack of disaggregation of the data by region, by application as well as by user's profile.

This project aimed to improve the quality and the disaggregation level of the information for the active solar applications in Greece. Data collected for the period 1989-1999 concern:

- Annual sales of solar collectors from
 - EBHE members
 - non-EBHE members
 - Importers

grouped by:

- Type of User
 - households
 - industry
 - hotels and other buildings of the tertiary sector

and

- Geographical region of Greece
 - Central Greece
 - Northern Greece
 - Island of Crete

Data Collection - Survey.

The required statistical information is based upon the quantity of annual end-user sales of solar systems. In particular, the sales of equipment are categorised by technology and user type (industrial systems, central systems, simple systems for households).

In order to estimate these parameters a questionnaire (See Annex II) was sent to all relevant market actors. These actors, data providers, constitute the basic volume of equipment distributors in the country.

There are included

- The members of the Greek Solar Industry association (21 members)
- Manufacturers of equipment who are not participate oin the association as well as distributors
 - representatives located in each prefecture of the country (50 out of 70 contacted filled the questionnaire form)
- Two associations of plumbers in Northern Greece and Crete provided information on their installations. These two associations are regarded to cover the 90% of the local market of household systems.

The survey was conducted by face to face meetings (in the case of non EBHE members and distributors) or by mail (in the case of associations and association members)n from March to September 2001 with the support of The Greek Solar Industry Association).

In enclosure 1 all the detailed support information for this survey (market lists) is presented.

Results

1. Sales - Installed Capacity

At the end of 2000 the surface area of the solar collectors in operation in Greece amounts to 2.96 millions m², 61.8%, of which are located in Central Greece, 27.6% in Northern Greece and 10.6% in Crete which has the highest surface area per capita.

Regarding the use of solar systems, 99% of them are small scale systems for domestic hot water, 0.75% are large scale systems for hot water in the tertiary sector (hotels, hospitals and swimming pools) and 0.17 % (5,118 m²) are large systems for hot water, air-conditioning and space heating in industry.

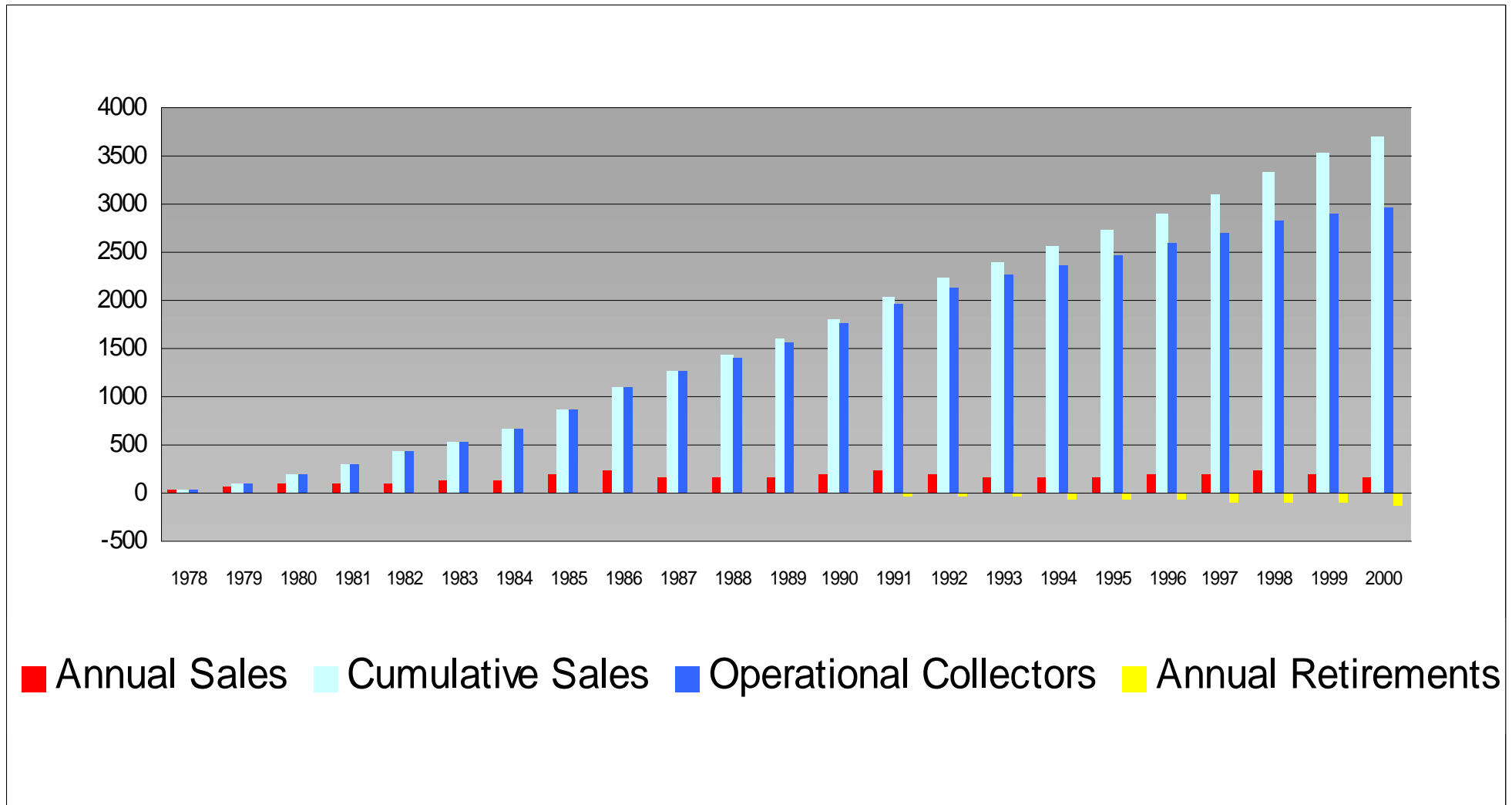
In table 1 annual sales and cumulative sales from 1978 are presented.

Table 1: Annual Sales, Cumulative Sales and Operational Collectors

Year	Annual Sales	Cumulative Sales	Annual Decommissioning	Operational Collectors
1978	30.0	30	0	30
1979	65.0	95	0	95
1980	103.0	198	0	198
1981	113.0	311	0	311
1982	115.0	426	0	426
1983	122.0	548	0	548
1984	132.0	680	0	680
1985	200.0	880	1-	879
1986	218.0	1098	1-	1096
1987	168.0	1266	3-	1261
1988	156.0	1422	6-	1411
1989	167.5	1589	8-	1570
1990	204.0	1793	15-	1759
1991	227.0	2020	22-	1964
1992	211.0	2231	31-	2144
1993	168.0	2399	42-	2270
1994	163.0	2562	53-	2380
1995	169.0	2731	66-	2483
1996	185.0	2916	79-	2589
1997	197.3	3114	91-	2696
1998	233.4	3347	101-	2828
1999	185.0	3532	112-	2901
2000	181.0	3713	121-	2961

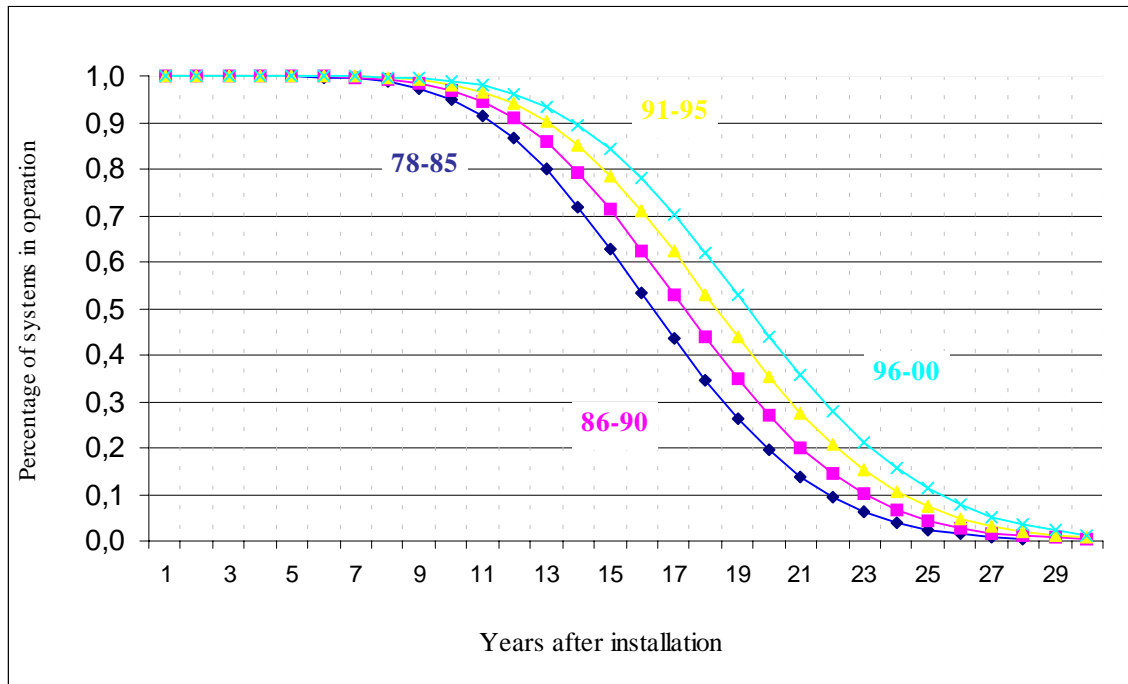
In figure 1, the development of solar collectors is illustrated, supposing that some of the collectors installed previously are out of order due to damages or due to the end of their life period

Figure 1



For the estimation of the collectors that have been set out of order (regardless of the reason), the collectors have been divided in 4 groups depending on the installation year. In figure 2 the life curves of these groups are presented.

Figure 2



The annual sales of the last 10 years for every type of use are presented in table 2, while,

Table 2 Annual Sales (m²)

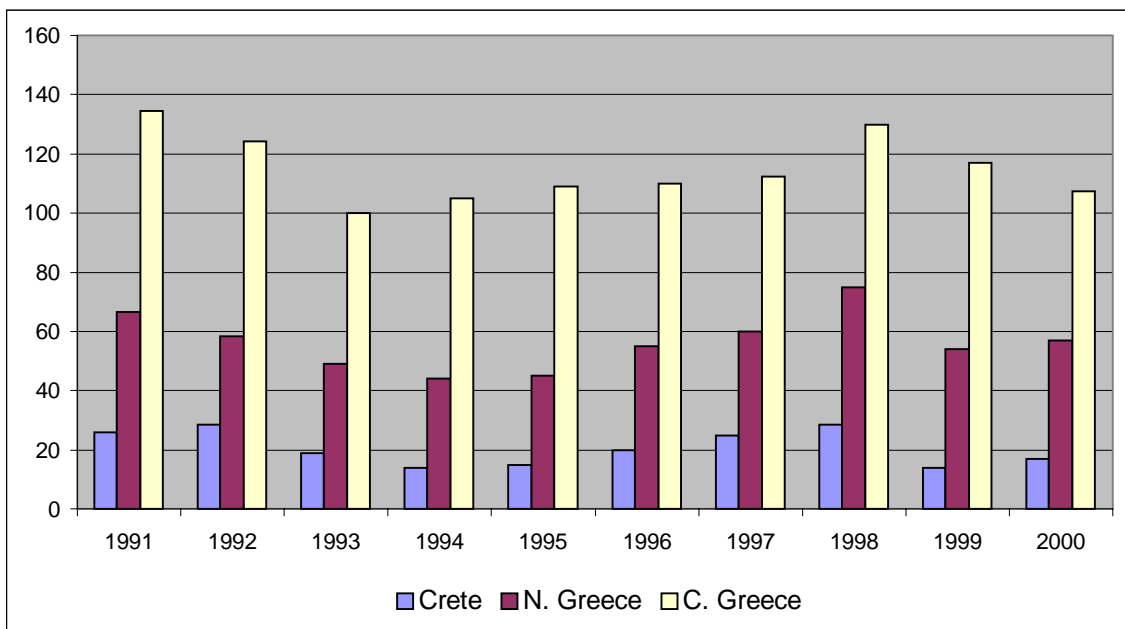
	Households	Tertiary	Industry
1991	225536	1464	0
1992	209855	1145	0
1993	165671	820	1509
1994	162650	350	0
1995	168840	160	0
1996	184970	30	0
1997	196448	852	0
1998	232448	937	15
1999	184137	863	0
2000	170014	7386	3600

in table 3 and in figure 3, the geographical distribution of the annual sales for the last 10 years are presented

Table 3

	N. Greece	C. Greece	Crete
1991	66500	134500	26000
1992	58300	124200	28500
1993	49000	100000	19000
1994	44000	105000	14000
1995	45000	109000	15000
1996	55000	110000	20000
1997	60000	112300	25000
1998	75000	129900	28500
1999	54000	117000	14000
2000	57000	107250	16750

Figure 3 Geographical distribution of sales (1000 m²)



2. Energy Production

The energy production can be estimated with the use of an average “energy gain” for each sq. meter of collector.

The efficiency of the collectors in Greece can reach 800KWh/m²/year but the average “energy gain”, as mentioned above, depends heavily on the geographical region and the user’s profile. In the following table the average values that have been taken into account for the calculations are presented.

KWh/m ² /Year	N. Greece	C. Greece	Crete
Households	350	400	450
Tertiary sector	400	450	500
Industry	450	500	550

There is no distinction between black paint collectors and selective collectors, since the market of the selective collectors, despite its growth the last four years, still remains small at the level of 15000 m² (8.1% of the total sales in 2000).

The energy produced from solar collectors in 2000 amounts to 1.15 TWh, being almost 8 % of the electricity consumption of the residential sector, while it is attributed mainly to the solar collectors in Households.

A survey performed by the Greek Statistical Service in 1997, estimated the number of Households equipped with solar systems to 800,000 or 22% of the total number of Households. According to the sales since 1997 the number of Households equipped with solar systems exceeds 1 million currently. This figure could be higher (1.2 millions) if we take into consideration that the average collectors' area of a domestic solar systems is 2.3 to 2.5 m².

The formula for the estimation of the annual energy production (EP) for every type of application, and region is:

$$EP = IC_{ac} * EG$$

Where IC_{ac} represents the total active area of installed solar collectors, calculated by:

$$IC_{ac} = (IC_{-1} + (S - Rt)/2)$$

where

IC_{-1} is the area of installed solar collectors at the end of the previous year

S : the sales of the current year, and

Rt : the retirements of the current year, while

EG is the average Energy Gain of the type of application, and region

It must be noted that, supposing a uniform rate of installation and retirement of collectors during a year, the "productive" area is half of total sales and retirements of the year in reference.

Apart from the avoided electricity consumption, the avoided CO₂ emissions are also considerable. Supposing that 1.1 Kg of CO₂ are produced for the generation of 1 KWh, the avoided CO₂ emissions for the year 2000 amount to 1.26 Mtonnes, almost 1.2% of the total CO₂ emissions of 2000.

Table 4 presents the annual energy production of solar systems since 1989, the percentage of this amount to the electricity consumed in Households and the avoided emissions.

Table 4

Year	Production (GWh)	% of elec. Consumed in Households	Avoided emissions (Ktonnes)
1989	588	6.4%	735
1990	656	7.2%	841
1991	733	7.3%	922
1992	808	7.6%	991
1993	868	8.3%	1048
1994	914	8.4%	1086
1995	955	8.3%	1108
1996	996	8.1%	1111
1997	1037	8.3%	1215
1998	1083	8.5%	1240
1999	1123	8.3%	1217
2000	1148	8.1%	1263*

* *Estimation*

References

- 1. National Statistical Service of Greece (1997).** “Energy Consumption in Households - Greece”, EUROSTAT contract No SOEC 65020009/11 - Final Report.
- 2. International Energy Agency.** “Energy Balances and Statistics of OECD Countries”
- 3. European Solar Industry Federation** “Sun In Action” Dec-1995 Altener Programme - Contract No 4.1030/E/94-003
- 4. Ministry For The Environment, Physical Planning And Public Works** “National Inventory For Greenhouse And Other Gases For The Years 1990-1999”, June 2001

Annex II

Detail Data for Greece

	Sales (m2)			Retirements (m2)			Total Area (m2)			Active Area (m ²)			Energy Production (GWh)		
	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry
1978	30000	0	0	0	0	0	30000	0	0	15000	0	0	6	0	0
1979	65000	0	0	0	0	0	95000	0	0	62500	0	0	25	0	0
1980	102400	600	0	0	0	0	197400	600	0	146200	300	0	58	0	0
1981	113000	0	0	0	0	0	310400	600	0	253900	600	0	101	0	0
1982	115000	0	0	0	0	0	425400	600	0	367900	600	0	146	0	0
1983	122000	0	0	62	0	0	547338	600	0	486369	600	0	193	0	0
1984	131420	580	0	235	0	0	678523	1180	0	612931	890	0	243	0	0
1985	199106	894	0	645	1	0	876984	2073	0	777753	1626	0	308	0.7	0
1986	217035	965	0	1450	2	0	1092569	3036	0	984776	2554	0	390	1.1	0
1987	166860	1140	0	2921	4	0	1256508	4171	0	1174539	3604	0	464	1.6	0
1988	154555	1445	0	5395	8	0	1405668	5608	0	1331088	4890	0	526	2.2	0
1989	164949	2551	0	9211	15	0	1561406	8144	0	1483537	6876	0	585	3.1	0
1990	201560	2440	0	14771	25	0	1748195	10559	0	1654801	9352	0	652	4.2	0
1991	225536	1464	0	21760	37	0	1951972	11986	0	1850084	11273	0	728	5.1	0
1992	209855	1145	0	31075	57	0	2130752	13074	0	2041362	12530	0	803	5.7	0
1993	165671	820	1509	41638	81	0	2254785	13814	1509	2192769	13444	755	862	6.2	0.4
1994	162650	350	0	53377	113	0	2364058	14051	1509	2309422	13932	1509	908	6.4	0.8
1995	168840	160	0	65772	156	0	2467126	14055	1509	2415592	14053	1509	949	6.4	0.8
1996	184970	30	0	78327	211	0	2573769	13873	1509	2520448	13964	1509	989	6.4	0.8
1997	196448	852	0	89906	276	0	2680311	14449	1509	2627040	14161	1509	1031	6.5	0.8
1998	232448	937	15	101435	364	0	2811324	15023	1524	2745818	14736	1517	1077	6.8	0.8
1999	184137	863	0	111510	464	0	2883951	15422	1524	2847638	15222	1524	1116	7.0	0.8
2000	170014	7386	3600	120277	576	6	2933688	22232	5118	2908820	18827	3321	1139	8.8	1.6

Detail Data for Northern Greece

	Sales (m2)			Retirements (m2)			Total Area (m2)			Active Area (m ²)			Energy Production (GWh)		
	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
1980	0	600	0	0	0	0	0	600	0	0	300	0	0	0.1	0.0
1981	25000	0	0	0	0	0	25000	600	0	12500	600	0	4	0.2	0.0
1982	25000	0	0	0	0	0	50000	600	0	37500	600	0	13	0.2	0.0
1983	30000	0	0	0	0	0	80000	600	0	65000	600	0	23	0.2	0.0
1984	30000	580	0	0	0	0	110000	1180	0	95000	890	0	33	0.4	0.0
1985	35000	74	0	0	1	0	145000	1253	0	127500	1216	0	45	0.5	0.0
1986	38000	200	0	52	2	0	182948	1451	0	163974	1352	0	57	0.5	0.0
1987	40000	0	0	136	4	0	222813	1446	0	202881	1449	0	71	0.6	0.0
1988	44000	0	0	325	8	0	266487	1438	0	244650	1442	0	86	0.6	0.0
1989	51000	0	0	680	15	0	316807	1423	0	291647	1431	0	102	0.6	0.0
1990	61500	0	0	1301	23	0	377006	1400	0	346906	1412	0	121	0.6	0.0
1991	66500	0	0	2202	35	0	441303	1365	0	409155	1383	0	143	0.6	0.0
1992	58300	0	0	3604	48	0	495999	1317	0	468651	1341	0	164	0.5	0.0
1993	48636	0	364	5409	63	0	539227	1254	364	517613	1285	182	181	0.5	0.1
1994	44000	0	0	7637	78	0	575589	1175	364	557408	1214	364	195	0.5	0.2
1995	45000	0	0	10228	93	0	610361	1083	364	592975	1129	364	208	0.5	0.2
1996	55000	0	0	13097	105	0	652264	978	364	631313	1030	364	221	0.4	0.2
1997	60000	0	0	15955	113	0	696309	865	364	674287	922	364	236	0.4	0.2
1998	75000	0	0	19106	117	0	752204	747	364	724257	806	364	253	0.3	0.2
1999	54000	0	0	22129	117	0	784074	630	364	768139	689	364	269	0.3	0.2
2000	56150	0	850	25088	112	1	815137	518	1213	799606	574	788	280	0.2	0.4

Detail Data for Central Greece

	Sales (m2)			Retirements (m2)			Total Area (m2)			Active Area (m ²)			Energy Production (GWh)		
	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry
1978	30000	0	0	0	0	0	30000	0	0	15000	0	0	6	0.0	0.0
1979	65000	0	0	0	0	0	95000	0	0	62500	0	0	25	0.0	0.0
1980	102400	0	0	0	0	0	197400	0	0	146200	0	0	58	0.0	0.0
1981	73000	0	0	0	0	0	270400	0	0	233900	0	0	94	0.0	0.0
1982	75000	0	0	0	0	0	345400	0	0	307900	0	0	123	0.0	0.0
1983	80000	0	0	62	0	0	425338	0	0	385369	0	0	154	0.0	0.0
1984	89420	0	0	235	0	0	514523	0	0	469931	0	0	188	0.0	0.0
1985	150106	140	0	645	0	0	663984	140	0	589253	70	0	236	0.0	0.0
1986	163035	765	0	1367	0	0	825652	905	0	744818	523	0	298	0.2	0.0
1987	108860	480	0	2704	0	0	931808	1385	0	878730	1145	0	351	0.5	0.0
1988	90555	1445	0	4887	0	0	1017476	2830	0	974642	2108	0	390	0.9	0.0
1989	94602	1898	0	8155	0	0	1103923	4728	0	1060699	3779	0	424	1.7	0.0
1990	115700	2000	0	12766	0	0	1206857	6728	0	1155390	5728	0	462	2.6	0.0
1991	133586	914	0	18384	0	0	1322059	7641	0	1264458	7184	0	506	3.2	0.0
1992	123630	570	0	25597	3	0	1420091	8208	0	1371075	7925	0	548	3.6	0.0
1993	98385	820	795	33475	6	0	1485001	9022	795	1452546	8615	398	581	3.9	0.2
1994	104650	350	0	41934	16	0	1547717	9356	795	1516359	9189	795	607	4.1	0.4
1995	108840	160	0	50565	32	0	1605993	9484	795	1576855	9420	795	631	4.2	0.4
1996	109970	30	0	58992	59	0	1656971	9455	795	1631482	9469	795	653	4.3	0.4
1997	112260	40	0	66502	95	0	1702730	9400	795	1679850	9428	795	672	4.2	0.4
1998	129183	717	0	73601	152	0	1758312	9965	795	1730521	9683	795	692	4.4	0.4
1999	116640	360	0	79442	224	0	1795510	10102	795	1776911	10034	795	711	4.5	0.4
2000	101834	2666	2750	84121	312	3	1813223	12456	3542	1804366	11279	2168	722	5.1	1.1

Detail Data for Crete

	Sales (m2)			Retirements (m2)			Total Area (m2)			Active Area (m ²)			Energy Production (GWh)		
	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry	Households	Tertiary	Industry
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	15000	0	0	0	0	0	15000	0	0	7500	0	0	3	0	0
1982	15000	0	0	0	0	0	30000	0	0	22500	0	0	10	0	0
1983	12000	0	0	0	0	0	42000	0	0	36000	0	0	16	0	0
1984	12000	0	0	0	0	0	54000	0	0	48000	0	0	22	0	0
1985	14000	680	0	0	0	0	68000	680	0	61000	340	0	27	0.2	0
1986	16000	0	0	31	0	0	83969	680	0	75985	680	0	34	0.3	0
1987	18000	660	0	81	0	0	101888	1340	0	92928	1010	0	42	0.5	0
1988	20000	0	0	183	0	0	121705	1340	0	111796	1340	0	50	0.7	0
1989	19347	653	0	376	0	0	140676	1993	0	131191	1667	0	59	0.8	0
1990	24360	440	0	703	1	0	164333	2432	0	152505	2212	0	69	1.1	0
1991	25450	550	0	1174	2	0	188609	2979	0	176471	2705	0	79	1.4	0
1992	27925	575	0	1873	5	0	214661	3549	0	201635	3264	0	91	1.6	0
1993	18650	0	350	2754	11	0	230557	3538	350	222609	3544	175	100	1.8	0.1
1994	14000	0	0	3806	18	0	240751	3520	350	235654	3529	350	106	1.8	0.2
1995	15000	0	0	4980	32	0	250772	3488	350	245762	3504	350	111	1.8	0.2
1996	20000	0	0	6238	48	0	264534	3440	350	257653	3464	350	116	1.7	0.2
1997	24188	812	0	7449	68	0	281272	4184	350	272903	3812	350	123	1.9	0.2
1998	28265	220	15	8729	94	0	300808	4310	365	291040	4247	358	131	2.1	0.2
1999	13497	503	0	9938	123	0	304367	4690	365	302587	4500	365	136	2.2	0.2
2000	12030	4720	0	11068	152	1	305329	9258	364	304848	6974	364	137	3.5	0.2

**Electricity Consumption in Households
(GWh)**

1989	9143
1990	9074
1991	10014
1992	10612
1993	10481
1994	10932
1995	11508
1996	12253
1997	12423
1998	12786
1999	13484
2000	14207

**CO₂ Emission Coefficient
(Kg/KWh of thermal origin)**

1989	1.25
1990	1.28
1991	1.26
1992	1.23
1993	1.21
1994	1.19
1995	1.16
1996	1.12
1997	1.17
1998	1.15
1999	1.08
2000	1.10

**Annex II Questionnaire for the assessment of the penetration of Solar Systems in the prefectures of Greece
2001 National Survey Supported by EUROSTAT**

Prefecture:	Tel.:
Company Name:	Date:
Responsible:	

Annual Sales of Collectors

Type of Use	Absorber	1996 (m ²)	1997 (m ²)	1998 (m ²)	1999 (m ²)	2000 (m ²)	Estimation of operational Collectors (m ²)
Thermosyphon Systems in Households	Selective						
	Black Paint						
Systems for Industrial Applications	Selective						
	Black Paint						
Central Solar Systems in Hospitals, Hotels, Swimming Pools etc.	Selective						
	Black Paint						
S-Total	Selective						
	Black Paint						
Total							

Annual Retirements of Collectors

Type of Use	1996 (m ²)	1997 (m ²)	1998 (m ²)	1999 (m ²)	2000 (m ²)	Estimation of operational Collectors (m ²)
Thermosyphon Systems in Households						
Systems for Industrial Applications						
Central Solar Systems in Hospitals, Hotels, Swimming Pools etc.						
Total						