

PHOTOVOLTAIC MARKET IN GREECE – FIRST RESULTS ON THE DEVELOPMENT OF INSTALLATIONS AND THE INDUSTRY

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ABSTRACT: An overview of the status of the developing PV market in Greece is presented in this paper. A review of the critical issues of Law 3468 for PV applications is done. The applications submitted for either exemption or approval of the Energy Production License are categorised per region and per system size. A comparison to the respective planned capacity for years 2007–2010 is also done. The results indicate a great public and private interest on PV technology and its applications and there is confidence that a considerable PV market expansion will take place in Greece in the coming 2 years, especially in medium and large system types. Additionally, the industrial development in the PV sector in the sectors of crystalline silicon wafers, solar cells and modules is now under way, creating sustainable conditions for economical growth, technology know-how and added value of the PV support measures on a national level.

Keywords: National Programme – 1; PV Market – 2; Manufacturing and Processing – 3

1 INTRODUCTION

The increasing concern of both the public and the private sectors in photovoltaic technology in Greece is discussed in this paper. Reference to the existing legislation is made and latest information on applications received and the planning and contribution of PV power in the different regions of the country is provided. A review of the main industrial activities in the country on PV cell and module technologies is also made.

2 SUMMARY OF MAIN LEGISLATIVE AND REGULATORY ISSUES

Law 3468 was approved by the Hellenic Parliament in June 2006 and provided a new legislative and regulatory framework for the development of renewable power supply systems in Greece, see details in [1] and [2]. For PV systems specifically, the main issues that are put in effect is as follows:

- In terms of power categorisation, three types of systems have been introduced, i.e. up to 20kWp, between 20kWp and 150kWp and systems above 150kWp.
- For grid-connected systems, two types are distinguished depending on the site of installation, i.e. mainland and systems installed on non-interconnected islands.
- Feed-in Tariffs depend on the size and the site of an application, particularly, for systems of higher than

150kWp installed capacity prices are €40c/kWh and €45c/kWh for mainland and insular regions respectively. The corresponding prices for systems below 150kWp capacity are €45c/kWh and €50c/kWh.

- FiT prices are guaranteed by contract for 10 years, plus another 10 years after renewing the contract with the electricity system operator and depending on the will of the PV system owner.
- The licensing procedures for the Energy Production Licence (EPL) to be submitted to the Regulatory Authority for Energy (RAE) and the environmental terms and approvals have been introduced. According to the time schedule indicated in the Law, the maximum time needed one to obtain all necessary documents and approvals is calculated 305 working days.
- Certain technical documents and specifications have been introduced by the utility (PPC) and the Hellenic TSO related to grid-connection issues to the LV and MV lines.
- A PV Plant Development Programme was introduced with minimum targets for 2020 on the installed PV capacity in the country 500MW for mainland and 200MW for systems installed on non-interconnected islands.

3 REGISTRY OF APPLICATIONS AND PLANNING

Since the introduction of Law 3468, a rapidly increasing number of applications submitted to RAE for issuing an EPL for PV plants with capacity exceeding 150kWp or an exemption from it for PV plants with capacity ranging between 20kWp and 150kWp has been noticed. This indicates potential for a sustainable development of the PV market in Greece.

3.1 Exemptions, 20kWp < PV ≤ 150kWp

For mainland, grid-connected PV systems, applications for exemption from an Energy Production Licence are submitted to RAE on a continuous basis.

3.2 EPL Applications, PV > 150kWp

Following a directive of RAE issued last winter, applications for an Energy Production Licence are open for submission during the first 10 calendar days of every even month, i.e. April (04), June (06), August (08), etc.

3.3 Record of Applications

The presentation of the results of the applications submitted so far for licensing is based on a regional distribution in the country. This is in accordance to the planning of the power from PV to be contributed to the respective regions. In this way, Greece is divided in 14 in total regions, as shown in Fig. 1 below.

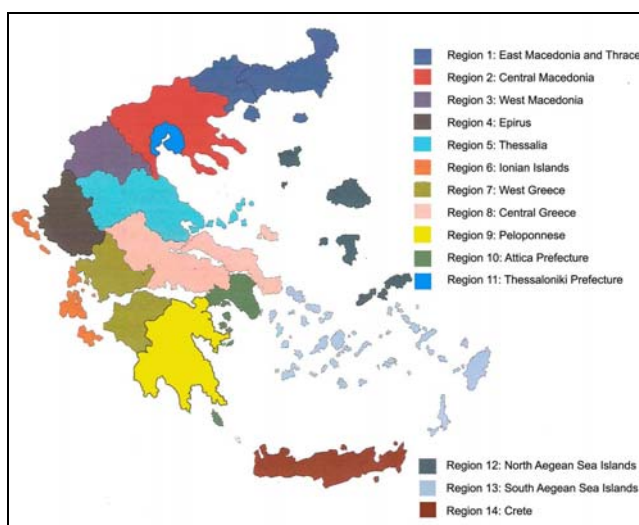


Fig. 1 Identification of regions in Greece

In Table 1 are summarised the number and the total equivalent power of applications submitted to RAE for regions 1 to 11 and are classified according to the power range. Data is valid from the opening of the programme and as of mid June 2007. The planned power shown in the third column is according the recent announcement of RAE for the distribution of PV capacity in the different regions, [3]. In the 4th column is presented the divergence in % between the actual applied and the planned capacity.

Table 3. Regional applied and planned PV capacity in Greece

REGIONS	Applications		Planned	Divergence
	No	MWp	MWp	%
PV ≤ 20kWp				
1	–	–	4.50	–
2	–	–	6.00	–
3	–	–	1.00	–
4	–	–	1.80	–
5	–	–	5.50	–
6	–	–	1.50	–
7	–	–	6.00	–
8	–	–	6.00	–
9	–	–	12.20	–
10	–	–	4.00	–
11	–	–	1.50	–
			50.00	
20kWp < PV ≤ 150kWp				
1	243	27.932	15.00	186.2
2	531	56.632	24.00	236.0
3	74	7.924	3.00	264.1
4	151	16.957	5.40	314.0
5	308	32.606	16.50	197.6
6	12	1.548	4.50	34.4
7	352	36.969	18.00	205.4
8	269	27.881	18.00	154.9
9	755	79.696	36.60	217.7
10	64	6.462	12.00	53.8
11	30	3.049	4.50	67.8
	2789	297.656	157.50	189.0
150kWp < PV ≤ 2MWp				
1	42	48.073	13.00	369.8
2	94	90.543	15.00	603.6
3	16	18.025	3.00	600.8
4	32	35.235	5.40	652.5
5	110	146.535	16.50	888.1
6	1	1.843	4.50	41.0
7	59	83.669	18.00	464.8
8	79	105.560	18.00	586.4
9	125	163.070	36.60	445.5
10	24	31.949	12.00	266.2
11	10	9.535	4.50	211.9
	592	734.037	146.50	501.0
PV > 2MWp				
1	13	53.420	12.50	427.4
2	20	91.007	15.00	606.7
3	6	32.366	3.00	1078.9
4	4	17.845	5.40	330.5
5	13	68.911	16.50	417.6
6	1	4.000	4.50	88.9
7	23	101.331	18.00	562.9
8	22	92.629	18.00	514.6
9	42	315.722	36.60	862.6
10	7	34.783	12.00	289.9
11	1	3.000	4.50	66.7
	152	815.014	146.00	558.2
TOTAL:	3533	1846.707	500.00	369.34

The data shown in Table 1 above indicate that the planned capacity of total 500MW has been already covered by an average factor of around 370%. In almost all regions, applications exceed the planned capacity, especially in the case of systems above 150kWp. In terms of number of applications, the most popular category is for power between 20kWp and 150kWp with around 2800 applications as by mid June 2007. In terms of capacity, very large PV systems of more than 2MWp power show the highest coverage in almost all regions of the country.

Data for systems below 20kWp capacity is not available as these cases are excluded from the application procedure to RAE. Thus, a record of these cases will be based on the actual installations, as every single system has to be registered to the utility.

3.4 Details on Planning

Concerning PV installations, the overall planning of RAE up to year 2010 for mainland and non-interconnected island regions and classified in 4 system size categories is summarised in Tables 2 and 3 below. The numbers are in MWp per year and indicate the upper threshold.

Table 2. Planning for Grid-connected PV Systems in Island Regions and the Mainland

REGIONS	Total PV Power				Island Regions				Mainland			
	Years	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009
1	24.00	9.29	9.29	3.88	1.50	0.60	0.60	0.30	22.50	8.69	8.69	3.58
2	30.08	12.00	12.00	5.98	0.08	0.03	0.03	0.01	30.00	11.97	11.97	5.97
3	20.00	8.00	8.00	4.00	-	-	-	-	20.00	8.00	8.00	4.00
4	9.00	3.60	3.60	1.80	-	-	-	-	9.00	3.60	3.60	1.80
5	29.10	11.32	11.32	4.86	1.60	0.64	0.64	0.33	27.50	10.68	10.68	4.53
6	7.50	3.00	3.00	1.50	7.50	3.00	3.00	1.50	-	-	-	-
7	30.00	12.00	12.00	6.00	-	-	-	-	30.00	12.00	12.00	6.00
8	33.15	12.62	12.62	4.74	3.14	1.26	1.26	0.63	30.00	11.36	11.36	4.11
9	61.07	24.42	24.42	12.18	0.08	0.03	0.03	0.01	61.00	24.39	24.39	12.17
10	23.60	8.75	8.75	2.56	3.60	1.44	1.44	0.72	20.00	7.31	7.31	1.84
11	7.50	3.00	3.00	1.50	-	-	-	-	7.50	3.00	3.00	1.50
TOTAL per year:	275.00	108.00	108.00	49.00	17.50	7.00	7.00	3.50	257.50	101.00	101.00	45.50
TOTAL aggregate:	275.50	383.00	491.00	540.00	17.50	24.50	31.50	35.00	257.50	358.50	459.50	505.00

Table 3. Classification based on the system size

REGIONS	PV ≤ 20kWp				20kWp < PV ≤ 150kWp				150kWp < PV ≤ 2MWp				PV > 2MWp			
	Years	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009
1	2.25	0.89	0.89	0.42	7.50	2.90	2.90	1.20	6.50	2.50	2.50	1.00	6.25	2.40	2.40	0.95
2	3.00	1.09	1.09	0.27	12.00	4.90	4.90	2.70	7.50	3.00	3.00	1.50	7.50	3.00	3.00	1.50
3	2.00	0.80	0.80	0.40	6.00	2.40	2.40	1.20	6.00	2.40	2.40	1.20	6.00	2.40	2.40	1.20
4	0.90	0.36	0.36	0.18	2.70	1.08	1.08	0.54	2.70	1.08	1.08	0.54	2.70	1.08	1.08	0.54
5	2.75	1.07	1.07	0.45	8.25	3.21	3.21	1.36	8.25	3.21	3.21	1.36	8.25	3.21	3.21	1.36
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	3.00	1.20	1.20	0.60	9.00	3.60	3.60	1.80	9.00	3.60	3.60	1.80	9.00	3.60	3.60	1.80
8	3.00	1.14	1.13	0.42	9.00	3.41	3.41	1.24	9.00	3.41	3.41	1.24	9.00	3.41	3.41	1.24
9	6.10	2.44	2.44	1.22	18.30	7.32	7.31	3.65	18.30	7.32	7.31	3.65	18.30	7.32	7.31	3.65
10	2.00	0.73	0.73	0.18	6.00	2.18	2.19	0.55	6.00	2.18	2.18	0.55	6.00	2.18	2.18	0.55
11	0.75	0.30	0.30	0.15	2.25	0.90	0.90	0.45	2.25	0.90	0.90	0.45	2.25	0.90	0.90	0.45
TOTAL per year:	25.75	10.01	10.01	4.29	81.00	31.90	31.90	14.69	75.50	29.60	29.59	13.29	75.25	29.50	29.49	13.24
TOTAL aggregate:	25.75	35.76	45.77	50.06	81.00	112.90	144.79	159.48	75.50	105.10	134.69	147.98	75.25	104.75	134.24	147.48

Especially in the Arcadia prefecture, which belongs to the West Greece region, an additional 50MWp PV power has been approved for year 2007 for system category above 2MW installed capacity.

3.5 Non-interconnected Insular Regions

A study on the penetration level of PV and small wind generators based capacity on non-interconnected islands has been completed and the results were announced by RAE, [3]. The penetration level from PV on each island

is a function of the installed capacity, the annual load profile and the prediction of the demand in the coming years.

Particularly for PV, the results indicate that in Crete, the cap is 52.50MWp while for the remaining island regions in the north and the south Aegean Sea, the overall capacity was determined 46.76MWp. Thus the total PV potential for non-interconnected islands is calculated 99.26MWp. Additionally, the maximum allowed capacity per project is 150kWp, i.e. RAE receives only EPL exemption applications. For 2007, the applications' schedule is as follows: for Crete 02 July to 31 August and for all other islands 01 August to 28 September.

4 LATEST INFORMATION ON APPLICATIONS

Latest information on the status of the applications as by end July 2007 are summarised in Tables 4 and 5 below. This data become available just before the presentation of the paper.

Table 4. Status of PV exemptions, mainland

	No	%	Equivalent Power, [MWp]
Negative Opinion	13	0.37	1.3409
Withdrawn	63	1.80	6.5022
Positive Opinion	721	20.55	70.4094
Under Evaluation	2712	77.28	295.1770
TOTAL:	3509	100.00	373.4295

Table 5. Status of EPL applications, mainland

	No	%	Equivalent Power, [MWp]
150kWp – 2MWp	627	80.20	750.8150
> 2MWp	155	19.80	834.0130
TOTAL:	782	100.00	1584.8280

So far, out of the 782 applications, 13 projects have obtained an EPL from RAE, all in the range 150kWp–2MWp. The total equivalent power of these projects sums up to 13MWp.

Disregarding the negative opinion and the withdrawn projects of Table 4, the total number of submitted applications is calculated 4215, with total equivalent power of 1950.4MWp.

5 DEVELOPMENT OF THE PV INDUSTRY IN GREECE

The expansion of the PV market in Greece is supported by a considerable industrial deployment in this sector. Relevant to PV technology industrial activities include:

- Crystalline silicon wafer and cell production facilities.

- PV module assembly lines.
- Development of power electronics devices.
- Lead-acid battery assembly lines.

The main PV industrial development is due to the activity of two companies.

5.1 Solar Cells Hellas

The Solar Cells Hellas SA Group [4], accomplishes an investment of total 80M Euros for the construction of an integrated PV production factory in the Industrial Area of Patras in Greece. Products will be multicrystalline silicon wafers, solar cells and PV modules. The investment of Solar Cells Hellas is associated with the recent developments on an international level for energy production from renewable sources, in accordance with the directives for pollution reduction and minimisation from fossil fuels dependence.

The first phase of the project refers to an annual capacity of 30MW and is now under way. The construction of the factory plant of 7000m² space has been completed, see Fig. 2 below. First production of wafers and solar cells is expected in December 2007.



Fig. 2 Model of the Solar Cells Hellas factory buildings at Patras

After the completion of the second phase of the project, the total production capacity of the factory will be 60MW; this is estimated in July 2008. In terms of working positions, Solar Cells Hellas will employ approximately 230 persons.

5.2 Energy Solutions

Back in 2004, a Greek investment was realised in Bulgaria by Energy Solutions SA, [5]. Production of crystalline silicon modules started in February 2005 with an initial annual potential of 2MW. So far, a total capacity of 5MW has been produced and forwarded to the European market. Energy Solutions occupies 20 persons.

Recent developments include integration of fully automated machinery and as of the beginning of 2007, the annual production potential has been increased to 10MW.

5.3 Other Professional Activities

Besides industrial development, a number of consultancy, marketing and construction companies, together with the support of certain financial institutions and banks have recently initiated activities.

Services cover all phases of a PV investment, i.e. initial design and proposal submission to the energy and environmental authorities for approvals, project financing, engineering, procurement of equipment, installation, O&M and security issues.

6 CONCLUSIONS

The current situation of the PV market in Greece was analysed in this paper. By introducing a generous FIT policy, Law 3468/2006 proved to be a strong mechanism to awaken investors and create sustainable conditions for PV technology in the country. In terms of applications, the initial results indicate that within the first 8 months after the programme opening, the planned PV capacity has been already covered by a factor of 4, virtually in all regions of the country.

In parallel, a considerable industrial activity is taking place in Greece with prospects for economical growth and technology development for products competitive on international level.

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