

PV SITUATION IN PORTUGAL

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Summary

The situation of PV in Portugal is presented in this work, as well as statistics on the evolution of renewable energy (RE) and photovoltaic energy (PV) in Portugal in the last years. Data is also shown on the forecast of these energies for the coming years. In addition, policy measures for the use of PV are addressed, which have an impact on the larger use of PV for power generation.

Keywords: PV, Portugal, energy statistics, energy forecast, energy policy

1. Introduction

Between 2010 and 2014 the electricity consumption changed from about 24% to 25,6% of the total final energy, showing the importance of this energy resource in Portugal. So, having in mind the environmental and territorial sustainability, besides energy efficiency it is important to simultaneously increase the contribution of endogenous renewable energy sources in order to decrease Portugal's energy dependency and contribute for a competitive and low carbon economy. The NATIONAL RENEWABLE ENERGY ACTION PLAN (NREAP), based on the European objectives, states a target of 31% of renewable energy sources in the total energy consumption by 2020. In 2014 about 61% of the electricity generated in Portugal was based on renewable energy sources and about 27% of the gross final energy consumption was based on these resources. Solar energy is practically inexhaustible and constant, easily available in Portugal, mainly in the south, where the potential is quite considerable. Portugal is one of the European countries with better conditions for exploitation of this resource (see Fig. 1), featuring an average annual number of hours of sunshine, variable between 2200 and 3000, on the mainland (www.dgeg.pt), with an yearly global radiation from 1600 to >2100 kWh/m² (http://re.jrc.ec.europa.eu/pvgis/cmmaps/eu_cmsaf_opt/G_opt_PT.png).

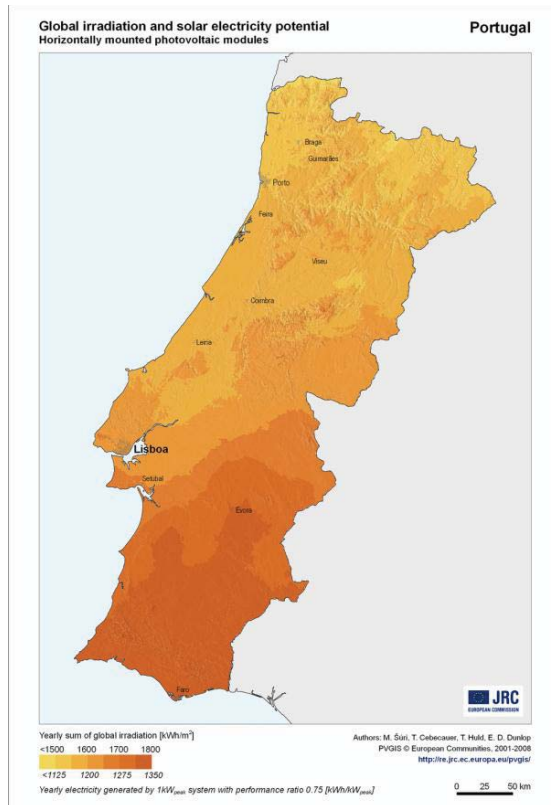


Fig. 1 – Global irradiation and solar electricity potential (re.jrc.ec.europa.eu/pvgis/cmmaps/eu_cmsaf_opt/G_opt_PT.png).

2. Statistics on RE in Portugal and Europe

Data is shown (Tables 1-10, Figures 2-7) on the situation of RE in 2015 or the evolution in the last years namely: a) 2006-2015 total energy production for the different RE types; b) 2006-2015 installed capacity for the different RE types; c) distribution of installed capacity by type of RE by country region in 2014; d) 2008-2015 micro and mini-production installed capacity for the different RE types; e) 2008-2015 micro and mini-production for the different RE types; f) situation in 2005 and 2014 of total electric energy production and % of RE source in several European countries; g) situation in 2014 in several European countries of the RE production by type of RE source; h) situation in 2005 and 2014 of total electric energy production and % of RE source in several OECD countries.

Table 1 – Electricity production (GWh) in 2006-2015 (RE types).

	Electricity Production (GWh)										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 ¹	
Total Renewable production ²	16.188	16.593	15.140	19.016	28.754	24.692	20.411	30.610	32.405	25.355	
Hydro	11.467	10.449	7.298	9.009	16.547	12.114	6.660	14.868	16.412	9.761	
Hydro(>30MW)	9.884	9.405	6.281	7.648	14.454	10.615	5.683	12.931	14.168	8.633	
Pumped Hydro	548	422	499	724	399	578	1.038	1.138	843	1.146	
Hydro (>10 e <=30 MW)	759	500	459	619	1.005	637	411	887	1.014	482	
Hydro (<= 10 MW)	823	544	558	742	1.088	862	566	1.050	1.229	646	
Wind	2.926	4.036	5.757	7.577	9.182	9.162	10.260	12.015	12.111	11.609	
Solid Biofuels ³	1.380	1.549	1.500	1.713	2.226	2.467	2.496	2.516	2.530	2.391	
CHP	1.302	1.385	1.338	1.364	1.560	1.722	1.710	1.780	1.765	1.607	
Electricity (only)	78	164	163	349	665	745	786	736	765	784	
Municipal Waste	585	551	561	579	577	592	490	571	481	592	
of which renewable	293	276	281	290	289	296	245	286	240	296	
Biogases	33	58	71	83	100	161	210	250	278	297	
Geothermal	85	201	192	184	197	210	146	197	205	204	
Solar Photovoltaic	5	24	41	160	215	282	393	479	627	797	

¹provisional data

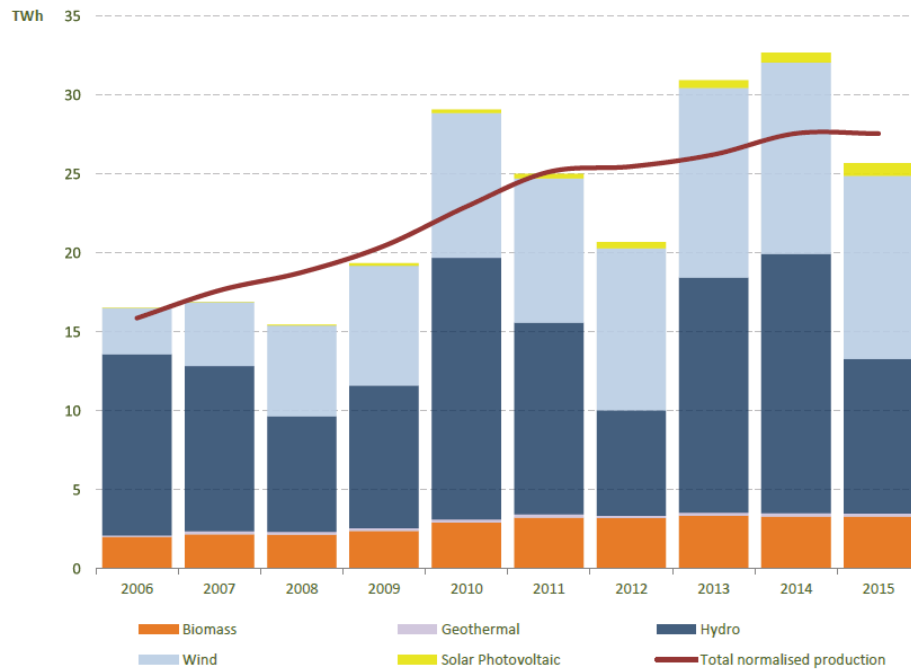


Fig. 2 - 2006-2015 total energy production for the different RE types (Portugal) (www.dgeg.pt).

The biggest changes in the several years are due to the hydro component, related with wet or dry years (rain).

Table 2 – Installed capacity (MW) by RE type for 2006-2015.

	Installed Capacity (MW)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 ¹
Total Renewable capacity	7.010	7.811	8.459	9.106	9.687	10.626	11.055	11.311	11.677	12.260
Hydro	4.850	4.855	4.857	4.884	4.898	5.332	5.539	5.535	5.571	6.024
Hydro (>30MW)	4.234	4.234	4.234	4.234	4.234	4.666	4.877	4.877	4.916	5.360
Hydro (>10 e ≤ 30 MW)	288	288	288	290	290	290	288	288	284	291
Hydro (≤ 10 MW)	328	333	335	361	374	377	374	370	371	372
Wind	1.699	2.464	3.058	3.564	3.914	4.378	4.531	4.731	4.953	5.013
Solid Biofuels	335	348	350	408	592	575	564	564	539	566
CHP	323	323	323	323	476	459	441	441	416	443
Electricity (only)	12	25	27	85	116	116	123	123	123	123
Municipal Waste	86	86	86	86	86	86	86	86	86	86
Biogases	8	15	16	24	34	51	62	68	81	82
Geothermal	29	29	29	29	29	29	29	29	29	29
Solar Photovoltaic	3	15	62	110	134	175	244	299	418	460

¹provisional data

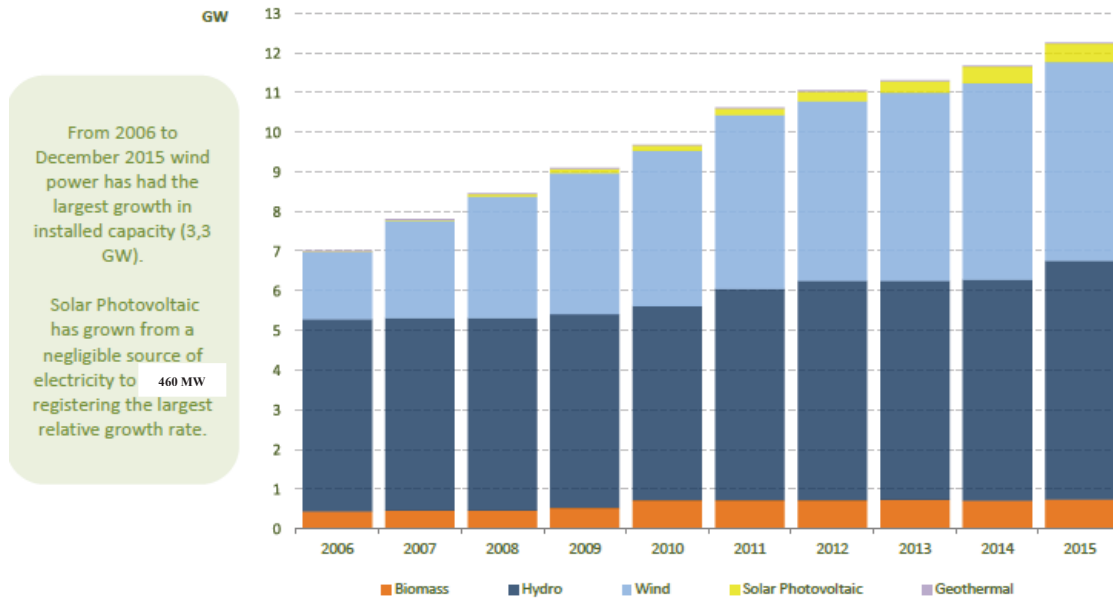


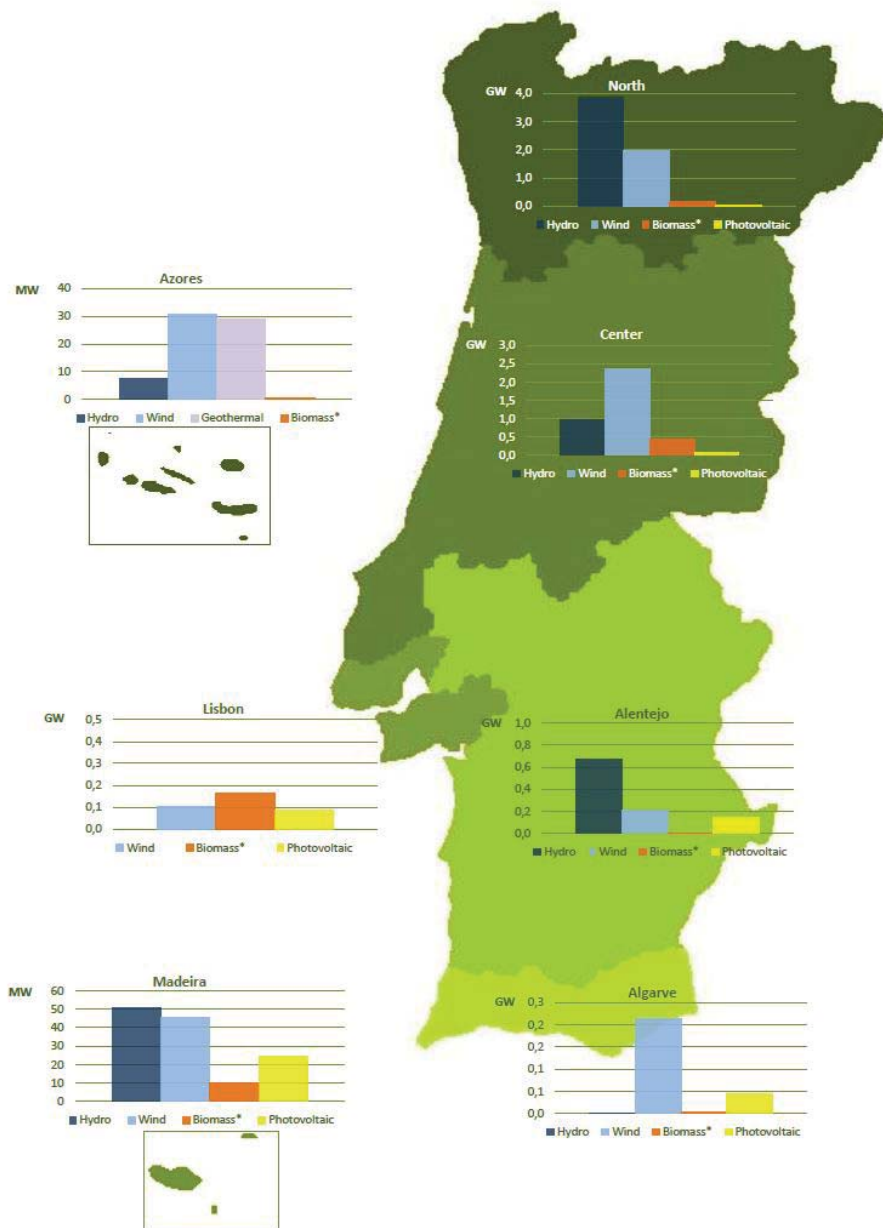
Fig. 3 - 2006-2015 installed capacity for the different RE types (Portugal) (www.dgeg.pt).

The RE installed capacity has increased constantly, namely in the solar energy case.

Table 3 – Installed capacity (MW) by country region.

	Installed Capacity by Region (MW)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Portugal	7.010	7.811	8.459	9.106	9.688	10.626	11.054	11.311	11.677	12.259
Mainland	6.886	7.687	8.330	8.954	9.521	10.429	10.863	11.109	11.467	12.038
North	3.951	4.255	4.588	4.715	4.976	5.682	5.773	5.846	5.978	6.357
Center	2.139	2.603	2.770	3.155	3.436	3.630	3.634	3.743	3.844	3.978
Lisbon	201	216	243	265	280	278	290	312	357	388
Alentejo	560	572	643	676	684	687	934	964	1.025	1.041
Algarve	35	40	86	143	145	152	232	243	264	275
Azores	46	46	50	50	50	63	62	69	69	69
Madeira	76	76	76	100	113	130	126	131	131	131
Non specified	2	2	3	2	3	4	3	3	10	22

Installed capacity distribution by technology and NUTS II in 2014



* Biomass: Solid Biofuels + Municipal Waste + Biogases

Fig. 4 - Distribution of installed capacity by type of RE by country region in 2014 (www.dgeg.pt).

Table 4 – Micro and mini-production installed capacity (kW) in 2008-2014.

	Micro/Mini Installed Capacity (kW)							
	2008	2009	2010	2011	2012	2013	2014	2015
Total Micro/Mini	10.390	27.256	35.339	65.146	105.709	138.092	163.390	174.142
Microproduction	10.390	27.256	34.692	63.536	83.338	91.899	98.156	101.533
Hydro				32	24	43	103	209
Wind				627	631	633	418	420
Solar Photovoltaic	10.390	27.256	34.692	62.877	82.683	91.223	97.635	100.904
Miniproduction			647	1.610	22.371	46.193	65.235	72.610
Hydro						20	20	20
Wind						50	60	60
Solar Photovoltaic			647	1.610	22.371	46.122	65.154	72.529
Biogases						0,7	0,7	0,7



Fig. 5 - 2008-2015 micro and mini-production installed capacity (MW) for the different RE types (Portugal) (www.dgeg.pt).

Microproduction Law (Decree-Law 363/2007, of 2 November, revised by the Decree-Law 118-A/2010, of 8 October and by the Decree-Law 25/2013, of 8 March) regulates the small generation production of electricity (up to 5,75 kW) from RES. It provides for simplified licensing procedures for local grid-connected, low voltage, small/residential energy producers. The licensing of solar, wind, hydro, biomass and non-renewable CHP is conducted on-line via internet, using the System of Registration of Microgenerators (SRM). The connection capacity of a microproduction can only be up to 50% of the contracted power.

Miniproduction Law (Decree-Law 34/2011, of 8 March, revised by the Decree-Law 25/2013, of 19 February) regulates the small generation production of electricity (from 5,75 kW to 250 kW) from RES. It also provides for the same simplified licensing procedures for local grid-connected, low or medium voltage, small/commercial/industrial energy producers. The licensing of solar, wind, hydro, biomass and biomass is conducted on-line via internet, using the System of Registration of Miniproducers (SRMini). The connection capacity of a miniproduction can only be up to 50% of the contracted power and the annual consumption value of the user installation has to be at least 50% of the annual value of the generated electricity.

Table 5 - Micro and mini annual production (MWh) in 2008-2015.

	Micro/Mini Annual Production (MWh)							
	2008	2009	2010	2011	2012	2013	2014	2015 ¹
Total Micro/Mini	7.120	21.215	45.047	80.176	145.088	200.103	232.271	272.355
Microproduction	7.120	21.215	44.677	78.728	131.674	148.775	148.994	164.589
Hydro				40	40	87	263	601
Wind				378	379	485	231	314
Solar Photovoltaic	7.120	21.215	44.677	78.310	131.255	148.204	148.500	163.673
Miniproduction			371	1.448	13.414	51.327	83.277	107.767
Hydro						16	61	15
Wind						5	70	94
Solar Photovoltaic			371	1.448	13.414	51.307	83.146	107.658
Biogases						1.319	2.536	2.620

¹ Provisional data.

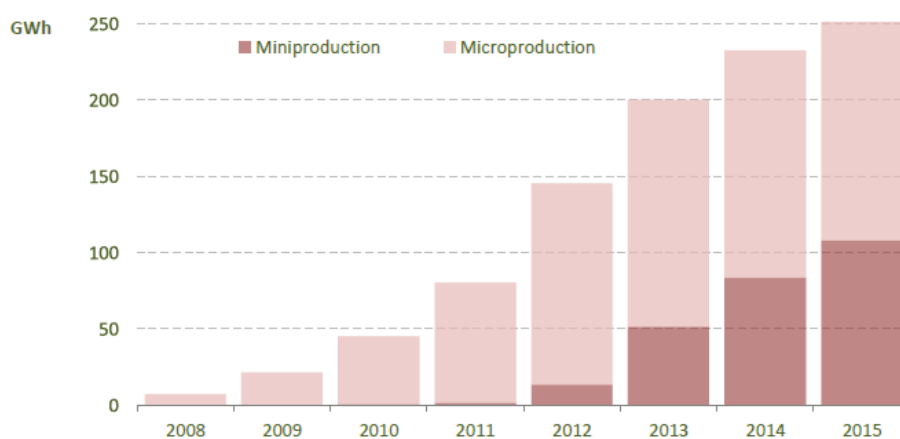
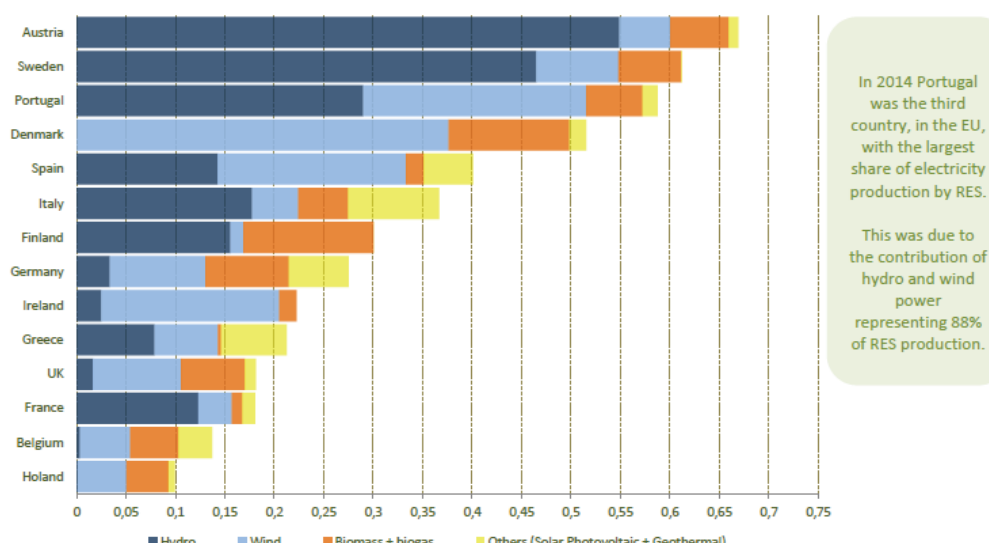


Fig. 6 - 2008-2015 micro and mini-production production for the different RE types (Portugal) (www.dgeg.pt).



In 2014 Portugal was the third country, in the EU, with the largest share of electricity production by RES.

This was due to the contribution of hydro and wind power representing 88% of RES production.

Fig. 7 - Situation in 2014 in several European countries of the RE production by type of RE source (www.dgeg.pt).

Table 6 - Situation in 2005 and 2014 of total electric energy production (TWh) and % of RE source in several European countries (www.dgeg.pt).

	Electricity production in EU countries (TWh)								
	2005			2014			Δ% 14/05		
	Total	RES	%RES	Total	RES	%RES	Total	RES	
Austria	63,1	39,9	0,1%	74,7	50,0	66,9%	18,4%	25%	
Sweden	159,0	80,9	0,1%	138,5	84,7	61,2%	-12,9%	5%	
Portugal	53,9	15,3	0,0%	53,7	31,6	58,8%	-0,4%	106%	
Denmark	36,8	9,5	0,0%	34,8	17,9	51,5%	-5,4%	89%	
Spain	291,5	49,4	0,0%	274,4	109,9	40,1%	-5,9%	122%	
Italy	293,6	44,1	0,0%	321,6	117,9	36,7%	9,5%	167%	
Finland	70,5	22,9	0,0%	85,9	25,8	30,0%	21,8%	13%	
Germany	612,1	61,8	0,0%	580,7	159,7	27,5%	-5,1%	158%	
Ireland	25,7	1,9	0,0%	28,5	6,3	22,2%	10,9%	239%	
Greece	59,2	5,9	0,0%	56,6	12,0	21,3%	-4,4%	103%	
UK	396,6	15,0	0,0%	355,5	64,4	18,1%	-10,4%	329%	
France	570,6	56,7	0,0%	495,8	89,5	18,1%	-13,1%	58%	
Belgium	93,3	2,1	0,0%	90,1	12,4	13,7%	-3,4%	486%	
Holand	100,2	7,5	0,0%	117,3	11,6	9,9%	17,1%	55%	

Table 7 - Situation in 2005 and 2014 of total electric energy production (TWh) and % of RE source in several OECD countries (www.dgeg.pt).

	Electricity production in other OECD countries (TWh)								
	2005			2014			Δ% 14/05		
	Total	RES	%RES	Total	RES	%RES	Total	RES	
Total OECD	10.461,0	1.670,3	16,0%	10.770,3	2.354,6	21,9%	3,0%	41%	
New Zealand	42,0	27,5	65,5%	43,5	34,4	79,2%	3,6%	25%	
Canada	628,2	379,0	60,3%	593,0	395,8	66,7%	-5,6%	4%	
Turkey	162,0	39,9	24,6%	255,5	52,0	20,4%	57,7%	30%	
Mexico	233,7	37,5	16,0%	300,1	52,3	17,4%	28,4%	40%	
USA	4.258,3	356,4	8,4%	4.379,1	556,6	12,7%	2,8%	56%	
Japan	1.049,1	92,8	8,8%	1.025,1	148,8	14,5%	-2,3%	60%	
Australia	248,2	17,3	7,0%	248,2	36,9	14,9%	0,0%	113%	
Norway	126,0	136,5	108,3%	126,7	138,3	109,2%	0,6%	1%	

From all this data it can be seen that in 2014 Portugal was the third European country (Sweden, Austria better) with the largest share of electricity production by RE source and that when comparing to OECD countries Portugal was only outpaced by Norway, Canada and New Zealand. In 2015, from the total electricity production in Portugal (25.355 GWh), PV (797 GWh) contributed with 3,1%.

3. Statistics on PV in Portugal

Data is shown (tables, graphics) on the situation of PV in 2015 or the evolution in the last years namely: a) number and characterization of existing PV installations; b) 2006-2015 PV total energy production by country region; c) 2006-2015 PV installed capacity by country region; d) gross PV electricity generation in several (38) European countries.

In Portugal (including Madeira and Azores), the list of photovoltaic parks account for 129, in which 63 use polycrystalline silicon technology, 19 monocrystalline silicon technology, 7 thin films, 4 amorphous silicon and 4 multi-junction (see Table 9). Besides this there exists also aggregate data in micro-production (<5.75 KW) and mini-production (5.75 kW – 250 kW). So, provisional data for 2015 are an installed capacity of about 460 MW and a produced energy of about 797 GWh, overcoming the values foreseen in NREAP which were respectively of 383 MW and 593 GWh (NREAP, Table 3, p. 2077).

Table 8 - Number and characterization of existing PV installations in Portugal in 2015.

No. installations	Polycrystalline silicon	Monocrystalline silicon	Amorphous silicon	Thin film	Multi-junction	Unknown
129	63	19	4	7	4	32

	Production by Region (GWh)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 ¹
Portugal	5	24	41	160	215	282	393	479	627	797
Mainland	0	20	36	156	207	262	355	439	591	738
North	0	0	0	6	11	21	40	55	67	81
Center	0	0	0	9	16	30	51	68	97	118
Lisbon	0	0	0	5	14	19	29	43	106	159
Alentejo	0	20	36	133	162	185	206	219	247	299
Algarve	0	0	0	2	4	7	29	53	73	80
Azores	0	0	0	0	0	0	0	1	0	0
Madeira	0	0	0	0	4	19	34	37	37	43
Non specified	5	4	4	4	4	1	3	3	0	16

¹ Provisional data.

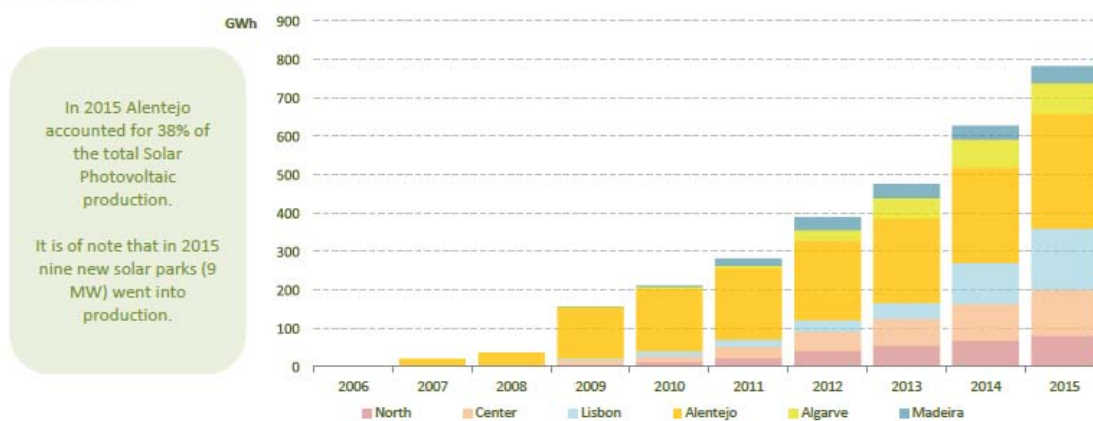


Fig. 8 – 2006-2015 PV total energy production (GWh) by country region (www.dgeg.pt).

Table 9 – 2006-2015 PV installed capacity (MW) by country region (www.dgeg.pt).

	Installed Capacity by Region (MW)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Portugal	3	15	62	110	134	175	244	299	418	460
Mainland	0	11	59	107	121	151	218	273	384	415
North	0	0	1	4	9	19	30	42	47	53
Center	0	0	1	5	12	23	36	49	65	66
Lisbon	0	0	0	8	11	16	22	44	88	91
Alentejo	0	11	57	88	86	87	103	109	140	156
Algarve	0	0	0	2	3	5	27	29	45	50
Azores	0	0	0	0	0	0	0	0	0	1
Madeira	0	0	0	1	10	21	23	24	24	24
Non specified	3	3	3	2	3	3	3	1	9	20

Table 10 – Gross PV electricity generation (GWh) in several (38) European countries (Eurostat).

COUNTRY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium	1	2	6	42	166	560	1.169	2.148	2.644	2.883
Bulgaria	0	0	0	0	3	15	101	814	1.361	1.252
Czech Republic	0	1	2	13	89	616	2.182	2.149	2.033	2.123
Denmark	2	2	2	3	4	6	15	104	518	596
Germany	1.282	2.220	3.075	4.420	6.583	11.729	19.599	26.380	31.010	36.056
Estonia	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	1	1	1	1
Greece	1	1	1	5	50	158	610	1.694	3.648	3.792
Spain	41	119	500	2.562	5.961	6.425	7.441	8.193	8.327	8.218
France	11	12	18	42	174	620	2.078	4.016	4.735	5.909
Croatia	0	0	0	0	0	0	0	2	11	35
Italy	31	35	38	193	676	1.906	10.796	18.862	21.589	22.306
Cyprus	0	1	2	3	4	7	12	22	47	84
Latvia	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	2	45	73
Luxembourg	18	21	21	20	20	21	26	38	74	95
Hungary	0	0	0	1	1	1	1	8	25	56
Malta	0	0	0	0	0	1	5	17	29	68
Netherlands	35	36	37	39	45	56	104	226	487	785
Austria	21	22	24	30	49	89	174	337	582	785
Poland	0	0	0	0	0	0	0	1	1	7
Portugal	3	5	24	38	160	211	280	393	479	627
Romania	0	0	0	0	0	0	1	8	420	1.616
Slovenia	0	0	0	1	4	13	65	163	215	257
Slovakia	0	0	0	0	0	17	397	424	588	597
Finland	3	3	4	4	4	5	5	6	6	8
Sweden	2	2	3	4	7	9	11	19	35	47
United Kingdom	8	11	14	17	20	41	244	1.352	1.989	4.050
Iceland	0	0	0	0	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	0	0	0
Montenegro	0	0	0	0	0	0	0	0	0	0
Macedonia	0	0	0	0	0	0	1	3	9	14
Albania	0	0	0	0	0	0	0	0	0	0
Serbia	0	0	0	0	0	0	0	0	0	6
Turkey	0	0	0	0	0	0	0	0	0	17
Kosovo	0	0	0	0	0	0	0	0	0	0
Moldova	0	0	0	0	0	0	0	0	0	1
Ukraine	0	0	0	0	0	1	30	333	570	429

From the previous data it can be seen that solar photovoltaic installed capacity has grown from very small numbers to 460 MW, registering the largest relative low rate, comparing to other renewable energy sources. In the 10 year period of 2006-2015, PV energy production grew from 5 GWh to 797 GWh, with an average growth near to 80 GWh/year. In the period of 2008-2015 micro PV installed capacity raised from 10.390 kW to 100904 kW (about 10 times more), a value over the foreseen for 2020 (see next item) and only in 6 years (2010-2015) mini PV installed capacity raised from 647kW to 72529 kW (about 112 times more), a value representing 29% of what is foreseen for 2020 (see next item). The micro/mini production represents about 34% of the total PV production. Only in 2015 ten new solar parks went into production. In this year Alentejo (south of Portugal) accounted for 38% of the total solar photovoltaic production. Comparing with other 38 European countries Portugal is the 13th PV electricity producer.

4. RE/PV Programmes/Policies

The NREAP is defined by the Council of Ministers' Resolution n° 20/2013, published in the Republic Diary, 1st Series, N°70 from 10th of April 2013. This official document foresees, that the contribution of PV for 2020

is 670 MW of installed capacity and 1039 GWh of produced energy, respectively. Solar energy is expected to have an important role in the increase of decentralized power production; the production cycle is adequate to the consumption peaks, and also because has great resources availability and also R&D capacity.

The Decree-Law 363/2007 of November 2nd and the Decree-Law 34/2011 of March 8th regulate the production and selling of electricity by micro and mini power plants, respectively. Another Decree-Law (n°153/2014 of October 20th) is also related with this. So, besides the micro-production program continuation, in 2011 a mini-production was set having as aim the installation of 250 MW until 2020, mainly for services and industry. The enlargement of mini-production to larger capacities in face of demand and technology evolution can be considered. Aiming also at more 80 MW of installation capacity by 2020 in micro-production the two support programs may be fused.

5. Conclusion

In the last 10 years PV power production per year grew from only 5 GWh to about 800 GWh with the installed capacity in the same period changing from 3 MW to about 460 MW. From 2010 to 2015, PV mini and micro-production raised from only 35 MW to more than 173 MW, almost five times more. PV infrastructures are mainly placed in the south of the country where the solar potential is greater. The provisional data for 2015 for PV show that the installed capacity was about 20% higher (achieving 69% of 2020 value) and the produced energy was about 34% higher (achieving 77% of 2020 value) than what was foreseen in the NREAP, demonstrating that national policies in this field are correct.

6. References

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