

SOLAR RESOURCES AND CARBON FOOTPRINT OF PHOTOVOLTAIC POWER IN DIFFERENT REGIONS IN EUROPE

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ABSTRACT: The 2011 world average carbon footprint of PV system manufacturing is estimated as 1798 kg CO₂-eq/kWp using technology shares (multi, mono, film Si, CdTe, CIGS) as weighting factors. The electricity mixes of all production countries of poly-Si, wafer, cell and modules was taken into account. New yearly irradiation data (kWh/m²) and PV energy output (kWh/kWp) are calculated for different regions in Europe on NUTS level 1 and 2 for horizontal, optimum and vertical angle. The world average carbon footprint of PV electricity generation is estimated as 55 g CO₂-eq/kWh with cumulative installations as weighting factors. Lowest value of 38 g CO₂-eq/kWh is for Cyprus which has a high irradiation and the highest value of 89 g CO₂-eq/kWh is for Iceland which has a low irradiation. It is assumed that the PV modules are installed at optimal angle to the sun and end-of-life treatment is excluded. The majority of countries can decrease the greenhouse gas emission of electricity generation by increasing the share of photovoltaics.

Keywords: energy performance, environmental effect, carbon footprint

1 INTRODUCTION

The 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) [1] states that 1) continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system and 2) limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. This raises the question whether photovoltaics could contribute to decreasing the life-cycle greenhouse gas emission (carbon footprint) of electricity generation. In other words: What is the mitigation potential of photovoltaics?

In this paper we will estimate carbon footprint of PV electricity for different countries and several regions in Europe. First we determine the life-cycle world average carbon footprint of PV systems (in kg CO₂-eq/kWp). Combined with regional specific data for irradiation (in kWh/m².year) and cumulative installations (MWp) we calculate the world average carbon footprint of PV (g CO₂-eq/kWh).

Country average irradiation levels have been published [2-4] but since there is often a large regional variation of this irradiation this paper presents new irradiation data for different regions in Europe on NUTS (Nomenclature des unités territoriales statistiques, Nomenclature of Units for Territorial Statistics) level 1 and 2 for horizontal, optimum and vertical angle of the installed PV module.

2 CARBON FOOTPRINT OF MANUFACTURING

The carbon footprint of photovoltaic system production (kg CO₂-eq/kWp), status 2011, is calculated using Life Cycle Assessment and based on data collected by SmartGreenScans [5,6] and auxiliary data from the ecoinvent 2.2 database. It is assumed that all potent greenhouse gases like NF₃, SF₆ and CF₄ are properly abated in the case they are used in manufacturing. Reliable information on the use and direct emission of

these gases is missing. End-of-life treatment is excluded. For the electricity mixes used at the manufacturing sites we used the electricity mix of the countries where the actual production takes place (Table 1). For Balance-of-System components we used the unmodified ecoinvent 2.2 data. The life-cycle greenhouse gas emissions are calculated with Simapro 7 software using the IPCC2007GWP100a impact assessment method.

Technology market shares of mono- and multicrystalline silicon, thin film silicon, CdTe, and CIGS are used as weighting factors to calculate the world average carbon footprint of PV system manufacturing per kWp module power (Table 2): 1798 kg CO₂-eq/kWp.

3 PV ENERGY OUTPUT

PV energy output (kWh/kWp.year) is estimated using models of irradiation (kWh/m².year) and the performance of the PV system and are shown in Table 3 and 4.

Irradiation is estimated using the PVGIS solar radiation database [2]. In most of Europe, this is based on solar radiation estimates from satellite data, processed by the CM SAF collaboration (www.cmsaf.eu). North of 60 degrees North the solar radiation data is a gridded dataset interpolated from ground station data [3]. The min - area weighted average - max irradiation values per year for European countries are

- 1) 780-1252-1982 kWh/m² for horizontal,
- 2) 963-1463-2233 kWh/m² for optimal angle and
- 3) 751-995-1331 kWh/m² for vertical installation.

PV performance is calculated using a model for the PV power as a function of irradiance and temperature [7]. The modules are assumed to use crystalline silicon solar cells. The balance-of-system energy losses are assumed to be 10%. The min - area weighted average - max PV energy output values per year for European countries are

- 1) 630-995-1532 kWh/kWp for horizontal,
- 2) 767-1163-1724 kWh/kWp for optimum angle,
- 3) 611-798-1025 kWh/kWp for vertical installation.

However, the calculation of the world average carbon

footprint is based on a performance ratio of 0.75, power degradation of 0.23% per year and lifetime of 30 years for all technologies and all countries since detailed calculation of PV performance outside Europe is missing.

Irradiation and PV energy output are calculated for horizontal-, optimum- and vertical angle of the PV module and for regions in Europe classified according to NUTS levels 1 and 2. The complete Excel file is available for download [8].

For other countries area-weighted irradiation data are taken from Breyer [4].

4 CUMULATIVE INSTALLATIONS

Cumulative installation for the year 2013 are taken from EPIA [9] and IEA PVPS [10]. Data for regions in Europe are available for EPIA members.

5 AVERAGE CARBON FOOTPRINT PER REGION

Per region the average carbon footprint is calculated using the cumulative installation per region as weighting factors (Table 5). The carbon footprint of the country electricity production mixes (excluding import of electricity) are shown as well and provide the mitigation potential of photovoltaics.

6 CONCLUSIONS

The world average carbon footprint is estimated as 55 g CO₂-eq/kWh with the lowest value of 38 g CO₂-eq/kWh for Cyprus which has a high irradiation and the highest value of 89 g CO₂-eq/kWh for Iceland which has a low irradiation. Assumed is that the PV modules are installed at optimal angle to the sun and end-of-life treatment is excluded. The majority of countries can decrease the greenhouse gas emission of electricity generation by increasing the share of photovoltaics.

7 ACKNOWLEDGEMENTS

EPIA kindly provided cumulative installation per region in Europe.

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Table II: Calculation of average carbon footprint of PV system manufacturing with technology shares as weighting factor

Technology	Technology shares	Carbon footprint PV system
	Photon International March 2012	kg CO ₂ -eq/kWp
	2011	2011
mono c-Si	30.9	2728
multi c-Si	57.0	1536
ribbon c-Si	0.0	
a-Si/μc-Si	3.4	876
CdTe	5.5	574
CIS	2.4	750
other	0.8	
	100.0	1798
		weighted average

Table I: Production (capacities) of poly-silicon, wafers, cells and modules in different regions in the world

xSi	Solar Silicon	capacity 2011	Grunwald 2012	Europe	Americas	Arabia-Africa	Asia-Pacific	China
				10%	23%	0%	26%	41%
		capacity 2012	EPIA 2013	17%	28%		20%	35%
		production 2012	EPIA 2013	20%	34%		19%	27%
		production 2012	Sage 2013	19%	26%	0%	24%	31%
	Wafers	production 2011	Mehta 2013	7%	1%	0%	25%	67%
		capacity 2012	EPIA 2013	8%	1%		13%	78%
		production 2012	EPIA 2013	7%	1%		12%	80%
	Cells	production 2011	Mehta 2013	6%	2%	0%	30%	62%
		capacity 2012	EPIA 2013	5%	2%		22%	71%
		production 2012	EPIA 2013	5%	2%		27%	66%
	Modules	production 2011	Mehta 2013	12%	4%	2%	15%	66%
		capacity 2012	EPIA 2013	13%	3%		11%	73%
		production 2012	EPIA 2013	14%	4%		13%	69%
film-Si	Modules	production 2011	Photon Int 2012	65%	13%	0%	22%	0%
CdTe	Modules	production 2011	Photon Int 2012	15%	14%	0%	70%	0%
CIGS	Modules	production 2011	Photon Int 2012	22%	19%	0%	59%	0%

Table III: Area-weighted yearly global irradiation (kWh/m²) and PV energy output (kWh/kWp) on horizontal-, optimum- and vertical angle for regions in Europe classified according to NUTS levels 1

NUTS code	Region name	Area (km ²)	Yearly global horizontal irradiation (kWh/m ²)	Yearly PV energy output (horizontal) (kWh/kWp)	Yearly global irradiation at optimum angle (kWh/m ²)	Yearly PV energy output at optimum angle (kWh/kWp)	Yearly global irradiation at 90 deg. (kWh/m ²)	Yearly PV energy output at 90 deg. (kWh/kWp)
	AUSTRIA	83866	1138	923	1329	1072	927	761
AT1	Ostösterreich	23532	1162	933	1340	1080	918	745
AT2	Südösterreich	25968	1165	947	1376	1112	970	801
AT3	Westösterreich	34366	1102	898	1287	1037	900	742
	BELGIUM	30662	1074	859	1237	995	863	696
BE1	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	164	1074	859	1242	998	870	702
BE2	Vlaams Gewest	13605	1083	865	1254	1007	882	711
BE3	Région Wallonne	16893	1066	855	1223	984	848	684
	BULGARIA	111010	1432	1134	1633	1293	1062	847
BG3	Severna i Iztochna Bulgaria	68303	1426	1122	1619	1275	1049	830
BG4	Yugozapadna i Yuzhna Centralna Bulgaria	42707	1440	1153	1654	1321	1082	874
	SWITZERLAND	41294	1194	972	1396	1121	963	792
CH0	Schweiz/Suisse/Svizzera	41294	1194	972	1396	1121	963	792
	CYPRUS	9302	1982	1532	2233	1724	1331	1025
CY0	Kýpros / Kibris	9302	1982	1532	2233	1724	1331	1025
	CZECH REPUBLIC	78902	1097	884	1254	1015	860	699
CZ0	Ceská republika	78902	1097	884	1254	1015	860	699
	GERMANY	357796	1081	867	1251	1008	874	708
DE1	Baden-Württemberg	36063	1145	921	1325	1070	913	741
DE2	Bayern	70638	1120	902	1291	1044	891	724
DE3	Berlin	887	1071	855	1245	996	877	707
DE4	Brandenburg	29673	1075	860	1252	1004	883	713
DE5	Bremen	385	1039	831	1212	973	862	696
DE6	Hamburg	767	1037	831	1212	977	861	697
DE7	Hessen	21127	1070	859	1227	988	849	687
DE8	Mecklenburg-Vorpommern	23060	1058	849	1240	1000	882	715
DE9	Niedersachsen	47779	1042	835	1211	974	856	692
DEA	Nordrhein-Westfalen	34127	1048	839	1212	973	851	687
DEB	Rheinland-Pfalz	19825	1093	876	1251	1007	861	695
DEC	Saarland	2565	1112	891	1272	1023	870	701
DED	Sachsen	18457	1062	854	1228	992	860	699
DEE	Sachsen-Anhalt	20501	1075	861	1248	1004	879	711
DEF	Schleswig-Holstein	15748	1042	835	1225	986	877	709
DEG	Thüringen	16194	1051	847	1208	976	841	684
	DENMARK	43125	1007	804	1192	955	865	696
DK0	Danmark	43125	1007	804	1192	955	865	696
	ESTONIA	45383	966	773	1152	927	840	681
EE0	Eesti	45383	966	773	1152	927	840	681
	GREECE excluding Mount Athos	131938	1698	1341	1924	1510	1185	938
EL1	Voreia Ellada	56586	1601	1269	1829	1444	1159	925
EL2	Kentriki Ellada	53993	1726	1363	1951	1525	1190	940
EL3	Attiki	3808	1816	1426	2050	1602	1239	971
EL4	Nisia Aigaïou; Kriti	17551	1895	1487	2119	1654	1246	971
N_A	Mount Athos							
	SPAIN excluding Atlantic Islands	498607	1688	1323	1970	1539	1275	1007
ES1	Noroeste	45535	1395	1109	1626	1288	1089	870
ES2	Noreste	70386	1586	1250	1873	1474	1247	992
ES3	Comunidad de Madrid	8026	1727	1355	2021	1579	1306	1035
ES4	Centro (ES)	215184	1710	1341	1993	1559	1283	1014
ES5	Este	60484	1680	1319	1990	1557	1321	1047
ES6	Sur	98992	1851	1432	2132	1643	1334	1038
ES7	Canarias	0	0	0	0	0	0	0
	FINLAND	337383	839	672	1056	858	822	675
FI1	Manner-Suomi	336059	839	672	1056	858	821	675
FI2	Åland	1324	960	770	1178	952	884	719
	FRANCE excluding overseas departments	549211	1299	1033	1520	1212	1042	836
FR1	Île de France	12063	1192	946	1377	1097	950	758
FR2	Bassin Parisien	146650	1203	959	1394	1116	959	770
FR3	Nord - Pas-de-Calais	12461	1116	892	1295	1040	907	731
FR4	Est	48315	1178	943	1364	1097	936	756
FR5	Ouest	85876	1287	1023	1511	1207	1049	840
FR6	Sud-Ouest	104459	1363	1079	1600	1271	1092	872
FR7	Centre-Est	71065	1323	1058	1550	1237	1054	850
FR8	Méditerranée	68322	1533	1214	1828	1441	1241	994
FR9	Départements d'outre-mer	0	0	0	0	0	0	0

NUTS code	Region name	Area (km2)	Yearly global horizontal irradiation (kWh/m2)	Yearly PV energy output (horizontal) (kWh/kWp)	Yearly global irradiation at optimum angle (kWh/m2)	Yearly PV energy output at optimum angle (kWh/kWp)	Yearly global irradiation at 90 deg. (kWh/m2)	Yearly PV energy output at 90 deg. (kWh/kWp)
	CROATIA	56518	1370	1086	1581	1253	1046	835
HR0	Hrvatska	56518	1370	1086	1581	1253	1046	835
	HUNGARY	93028	1296	1032	1494	1193	1008	810
HU1	Közép-Magyarország	6903	1291	1027	1487	1187	1005	807
HU2	Dunántúl	36640	1297	1033	1496	1196	1008	811
HU3	Alföld és Észak	49485	1296	1031	1492	1191	1008	809
	IRELAND	69999	998	800	1175	951	858	696
IE0	Ireland	69999	998	800	1175	951	858	696
	ICELAND	102649	780	630	963	767	751	611
IS0	Ísland	102649	780	630	963	767	751	611
	ITALY	301027	1521	1202	1768	1389	1162	926
ITC	Nord-Ovest	57940	1384	1105	1645	1298	1131	915
ITF	Sud	73457	1598	1254	1832	1433	1171	922
ITG	Isole	49935	1752	1371	1998	1560	1245	974
ITH	Nord-Est	61614	1366	1090	1614	1277	1108	896
ITI	Centro (IT)	58081	1526	1204	1775	1397	1170	931
	LIECHTENSTEIN	163	1141	920	1345	1079	946	770
LI0	Liechtenstein	163	1141	920	1345	1079	946	770
	LITHUANIA	64918	1016	809	1178	938	834	667
LT0	Lietuva	64918	1016	809	1178	938	834	667
	LUXEMBOURG	2608	1090	876	1243	1002	850	686
LU0	Luxembourg	2608	1090	876	1243	1002	850	686
	LATVIA	64642	1000	798	1176	940	845	680
LV0	Latvija	64642	1000	798	1176	940	845	680
	MONTENEGRO	13849	1367	1093	1565	1244	1019	820
ME0	Crna Gora	13849	1367	1093	1565	1244	1019	820
	MACEDONIA	25371	1497	1193	1711	1356	1098	882
MK0	Poranešna Jugoslovenska Republika Makedonija	25371	1497	1193	1711	1356	1098	882
	MALTA	311	1918	1491	2163	1683	1308	1014
MT0	Malta	311	1918	1491	2163	1683	1308	1014
	NETHERLANDS	35514	1067	852	1244	997	883	711
NL1	Noord-Nederland	8631	1049	838	1227	984	877	707
NL2	Oost-Nederland	10119	1054	841	1227	983	871	701
NL3	West-Nederland	9490	1095	875	1280	1028	908	732
NL4	Zuid-Nederland	7274	1069	853	1239	993	874	704
	NORWAY	324001	820	657	1020	811	791	648
NO0	Norge	324001	820	657	1020	811	791	648
	POLAND	311905	1082	868	1252	1009	876	709
PL1	Region Centralny	53745	1090	875	1259	1016	877	710
PL2	Region Poludniowy	27510	1081	871	1245	1009	863	704
PL3	Region Wschodni	74845	1093	878	1257	1014	871	706
PL4	Region Północno-Zachodni	66248	1074	860	1251	1005	881	712
PL5	Region Poludniowo-Zachodni	29371	1090	876	1262	1021	882	717
PL6	Region Północny	60186	1064	851	1241	996	877	707
	PORTUGAL excluding Atlantic Islands	88957	1734	1356	2007	1565	1280	1002
PT1	Continente	88957	1734	1356	2007	1565	1280	1002
PT2	Região Autónoma dos Açores	0	0	0	0	0	0	0
PT3	Região Autónoma da Madeira	0	0	0	0	0	0	0
	ROMANIA	238313	1295	1027	1488	1181	998	798
RO1	Macroregiunea Unu	68309	1210	966	1393	1112	947	762
RO2	Macroregiunea Doi	72572	1308	1037	1506	1195	1012	810
RO3	Macroregiunea Trei	36205	1385	1091	1587	1251	1049	833
RO4	Macroregiunea Patru	61227	1322	1047	1515	1198	1008	804
	SWEDEN	449503	873	699	1090	879	841	689
SE1	Östra Sverige	50310	931	743	1122	903	835	675
SE2	Södra Sverige	84930	938	749	1103	883	799	643
SE3	Norra Sverige	314263	846	678	1082	874	854	704
	SLOVENIA	20242	1255	1007	1459	1166	991	804
SI0	Slovenija	20242	1255	1007	1459	1166	991	804
	SLOVAKIA	49088	1160	932	1339	1078	919	746
SK0	Slovensko	49088	1160	932	1339	1078	919	746
	TURKEY	772044	1658	1307	1876	1478	1154	913
TR1	Istanbul	5285	1524	1206	1703	1353	1054	833
TR2	Bati Marmara	43067	1607	1272	1811	1433	1120	887
TR3	Ege	89275	1791	1410	2040	1598	1256	992
TR4	Dogu Marmara	49343	1554	1235	1753	1390	1090	868
TR5	Bati Anadolu	73027	1726	1364	1955	1542	1198	949
TR6	Akdeniz	88513	1806	1409	2049	1588	1250	978
TR7	Orta Anadolu	91043	1665	1317	1884	1492	1159	918
TR8	Bati Karadeniz	74069	1491	1186	1693	1347	1078	860
TR9	Dogu Karadeniz	35092	1316	1047	1493	1194	968	777
TRA	Kuzeydogu Anadolu	70802	1502	1192	1690	1354	1044	831
TRB	Ortadogu Anadolu	77440	1664	1311	1861	1467	1109	874
TRC	Güneydogu Anadolu	75088	1823	1417	2066	1606	1254	981
	UNITED KINGDOM	245072	982	788	1154	933	838	681
UKC	North East (England)	8641	945	761	1125	916	833	680
UKD	North West (England)	14181	957	769	1121	910	814	662
UKE	Yorkshire and the Humber	15440	983	788	1164	945	854	695
UKF	East Midlands (England)	15670	1034	828	1225	990	894	726
UKG	West Midlands (England)	13029	1024	821	1198	968	865	701
UKH	East of England	19219	1077	863	1275	1028	924	750
UKI	London	1594	1086	870	1274	1027	912	739
UKJ	South East (England)	19155	1111	890	1308	1056	935	758
UKK	South West (England)	23989	1098	881	1287	1040	918	744
UKL	Wales	20870	1009	812	1177	954	842	684
UKM	Scotland	79127	880	708	1032	833	757	616
UKN	Northern Ireland	14157	944	759	1108	900	810	659

Table IV: Area-weighted yearly global irradiation (kWh/m²) and PV energy output (kWh/kWp) on horizontal-, optimum- and vertical angle for regions in Europe classified according to NUTS levels 2

NUTS code	Region name	Area (km ²)	Yearly global horizontal irradiation (kWh/m ²)	Yearly PV energy output (horizontal) (kWh/kWp)	Yearly global irradiation at optimum angle (kWh/m ²)	Yearly PV energy output at optimum angle (kWh/kWp)	Yearly global irradiation at 90 deg. (kWh/m ²)	Yearly PV energy output at 90 deg. (kWh/kWp)
AUSTRIA		83866	1138	923	1329	1072	927	761
AT11	Burgenland (AT)	3939	1240	990	1436	1152	981	792
AT12	Niederösterreich	19179	1145	921	1319	1064	905	735
AT13	Wien	414	1207	965	1391	1118	946	764
AT21	Kärnten	9529	1209	985	1434	1157	1011	836
AT22	Steiermark	16439	1140	925	1343	1086	946	780
AT31	Oberösterreich	11969	1129	912	1306	1055	901	735
AT32	Salzburg	7161	1064	870	1249	1007	882	729
AT33	Tirol	12635	1097	901	1289	1035	909	754
AT34	Vorarlberg	2601	1098	895	1292	1042	906	746
BELGIUM		30662	1074	859	1237	995	863	696
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	164	1074	859	1242	998	870	702
BE21	Prov. Antwerpen	2888	1068	853	1235	991	869	700
BE22	Prov. Limburg (BE)	2439	1073	857	1240	994	869	700
BE23	Prov. Oost-Vlaanderen	2999	1081	864	1253	1006	882	711
BE24	Prov. Vlaams-Brabant	2111	1080	863	1248	1002	875	706
BE25	Prov. West-Vlaanderen	3168	1107	885	1288	1035	908	732
BE31	Prov. Brabant Wallon	1078	1082	865	1248	1002	873	703
BE32	Prov. Hainaut	3840	1086	868	1252	1005	874	703
BE33	Prov. Liège	3843	1050	842	1206	971	838	678
BE34	Prov. Luxembourg (BE)	4454	1057	849	1205	973	827	668
BE35	Prov. Namur	3678	1069	856	1225	985	848	684
BULGARIA		111010	1432	1134	1633	1293	1062	847
BG31	Severozapaden	19089	1398	1103	1589	1252	1033	821
BG32	Severen tsentralen	14841	1424	1118	1619	1273	1053	833
BG33	Severozitochen	14574	1427	1119	1620	1273	1052	830
BG34	Yugoiztochen	19799	1456	1146	1648	1299	1059	839
BG41	Yugozapaden	20289	1407	1130	1619	1295	1064	862
BG42	Yuzhen tsentralen	22418	1469	1173	1686	1345	1098	885
SWITZERLAND		41294	1194	972	1396	1121	963	792
CH01	Région lémanique	8737	1259	1023	1477	1179	1016	833
CH02	Espace Mittelland	10012	1204	977	1407	1136	971	796
CH03	Nordwestschweiz	1972	1204	968	1395	1123	949	769
CH04	Zürich	1732	1208	972	1396	1127	949	771
CH05	Ostschweiz	11523	1138	932	1325	1067	916	756
CH06	Zentralschweiz	4486	1137	927	1320	1065	910	748
CH07	Ticino	2832	1265	1032	1517	1195	1071	887
CYPRUS		9302	1982	1532	2233	1724	1331	1025
CY00	Kýpros / Kibris	9302	1982	1532	2233	1724	1331	1025
CZECH REPUBLIC		78902	1097	884	1254	1015	860	699
CZ01	Praha	505	1106	886	1264	1018	870	702
CZ02	Střední Čechy	11033	1098	883	1255	1014	863	698
CZ03	Jihozápad	17612	1096	885	1254	1019	862	702
CZ04	Severozápad	8651	1059	855	1206	978	829	674
CZ05	Severovýchod	12493	1079	871	1233	998	847	688
CZ06	Jihovýchod	13992	1133	912	1296	1047	883	716
CZ07	Střední Morava	9251	1111	896	1272	1028	870	707
CZ08	Moravskoslezsko	5365	1078	871	1235	1002	850	693
GERMANY		357796	1081	867	1251	1008	874	708
DE11	Stuttgart	10566	1132	909	1308	1054	903	731
DE12	Karlsruhe	6912	1133	909	1310	1054	904	732
DE13	Freiburg	9495	1159	934	1347	1088	929	756
DE14	Tübingen	9090	1153	931	1333	1080	915	745
DE21	Oberbayern	17544	1139	918	1327	1072	922	752
DE22	Niederbayern	10325	1141	920	1314	1062	900	732
DE23	Oberpfalz	9666	1100	887	1259	1018	863	701
DE24	Oberfranken	7225	1069	862	1221	988	840	682
DE25	Mittelfranken	7286	1117	898	1283	1036	884	716
DE26	Unterfranken	8561	1095	879	1255	1011	865	700
DE27	Schwaben	10031	1143	922	1325	1073	914	745
DE30	Berlin	887	1071	855	1245	996	877	707
DE40	Brandenburg	29673	1075	860	1252	1004	883	713
DE50	Bremen	385	1039	831	1212	973	862	696
DE60	Hamburg	767	1037	831	1212	977	861	697
DE71	Darmstadt	7445	1100	881	1264	1016	873	705
DE72	Gießen	5387	1068	858	1224	986	846	685
DE73	Kassel	8295	1044	841	1196	965	829	673
DE80	Mecklenburg-Vorpommern	23060	1058	849	1240	1000	882	715
DE91	Braunschweig	8131	1044	839	1205	971	844	683
DE92	Hannover	9072	1044	837	1210	973	851	688
DE93	Lüneburg	15570	1041	834	1214	976	860	695
DE94	Weser-Ems	15006	1041	832	1212	973	861	694
DEA1	Düsseldorf	5301	1065	849	1234	988	869	699
DEA2	Köln	7380	1063	850	1227	986	858	693
DEA3	Münster	6928	1052	840	1220	978	861	694
DEA4	Detmold	6509	1039	833	1200	965	843	681
DEA5	Arnsberg	8009	1028	825	1185	955	830	672
DEB1	Koblenz	8085	1071	859	1225	986	845	683
DEB2	Trier	4927	1072	861	1222	985	838	677
DEB3	Rheinhessen-Pfalz	6813	1133	907	1303	1047	897	723
DEC0	Saarland	2565	1112	891	1272	1023	870	701
DED2	Dresden	7934	1069	859	1238	999	868	705
DED4	Chemnitz	6534	1039	838	1197	971	837	683
DED5	Leipzig	3989	1086	870	1260	1012	884	716
DEE0	Sachsen-Anhalt	20501	1075	861	1248	1004	879	711
DEF0	Schleswig-Holstein	15748	1042	835	1225	986	877	709
DEG0	Thüringen	16194	1051	847	1208	976	841	684
DENMARK		43125	1007	804	1192	955	865	696
DK01	Hovedstaden	2586	1033	828	1227	987	886	716
DK02	Sjælland	7310	1051	842	1249	1005	901	728
DK03	Syddanmark	12088	1015	812	1200	964	867	700

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DK04	Midtjylland	13177	990	789	1171	936	853	685
DK05	Nordjylland	7964	972	774	1149	918	840	674
ESTONIA		45383	966	773	1152	927	840	681
EE00	Eesti	45383	966	773	1152	927	840	681
GREECE excluding Mount Athos		131938	1698	1341	1924	1510	1185	938
EL11	Anatoliki Makedonia; Thraki	14134	1580	1256	1812	1436	1161	930
EL12	Kentriki Makedonia	18900	1608	1271	1845	1455	1178	939
EL13	Dytiki Makedonia	9521	1568	1249	1789	1417	1135	911
EL14	Thessalia	14031	1637	1293	1854	1457	1148	910
EL21	Ipeiros	9171	1633	1294	1863	1457	1166	928
EL22	Ionia Nisia	2338	1785	1405	2019	1578	1225	961
EL23	Dytiki Ellada	11370	1761	1389	1996	1558	1219	962
EL24	Stereia Ellada	15564	1693	1335	1906	1490	1157	913
EL25	Peloponnisos	15550	1780	1405	2006	1568	1209	954
EL30	Attiki	3808	1816	1426	2050	1602	1239	971
EL41	Voreio Aigaio	3847	1831	1442	2077	1631	1264	994
EL42	Notio Aigaio	5379	1925	1505	2170	1692	1295	1007
EL43	Kriti	8325	1906	1495	2106	1640	1206	938
SPAIN excluding Atlantic Islands		498607	1688	1323	1970	1539	1275	1007
ES11	Galicia	29551	1441	1145	1678	1328	1114	887
ES12	Principado de Asturias	10649	1309	1044	1534	1217	1049	842
ES13	Cantabria	5335	1307	1040	1525	1207	1035	828
ES21	País Vasco	7225	1302	1033	1506	1193	1008	803
ES22	Comunidad Foral de Navarra	10383	1482	1172	1734	1372	1155	920
ES23	La Rioja	5055	1485	1172	1735	1369	1151	916
ES24	Aragón	47723	1662	1308	1973	1549	1313	1044
ES30	Comunidad de Madrid	8026	1727	1355	2021	1579	1306	1035
ES41	Castilla y León	94166	1630	1289	1905	1500	1240	988
ES42	Castilla-La Mancha	79399	1759	1376	2050	1600	1315	1039
ES43	Extremadura	41619	1797	1395	2082	1612	1317	1029
ES51	Cataluña	32150	1628	1284	1947	1528	1316	1049
ES52	Comunidad Valenciana	23314	1739	1358	2042	1593	1333	1049
ES53	Illes Balears	5020	1742	1362	2024	1581	1302	1020
ES61	Andalucía	87682	1855	1434	2134	1643	1332	1036
ES62	Región de Murcia	11288	1821	1413	2115	1637	1349	1054
ES63	Ciudad Autónoma de Ceuta	12	1822	1413	2040	1571	1225	944
ES64	Ciudad Autónoma de Melilla	10	1862	1443	2124	1638	1317	1019
ES70	Canarias	0	0	0	0	0	0	0
FINLAND		337383	839	672	1056	858	822	675
FI19	Länsi-Suomi	64534	886	710	1096	888	836	683
FI1B	Helsinki-Uusimaa	9462	930	745	1122	904	833	676
FI1C	Etelä-Suomi	35352	919	735	1115	898	834	677
FI1D	Pohjois- ja Itä-Suomi	226711	809	648	1032	841	815	672
FI20	Åland	1324	960	770	1178	952	884	719
FRANCE excluding overseas departments		549211	1299	1033	1520	1212	1042	836
FR10	Île de France	12063	1192	946	1377	1097	950	758
FR21	Champagne-Ardenne	25697	1166	929	1344	1077	923	741
FR22	Picardie	19456	1141	909	1318	1056	916	735
FR23	Haute-Normandie	12353	1159	924	1346	1078	939	754
FR24	Centre	39561	1256	1000	1457	1166	998	800
FR25	Basse-Normandie	17804	1178	938	1373	1098	958	769
FR26	Bourgogne	31779	1238	987	1432	1148	976	784
FR30	Nord - Pas-de-Calais	12461	1116	892	1295	1040	907	731
FR41	Lorraine	23673	1149	919	1322	1063	906	730
FR42	Alsace	8308	1172	937	1358	1090	935	755
FR43	Franche-Comté	16334	1223	980	1427	1148	980	793
FR51	Pays de la Loire	32383	1290	1025	1517	1212	1055	845
FR52	Bretagne	27510	1224	975	1433	1146	1001	803
FR53	Poitou-Charentes	25983	1350	1070	1588	1265	1092	873
FR61	Aquitaine	41816	1367	1080	1605	1273	1097	873
FR62	Midi-Pyrénées	45578	1385	1097	1630	1293	1109	887
FR63	Limousin	17065	1292	1029	1512	1210	1036	831
FR71	Rhône-Alpes	44926	1345	1076	1580	1257	1074	867
FR72	Auvergne	26139	1284	1027	1497	1202	1019	821
FR81	Languedoc-Roussillon	27743	1479	1171	1755	1391	1193	955
FR82	Provence-Alpes-Côte d'Azur	31876	1566	1242	1886	1485	1293	1040
FR83	Corse	8703	1586	1250	1846	1442	1207	956
FR91	Guadeloupe	0	0	0	0	0	0	0
FR92	Martinique	0	0	0	0	0	0	0
FR93	Guyane	0	0	0	0	0	0	0
FR94	Réunion	0	0	0	0	0	0	0
CROATIA		56518	1370	1086	1581	1253	1046	835
HR03	Jadranska Hrvatska	24654	1442	1140	1678	1324	1112	887
HR04	Kontinentalna Hrvatska	31864	1315	1044	1506	1198	995	796
HUNGARY		93028	1296	1032	1494	1193	1008	810
HU10	Közép-Magyarország	6903	1291	1027	1487	1187	1005	807
HU21	Közép-Dunántúl	11106	1286	1024	1482	1184	1001	804
HU22	Nyugat-Dunántúl	11333	1281	1020	1480	1184	1002	807
HU23	Dél-Dunántúl	14201	1320	1051	1521	1215	1019	819
HU31	Észak-Magyarország	13440	1249	996	1442	1153	982	792
HU32	Észak-Alföld	17695	1296	1032	1493	1192	1009	810
HU33	Dél-Alföld	18350	1330	1056	1530	1218	1026	821
IRELAND		69999	998	800	1175	951	858	696
IE01	Border; Midland and Western	33336	975	782	1150	932	844	686
IE02	Southern and Eastern	36663	1019	817	1198	969	871	706
ICELAND		102649	780	630	963	767	751	611
IS00	Ísland	102649	780	630	963	767	751	611
ITALY		301027	1521	1202	1768	1389	1162	926
ITC1	Piemonte	25364	1383	1103	1648	1301	1138	921
ITC2	Valle d'Aosta/Vallée d'Aoste	3262	1286	1048	1527	1196	1057	871
ITC3	Liguria	5473	1423	1125	1679	1317	1140	912
ITC4	Lombardia	23841	1390	1110	1649	1305	1132	916
ITF1	Abruzzo	10827	1485	1181	1716	1357	1122	899
ITF2	Molise	4431	1544	1216	1778	1398	1151	912
ITF3	Campania	13664	1587	1241	1817	1414	1161	911
ITF4	Puglia	19412	1651	1287	1900	1481	1221	956

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ITF5	Basilicata	10004	1588	1245	1818	1422	1162	914
ITF6	Calabria	15119	1646	1292	1867	1459	1164	914
ITG1	Sicilia	25853	1792	1401	2029	1581	1244	971
ITG2	Sardegna	24082	1709	1340	1965	1537	1246	978
ITH1	Provincia Autonoma di Bolzano/Bozen	7429	1231	1010	1478	1180	1052	876
ITH2	Provincia Autonoma di Trento	6188	1276	1040	1543	1222	1103	916
ITH3	Veneto	17733	1388	1103	1644	1298	1133	913
ITH4	Friuli-Venezia Giulia	7771	1304	1042	1554	1228	1088	884
ITH5	Emilia-Romagna	22493	1439	1137	1674	1323	1114	889
ITL1	Toscana	22988	1502	1184	1750	1376	1160	922
ITL2	Umbria	8510	1524	1206	1774	1400	1170	934
ITL3	Marche	9391	1466	1159	1691	1336	1106	881
ITL4	Lazio	17192	1592	1255	1855	1458	1217	967
	LIECHTENSTEIN	163	1141	920	1345	1079	946	770
LI00	Liechtenstein	163	1141	920	1345	1079	946	770
	LITHUANIA	64918	1016	809	1178	938	834	667
LT00	Lietuva	64918	1016	809	1178	938	834	667
	LUXEMBOURG	2608	1090	876	1243	1002	850	686
LU00	Luxembourg	2608	1090	876	1243	1002	850	686
	LATVIA	64642	1000	798	1176	940	845	680
LV00	Latvija	64642	1000	798	1176	940	845	680
	MONTENEGRO	13849	1367	1093	1565	1244	1019	820
ME00	Crna Gora	13849	1367	1093	1565	1244	1019	820
	MACEDONIA	25371	1497	1193	1711	1356	1098	882
MK00	Poranešna Jugoslovenska Republika Makedonija	25371	1497	1193	1711	1356	1098	882
	MALTA	311	1918	1491	2163	1683	1308	1014
MT00	Malta	311	1918	1491	2163	1683	1308	1014
	NETHERLANDS	35514	1067	852	1244	997	883	711
NL11	Groningen	2415	1041	831	1218	977	872	703
NL12	Friesland (NL)	3520	1068	853	1254	1006	898	724
NL13	Drenthe	2696	1032	824	1201	962	855	688
NL21	Overijssel	3428	1047	836	1219	977	866	698
NL22	Gelderland	5131	1054	840	1223	980	866	697
NL23	Flevoland	1560	1070	854	1255	1008	896	723
NL31	Utrecht	1442	1064	849	1238	993	878	707
NL32	Noord-Holland	2876	1092	873	1281	1028	910	735
NL33	Zuid-Holland	3247	1099	878	1284	1031	909	733
NL34	Zeeland	1925	1114	891	1304	1049	923	745
NL41	Noord-Brabant	5064	1067	851	1237	992	874	703
NL42	Limburg (NL)	2210	1074	857	1244	997	874	704
	NORWAY	324001	820	657	1020	811	791	648
NO01	Oslo og Akershus	5366	859	691	1029	834	766	627
NO02	Hedmark og Oppland	52581	860	691	1046	838	793	650
NO03	Sør-Østlandet	36593	869	698	1032	829	765	624
NO04	Agder og Rogaland	25813	876	704	1029	825	754	612
NO05	Vestlandet	49038	845	677	1007	790	756	614
NO06	Trøndelag	41218	839	671	1056	841	828	676
NO07	Nord-Norge	113392	754	602	993	786	810	670
	POLAND	311905	1082	868	1252	1009	876	709
PL11	Łódzkie	18209	1094	878	1264	1020	879	712
PL12	Mazowieckie	35536	1088	873	1257	1014	875	709
PL21	Małopolskie	15172	1079	870	1243	1008	862	704
PL22	Slaskie	12338	1083	873	1247	1011	865	704
PL31	Lubelskie	25166	1108	890	1275	1029	882	714
PL32	Podkarpackie	17785	1098	884	1262	1021	869	707
PL33	Świętokrzyskie	11683	1103	887	1269	1028	880	715
PL34	Podlaskie	20211	1063	851	1225	983	855	689
PL41	Wielkopolskie	29836	1088	871	1265	1017	888	718
PL42	Zachodniopomorskie	22448	1056	846	1233	991	872	705
PL43	Lubuskie	13964	1075	860	1250	1004	879	710
PL51	Dolnoślaskie	19937	1082	870	1254	1014	878	714
PL52	Opolskie	9434	1106	890	1280	1035	891	724
PL61	Kujawsko-Pomorskie	17976	1080	865	1259	1012	887	716
PL62	Warmińsko-Mazurskie	24022	1061	847	1233	988	869	699
PL63	Pomorskie	18188	1053	843	1234	990	878	708
	PORTUGAL excluding Atlantic Islands	88957	1734	1356	2007	1565	1280	1002
PT11	Norte	21256	1622	1278	1890	1483	1227	970
PT15	Algarve	5000	1888	1467	2164	1675	1341	1040
PT16	Centro (PT)	28274	1694	1328	1967	1537	1264	994
PT17	Lisboa	2842	1803	1415	2087	1634	1321	1034
PT18	Alentejo	31585	1815	1410	2090	1621	1316	1023
PT20	Região Autónoma dos Açores	0	0	0	0	0	0	0
PT30	Região Autónoma da Madeira	0	0	0	0	0	0	0
	ROMANIA	238313	1295	1027	1488	1181	998	798
RO11	Nord-Vest	34159	1212	966	1392	1109	946	759
RO12	Centru	34150	1208	965	1393	1116	949	765
RO21	Nord-Est	36824	1226	978	1415	1130	963	776
RO22	Sud-Est	35748	1392	1098	1600	1263	1062	844
RO31	Sud - Muntenia	34412	1383	1090	1585	1249	1048	833
RO32	Bucuresti - Ilfov	1793	1427	1120	1629	1279	1068	845
RO41	Sud-Vest Oltenia	29252	1375	1087	1575	1242	1039	827
RO42	Vest	31975	1274	1010	1460	1157	979	782
	SWEDEN	449503	873	699	1090	879	841	689
SE11	Stockholm	7026	941	754	1142	922	851	690
SE12	Östra Mellansverige	43284	929	741	1119	900	832	673
SE21	Småland med öarna	35922	943	752	1105	883	799	641
SE22	Sydsverige	14413	995	797	1173	941	845	681
SE23	Västsverige	34595	910	726	1071	858	781	629
SE31	Norra Mellansverige	71917	894	716	1092	883	826	674
SE32	Mellersta Norrland	77224	851	683	1075	870	841	692
SE33	Övre Norrland	165122	822	659	1081	872	872	723
	SLOVENIA	20242	1255	1007	1459	1166	991	804
SI01	Vzhodna Slovenija	12201	1259	1009	1461	1170	990	802
SI02	Zahodna Slovenija	8041	1250	1004	1458	1162	993	807
	SLOVAKIA	49088	1160	932	1339	1078	919	746
SK01	Bratislavský kraj	2058	1212	966	1394	1114	947	762

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SK02	Západné Slovensko	15013	1216	970	1402	1122	954	769
SK03	Stredné Slovensko	16244	1126	909	1301	1051	897	733
SK04	Východné Slovensko	15773	1136	915	1312	1058	904	736
	TURKEY	772044	1658	1307	1876	1478	1154	913
TR10	Istanbul	5285	1524	1206	1703	1353	1054	833
TR21	Tekirdag	18910	1557	1233	1754	1392	1098	871
TR22	Balikesir	24157	1647	1302	1855	1465	1137	899
TR31	Izmir	11773	1840	1444	2103	1644	1296	1019
TR32	Aydin	32076	1867	1461	2130	1657	1305	1025
TR33	Manisa	45426	1725	1365	1961	1544	1211	962
TR41	Bursa	29090	1610	1279	1818	1439	1124	894
TR42	Kocaeli	20253	1474	1173	1661	1318	1042	830
TR51	Ankara	24914	1657	1319	1888	1497	1180	943
TR52	Konya	48113	1762	1386	1990	1565	1207	953
TR61	Antalya	35937	1817	1425	2066	1607	1262	993
TR62	Adana	29291	1821	1417	2069	1599	1267	989
TR63	Hatay	23285	1770	1375	1997	1545	1210	943
TR71	Kirikkale	31303	1715	1354	1948	1539	1201	952
TR72	Kayseri	59740	1639	1297	1850	1468	1136	901
TR81	Zonguldak	9515	1455	1159	1650	1312	1049	836
TR82	Kastamonu	26545	1472	1171	1674	1330	1070	855
TR83	Samsun	38009	1513	1202	1718	1367	1092	870
TR90	Trabzon	35092	1316	1047	1493	1194	968	777
TRA1	Erzurum	40818	1522	1209	1712	1370	1053	839
TRA2	Agri	29984	1475	1168	1660	1332	1032	820
TRB1	Malatya	36679	1699	1331	1912	1495	1153	906
TRB2	Van	40761	1633	1292	1815	1442	1069	844
TRC1	Gaziantep	15213	1832	1416	2069	1593	1246	967
TRC2	Sanliurfa	33972	1839	1425	2090	1621	1277	997
TRC3	Mardin	25903	1799	1408	2032	1593	1229	966
	UNITED KINGDOM	245072	982	788	1154	933	838	681
UKC1	Tees Valley and Durham	3034	952	765	1131	921	836	682
UKC2	Northumberland and Tyne and Wear	5607	941	758	1122	913	832	679
UKD1	Cumbria	6821	931	750	1089	886	791	644
UKD3	Greater Manchester	1267	956	766	1111	899	804	652
UKD4	Lancashire	3114	973	782	1144	928	831	676
UKD6	Cheshire	2282	994	796	1162	940	843	684
UKD7	Merseyside	697	1027	824	1213	983	882	717
UKE1	East Yorkshire and Northern Lincolnshire	3522	1028	823	1228	996	905	737
UKE2	North Yorkshire	8334	967	776	1143	928	838	683
UKE3	South Yorkshire	1543	994	797	1175	951	860	699
UKE4	West Yorkshire	2041	963	772	1131	917	825	671
UKF1	Derbyshire and Nottinghamshire	4811	1001	801	1178	952	857	696
UKF2	Leicestershire; Rutland and Northamptonshire	4909	1048	839	1238	1000	900	731
UKF3	Lincolnshire	5950	1049	839	1251	1012	919	747
UKG1	Herefordshire; Worcestershire and Warwickshire	5948	1039	833	1216	982	877	711
UKG2	Shropshire and Staffordshire	6180	1009	809	1180	954	853	692
UKG3	West Midlands	901	1026	822	1202	970	869	704
UKH1	East Anglia	12638	1071	858	1270	1024	923	749
UKH2	Bedfordshire and Hertfordshire	2864	1070	856	1260	1015	909	737
UKH3	Essex	3717	1101	882	1301	1049	937	761
UKI1	Inner London	320	1092	875	1281	1033	917	743
UKI2	Outer London	1274	1084	868	1272	1025	911	738
UKJ1	Berkshire; Buckinghamshire and Oxfordshire	5743	1069	856	1256	1013	903	732
UKJ2	Surrey; East and West Sussex	5499	1136	911	1340	1081	954	774
UKJ3	Hampshire and Isle of Wight	4168	1119	896	1319	1064	943	764
UKJ4	Kent	3745	1129	906	1330	1074	948	769
UKK1	Gloucestershire; Wiltshire and Bristol/Bath area	7477	1068	856	1251	1011	897	727
UKK2	Dorset and Somerset	6120	1111	892	1306	1055	932	755
UKK3	Cornwall and Isles of Scilly	3591	1147	921	1350	1090	959	776
UKK4	Devon	6801	1092	877	1276	1032	908	735
UKL1	West Wales and The Valleys	13182	1016	818	1189	964	852	692
UKL2	East Wales	7688	996	801	1156	936	826	670
UKM2	Eastern Scotland	18169	899	723	1058	855	779	634
UKM3	South Western Scotland	13439	919	740	1075	873	784	638
UKM5	North Eastern Scotland	6509	882	708	1047	845	779	634
UKM6	Highlands and Islands	41010	859	691	1003	808	735	597
UKN0	Northern Ireland	14157	944	759	1108	900	810	659

Table V: Estimation of carbon footprint of photovoltaics and the country electricity production mix (excluding import) per country and some regions in Europe

Country	Region	Irradiation on optimized angle	Irradiation	Cumulative installed capacity	2013	2013	2013	Carbon footprint PV	Carbon footprint country
		Selected reference	Selected value	2013	2013	2013	2013	IPCC2007 GWP100a	IPCC2007 GWP100a
			kWh/m2.yr	MWp	MWp	MWp	MWp	g CO2-eq/kWh	g CO2-eq/kWh
				Selected	EPIA 2014	EurObserver 2014	IEA PVPS status 20 March 2014		
		optimized angle, area weighted		EPIA, IEA		Total on grid + off grid			
WEIGHTED AVERAGE								54.9	
SUM / AVERAGE / WEIGHTED AVERAGE			1518	135234				55.2	
Australia		Breyer 2010	2215	3255			3255	39	
Austria		Huld 2014	1329	613	613	690.4	580	65	320
Belgium		Huld 2014	1237	2983	2983	2983.4	2983	69	
Bulgaria		Huld 2014	1633	1020	1020	1019.2	1020	53	620
Canada		Breyer 2010	1095	1210			1210	78	251
China		Breyer 2010	1911	18300			18300	45	1164
Croatia		Huld 2014	1581	20	20	21.7		54	345
Cyprus		Huld 2014	2233	32	32	34.8		38	904
Czech Republic		Huld 2014	1254	2175	2175	2132.8	2162	68	781
Denmark		Huld 2014	1192	548	548	531.4	532	72	639
Estonia		Huld 2014	1152	0	0	0.2		75	1147
Finland		Huld 2014	1056	11	11	11.2		81	392
France		Huld 2014	1520	4673	4673	4697.6	4632	56	92
Germany		Huld 2014	1251	35715	35715	36013.0	35500	69	680
Greece		Huld 2014	1924	2579	2579	2585.8	2579	45	1030
Hungary		Huld 2014	1494	22	22	15.4		57	714
Iceland		Huld 2014	963					89	22
India		Breyer 2010	2027	2319			2319	42	876
Ireland		Huld 2014	1175	3	3	1.0		73	799
Israel		Breyer 2010	2258	420			420	38	
Italy		Huld 2014	1768	17928	17928	17614.0	17600	49	650
Japan		Breyer 2010	1603	13643			13643	54	565
Korea, Republic of		Breyer 2010	1779	1467			1467	48	660
Latvia		Huld 2014	1176	1	1	1.5		73	248
Liechtenstein		Huld 2014	1345					64	
Lithuania		Huld 2014	1178	6	6	68.1		73	148
Luxembourg		Huld 2014	1243	30	30	100.0		69	539
Montenegro		Huld 2014	1565					55	
Macedonia, the former Yugoslav Republic of		Huld 2014	1711					50	1006
Malaysia		Breyer 2010	1844	73			73	47	1045
Malta		Huld 2014	2163	23	23	24.7		40	776
Mexico		Breyer 2010	2194	100			100	39	676
Netherlands		Huld 2014	1244	665	665	665.0	650	69	699
Norway		Huld 2014	1020	0	0		284	84	13
Poland		Huld 2014	1252	7	7	4.2		69	1162
Portugal		Huld 2014	2007	278	278	281.0		43	629
Romania		Huld 2014	1488	1151	1151	1022.0	1100	58	676
Serbia		Huld 2014	0						
Slovakia		Huld 2014	1339	524	524	537.1	524	64	380
Slovenia		Huld 2014	1459	212	212	254.8		59	504
Spain		Huld 2014	1970	5340	5340	4705.5	5566	44	526
Sweden		Huld 2014	1090	40	40	43.1	43	79	42
Switzerland		Huld 2014	1396	737	737		740	61	24
Taiwan		Breyer 2010	1628	376			376	53	
Thailand		Breyer 2010	1899	704			704	45	736
Turkey		Huld 2014	1876	18	18		15	46	
Ukraine		Breyer 2010	1424	616	616		616	60	521
United Kingdom		Huld 2014	1154	3375	3375	2739.3	2900	74	617
USA		NREL, average of cities California	2048	12022			12022	42	729

Regional data available for EPIA members

BELGIUM				69
Belgium	Brussels-Capital Region	Huld 2014	1242	69
Belgium	Flemish Region	Huld 2014	1254	68
Belgium	Wallon Region	Huld 2014	1223	70
BULGARIA				52
Bulgaria	Northwest region	Huld 2014	1589	54
Bulgaria	Northcentral region	Huld 2014	1619	53
Bulgaria	Northeast region	Huld 2014	1620	53
Bulgaria	Southwest region	Huld 2014	1619	53
Bulgaria	Southcentral region	Huld 2014	1686	51
Bulgaria	Southeast region	Huld 2014	1648	52
FRANCE, Métropole				54
France	Île-de-France	Huld 2014	1377	62
France	Champagne-Ardenne	Huld 2014	1344	64
France	Picardie	Huld 2014	1318	65
France	Haute-Normandie	Huld 2014	1346	64
France	Centre	Huld 2014	1457	59
France	Basse-Normandie	Huld 2014	1373	63
France	Bourgogne	Huld 2014	1432	60
France	Nord-Pas-de-Calais	Huld 2014	1295	66
France	Lorraine	Huld 2014	1322	65
France	Alsace	Huld 2014	1358	63
France	Franche-Comté	Huld 2014	1427	60
France	Pays de la Loire	Huld 2014	1517	57
France	Bretagne	Huld 2014	1433	60
France	Poitou-Charentes	Huld 2014	1588	54
France	Aquitaine	Huld 2014	1605	53
France	Midi-Pyrénées	Huld 2014	1630	53
France	Limousin	Huld 2014	1512	57
France	Rhône-Alpes	Huld 2014	1580	54
France	Auvergne	Huld 2014	1497	57
France	Languedoc-Roussillon	Huld 2014	1755	49
France	Provence-Alpes-Côte d'Azur	Huld 2014	1886	46
France	Corse	Huld 2014	1846	46
FRANCE, DOM (= French				

	overseas departments)				
France	Guadeloupe				
France	Martinique				
France	Guyane				
France	Réunion				
	GERMANY				68
Germany	Baden-Württemberg	Huld 2014	1325		65
Germany	Bayern	Huld 2014	1291		66
Germany	Berlin	Huld 2014	1245		69
Germany	Brandenburg	Huld 2014	1252		69
Germany	Bremen	Huld 2014	1212		71
Germany	Hamburg	Huld 2014	1212		71
Germany	Hessen	Huld 2014	1227		70
Germany	Mecklenburg-Vorpommern	Huld 2014	1240		69
Germany	Niedersachsen	Huld 2014	1211		71
Germany	Nordrhein-Westfalen	Huld 2014	1212		71
Germany	Rheinland-Pfalz	Huld 2014	1251		69
Germany	Saarland	Huld 2014	1272		67
Germany	Sachsen	Huld 2014	1228		70
Germany	Sachsen-Anhalt	Huld 2014	1248		69
Germany	Schleswig-Holstein	Huld 2014	1225		70
Germany	Thüringen	Huld 2014	1208		71
	GREECE				45
Greece	Eastern Macedonia and Thrace	Huld 2014	1812		47
Greece	Central Macedonia	Huld 2014	1845		47
Greece	Western Macedonia	Huld 2014	1789		48
Greece	Thessalia	Huld 2014	1854		46
Greece	Epirus	Huld 2014	1863		46
Greece	Ionian Islands	Huld 2014	2019		43
Greece	Western Greece	Huld 2014	1996		43
Greece	Central Greece	Huld 2014	1906		45
Greece	Peloponnese	Huld 2014	2006		43
Greece	Attica	Huld 2014	2050		42
Greece	North Aegean	Huld 2014	2077		41
Greece	South Aegean	Huld 2014	2170		40
Greece	Crete	Huld 2014	2106		41
Greece	Aegean Islands (incl. Crete)	Huld 2014	2119		41
	ITALY				49
Italy	Piemonte	Huld 2014	1648		52
Italy	Valle d' Aosta	Huld 2014	1527		56
Italy	Liguria	Huld 2014	1679		51
Italy	Lombardia	Huld 2014	1649		52
Italy	Abruzzo	Huld 2014	1716		50
Italy	Molise	Huld 2014	1778		48
Italy	Campania	Huld 2014	1817		47
Italy	Puglia	Huld 2014	1900		45
Italy	Basilicata	Huld 2014	1818		47
Italy	Calabria	Huld 2014	1867		46
Italy	Sicilia	Huld 2014	2029		42
Italy	Sardegna	Huld 2014	1965		44
Italy	Trentino-Alto Adige	Huld 2014	1511		57
Italy	Provincia Autonoma di Bolzano/Bozen	Huld 2014	1478		
Italy	Provincia Autonoma di Trento	Huld 2014	1543		
Italy	Veneto	Huld 2014	1644		52
Italy	Friuli-Venezia Giulia	Huld 2014	1554		55
Italy	Emilia-Romagna	Huld 2014	1674		51
Italy	Toscana	Huld 2014	1750		49
Italy	Umbria	Huld 2014	1774		48
Italy	Marche	Huld 2014	1691		51
Italy	Lazio	Huld 2014	1855		46
	SPAIN				43
Spain	Galicia	Huld 2014	1678		51
Spain	Asturias, Principado de	Huld 2014	1534		56
Spain	Cantabria	Huld 2014	1525		56
Spain	País Vasco	Huld 2014	1506		57
Spain	Navarra	Huld 2014	1734		49
Spain	La Rioja	Huld 2014	1735		49
Spain	Aragón	Huld 2014	1973		44
Spain	Madrid, Comunidad de	Huld 2014	2021		42
Spain	Castilla y León	Huld 2014	1905		45
Spain	Castilla-La Mancha	Huld 2014	2050		42
Spain	Extremadura	Huld 2014	2082		41
Spain	Cataluña	Huld 2014	1947		44
Spain	Valenciana, Comunidad	Huld 2014	2042		42
Spain	Baleares	Huld 2014	2024		42
Spain	Andalucía	Huld 2014	2134		40
Spain	Murcia, Región de	Huld 2014	2115		41
Spain	Ceuta (city in North Africa)	Huld 2014	2040		42
Spain	Melilla (city in North Africa)	Huld 2014	2124		40
Spain	Canarias	Huld 2014			
	UNITED KINGDOM				70
United Kingdom	North East	Huld 2014	1125		76
United Kingdom	North West	Huld 2014	1121		77
United Kingdom	Yorkshire and the Humber	Huld 2014	1164		74
United Kingdom	East Midlands	Huld 2014	1225		70
United Kingdom	West Midlands	Huld 2014	1198		72
United Kingdom	East of England	Huld 2014	1275		67
United Kingdom	Greater London	Huld 2014	1274		67
United Kingdom	South East	Huld 2014	1308		66
United Kingdom	South West	Huld 2014	1287		67
United Kingdom	Wales	Huld 2014	1177		73
United Kingdom	Scotland	Huld 2014	1032		83
United Kingdom	Northern Ireland	Huld 2014	1108		77