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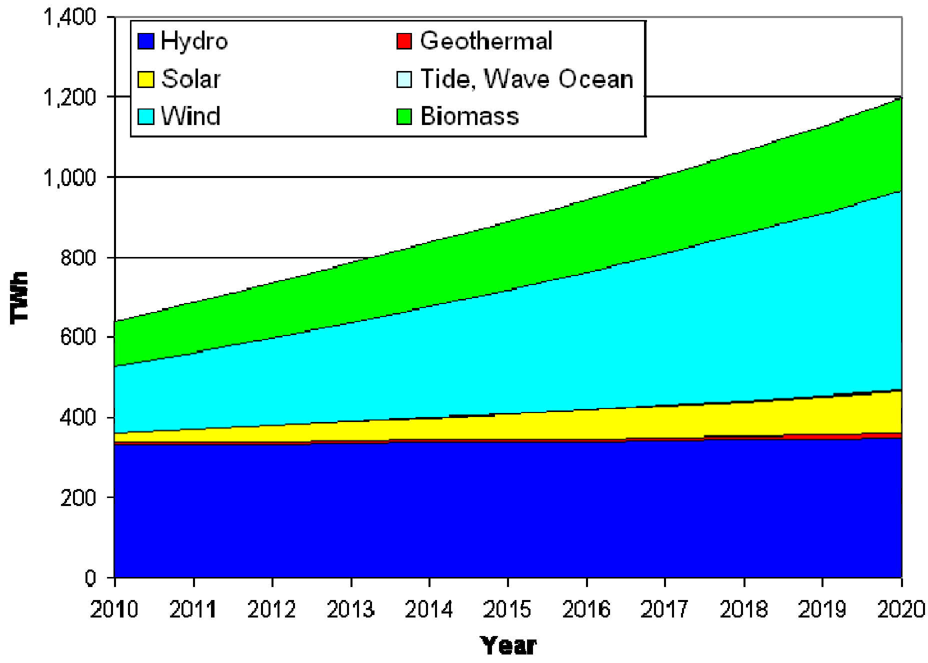
Renewable Energy Snapshots 2011

Arnulf Jäger-Waldau, Márta Szabó, Fabio Monforti-Ferrario, Hans Bloem, Thomas Huld, Roberto Lacal Arantegui



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Renewable Energy Snapshots 2011

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PREFACE

The European Council endorsed at its Meeting in Brussels on 8/9 March 2007 a binding target of a 20% share of renewable energies in the overall EU energy consumption by 2020 and a 10% binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption.

The 2009 Directive on the "Promotion of the use of energy from renewable sources" not only set the mandatory targets for the European Union's Member States, but also drafted a trajectory how to reach the targets for each of them.

A total of about 58.8 GW of new power capacity was constructed in the EU last year[1] and 2.5 GW were decommissioned, resulting in 56.3 GW of new net capacity. Gas-fired power stations accounted for 28.3 GW, or 48% of the newly installed capacity. Solar photovoltaic systems moved to the second place with 13.5 GW (23%), followed by 9.4 GW (16%) wind power; 4.1 GW (7%) MW coal-fired power stations; 570 MW (> 1%) biomass; 450 MW (> 1%) CSP, 210 MW (> 1%) hydro, 230 MW (> 1%) peat and 150 MW (> 1%) waste. The net installation capacity for oil-fired and nuclear power plants was negative, with a decrease of 245 MW and 390 MW respectively. The renewable share of new power installations was 40% in 2010.

Renewable Energies are a very dynamic field with high growth rates and therefore it is of great importance to base decisions on the latest information available as otherwise important development trends might be missed. For certain renewable energy technologies the development of effective policy measures is not yet possible due to the lack of robust, consistent and up to date data.

These Renewable Energy Snapshots are based on various data providers including *grey data sources* and tries to give an overview about the latest developments and trends in the different technologies. Due to the fact that unconsolidated data are used there is an uncertainty margin which should not be neglected. We have cross checked and validated the different data against each others, but do not take any responsibility about the use of these data. Nevertheless, we try to update the data as frequent as possible and would be most grateful for any update of information, if outdated or incorrect information are observed.

Ispra, September 2011

Dr. Arnulf Jäger-Waldau
European Commission
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[1] EWEA, Wind in power – 2010 European statistics, February 2011 and data in the Snapshots

CONTENT

INTRODUCTION

The Directive 2009/28/EC and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources set the mandatory targets and drafted also a trajectory to the EU Member States related to the renewable energy sources. In accordance with Article 4(3) of each Member States shall adopt and submit a National Renewable Energy Action Plan to the Commission by 30 June 2010 described how to reach the targets until and by 2020.
Renewable energy technologies in the EU and their utilisation have been dynamic in the last years and now it became even more importance.

In the Renewable energy snapshots 2011 collects and summarize the latest available data on the renewable technologies in the EU and worldwide context on the installations, and energy consumption.

The report has the following structure: after the summary, each chapter is dedicated to one renewable source and technology (we focus on bioelectricity, bioheat, biofuel, CSP, PV, Solar thermal, wind) describing the status by now and in some cases the market development. The detailed technology analysis is followed by one chapter on the resource development until 2020 according to the NREAPs.

SUMMARY

According to the Directive 2009/28/EC and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, the share of the Renewable Energies in the overall EU energy consumption has to be at least 20 % including a 10% binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption.

In 2008, the EU's Climate Change Package aims to ensure that the EU will achieve its climate targets by 2020: a 20% reduction in greenhouse gas emissions, a 20% improvement in energy efficiency, and a 20% share for renewables in the EU energy mix.

In accordance with Article 4(3) the RES Directive requires Member States to adopt a National Renewable Energy Action Plan (NREAP), setting out sectoral targets and measures for achieving these targets and submit them to the Commission by 30 June 2010, using a template according to the Commission Decision of 30 June 2009.

In the National Renewable Energy Action Plans, each Member State had to set its national target for the share of energy coming from renewable energy sources consumed in electricity, heating and cooling, and the transport sector, as well as in every second year up to 2020; taking into account the effect of energy efficiency related measures on final consumption of energy compared to the indicative trajectory. The Member States announce the excess or deficit production which can be used in the cooperation mechanism or in the statistical transfer.

In general terms the total energy demand is split equally between 4 sectors (Industry, Transport, Heating and Electricity) each having a 25% share. Under the assumption that the 20% improvement in energy efficiency will be realised and that Industry and Heating will meet their 20% Renewable obligations, it is up to the Electricity Sector to compensate for the reduced target in the Transport Sector. We estimate that 35 to 40% of the total electricity (3,200 – 3,500 TWh) has to come from Renewable Energy Sources in 2020 to meet the target.

The target corridor which has to be reached for electricity generation from Renewable Energy Resources is 1120 – 1400 TWh. In 2010 about 19.4% (640 TWh) of the gross final electricity Consumption (3,306 TWh) came from Renewable Energy sources[2]. Hydro power contributed the largest share with 10.2%, followed by Biomass with 3.5%, Wind with 5% and solar with 0.6%.

With the Renewable Energy Snapshots we would like to monitor how was and will be the development of renewable energy generation (mainly electricity) and whether the 2020 targets can be reached.

For electricity generation from Hydro Power (2010: 330 TWh), no major increase is expected as most large hydro resources are already in use today. In addition, it is not clear if the same resources will still be available on a continuous base in the future if extreme weather conditions become more frequent and additional water resource needs might arise. Small Hydro is an option, but was not investigated in this report. However, pumped Hydro will play an increasingly important role as storage capacity for the other Renewable Energy Resources.

Additional renewable electricity generation technologies include geothermal, tidal and wave power with energy generation of 6 TWh and 0.5 TWh respectively in 2010 and will the expected growth will be to 10.9 TWh and 6 TWh by 2020 according to the NREAPs. These technologies are in a research

[2] NREAP analysis data

and development phase and no major market penetration is happening yet. Therefore, they are not yet included in this Snapshots, but it is expected that their market introduction will take place within the next decade.

It is expected that if the current growth of electricity generation from biomass continues, bioelectricity generation could be around 230 TWh in 2020 up from 100.5 TWh in 2009. An uncertainty in this estimation is clearly the competitive use of biomass for other energy uses like heat and transport fuels. To what effect this will change the development of bioelectricity is not yet clear. Bioelectricity generation, especially via biogas or CHP has the big advantage that biomass is storable and the electricity can be generated on demand. This variable dispatchability is extremely important for a renewable energy supply and increases the value significantly.

In Europe, installed capacity from Concentrated Solar Power is still small today (730 MW in Jan 2011), but is steadily accelerating. According to the European Solar Thermal Electricity Association (ESTELA) 30 GW of CSP capacity could be installed in Europe generating around 100 TWh of electricity in 2020.

In Europe Solar Photovoltaic Electricity Generation has again increased its cumulative installed capacity by more than 80% to 29 GW in 2010. This results a capacity almost 10 times as high as was foreseen in the White Paper as the Target for 2010. The European Photovoltaic Industry Association published their ambitious vision plan for 2020 last year. The new target calls for up to 12% of the European electricity generated with solar photovoltaic electricity generation, or 380 to 420 TWh. The necessary growth rate would be 36% annually, which is much lower than what the industry has seen in the last 8 years. From an industry point of view the target is ambitious, but achievable, however it will need accompanying measures to ensure that the electricity grid will be able to absorb and distribute the generated solar electricity. This is especially important, because 12% of total electricity from solar photovoltaics translates to a cumulative installed PV capacity of 350 GW or close to 60% of the total European thermal electricity generation capacity (590 GW in 2008) or more than 40% of the total European electricity generation capacity (800 GW in 2008). Therefore, efficient transmission and storage systems, as well as modern supply and demand management, have to be available to fulfil this vision.

Wind energy is the number one in newly installed capacities in Europe. In 2010 the additional installed capacity was 10 GW with more than 84 GW of cumulative installed capacity in 2010, it exceeded the White Paper target of 40 GW by more than 100%. The new target of the European Wind Association is aiming at 230 GW installed capacity (40 GW offshore) in 2020 capable of providing about 20% of European electricity demand. According to the NREAPs the installed capacity is in 2010 84.9 and will grow to 213.4 GW by 2020.

It can be concluded that if the current growth rates of the above-mentioned Renewable Electricity Generation Sources can be maintained, up to 1,600 TWh (45 – 50%) of renewable electricity could be generated in 2020. With this contribution the renewable electricity industry would significantly contribute to the fulfilment of the 2020 targets.

In RES heat production biomass has the highest share with a 326.5 PJ in 2009, with a decreased growth rate. Solar thermal market decreased also by 13 % in the year 2010, however 2.5 GWth new capacity has been installed reaching the 23.5 GW total operation capacity in EU27.

Altogether from the market and also from the NREAP data it can be seen that the 2020 targets can be fulfilled.

Last but not least it has to be pointed out that this significant contribution of the renewable electricity sector will not come by itself. Without increased political support, especially in the field of fair grid access and regulatory measures to ensure that the current electricity system is transformed to be capable to absorb these amounts of Renewable Electricity, these predictions will not come about. In addition, the different renewable energy sources will need for the next decade substantial public R&D support as well as accompanying measures to enlarge the respective markets, **as cost reduction and accelerated implementation will depend on the production volume and not on time!**

ENERGY FROM BIOMASS IN THE EUROPEAN UNION

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The total amount of primary bioenergy[3] production in the 27 Members states of the European Union was 95.37 Mtoe in 2008 and 100.53 Mtoe in 2009 respectively.

BIOELECTRICITY

The total **installed capacity of bioelectricity** power plant was 21.969 GW in 2008 and 25.092 GW in 2009; it is resulted from an average yearly increase of 1974 MW/a between 2001 and 2009, as it is shown in Figure 1. From 2003 the yearly average increase has been raised about four times (to 2020 MW/a) than the yearly average between 1996 and 2002 (which was 457 MW/a).

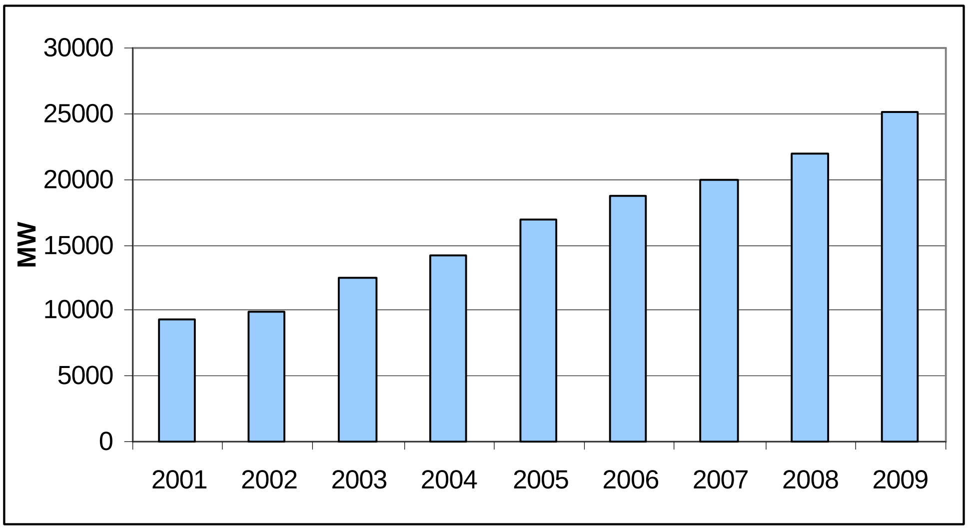

Figure 1 Total bioenergy installed capacity in the EU 27 from 2001 [4]

In the installed capacity wood and wood waste represents the biggest proportion with 57 % (Figure 2); this concentrates in Sweden, Germany, Austria and Finland with more than 1500 MW in each. The highest amount has Sweden with 3142 MW (Figure 3).

[3] Bioenergy: bio-heat + bio-electricity + biofuels for transport

[4] Source Eurostat. indicators: Infrastructure – electricity annual data (nrg-113a) Net maximum capacity: Municipal wastes (12-1176253), wood/wood wastes (12-1176263), biogas (12-1176333); Product: Electrical Capacity (9007)

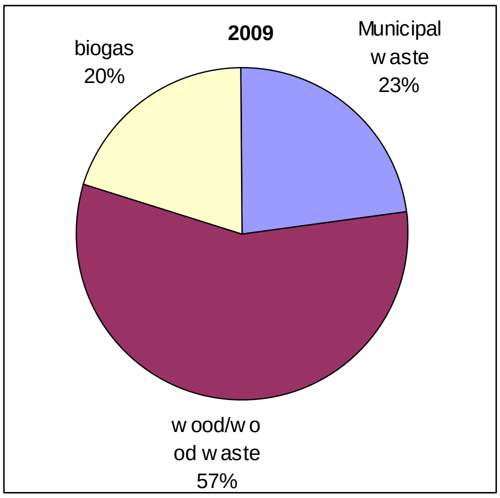

Figure 2 Installed bioelectricity sources in the EU 27 in the year 2009

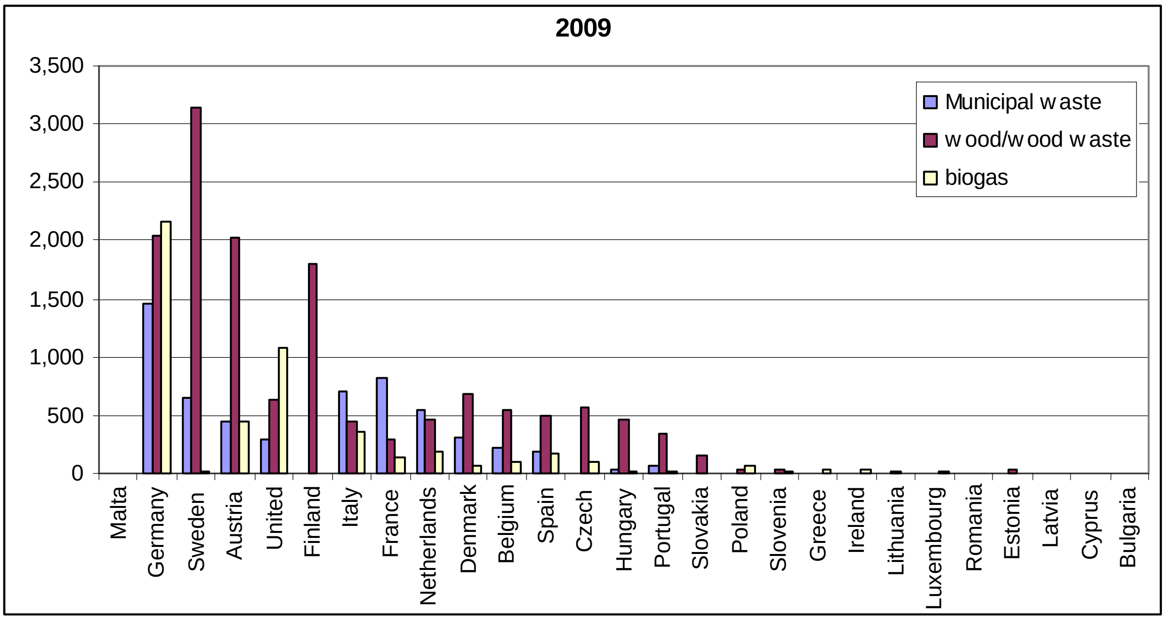

Figure 3 Bioelectricity installed capacity in the EU MS-s by source in 2008

The **produced electricity originated from biomass** was 108 TWh in 2008 and 121 in 2009 in the EU-27 with an average yearly increase of almost 13.5 % between 2001 and 2009. (Figure 4). Germany keeps his role as a biggest bioelectricity producer also in 2009 with 34260 GWh followed by Sweden and UK in a same leading range with the value of 12074 and 11512 GWh respectively (Figure 5). Almost the half (48 %) of the production is concentrated in this three states.

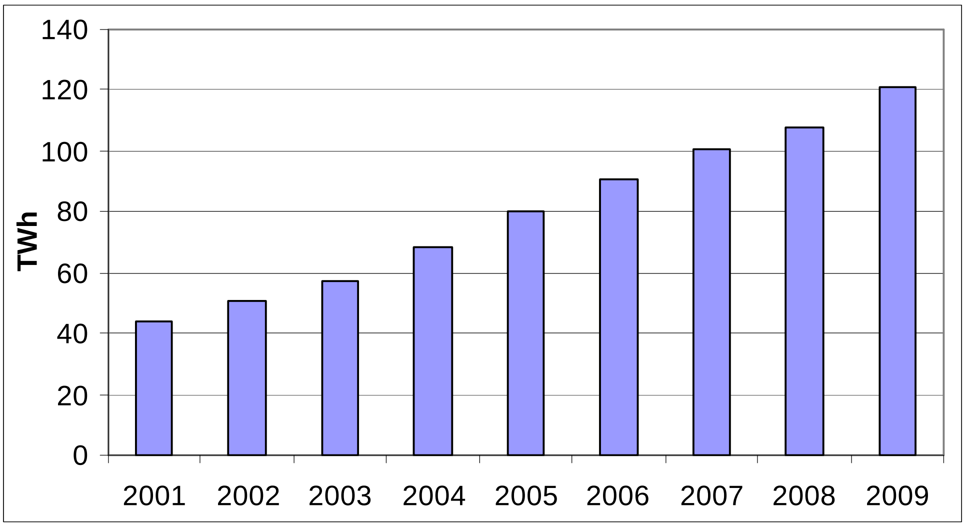

Figure 4 Bioelectricity production in the EU27 from 2001

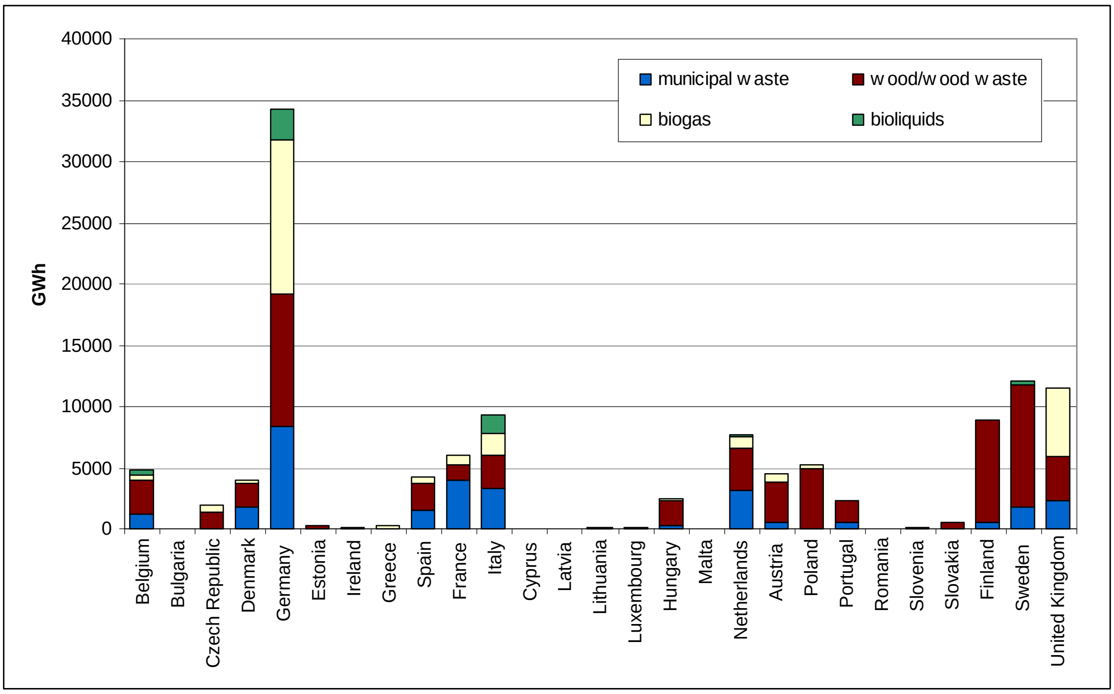

Figure 5 Biolectricity production in the EU27 MS-s in 2009 by categories.[5]

In the electricity production wood/wood waste is the main source with a proportion of 51 % followed by municipal solid waste (24 %). The biogas percentage was 21 % (Figure 6). More than the half (17) of the member states the wood and wood waste is the leading bioelectricity source, in a small number of countries (Germany, Ireland, Greece, UK and Latvia) the biogas and only in the France Italy and Luxembourg the municipal waste.

[5] Source Eurostat. Supply, transformation, consumption - electricity - annual data [nrg_105a]

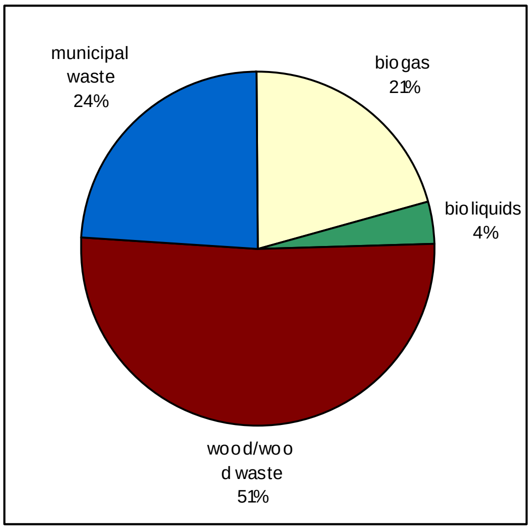

Figure 6 Distribution of the sources in the electricity generation from biomass in the EU27 in 2008

HEAT FROM BIOMASS

Heat produced from biomass was 7,6 Mtoe in 2008 and 7.8 Mtoe in 2009 in the EU27 (Figure 7). The increase of the bioheat production slowed down between the last two years, after an average yearly growth of 11 % from 2001. Sweden is the leading member state in the bioheat production with 2.7 Mtoe, followed by Finland, Denmark and Germany with 1.23, 0.98 and 0.9 Mtoe, respectively (Figure 8). These for country cover around 75 % of the EU27 bioheat production.

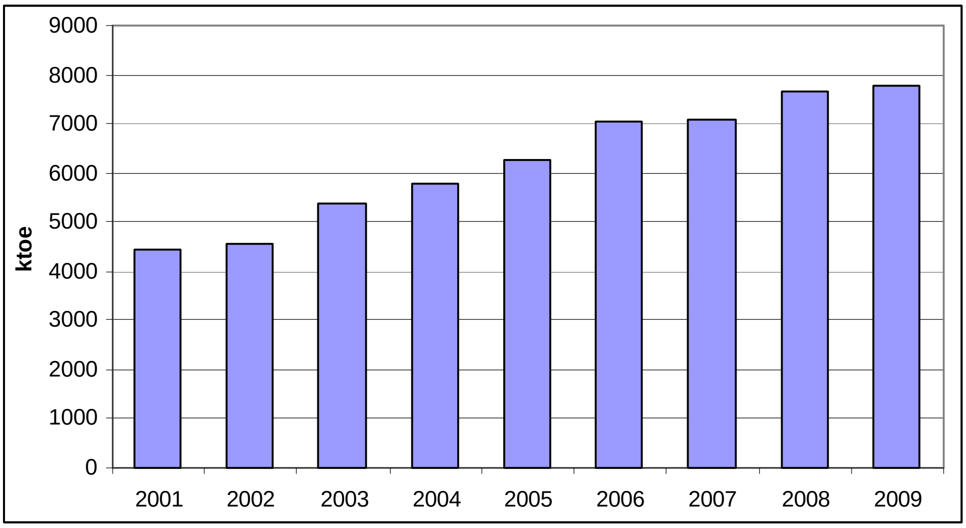

Figure 7 Heat production from biomass in the EU 27 from 2001[6]

The solid form is the main source (wood and wood waste covers the 75 %) for the heat production from biomass in the EU27 (Figure 9). The majority of the Member States the highest proportion has the wood/wood waste, only in Germany and in the Netherlands the municipal waste has the highest share (58.3 and 72.6 %).

[6] Source: Eurostat. Supply, transformation, consumption - heat - annual data [nrg_106a]

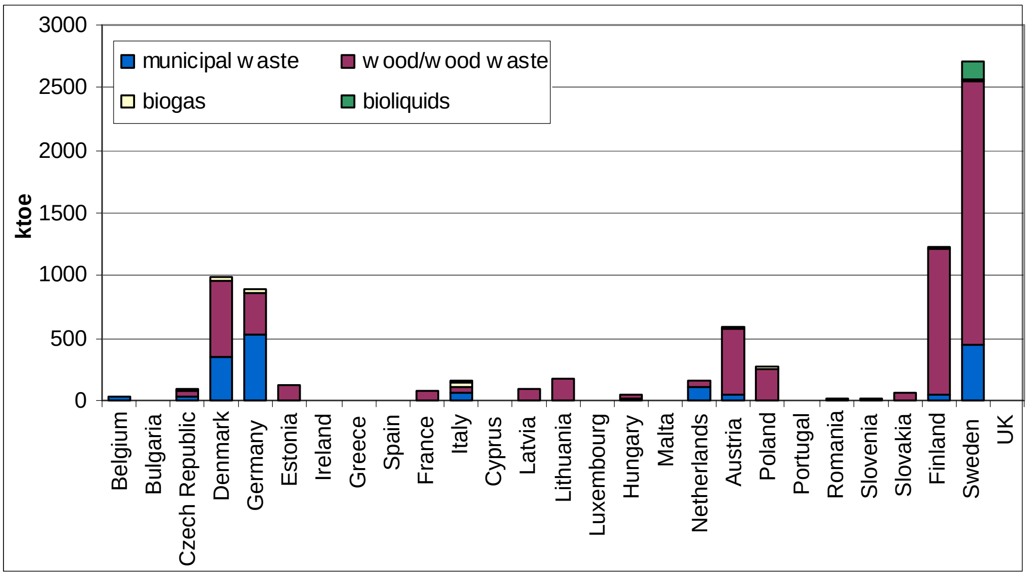

Figure 8 Bioheat production by categories in the Member states in 2009

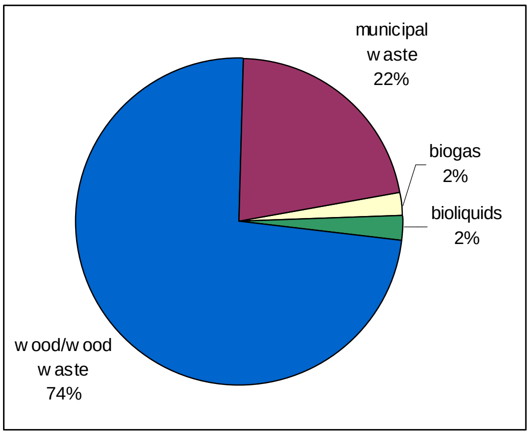

Figure 9 Share of bioheat sources in the EU27 in 2009

BIOFUELS: SOURCES AND USE

Table 1 summarizes the total flows of liquid biofuels in EU-27 in 2009.

Primary production of biofuels in EU-27 totalled 11.5 Mtoe in 2009. The majority of the produced biofuels is biodiesel (65%) while biogasoline and other liquid biofuels contributed less (16% and 19%, respectively). Imported biofuels provided 3.3 Mtoe while 1 Mtoe of biofuels was exported in 2009 summing to a net import balance of 2.35 Mtoe.

Almost all biogasoline (i.e., the sum of bioethanol, biomethanol, bio-ETBE and bio-MTBE7) and biodiesel is used in transport sector, while a consistent amount of other liquid biofuels (mainly pure vegetable oils) are used for district heating, power generation and industry.

In EU-27, Germany is the main biofuel producer with 3.8 Mtoe (33% of EU-27 production) followed by France with 2.2 Mtoe (19% of EU-27 production). Other relevant biofuels producers are shown in Figure 10.

[7] See Eurostat's Concepts and definition database (CODED) and definitions in Directive 2003/30/EC on the promotion of the use of biofuels and other renewable fuels for transport.

Table 1: Biofuels flows in EU-27 in 2007. Data in ktoe. (Eurostat 2011)[8] [9]

	Biogasoline	Biodiesel	Other liquid biofuels	Total
Primary production	**1870**	**7442**	**2153**	**11465**
Total imports	742	2568	71	3381
Stock change	-20	18	0	-2
Total exports	293	731	0	1024
Net imports	449	1837	71	2357
Gross inland consumption	**2299**	**9298**	**2223**	**13820**
Input to thermal power stations	0	1	1314	1315
Input to district heating plants	0	0	88	88
Energy available for final consumption	2346	9245	822	12413
Final energy consumption	**2264**	**9160**	**821**	**12245**
Final energy consumption - Industry	0	31	303	334
Final energy consumption - Transport	2264	9105	505	11874
Final energy consumption - Households	0	25	13	38

Import/export flows for EU-27 countries are shown in Figure 11. UK imports slightly more than 750 ktoe of biofuels, mainly biodiesel while Italy is the second importer with 330 ktoe. In the case of UK biofuels import is roughly equivalent to four times the domestic production while in case of Italy it accounts for about 30% of the domestic production. In the large majority of EU countries, biodiesel is both produced and imported/exported more than biogasoline.

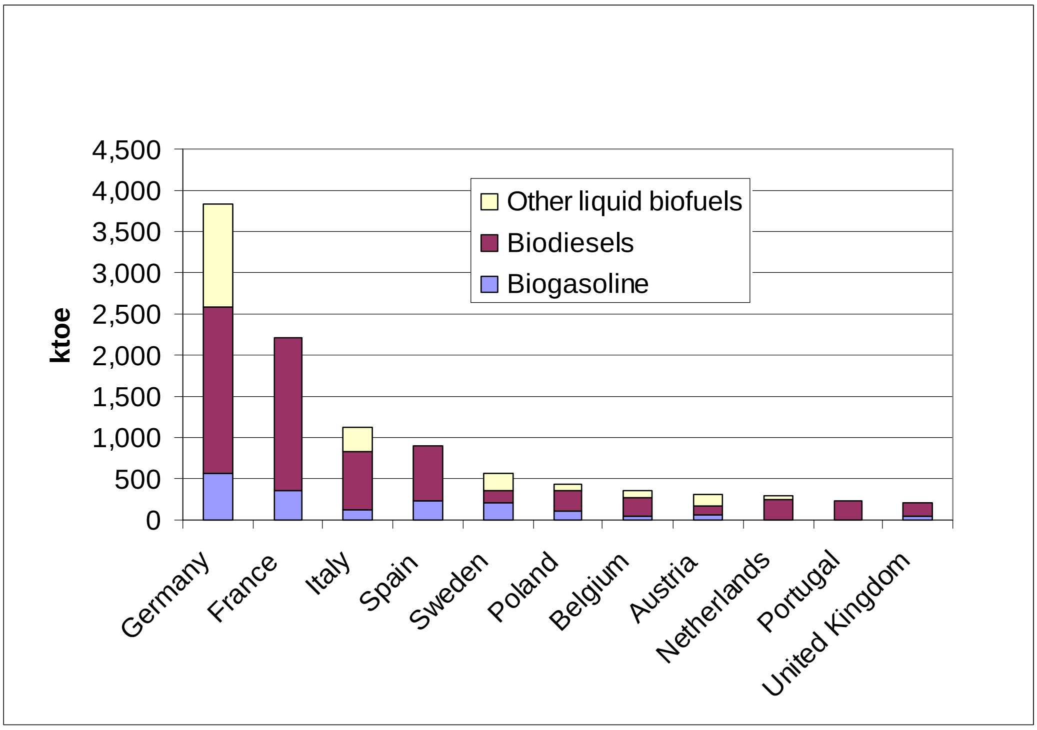

Figure 10 Relevant biofuels producer in EU-27 in 2007. Countries not included in the figure produce less than 200 ktoe[10].

[8] In the whole analysis the following biofuels products coded by EuroStat have been considered: biogasoline (5546), biodiesel (5547), other liquid biofuels (5548), biofuels (5545).

[9] Eurostat indicators: Primary production (100100), total imports (100300), stock change (100400), total exports (100500), net imports (100600) , gross inland consumption (100900), Input to conventional thermal power stations (101001), Input to district heating plants (101009), Final energy consumption (101700), Final energy consumption – Industry (101800), Final energy consumption – Transport (101900), Final energy consumption - Households/Services (101200)

[10] Eurostat indicators: Primary production (100100)

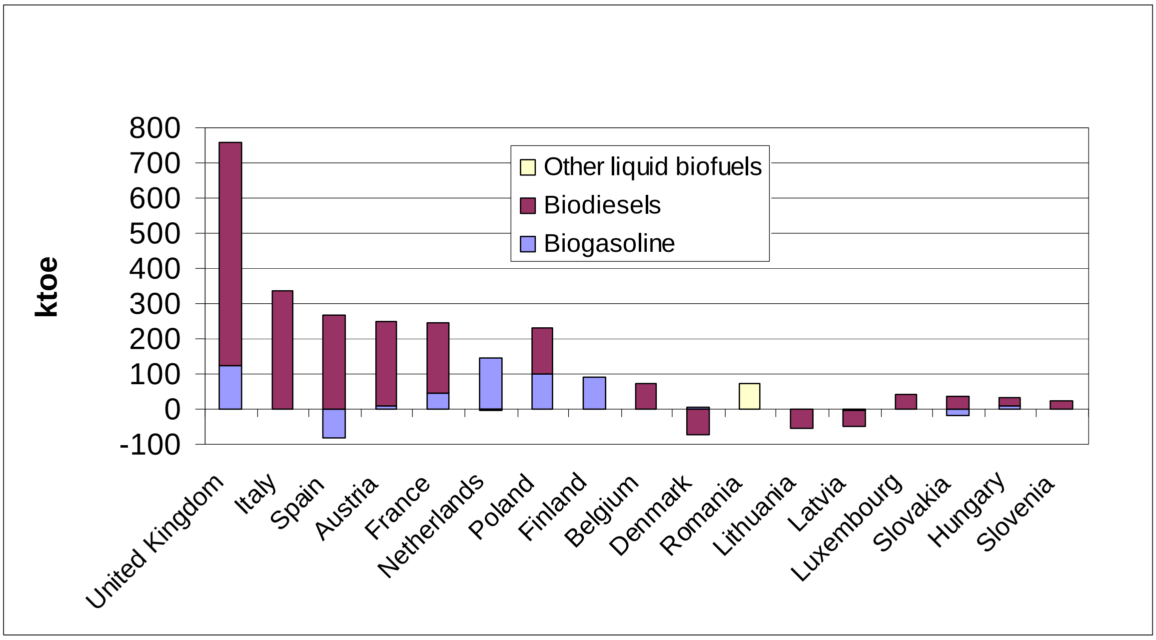

Figure 11 Relevant biofuels imports (positive values) and exports (negative in EU-27 in 2007. Countries not included in the figure import and export less than 20 ktoe[11].

Trends in biofuels market.

Figure 12 shows as the production of biofuels is constantly increasing in last decade and how the import of a relevant share of biofule is a recent phenomena starting to in 2005-2006.

In the last 4 years, the EU biofuels production has grown by roughly 20% every year, something less than the huge 60% yearly growth registered in 2004-2006 period. In absolute terms, the annual production increase has become stable in last three year around 1800 ktoe per year.

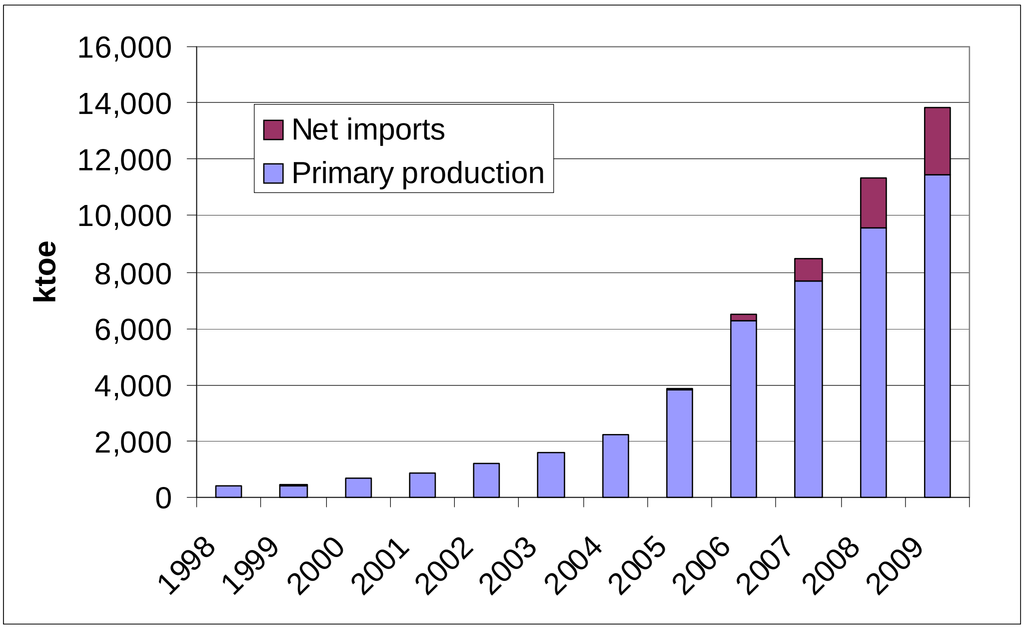

Figure 12 Trends of biofuels production and imports in 1997 – 2009 in EU-27 [12].

[11] Eurostat indicators: Total imports (100300), total exports (100500)

[12] Eurostat indicators: Primary production (100100),Total imports (100300).

Biofuels in transport sector

In 2009 the **consumption of biofuels** in the transport sector amounted to 11.9 MToe in EU-27. Biodiesel has been by far the most consumed biofuel with a share of 77% while biogasoline accounted for 19 % and other biofuels accounting for around 4%.

Germany is still the largest consumer of biofuels in EU-27 (2.8 MToe with a 23% share) but France has reached 2.5 Mtoe accounting for 20.6 % of EU-27 consumption. Italy, Spain and UK follow with a biofuels consumption share ranging between 8 and 10 percent.

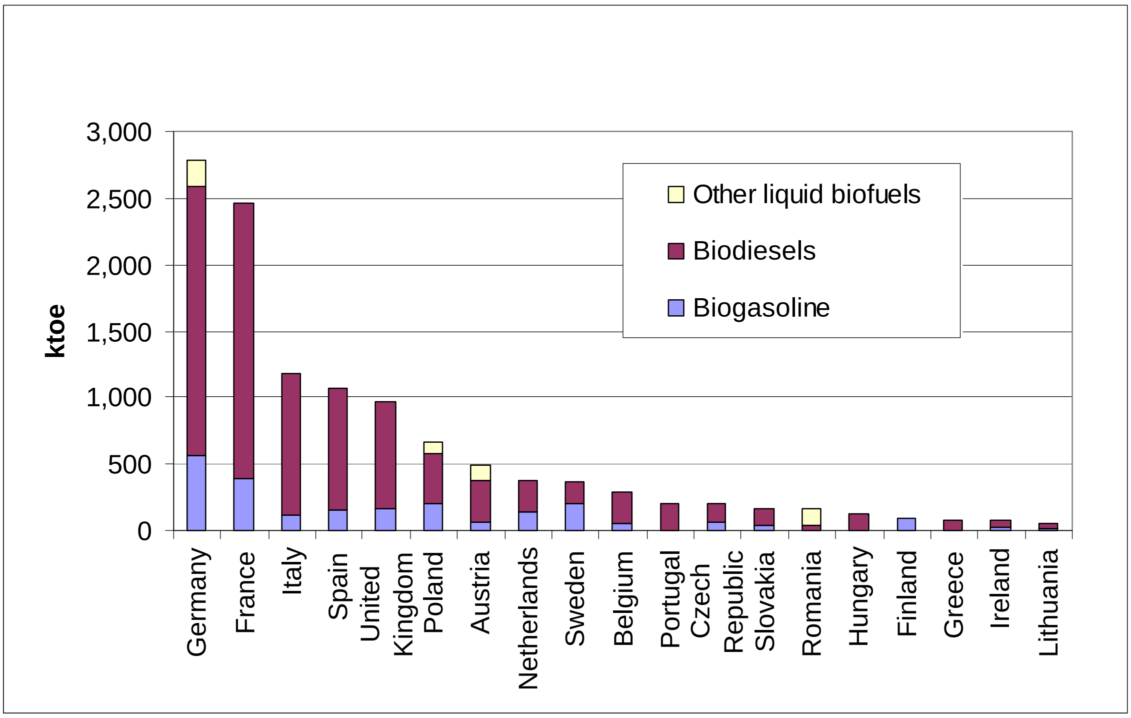

Figure 13 Final energy consumption of biofuels in the transport sector in the EU27 in 2009 (Eurostat 2011).[13]

Figure 14 shows the **share of biofuel contribution to the overall energy consumption in transport sector** for the EU-27 countries. On average biofuels accounted for 3.2% of the energy consumed in transport in 2009 with an increase of about 1% in comparison with 2007 figure. Nevertheless, the situation is very diverse throughout Europe.

Slovakia (7%), Austria (5.7%), France (4.9%), Germany (4.5%) and Sweden (4.2%) Poland (4%) and Lithuania (3.5%) lead the way, while all other countries are below the EU-27 average, with 6 countries not reaching the 1%, in front of a compulsory target of 10% of renewable energy in transport in 2020.

[13] Eurostat indicators: Final energy consumption – Transport (101900).

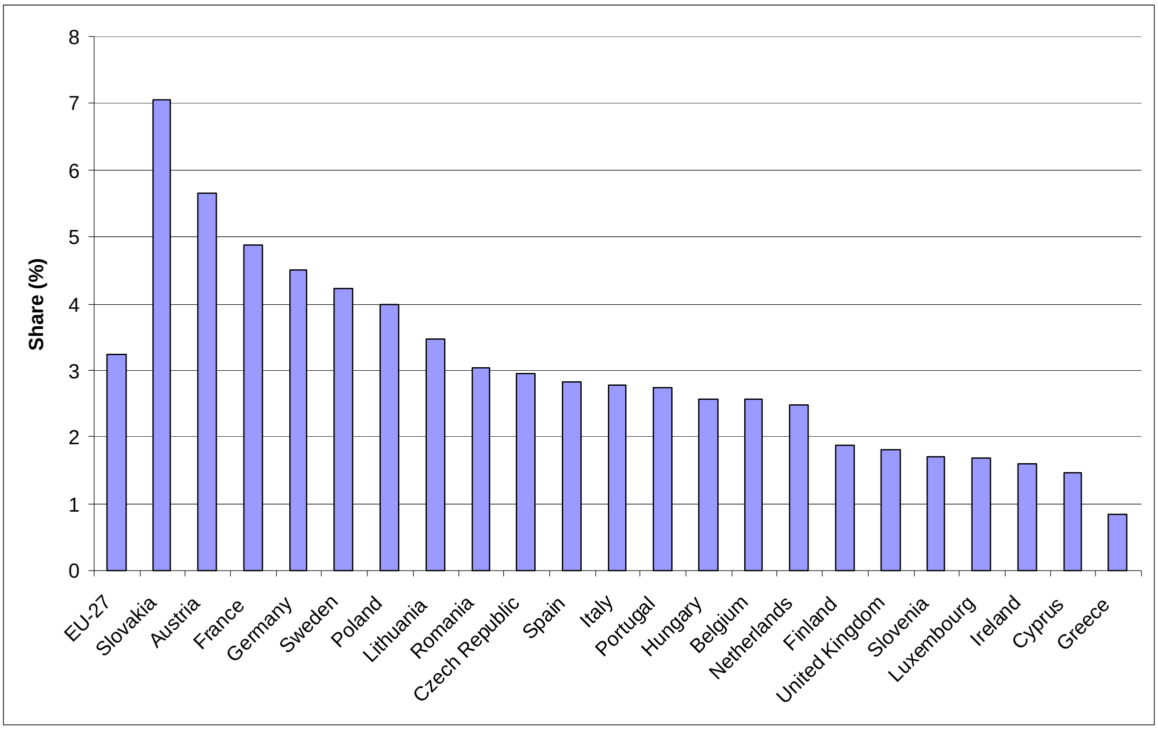

Figure 14 Share of energy consumption in transport provided by biofuels in 2009. (Eurostat 2011. Countries not shown in the figure have a biofuels share smaller than 0.5%) [14].

References

Eurostat 2011: Data navigation tree at http://epp.eurostat.ec.europa.eu/ , last update July 29th 2011.

[14] Eurostat indicators: Final energy consumption – Transport (101900) for all products (0000) and biogasoline (5546), biodiesel (5547), other liquid biofuels (5548).

CONCENTRATED SOLAR THERMAL ELECTRICITY (CSP) SNAPSHOT 2011

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Solar thermal electric power plants are generating electricity by converting concentrated solar energy to heat, which is converted to electricity in a conventional thermal power plant. The two major concepts used today are *Parabolic Trough* power plants and *Power Towers*. Other concepts including the *Dish Design* with a Stirling engine are researched as well, but so far no commercial plant has been realised.

After more than 15 years, the first new major capacities of Concentrated Solar Thermal Electricity Plants came online with Nevada One (64 MW[15], USA) and the PS 10 plant (11 MW, Spain) in the first half of 2007. In Spain the Royal Decree 661/2007 dated 25 March 2007 is a major driving force for the current CSP plant constructions and the ambitious expansion plans. The guaranteed feed-in tariff is 0.269 €/kWh for 25 years (the previous RD 436/2004 had a fix at 0.215 €/kWh). In November 2009 an annual cap of 500 MW for new installations was fixed for 2010 to 2013 [1].

At the end of January 2011 CSP plants with a cumulative capacity of about 730 MW were in commercial operation in Spain about 58% of the worldwide capacity of 1.26 GW. Additional 898 MW are currently under construction and another 842 MW have already registered for the feed-in tariff bringing the total capacity to about 2.5 GW by 2013. This capacity is equal to 60 plants which are eligible for the feed-in tariff.

In total projects with a total capacity of 15 GW have applied for interconnection. This is in line with the European Solar Industry Initiative, which aims at a cumulative installed CSP capacity of 30 GW in Europe out of which 19 GW would be in Spain [2]. More than 100 projects are currently in the planning phase mainly in Spain, North Africa and the USA.

The current average investment costs for the solar part are given in various projects at around € 4/W. Depending whether the plant has a backup in the form of a fossil fired gas turbine and/or a thermal storage the project costs can increase up to € 14/W.

Table 1 to 4 show the CSP plants in operation and those under construction which are scheduled to become operational until 2013. If the announced schedules are kept, the current installed capacity of about 1.5 GW should more than triple to 4.7 GW in 2013.

[15] The capacity figures given are MW_{el} (electric) not MW_{th} (thermal)

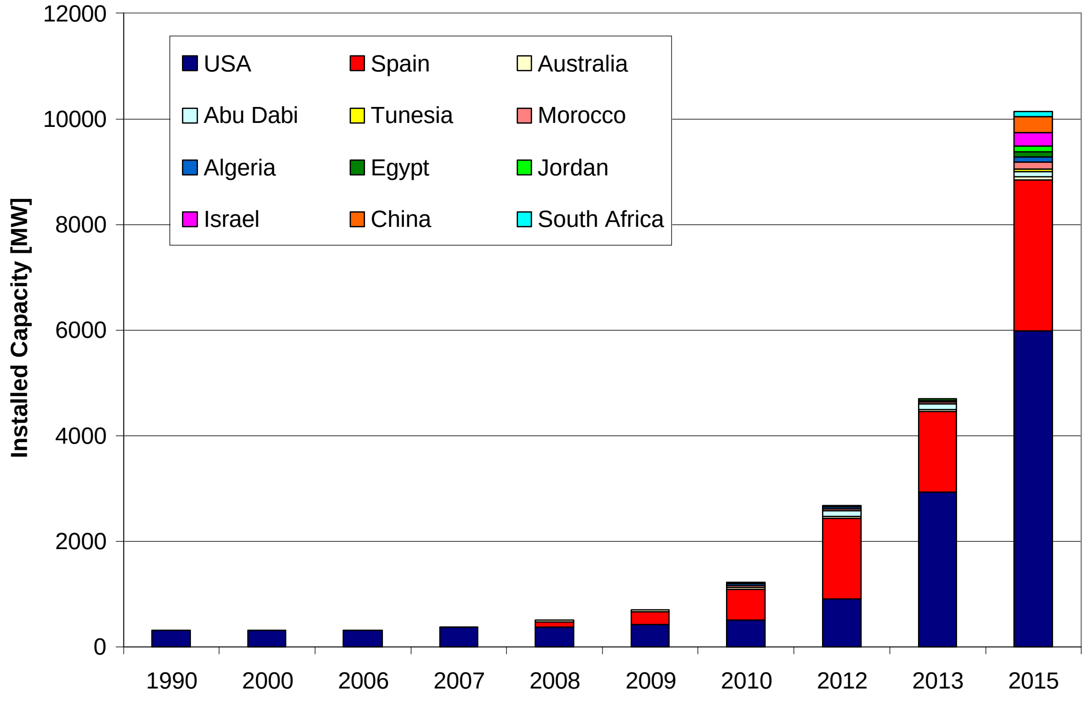

Figure 1: Installed and planned Concentrated Solar Thermal Electricity Plants [3,4,5]

Table 1: List of plants in commercial operation [3, 4, 5]

Name of Project and Consortium	Technology	Capacity [MW_{el}]	Start of operation	Investment Volume
SEGS (Mojave Dessert, CA, USA)	parabolic troughs	354	1984 -1990	n.a.
Saguaro Solar Facility, Arizona Public Service (Red Rock, AZ, USA)	parabolic troughs	1	2006	n.a.
Nevada Solar One, Acciona/Duke Energy (Boulder City, NV, USA)	parabolic troughs	64	2007	$ 266 million
Solúcar Platform – PS 10 Abengoa; (Sanlúcar la Mayor, Spain)	tower	11	2007	n.a.
Andasol 1; Solar Millenium (Guadix, Spain)	parabolic troughs	50	2008	€ 300 million
Kimberlina Ausra; (Bakersfield, CA, USA)	fresnel reflectors	5	2008	n.a.
Liddel Power Station (Lake Liddel, Australia)	fresnel reflectors	2	2008	n.a.
Andasol 2 Solar Millenium; (Guadix, Spain)	parabolic troughs	50	2009	€ 300 million
Solúcar Platform – PS 20 Abengoa; (Sanlúcar la Mayor, Spain)	tower	20	2009	n.a.
Puertollano 1 Iberdrola; (Ciudad Real, Spain)	parabolic troughs	50	2009	n.a.

Name of Project and Consortium	Technology	Capacity [MW_{el}]	Start of operation	Investment Volume
Alvarado I; Acciona (Alvardao, Badajoz, Spain)	parabolic troughs	50	2009	€ 236 million
Sierra Sun Tower eSolar; (Lancaster, CA, USA)	tower	5	2009	n.a.
Puerto Errado 1, Novatec Solar (Calasparra, Spain)	fresnel reflector	1.4	2009	n.a.
Keahole Solar Power (Hawaii, HI, USA)	parabolic troughs	2	2009	n.a.
Shiraz solar power plant, Iran	parabolic troughs	0.25	2009	n.a.
Maricopa Solar, NTR (Phoenix, AZ, USA)	dish stirling	1.5	2010	n.a.
Extresol 1 & 2; ACS-Cobra-Group/Solar Millenium AG (Torre de Miguel, Spain)	parabolic troughs + 7.5h storage	100	2010	Extresol 1, € 300 million
Solúcar Platform – Solnova 1 ,3; 4, Abengoa/Schott Solar (Sanlúcar la Mayor, Spain)	parabolic troughs	150	2010	Solnova 1 & 3, € 400 million
Archimedes, Sicily, Italy	Gas, Solar + storage	5 solar	2010	€ 40 million
La Florida, Renovables SAMCA (Badajoz, Spain)	parabolic troughs + 7.5h storage	50	2010	n.a.
Hassi-R'mel I; Algéria (Sonartrach/Abener)	Solar Combined Cycle	150 total, 35 solar	2010	€ 320 million
Ain-Ben-Mathar, Morocco (Abengoa/ONE)	Solar Combined Cycle	470 total, 35 solar	2010	€ 469 million
Yazd Solar Thermal Power Plant, Iran	Solar Combined Cycle	467 total 17 solar	2010	n.a.
Palma de Rio II, Acciona (Palma del Río, Spain)	parabolic troughs	50	2010	€ 251 million
Majades I, Acciona (Majadas de Tiétar, Spain)	parabolic troughs	50	2010	€ 237 million
Martin Next Generation Solar Energy Center, FPL (Indiantown, FL, USA)	ISCC	75 solar	2010	$ 480 million
La Dehesa, Renovables SAMCA (La Garrovilla, Spain)	parabolic troughs + 7.5h storage	50	2011	n.a.
Lebrija-1, Solel/Sacyr (Lebrija, Spain)	parabolic troughs	50	2011	$ 400 million
Manchasol 1 & 2, ACS/Cobra Group (Alcazar de San Juan, Spain)	parabolic troughs + 7.5h storage	100	2011	n.a.
Kuraymat; Iberdrola/Mitsui/Solar Millenium; (Kuraymat, Egypt)	Solar Combined Cycle	150 total, 25 solar	2011	solar part: 4,935 $/kW.
Gemasolar, Terresol Energy (Fuentes de Andalucía, Seville, Spain)	Solar tower with molten salt storage	20 (6,500h/a	2011	€ 240 million
Palma de Rio I, Acciona/Mitsubishi Corp. (Cordoba, Spain)	parabolic troughs	50	2011	€ 240 million
Helioenergy 1 Abengoa (Écija, Sapin)	parabolic troughs	50	2011	€ 275 million.
Total (April 2011)		**1,579.15**		

Table 2: List of projects currently under construction with projected operation 2011 [3, 4, 5]

Name of Project	Technology	Capacity [MW_{el}]	Start of construction and/or operation	Investment Volume
Andasol 3; Solar Millenium AG (Spain)	parabolic troughs; solar (90%) + gas + thermal storage	50	construction 2009, Operation 2011	€ 300 million
Valle 1 & 2; Torresolar (San Jose de Valle, Spain)	parabolic troughs + 7h storage	100	Construction 2009 operation 2011	€ 660 million
Helioenergy 2 Abengoa (Écija, Sapin)	parabolic troughs	50	construction 2009 operation 2011	€ 275 million
El Reboso II, Bogaris (La Puebla del Río, Spain)	parabolic troughs	50	Construction 2009 operation 2011	€ 220 million
Victorville 2 Voctorville, CA (USA)	gas fired + parabolic troughs	553 total with 50 solar	operation 2011	$ 450 million
Total		**300**		

Table 3: List of projects currently under construction with projected operation 2012 [3, 4, 5]

Name of Project	Technology	Capacity [MW_{el}]	Start of construction and/or operation	Investment Volume
El Reboso III, Bogaris (La Puebla del Río, Spain)	parabolic troughs + 116 MWh storage	50	Construction 2010 operation 2012	€ 220 million
Extresol 2; ACS-Cobra-Group (Torre de Miguel, Spain)	parabolic troughs + 7.5h storage	50	Construction 2009 operation 2012	€ 300 million
Extresol 3; ACS-Cobra-Group (Torre de Miguel, Spain)	parabolic troughs + 7.5h storage	50	Construction 2009 operation 2012	€ 300 million
Solaben 1& 2 (Logrosan, Spain)	parabolic troughs	100	Construction 2011 Operation 2012	> € 500 million
La Africana (Palma de Rio, Spain)	parabolic troughs	50	Construction 2011 Operation 2012	n.a.
El Carpio (Cordoba, Spain)	parabolic troughs	50	Construction 2011 Operation 2012	n.a.
Alpine Sun Tower, eSolar (Lancaster, CA, USA)	tower	92	Operation 2012	n.a.
New Mexico SunTower, NRG Energy/ eSolar (Santa Teresa, NM, USA)	tower	92	Operation 2012	n.a.
Shams 1 (Madinat Zayed, UAE)	parabolic trough	100	Construction 2010 Operation 2012	$ 600 million
Name of Project	Technology	Capacity [MW_{el}]	Start of construction and/or operation	Investment Volume
Puerto Errado 2 (Calasparra, Spain)	fresnel	30	Construction 2011 Operation 2012	n.a.
Gascel (Lancaster, CA, USA)	tower	245	Construction 2011 Operation 2012	n.a.
Total		**909**		

Table 4: List of projects currently under construction with projected operation 2012 [3, 4, 5]

Name of Project	Technology	Capacity [MW_{el}]	Start of construction and/or operation	Investment Volume
Crescent Dunes (NV, USA)	tower + 10h storage	110	Construction 2011 Operation 2013	n.a.
Rice Solar Energy Project (Riverside, CA, USA)	tower + storage	150	Construction 2011 Operation 2013	n.a.
Blythe (CA, USA)	parabolic trough	4×250	Construction 2010 Operation 2013	$ 6 billion
Abengoa Mojave Project (Harper Dry Lake, CA, USA)	parabolic troughs	250	Construction 2010 Operation 2013	n.a.
Solana, Abengoa Solar, Gila Bend, AZ (USA)	parabolic troughs + 6h storage	280	Construction 2011 Operation 2013	$ 2 billion.
Ivanpah 1, 2 & 3, Ivanpah Solar, San Bernardino, CA (USA)	solar tower + gas-fired start-up boiler	100 100 200	Operation 2013	n.a.
Total		**2,190**		

In December 2009 the World Bank's Clean Technology Fund (CTF) Trust Fund Committee endorsed a CTD resource envelope for projects and programmes in five countries in the Middle East and North Africa to implement CSP [6]. The budget envelope proposes CTF co-financing of $ 750 million (€ 600 million[16]), which should mobilize an additional $ 4.85 billion (€ 3.88 billion) from other sources and help to install more than 1.1 GW of CSP by 2020.

As a follow up to this initiative, the World Bank commissioned and published a report early 2011 about the Local Manufacturing Potential in the MENA region [7]. The report concludes: *MENA could become home to a new industry with great potential in a region with considerable solar energy resources. If the CSP market increases rapidly in the next few years, the region could benefit from significant job and wealth creation, as well as from enough power supply to satisfy the growing demand, while the world's renewable energy sector would benefit from increased competition and lower costs in CSP equipment manufacturing.*

Within just a few years, the CSP industry has grown from negligible activity to over 4 GW_e either commissioned or under construction. More than ten different companies are now active in building or preparing for commercial-scale plants, compared to perhaps only two or three who were in a position to develop and build a commercial-scale plant a few years ago. These companies range from large organizations with international construction and project management expertise who have acquired rights to specific technologies, to start-ups based on their own technology developed in house. In addition, major renewable energy independent power producers such as Acciona, and utilities such as Iberdrola and Florida Power & Light (FLP) are making plays through various mechanisms for a role in the market.

[16] Exchange rate 1 € = 1.25 $

The supply chain is not limited by raw materials, because the majority of required materials are glass, steel/aluminum, and concrete. At present, evacuated tubes for trough plants can be produced at a sufficient rate to service several hundred MW/yr. However, expanded capacity can be introduced fairly readily through new factories with an 18-month lead time.

Important!

The amount of delivered electricity of a solar thermal power plant strongly depends whether or not the plant has a thermal storage and/or a fossil – generally gas – back-up. The solar fraction of electricity production in southern Spain and the projects in California and Nevada are expected to be between 2000 and 2100 KWh annually per kW installed capacity.

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Technical Annex:

Trough Systems

The sun's energy is concentrated by parabolically curved, trough-shaped reflectors onto a receiver pipe running along the focal plane of the curved surface. This energy heats oil or another medium flowing through the pipe and the heat energy is then used to generate electricity in a conventional steam generator.

Power Tower Systems

The sun's energy is concentrated by a field of hundreds or even thousands of mirrors called **heliostats** onto a receiver on top of a tower. This energy heats molten salt flowing through the receiver and the salt's heat energy is then used to generate electricity in a conventional steam generator. The molten salt retains heat efficiently, so it can be stored for hours or even days before being used to generate electricity.

Dish/Engine Systems

A dish/engine system is a stand-alone unit composed primarily of a collector, a receiver and an engine. The sun's energy is collected and concentrated by a dish-shaped surface onto a receiver that absorbs the energy and transfers it to the engine's working fluid. The engine converts the heat to mechanical power in a manner similar to conventional engines—that is, by compressing the working fluid when it is cold, heating the compressed working fluid, and then expanding it through a turbine or with a piston to produce work. The mechanical power is converted to electrical power by an electric generator or alternator.

2011 SNAPSHOT ON EUROPEAN PHOTOVOLTAICS IN A WORLD WIDE PERSPECTIVE

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Production data for the global cell production[17] in 2010 vary between 18 GW and 27 GW. The significant uncertainty in the data for 2010 is due to the highly competitive market environment, as well as the fact that some companies report shipment figures, others report sales and again others report production figures. In addition, the difficult economic conditions and increased competition led to a decreased willingness to report confidential company data. The year was characterised by a boom in the first half of 2010 due to the non-scheduled cut of the feed-in tariffs in Germany on 1 July 2010 and an increasing build up of solar cell manufacturing capacities throughout 2010.

The presented data, collected from various companies and colleagues were compared to various data sources and thus led to an estimate of 24.1 GW (Fig. 1), representing a doubling of production compared to 2009.

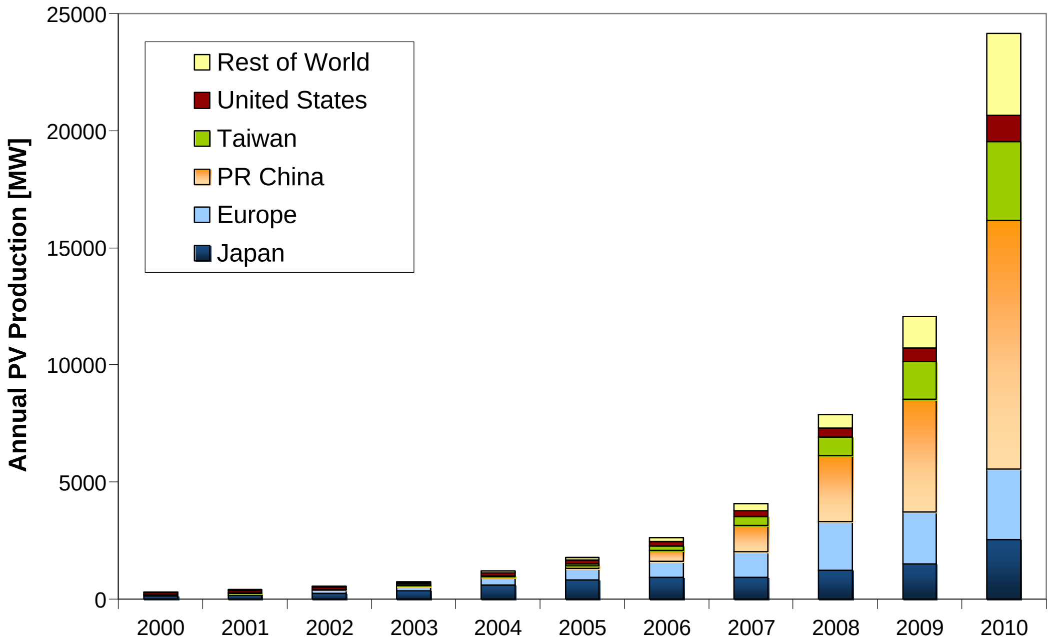

Figure 1: World-wide PV Production from 2000 to 2010
Data Source: PV News [1], Photon International [2] and own analysis

Since 2000, total PV production increased almost by two orders of magnitude, with annual growth rates between 40% and 90%. The most rapid growth in annual production over the last five years could

[17] **Solar cell production capacities** mean:
- In the case of wafer silicon based solar cells only the cells
- In the case of thin-films, the complete integrated module
- Only those companies which actually produce the active circuit (solar cell) are counted
- Companies which purchase these circuits and make cells are not counted.

be observed in Asia, where China and Taiwan together now account for almost 60% of world-wide production.

The announced future production capacities – based on a survey of more than 300 companies worldwide – increased despite difficult economic conditions. Despite the fact that a significant number of players announced a scale back or cancellation of their expansion plans for the time being, the number of new entrants into the field, notably large semiconductor or energy related companies overcompensated this. At least on paper the expected production capacities are increasing. Only published announcements of the respective companies and no third source info were used. The cut-off date of the used info was August 2011.

It is important to note that production capacity announcements are often based different operational assumptions, so factors such as number of shifts, operating hours per year, etc may not be consistent. In addition these announcements do not always specify when the capacity will be fully operational. It also has to be considered that a) not all companies announce their capacity increases in advance and b) in times of financial tightening, announcements of scale backs of expansion plans are often delayed in order not to upset financial markets. Therefore the capacity figures just give a trend but do not represent the final numbers.

If all these ambitious plans can be realised by 2015, China will have about 47.3% of the world-wide production capacity of 105 GW, followed by Taiwan (15.2%), Europe (9.0%) and Japan (6.7%) (Fig. 2) [3, 4].

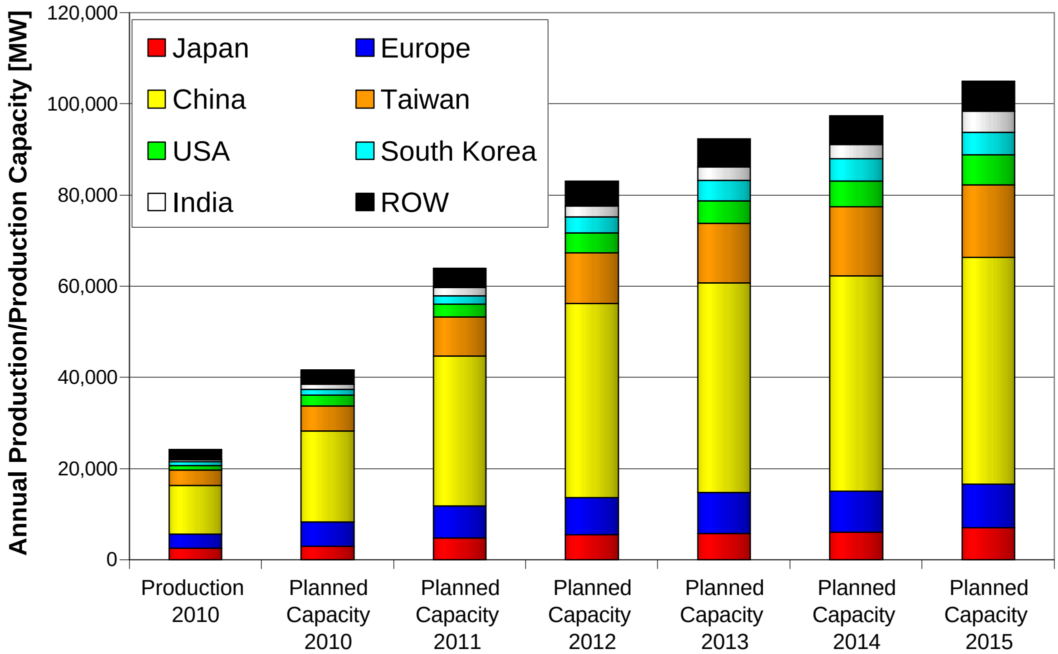

Figure 2: World-wide PV production with future planned production capacity increases

These ambitious projections to expand production at such a rapid pace depend on the expectations that the markets will grow accordingly. Predictions for the 2011 PV market vary from 17.3 GW by the Navigant Consulting conservative scenario [5] to 19.6 GW by Macquarie [6] and 24.9 GW by iSuppli [7], with a consensus value in the 18 to 19 GW range In addition most markets are still dependent on public support in the form of feed-in tariffs, investment subsidies or tax-breaks.

Wafer-based silicon solar cells are still the main technology and had more than 80% market share in 2010. Of these polycrystalline solar cells still dominate the market (45 to 50%) even if their share has been slowly decreasing since 2003.

The previous tight silicon supply situation reversed due to massive production expansions, as well as the economic situation. This led to a price decrease from the 2008 peak of around 500 $/kg to about 50–55 $/kg at the end of 2009, with a slight upwards tendency throughout 2010 and early 2011.

For 2010, about 140,000 metric tons of solar grade silicon production were reported, sufficient for around 20 GW, under the assumption of an average materials need of 7 g/Wp [8]. China produced about 45,000 metric tons, or 32%, capable of supplying about 75% of the domestic demand [9]. According to the Semi PV Group Roadmap, the Chinese production capacity rose to 85,000 metric tons of polysilicon in 2010.

In January 2011, the Chinese Ministry of Industry and Information Technology tightened the rules for polysilicon factories. New factories must be able to produce more than 3,000 metric tons of polysilicon a year and meet certain efficiency, environmental and financing standards. The maximum electricity use is 80 kWh/kg of polysilicon produced a year, and that number will drop to 60 kWh at the end of 2011. Existing plants that consume more than 200 kWh/kg of polysilicon produced at the end of 2011 will be shut down.

Projected silicon production capacities available for solar in 2012 vary between 250,000 metric tons [10] and 410,665 metric tons [11]. The possible solar cell production will in addition depend on the material use per Wp. Material consumption could decrease from the current 7 to 8 g/Wp down to 5 to 6 g/Wp, but this might not be achieved by all manufacturers.

More than 200 companies are involved in thin-film solar cell activities, ranging from basic R&D activities to major manufacturing activities and over 120 of them have announced the start or increase of production. The first 100 MW thin-film factories became operational in 2007, followed by the first 1 GW factory in 2010. If all expansion plans are realised in time, thin-film production capacity could be 17 GW, or 21% of the total 83 GW, in 2012 and 27 GW, or 26%, in 2015 of a total of 105 GW (Fig. 3).

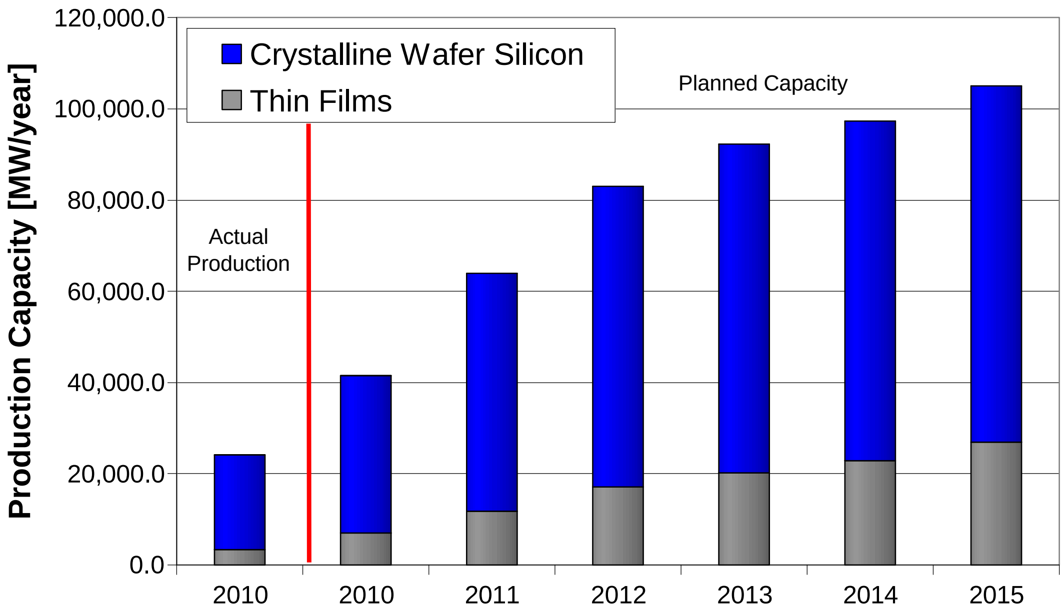

Fig. 3: 2010 production and planned PV Production capacities of Thin-Film and Crystalline Silicon based solar modules.

One should bear in mind that only one third of the over 120 companies, with announced production plans, have produced thin-film modules of 10 MW or more in 2010.

More than 70 companies are silicon-based and use either amorphous silicon or an amorphous/microcrystalline silicon structure. 36 companies announced using $Cu(In,Ga)(Se,S)_2$ as absorber material for their thin-film solar modules, whereas nine companies use CdTe and eight companies go for dye and other materials.

Concentrating Photovoltaics (CPV) is an emerging technology which is growing at a very high pace, although from a low starting point. About 50 companies are active in the field of CPV development and almost 60% of them were founded in the last five years. Over half of the companies are located either in the United States of America (primarily in California) and Europe (primarily in Spain).

Within CPV there is a differentiation according to the concentration factors[18] and whether the system uses a dish (Dish CPV) or lenses (Lens CPV). The main parts of a CPV system are the cells, the optical elements and the tracking devices. The recent growth in CPV is based on significant improvements in all of these areas, as well as the system integration. However, it should be pointed out that CPV is just at the beginning of an industry learning curve, with a considerable potential for technical and cost improvements. The most challenging task is to become cost-competitive with other PV technologies quickly enough in order to use the window of opportunities for growth.

With market estimates for 2010 in the 5 to 10 MW range, the market share of CPV is still small, but analysts forecast an increase to more than 1,000 MW globally by 2015. At the moment, the CPV pipeline is dominated by just three system manufacturers: Concentrix Solar, Amonix, and SolFocus.

In 2010 the world-wide photovoltaic market more than doubled, driven by major increases in Europe. For 2010 the market volume of newly installed solar photovoltaic electricity systems varies between 17 and 19 GW, depending on the reporting consultancies and our value is at the lower end with 17.5 GW (Fig. 4). This represents mostly the grid-connected photovoltaic market. To what extent the off-grid and consumer product markets are included is not clear, but it is believed that a substantial part of these markets are not accounted for, as it is very difficult to track them. A conservative estimate is that they account for approx. 400 to 800 MW (approx. 1-200 MW off-grid rural, approx. 1-200 MW communication/signals, approx. 100 MW off-grid commercial and approx. 1-200 MW consumer products).

[18] High concentration > 300 suns (HCPV), medium concentration 5 < x < 300 suns (MCPV), low concentration < 5 suns (LCPV) .

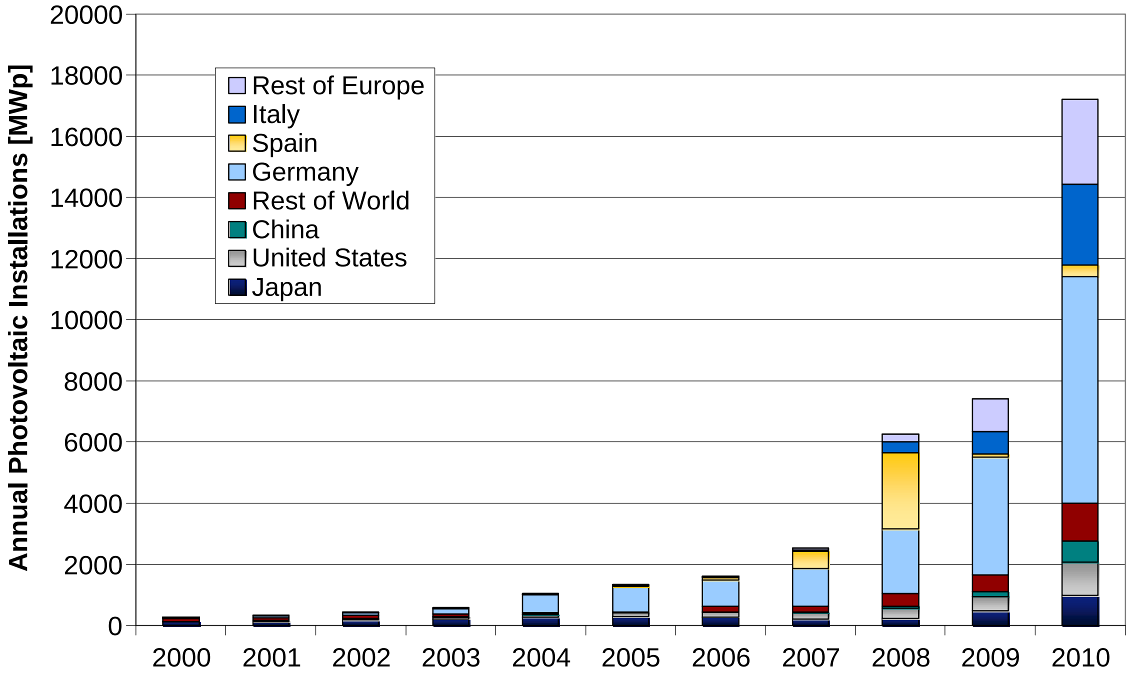

Figure 4: Annual photovoltaic installations from 2000 to 2010
(data source: EPIA [12], Eurobserver [13] and own analysis)

With a cumulative installed capacity of over 29 GW, the European Union is leading in PV installations with a little more than 70% of the total world-wide 39 GW of solar photovoltaic electricity generation capacity at the end of 2010.

At the beginning of September 2011, the cumulative installed capacity in Italy exceeded 10 GW and the total cumulative capacity in Europe was estimated to have exceeded 40 GW [14, 15].

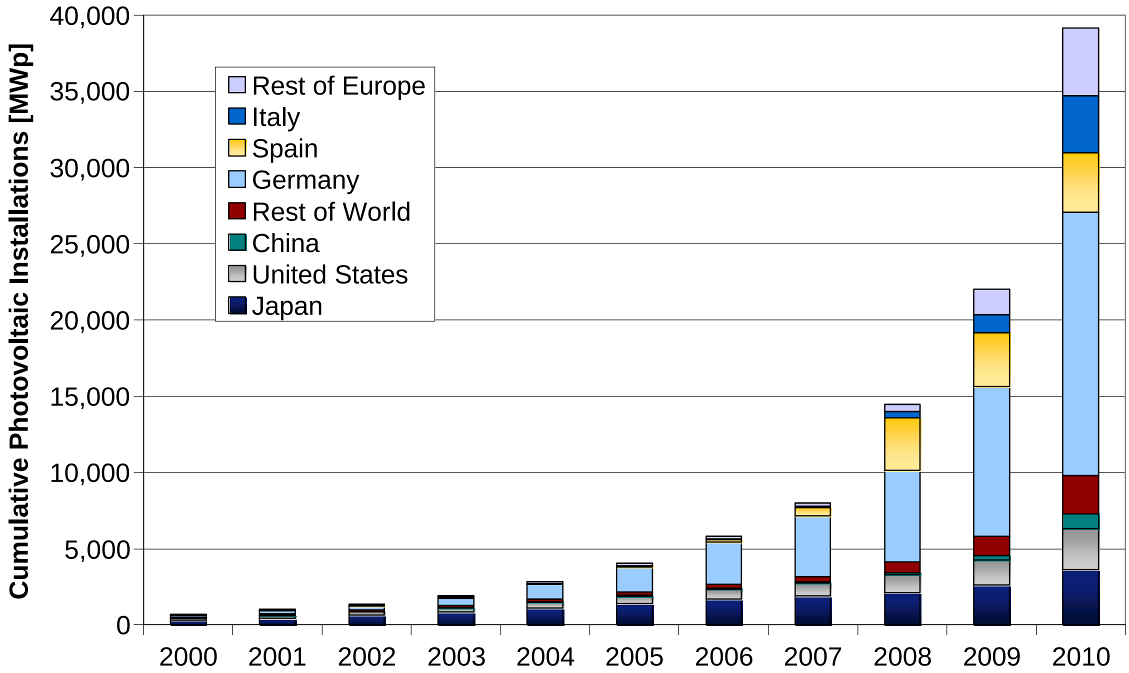

Figure 5 Cumulative Photovoltaic Installations from 2000 to 2010
(data source: EPIA [12], Eurobserver [13] and own analysis)

Important!

1) The announced production capacity increases have quite a high degree of uncertainty due to the fact that some companies quote maximum capacity (4 shifts 365 days/year) while others use capacity under real operation conditions. Also the time when the new lines actually start operating can be quite different, with some companies referring to date installation and others to when they are fully operational.
2) Production output of the announced production capacity depends a lot on the availability of raw material. Not all companies have secured their raw material for the announced expansions yet. This might lead to lower capacity to production ratios or delays in the actual start up.
3) On average, 1,000 MW of PV systems produce 1 TWh of electricity annually.

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SNAPSHOT ON EUROPEAN SOLAR HEAT 2011

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Solar thermal

After the impressive growth developments for the year 2008 the solar thermal market in Europe decreased in 2010 another time by 13% (in 2009 by 10%) as reported by the European Solar Thermal Industry Federation (ESTIF www.estif.org). However these figures indicate that solar thermal overall installed capacity is still growing and remains a significant economic stimulator.

This time the industrial market data can be put a side of figures reported by the EU governments in the National Renewable Energy Action Plans (NREAP) and the target figures for 2020. Some countries indicate ambitious growth figures until 2020.

The total market for glazed collectors in the 27 EU Member States increased with 2.5 GW_{th} of new capacity (3,5 million m^2 of collector area). The total capacity in operation at the end of 2010 reached 23,5 GW_{th} (33.5 million m^2 of collector area). The various national markets developed quite differently from one another. The German and Austrian market growth has decreased significantly while the demand for solar thermal technology increased strongly in smaller markets also, such as Czech Republic, Slovakia and United Kingdom.

Annual market data is available from National Energy Agencies and collected by ESTIF[19]. EU projects have been supporting the development of reliable databases for solar thermal collectors [6]. Usually information is available in m^2 and kW_{th} (kilowatt thermal) and energy produced by type of collector (glazed, unglazed & vacuum) from the Member States. The International Energy Agency's Solar Heating & Cooling Programme, together with ESTIF and other major solar thermal trade associations have decided to publish statistics in kW_{th} and have agreed to use a factor of 0.7 kW_{th}/m^2 to convert square meters of collector area into kW_{th}.

At present the calculation of produced energy from solar thermal installations is studied by several organisations. A proposal is presented in this chapter.

Technology and Application

Solar thermal systems in the built environment are used for:

- Domestic Hot Water systems (DHW), being the major application.
- Space Heating, mainly in Northern Europe
- Space Cooling in the Mediterranean area although at marginal level

The applied solar thermal technology can be distinguished in:

- Flat glazed thermo-siphon systems of about 2-3 m^2 can be found mostly in Southern Europe.
- Flat glazed forced circulation systems of about 2-6 m^2 is installed in Mid- and Northern Europe.
- Evacuated Tube Collectors which have about 15% higher efficiency in south Europe and about 30% in northern Europe than the flat plate collector.
- Unglazed collectors.

[19] Copyright for figures and tables 2010 © European Solar Thermal Industry Federation (ESTIF) Rue d'Arlon 63-67 - B-1040 Bruxelles.

Evacuated Tube Collectors take about 10% of the total collector sales in 2010 and keeps trend with the flat plate collector market. By far, most of the systems are used for Domestic Hot Water (90%). Unglazed collectors take about 4% of the market.

Other applications are space heating (in almost all cases these are combined systems) and pool water heating (mostly by unglazed collectors). Cooling assisted solar thermal provides in general low temperature heat and in addition could assist to cooling [7]. The technology is only in its starting phase and might first become economic feasible for the tertiary building sector. In some countries solar thermal technology has become an obligation for construction of new buildings.

EurObserv'ER [2] and ESTIF report [3] data that differ slightly for 2010 solar thermal capacity mainly to differences in some figures from national databases. The difference is also partially due to the inclusion of unglazed collectors by EurObserv'ER. The figures presented by ESTIF are the latest available information at the end of May 2011.

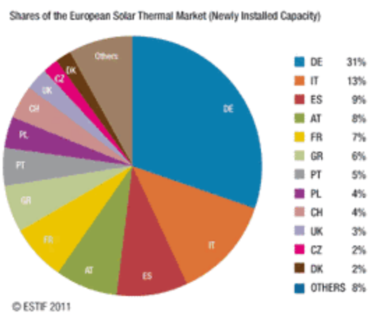

Figure 1. Market share in 2010.

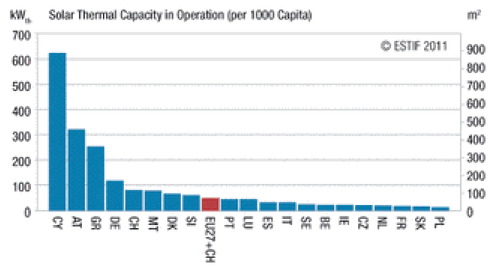

Figure 2. EU Solar Thermal Capacity

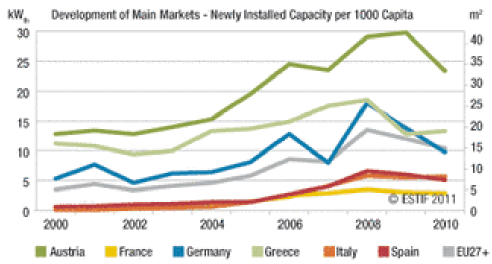

Figure 3. Market development.

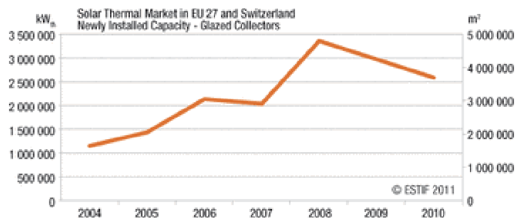

Figure 4. EU Solar Thermal Market

Table 1. Market data 2010 provided by ESTIF and elaborated by JRC.

2010	Total installed capacity m²	new glazed capacity m² 2008	2009	2010	Change 2009-2010 [%]	2010 m²/1000	NREAP target 2020 m²/1000
Belgium	328148	62200	50700	38301	-24.5	21.5	306.4
Bulgaria*	105300	25500	8000	8400	-	9.6	45.2
Czech Republic	308376	35000	51669	86000	66.4	20.8	34.9
Denmark	525146	33000	54500	58100	6.6	67.1	48.0
Germany	13824000	2100000	1615000	1150000	-28.8	117.7	249.1
Estonia*	2920	500	450	500	-	1.5	0.0
Ireland	131489	43610	32221	24918	-22.7	20.9	74.8
Greece	4084200	298000	206000	214000	3.9	254.9	520.8
Spain	2106866	433000	391000	336800	-13.9	32.6	234.0
France	1573900	313000	265000	256000	-3.4	17.8	246.4
Italy	2671730	500000	475000	490000	3.2	31.4	437.6
Cyprus	715022	60000	34709	30713	-11.5	634.4	1885.9
Latvia*	1940	210	180	200	-	0.6	14.3
Lithuania*	2400	300	200	200	-	0.5	43.7

Luxemburg*	31600	3600	4700	4500	-	45.7	274.7
Hungary	149814	32000	22000	21000	-4.5	10.4	134.3
Malta*	45860	6000	5500	5000	-	78.3	110.7
Netherlands	447595	25000	45260	40834	-9.8	19.1	23.0
Austria	3836509	347703	356166	279898	-21.4	322.3	531.0
Poland	655890	129632	144308	145906	1.1	12.0	218.4
Portugal	672697	86820	173762	182271	4.9	44.3	247.9
Romania*	104700	8000	14900	15500	-	3.4	0.0
Slovenia	175300	16000	22000	19000	-13.6	60.6	170.3
Slovakia	121750	13500	13500	15000	11.1	15.8	91.4
Finland*	32923	4100	4000	6000	-	4.3	0.0
Sweden	323735	26813	21309	20699	-2.9	24.7	10.8
United Kingdom	573220	81000	89100	105200	18.1	6.6	9.1
EU27	33553029	4684488	4101134	3554940	-13.3		

Notes:
Countries marked with an * are ESTIF estimations and are therefore not sufficient to set a percentage variation in the market.

Total installed capacity (in operation) refers to the solar thermal capacity built in the past and deemed to be still in use. A product life of 20 years is assumed by ESTIF for all systems installed since 1990. Most products today would last considerably longer, but they often cease to be used earlier, e.g. because the building is demolished, or the use of the building has changed.

The total installed capacity in 3 countries, Germany, Austria, and Greece account for 64% of the total EU27 installed capacity. In 2010, the top five countries accounted for almost 80% of the total EU27 installed capacity (Germany, Austria, Greece, Spain and Italy).

When it concerns the annual growth Greece remains at the sixth place. From the big EU countries, the United Kingdom and Poland are not yet seen amongst the top solar thermal markets. Despite their strong growth in recent years, the market in France and Italy is still under 30 kWth per 1.000 capita, while EU average is around 50 kWth. From the fast growing markets, Slovenia and Denmark have just surpassed the EU average.

The solar thermal market development might still be hampered by the impact of the financial and economic crisis.

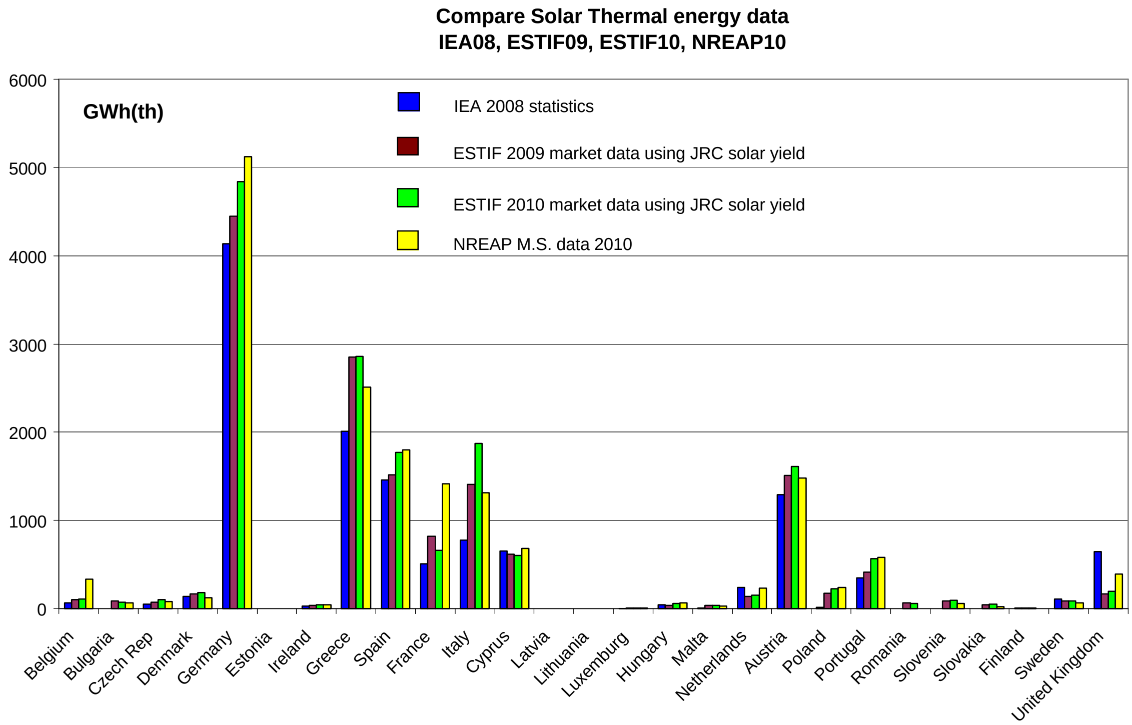

Figure 5. A graphical representation of solar thermal energy in European M.S.

National Renewable Energy Action Plans

Data on produced solar thermal energy from all Member States have become available through the NREAP. Also targets have been reported for 2020. Some Member States indicate ambitious plans for solar thermal, like Italy, France and Poland. The NREAP 2010 data for solar thermal energy produced in EU27 shows a figure of 16.7 TWh(th) which is slightly higher than the figure of 16.3 TWh(th) as has been calculated by JRC from the solar yield and the ESTIF market data. See also figure 5.

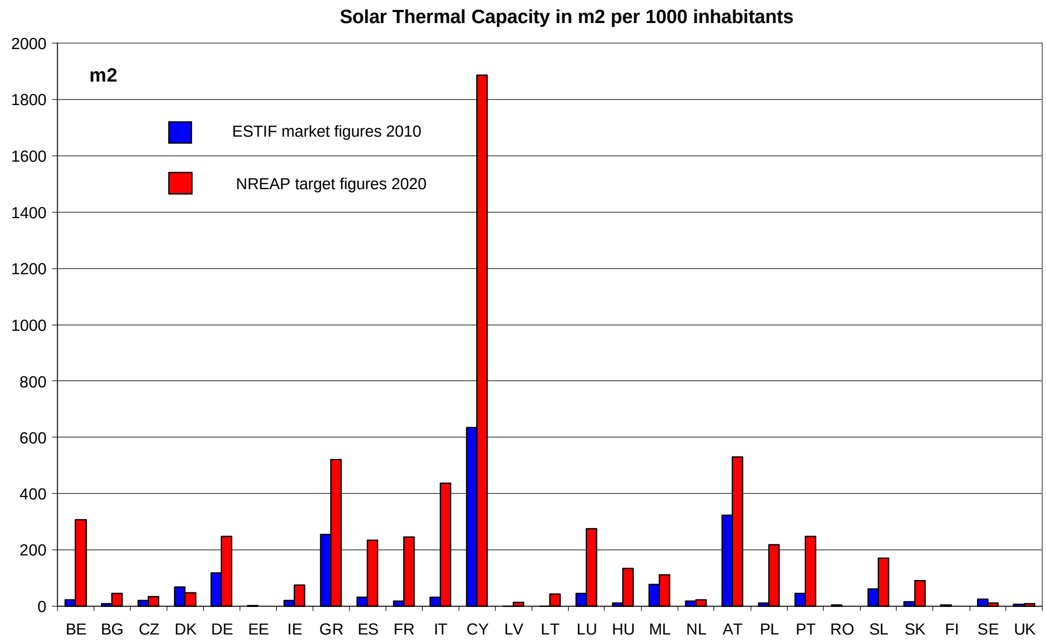

Figure 6. Solar thermal capacity in m^2/1000 inhabitants

The potential in EU has been studied by RESTMAC [9] along three scenarios. The AMD scenario (annual growth from 2006 onwards, of 15%) indicates a solar thermal contribution of 2.4% of the 20% target for Renewable Energy in 2020, corresponding to 59 TWh. The presented NREAP target data for the solar thermal share gives 73 TWh (about 20% higher) mainly due to ambitious growths in Italy, France and Poland beside the continuing growth in Germany and Spain.

Solar Thermal Capacity and Energy

Heat dominates energy end use. In particular the application of solar thermal installations in the building sector may contribute to a reduction of GHG emission. Empirical data from final energy consumption shows that heat takes about half of the total consumption.

Table 2. Final energy consumption. Data Source: Eurostat data - elaborated JRC.

	Final energy consumption share [%]
Electricity	20
Heat	48
Fuel for transport	32

The ESTIF urged the European Commission (Dec 2009) to include the renewable heating and cooling sector in the SET-Plan. As heat accounts for nearly 50% of Europe's overall energy demand, major investments are needed in renewable heating and cooling technologies to meet the 20-20-20 targets, to secure energy supply in Europe and to significantly reduce CO2 emissions.

Despite its relevant share in the total heat demand, the domestic hot water consumption remains an unknown factor, as no recent and reliable survey regarding this consumption exists. A detailed assessment of this parameter at national and European level would contribute to a better understanding of the heat market.

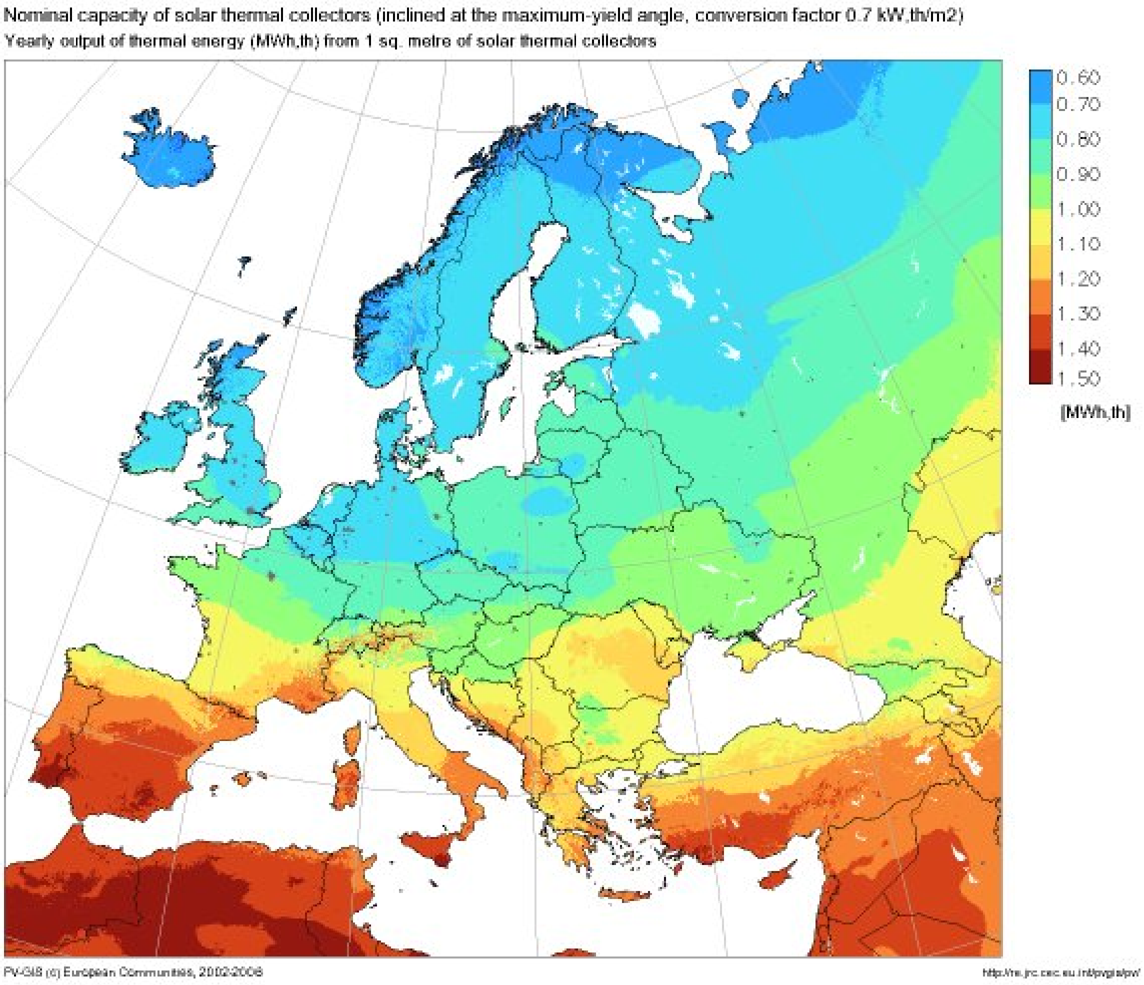

Figure 7: Yearly global irradiation at optimal inclination for solar energy applications.

Solar yield for glazed flat plate solar collector installations.

One of the major uncertainties comes from the fact that the produced energy is not measured and calculation is based on empirical methodology. To have an indication of the energy produced by solar thermal installations it is important to have data of solar irradiation. The figure (based on JRC data; Ref [4 and 5]) below gives an impression of a 1 m^2 inclined at 45º while applying a conversion of 0.7 kW/m2. This figure has to be considered as a maximum efficient figure of the installed system and does not include a load. An assumption for a load can be made of 0.7 which might bring the solar yield to approximately 0.5/m^2 for a given climate position in Europe.

Note that roughly a factor 2 can be applied when Northern Europe is compared with the Mediterranean area. In practise this means that a house-owner in Scandinavia will need twice more m2 of solar collectors than in Southern Europe to produce the same thermal energy. A further remark has to be made concerning the optimal inclination because of its definition as the angle that produces the most energy over the whole year. However during the winter months the low level of solar radiation at this inclination is not sufficient to fulfil the request for hot water, and therefore the angle of the solar collectors might be more inclined for higher efficiency in the winter than in the summer months.

Based on this information a solar yield is defined for each M.S. :

JRC calculation is area $m^2 * G_{opt} * 0.7 *$ yield; G_{opt} is taken from JRC data (PVGIS).

There are many factors that influence the uncertainty of this yield, ranging from the size of the country (averaging radiation data) until final energy consumption efficiency (multi-apartment buildings). However the result gives estimation with presently an uncertainty of up to 15% which can be improved. A harmonised and location depended calculation is required to obtain more reliable data for solar thermal end-use energy consumption.

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2011 SNAPSHOT ON EUROPEAN WIND ENERGY

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In 2010 39.4 GW [1] of new wind turbine capacity were installed bringing the world wide total installed wind capacity to almost 200 GW (Fig. 1). The total value of new generation equipment installed in 2010 is estimated to be about € 40 billion [2]. China moved to the first place (44.7 GW), followed by the United States (40.2 GW), Germany (27.2 GW), Spain (20.7 GW) and India (13.1 GW). With almost 19 GW of new installations, China had about 50% market share of new installations. The total installed wind capacity at the end of 2010 can produce about 440 TWh of electricity or about 2.2% of the global electricity demand.

The European Union Member States added 9,259 MW and reached a total installed capacity of 84,074 MW [3]. Other European countries and Turkey added 624 MW, bringing the total wind installations in Europe and Turkey to 86,075 MW.

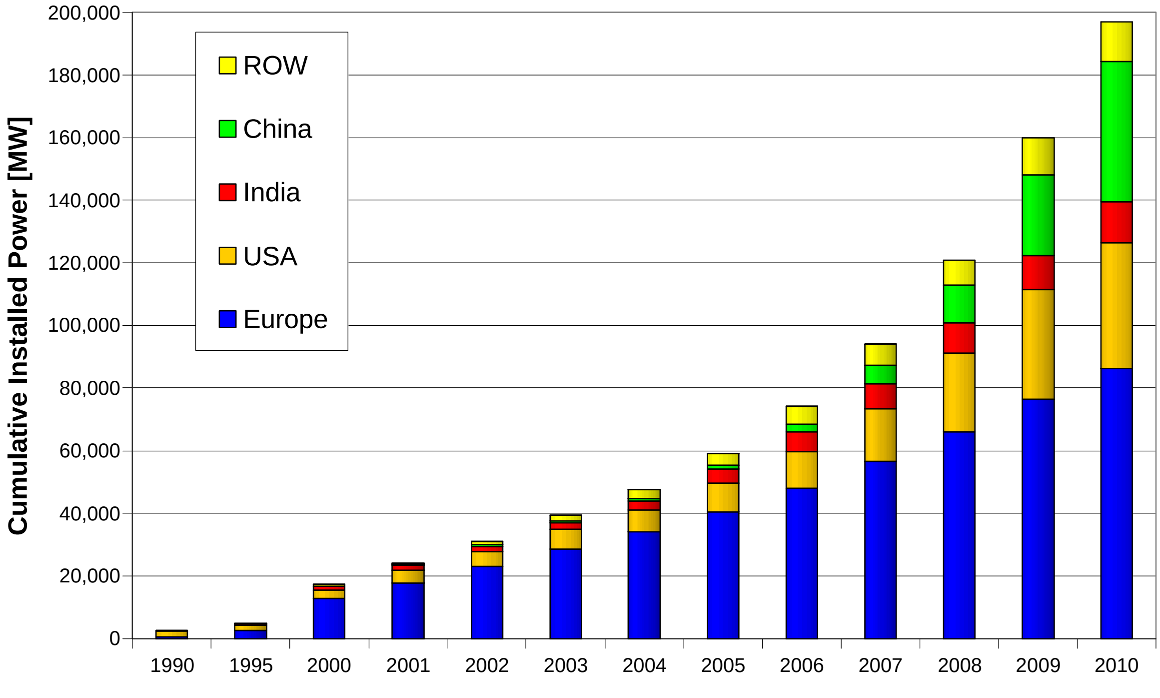

Figure 1: Cumulative world-wide installed Wind Power capacity from 1990 to 2010 Data Source: BTM, EWEA, GWEC, WWEA [1, 2, 3, 4]

Six countries added capacities of more than 1 GW in 2010: China (18.9 GW), United States of America (5.1 GW), India (2.1 GW), Germany (1,551 MW), Spain (1,527 MW) and France (1,086 MW). Another five countries added 500 MW or more: United Kingdom (962 MW) Italy (950 MW), Canada (690 MW), Sweden (604 MW), Romania (577 MW) and Turkey (528 MW).

After an almost even distribution of market shares amongst Europe, North America and Asia in 2009, Asia dominated the installations with almost 54% in 2010, whereas the North American share sharply declined to 15% leaving Europe with 25%.

In 2010, the European Union's wind capacity grew by 12.2 %, well below the global average of 24.8%. The total capacity of 84 GW is equal to 10% of the total European electricity generation capacity and is capable to produce about 185 TWh of electricity or roughly 6% of the European electricity consumption. The German and Spanish markets each still represent 16% of the EU market, but France (12%), the United Kingdom (10%) and Italy (10%) are catching up.

The general trend shows that the wind energy sector is broadening its market base and more and more countries are increasing the installation of wind energy capacities. In 2010 a total of 83 countries used wind energy on a commercial basis and 50 out of them increased their installations in that year. The European market accounted for about 25% of the total new capacity, a significant percentage decrease from the 75% in 2004.

In 2010 offshore wind capacity increased more than twice the rate of onshore installations with 59.4%. However this high growth rate was from a low basis and the added offshore capacity of 1.16 GW brought the total offshore capacity to 3.1 GW or 1.6% of the total wind capacity worldwide.

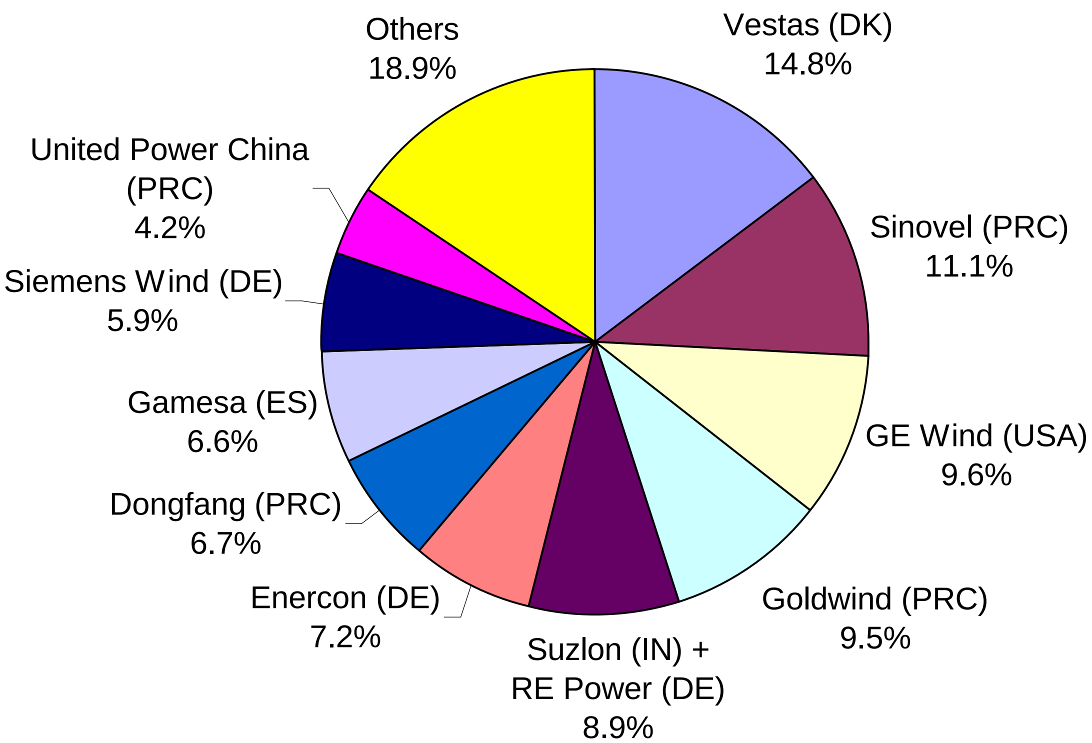

Figure 2: Market shares of manufacturers 2010 (39.4 GW installations) [1]
(The total is more than 100% due to the difference between supplied and installed turbines)

Market shares of manufacturers published by *MAKE consulting* and *BTM Consult* showed that Denmark's Vestas continued to defend its top manufacturing position, followed by Sinovel and Goldwind from China and GE Wind from the USA. 4 of the top 10 wind turbine manufacturers are from the People's Republic of China and there are more than 100 companies involved in wind equipment manufacturing [1, 5, 6, 7].

It should be noted, that the two consulting companies differ most in the market share of Vestas, which is given with 14.8% from BTM and 12 from MAKE.

So far most of the Chinese wind turbines are only sold in China, but a number of players have already announced to expand outside China in the future partly because of overcapacity and fierce competition within the domestic market. Chinese companies were highly present at the recent European wind industry fairs of Husum 2010 and EWEA 2011, and some have even established a European office, e.g. Sinovel in Madrid. It is obvious, that the vision of the Chinese wind turbine manufacturers is not limited to sell wind turbines overseas, but to establish manufacturing strongholds in the big markets and offer wind farm financing and operation. This strategy is backed by the Chinese government in order to accelerate the maturing of the domestic industry.

Despite a record capacity of 44.7 GW, China is still facing a severe connection problem. The State Grid Cooperation of China (SGCC) estimates that by the end of 2010, that wind farms with about 15 GW capacity were not connected to the national grid [8]. In 2010, coal accounted for 67.6 percent of the country's power, about 30 percent higher than the world average. Wind power accounted for just 1.1 percent of China's electricity. At the end of 2009 the Chinese Renewable Energy Law from 2006 was amended and the renewable energy target for 2020 was increased from the previous 9% to 15%. The 30 MW wind target for 2020, set in 2006, was surpassed in 2010 and the Chinese State Grid Corporation released a white paper in 2011 which states: "China's accommodated wind power will exceed 90 GW in 2015 and 150 GW in 2020” [8]. Analysts like Morgan Stanley are even more ambitious and predict that China will increase its wind power capacity to 300 GW by 2020 [7].

In 2009 the European Wind Energy Association (EWEA) increased its 2020 target from 180 GW installed capacity in 2020 to 230 GW including 40 GW offshore. This cumulative installed capacity would be able to produce some 600 TWh of electricity or 14 to 18% of the European Union's expected electricity demand in 2020.

On a world wide scale, the World Wind Energy Association (WWEA) is forecasting on the basis of the current growth rates and the increased risk awareness of fossil fuel supply and nuclear power plants an installed wind capacity of 600 GW by 2015 and 1,500 GW by 2010. According to the WWEA, the sector provided 670,000 direct and indirect jobs at the end of 2010 and has more than tripled its employment figures within the last five years. In 2012 the Association expects that the wind industry will provide more than 1 million jobs world wide.

Important!

1) In Europe, the potential annual average electricity production of wind turbines with a nominal capacity of 1,000 MW is 2.2 TWh. This means that the cumulative installed capacity in EU 27 by the end of in 2010 (84 GW) could deliver about 185 TWh of electricity in an average wind year, roughly 6% of the EU 27 electricity consumption. However, real production depends on the annual wind conditions and can vary by at least ± 10%.

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RES status in the National Renewable Action Plans

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Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources (RES Directive) not only set the mandatory targets for the European Union's Member States, but also drafted a trajectory how to reach the targets for each of them and requires Member States to adopt a National Renewable Energy Action Plan (NREAP), setting out sectoral targets and measures for achieving these targets.

The National Renewable Action Plans had to be submitted to the European Commission by 30 June 2010 using a Template established in accordance with Article 4 of the Directive, requiring data by sectoral and source breakdown.

RES mix in the EU27

Table 1: RES breakdown by source in EU27 from 2005 to 2020 in PJ

	2005*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	CAGR 2020/ 2010
hydro	1180.87	1204.79	1203.53	1208.09	1213.97	1221.08	1225.10	1228.91	1240.94	1246.90	1254.68	1265.04	0.5
geothermal	37.84	49.89	55.35	60.69	67.63	75.73	83.04	94.78	106.37	120.34	132.66	149.40	11.6
Solar total	35.04	132.90	183.48	222.67	261.77	302.26	345.91	396.00	448.97	507.20	569.25	639.22	17.0
Solar electricity	6.57	76.90	114.19	142.68	168.26	193.70	219.43	247.04	275.72	305.88	338.29	373.19	17.1
PV	6.60	72.74	104.41	125.99	145.83	166.16	186.77	208.17	230.16	252.86	276.40	301.10	15.3
CSP	0.00	4.16	9.78	16.69	22.43	27.54	32.66	38.87	45.56	53.02	61.89	72.09	33.0
Solar thermal	28.47	56.00	69.29	79.98	93.51	108.57	126.48	148.96	173.25	201.32	230.96	266.03	16.9
marine	1.93	1.81	1.81	2.08	2.36	2.72	3.12	6.09	9.32	12.55	16.78	21.64	28.2
Wind total	256.79	594.28	686.84	783.44	891.12	1003.34	1114.56	1236.05	1365.82	1504.05	1634.87	1786.07	11.6
onshore	241.40	557.02	634.32	705.07	772.04	845.62	917.92	980.07	1041.45	1110.72	1170.51	1237.77	8.3
offshore	6.94	30.74	42.07	62.67	97.41	130.84	165.66	216.54	277.28	339.76	404.61	483.08	31.7
heat pump	25.83	168.64	197.13	226.59	249.96	275.52	304.42	338.01	373.59	414.19	455.98	510.37	11.7
biomass	2455.41	3002.62	3126.16	3250.84	3397.04	3535.87	3682.44	3846.86	4026.45	4208.20	4434.50	4635.95	4.4
biofuel	130.56	589.43	637.33	687.86	705.86	769.87	820.97	878.58	975.12	1043.22	1105.22	1243.93	7.8
total RES	**4124.27**	**5744.38**	**6091.63**	**6442.25**	**6789.70**	**7186.38**	**7579.54**	**8025.28**	**8546.59**	**9056.65**	**9603.94**	**10239.00**	**6.0**

* MT and HU did not reported the RES generation data for 2005

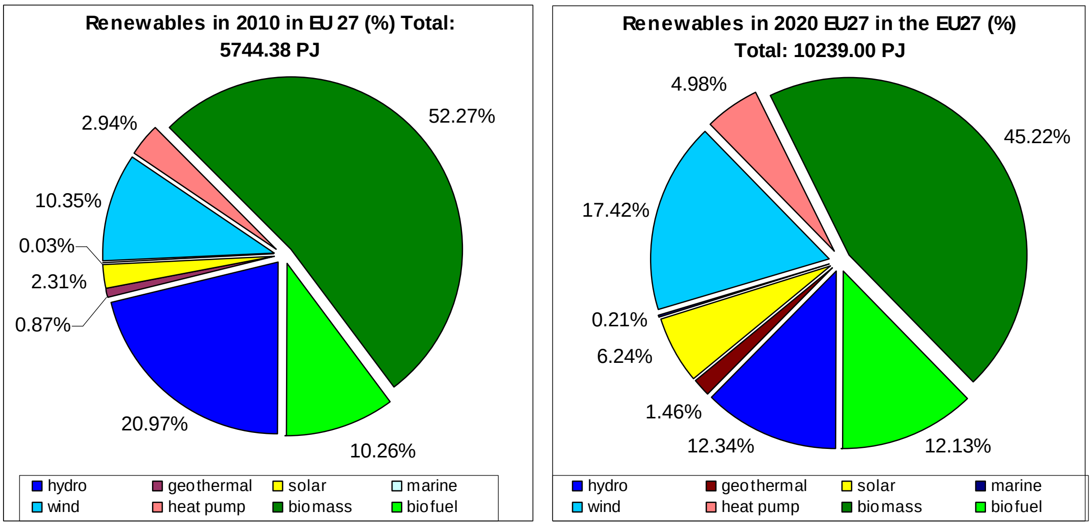

Figure 15: Resource share in RES in the EU27 in 2010 and 2020

The RES generation mix according to the NREAPs in the EU27 is presented in absolute and relative term in the Table and Figure 15 from 2005 to 2020.

Table 2: Yearly growth rate of energy production from renewable resources in EU27

%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
hydro	-0.1	0.4	0.5	0.6	0.3	0.3	1.0	0.5	0.6	0.8
$Geothermal_{th+e}$	10.7	9.5	11.3	11.9	9.6	14.3	12.3	13.3	10.3	12.7
solar	38.0	21.3	17.5	15.4	14.4	14.4	13.3	12.9	12.1	12.2
electricity	48.5	25.0	17.9	15.1	13.3	12.6	11.6	10.9	10.6	10.3
PV	43.5	20.7	15.7	13.9	12.4	11.5	10.6	9.9	9.3	8.9
CSP	134.9	70.7	34.4	22.8	18.6	19.0	17.2	16.4	16.7	16.5
thermal	23.7	15.3	16.8	16.0	16.4	17.7	16.2	16.1	14.5	15.0
marine	0.2	14.5	13.6	15.2	14.9	95.1	53.1	34.6	33.7	28.9
wind	15.6	14.1	13.7	12.6	11.1	10.9	10.5	10.1	8.7	9.2
onshore	13.9	11.2	9.5	9.5	8.5	6.8	6.3	6.7	5.4	5.7
offshore	36.8	49.0	55.4	34.3	26.6	30.7	28.1	22.5	19.1	19.4
heat pump	16.9	14.9	10.3	10.2	10.5	11.0	10.5	10.9	10.1	11.9
biomass	4.3	3.9	4.7	4.3	4.2	4.6	4.7	4.5	5.3	4.4
biofuel	9.2	7.9	2.6	9.1	6.6	7.0	10.9	7.0	5.9	11.4
total RES	**6.3**	**5.8**	**5.5**	**6.0**	**5.5**	**5.9**	**6.5**	**6.0**	**6.0**	**6.6**

RES Electricity

According to the NREAP-s, the RES electricity capacity in the EU27 will be 464088 MW in 2020 growing from 239223.3 MW in 2010 and 160284.7 MW in 2005.

Wind energy has the highest part in the renewable electricity capacity (46 %) by 2020, followed by hydro (24.2 %) and solar (19.7 %); marine and geothermal has 0.5 and 0.3 %.

Germany is the leading MS with the highest RES installed capacity in electricity with 110.9 GW which represents the 13.9 % of the total RES capacity by 2020 in the EU27. ES, FR, UK RES installed capacity is over 40 GW, this 3 country contribute with 35.4 % to the RES electricity installed capacity by 2020 in EU27. Sweden and Italy with an amount of higher than 20 MW represent 13.4 %. These 6 MS has 72.7 % EU27's RES electricity installed capacity by 2020.

The additional capacity between 2005 and 2010 is 78938.6 MW almost triples (285 %) within the years between 2010 and 0202 to 224864.7 MW.

Table 3: EU27 RES electricity total installed capacity numbers in MW

2005	2010	2020	2005-2010		2010-2020	
			Additional	Share of the 2005	Additional	Share of the 2010
160284.7	239223.3	464088	78938.6	49.3 %	224864.7	94 %

The leading countries with the highest additionally installed capacities are DE, UK, ES, FR and IT. However Sweden is among the countries with the highest installed RES capacity this is reached already at the beginning years, as there is minor development within the additional installation (Figure).

In the newly installed capacities between 2005 and 2010 onshore wind had the highest share with 52.9 % followed by PV 29.5 %, biomass has 8.7 %. Between 2010 and 2020 onshore wind has 37 % PV 26.2 % offshore wind 17.2 %, biomass 9.2 %. Hydro and CSP has 3.5 and 2.8 % Marine and geothermal represents only 0.8 and 0.4 %.

According to the NREAPs, the RES contribution to electricity in the EU27 will be 4323 PJ (1,200 TWh), representing about 33.9 % of electricity production in 2020.

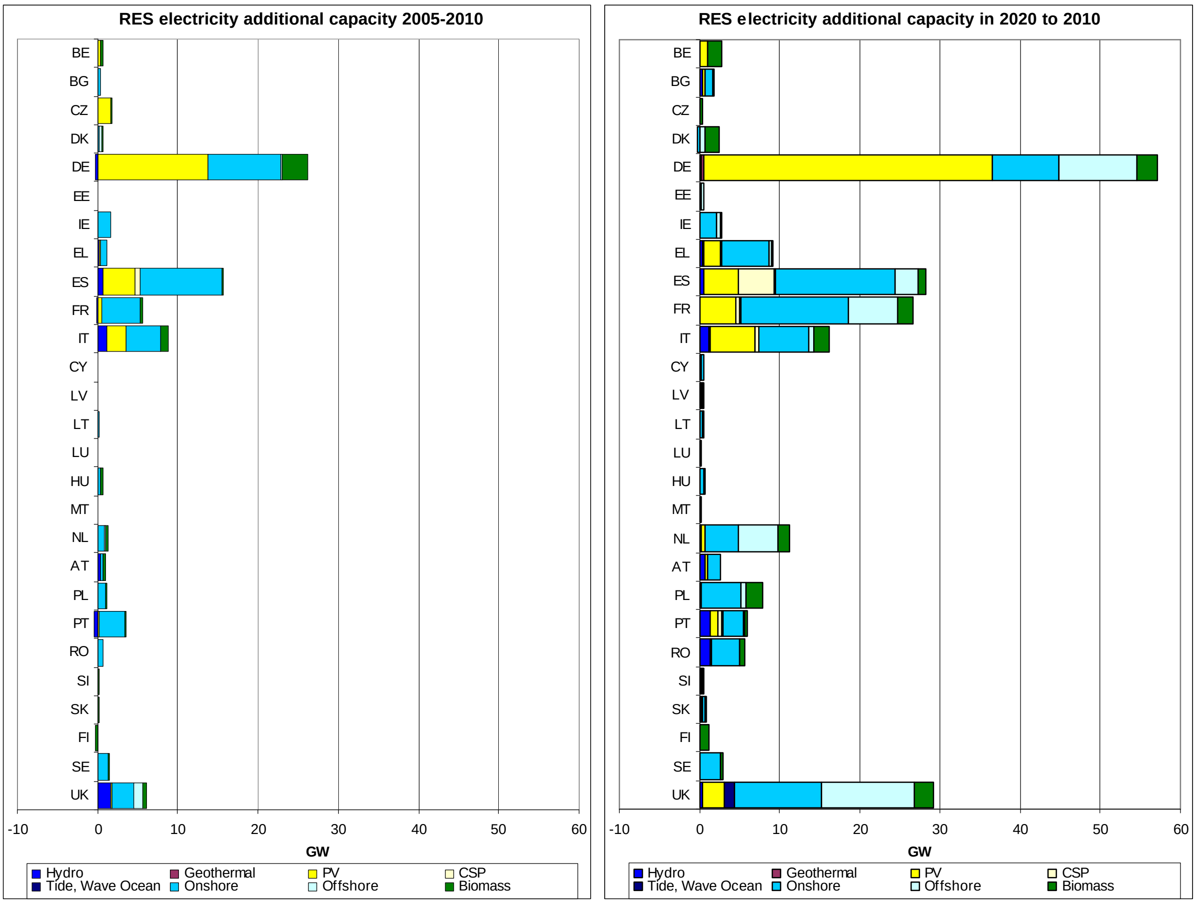

Figure 2: Additional RES electricity capacity growth between 2005-2010 and 2010-2020

Wind energy has the highest contribution in the renewable electricity generation (41.3 %) by 2020, followed by hydro (29.3 %) and biomass with 19.4 %. Solar represents 8.6 %, geothermal 0.9 % and marine resource is 0.5 %.

Table 4: Resource share in RES electricity in NREAPs for EU27

	2005					2010					2020				
	RES electricity generation		% of			RES generation		% of			RES generation		% of		
	in PJ	in TWh	RES el	total RES	electricity	in PJ	in TWh	RES el	total RES	electricity	in PJ	in TWh	RES el	total RES	electricity
Hydro	1180.87	326.99	69.0	28.67	10.48	1204.79	333.61	52.1	20.99	10.12	1265.04	350.30	29.3	12.36	9.92
Geothermal	19.78	5.48	1.2	0.48	0.18	21.59	5.98	0.9	0.38	0.18	39.27	10.87	0.9	0.38	0.31
Solar electricity	6.57	1.82	0.4	0.16	0.06	76.90	21.29	3.3	1.34	0.65	373.19	103.34	8.6	3.64	2.93
PV	6.60	1.83	0.4	0.16	0.06	72.74	20.14	3.1	1.27	0.61	301.10	83.37	7.0	2.94	2.36
CSP	0.00	0.00	0.0	0.00	0.00	4.16	1.15	0.2	0.07	0.03	72.09	19.96	1.7	0.70	0.57
Marine	1.93	0.54	0.1	0.05	0.02	1.81	0.50	0.1	0.03	0.02	21.64	5.99	0.5	0.21	0.17
Wind total	256.79	71.11	15.0	6.23	2.28	594.28	164.56	25.7	10.36	4.99	1786.07	494.57	41.3	17.44	14.01
Onshore	241.40	66.84	14.1	5.86	2.14	557.02	154.24	24.1	9.71	4.68	1237.77	342.74	28.6	12.09	9.71
Offshore	6.94	1.92	0.4	0.17	0.06	30.74	8.51	1.3	0.54	0.26	483.08	133.77	11.2	4.72	3.79
Biomass	245.09	67.87	14.3	5.95	2.17	413.02	114.37	17.9	7.20	3.47	837.73	231.97	19.4	8.18	6.57
Total RES el.	**1711.0**	**473.79**	**100.0**	**41.54**	**15.18**	**2312.4**	**640.31**	**100.0**	**40.30**	**19.43**	**4322.9**	**1197.04**	**100.0**	**42.22**	**33.91**
total RES	**4119.22**					**5738.65**					**10239**				
total electricity	**11272.50**					**11901.8**					**12748.1**				

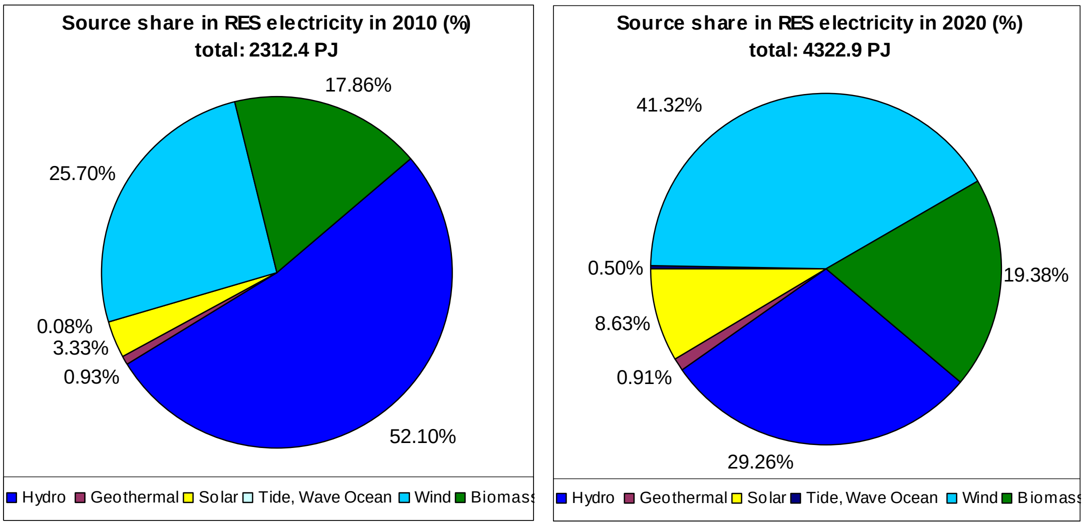

Figure 3: RES share in electricity generation in source break down

Germany is the leading MS with the highest electricity generation from RES with 783,4 PJ which represents the 18 % of the total RES electricity in EU27. ES, FR, UK RES electricity generation is over 400 PJ, this 3 country contribute with almost 35 % of the RES electricity in EU27. Sweden and Italy with an amount of around 350 PJ represents 16, 2 %. These 6 MS gives the 69 % of the RES electricity in the EU27.

H&C generation

Table 5: Resource share in RES heating and cooling

	2005				2010				2020			
	RES H&C generation in PJ	% of RES H&C	% of total RES	% of H&C	RES H&C generation in PJ	% of RES H&C	% of total RES	% of H&C	RES H&C generation in PJ	% of RES H&C	% of total RES	% of H&C
Geothermal	18.06	0.79	0.44	0.08	28.31	1.00	0.49	0.12	110.13	2.35	1.08	0.50
Solar thermal	28.47	1.25	0.69	0.12	56.00	1.97	0.98	0.25	266.03	5.68	2.60	1.22
Biomass	2210.33	96.83	53.66	9.53	2589.61	91.10	45.13	11.36	3798.22	81.08	37.10	17.38
Heat pump	25.83	1.13	0.63	0.11	168.64	5.93	2.94	0.74	510.37	10.89	4.98	2.33
Total RES H&C	**2282.7**	**100**	**55.42**	**9.84**	**2842.6**	**100**	**49.53**	**12.47**	**4684.8**	**100**	**45.75**	**21.43**
total RES	**4119.22**				**5738.65**				**10239**			
total H&C	**23186.4**				**22793.0**				**21857.8**			

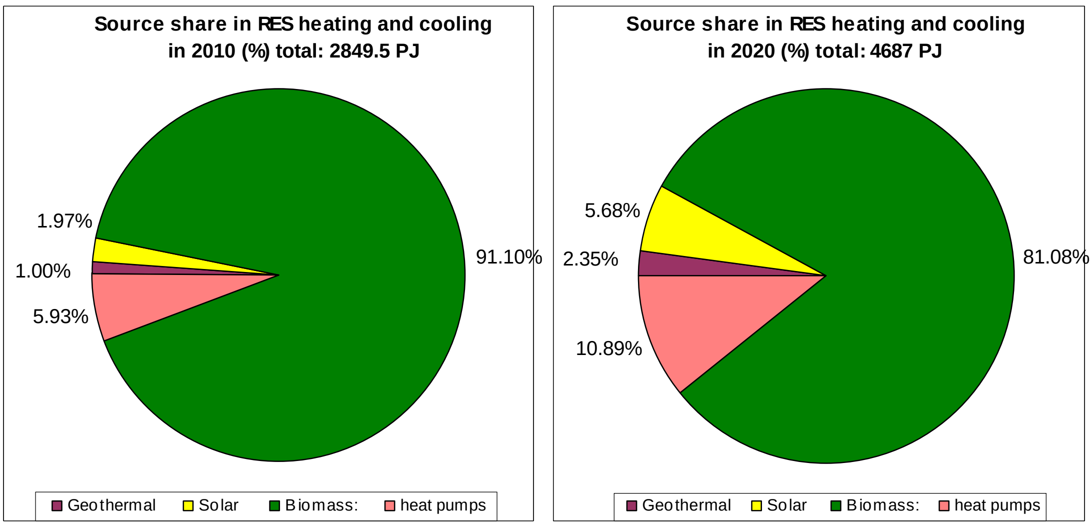

Figure 16: RES share in heating and cooling in source break down

Biomass has the major contribution in the renewable heating and cooling (81.1 %) 3,798.7. PJ (90.5 Mtoe) followed by 10.9 % of heat pumps, 5.7 % of solar and 2.4 % of geothermal by 2020 (Table). The biggest increase is in the solar generation, the solar energy in 2020 will be 4.7 fold more than in 2010 (437 % from 60.8 PJ to 266 PJ), the share in H&C was grown from 2 % (2010). The geothermal energy is 3.8 times more than in 2010, the share increased from 1 % to 2.4 %. Heat pump is tripled between 2010 and 2020, the share almost doubled, it is changed from 5.9 to 10.9 %.

France is the leading MS with the highest H&C generation from RES with 829 PJ (almost 20000 ktoe) which represents the 17.7 % of the total RES H&C in EU27. DE, SE, IT RES H&C generation is over 400 PJ (10000 ktoe), this 3 country contribute with almost 32 % of the RES H&C in EU27. Finland, UK, Poland and Spain with an amount of higher than 200 PJ (5000 ktoe) represents 22.5 %. These 8 MS gives the 72 % of the RES Heating and Cooling in the EU27 by 2020.

RES Transport

The development of the RES transport according to the NREAP-s in absolute and relative terms is summarized in Table 6.

Table 6: Resource share in RES transport

	2005				2010				2020			
	RES transport generation in PJ	% of RES transport	% of total RES	% of transport	RES transport generatio in PJ	% of RES transport	% of total RES	% of transport	RES transport generation in PJ	% of RES transport	% of total RES	% of transport
Bioethanol/ bio-ETBE	22.17	12.59	0.54	0.18	120.56	18.72	2.10	0.92	306.15	22.25	2.99	2.34
Biodiesel	99.87	56.72	2.41	0.79	460	71.43	8.00	3.50	906.47	65.89	8.84	6.92
Hydrogen from renewables	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0.1	0.01	0.00	0.00
Renewable electricity	45.5	25.84	1.10	0.36	54.58	8.47	0.95	0.41	131.88	9.59	1.29	1.01
Others	8.34	4.74	0.20	0.07	8.86	1.38	0.15	0.07	31.19	2.27	0.30	0.24
Total RES transport	**176.06**	100.00	4.25	1.40	**644.01**	100.00	11.20	4.89	**1375.8**	100.00	13.42	10.50
total RES	**4119.22**	4139.3			**5738.65**	5750.6			**10239**	10253.9		
Total transport	12562.4				13157.9				13105			
total RES transport adjusted to the target	178.3				667.5				1532			

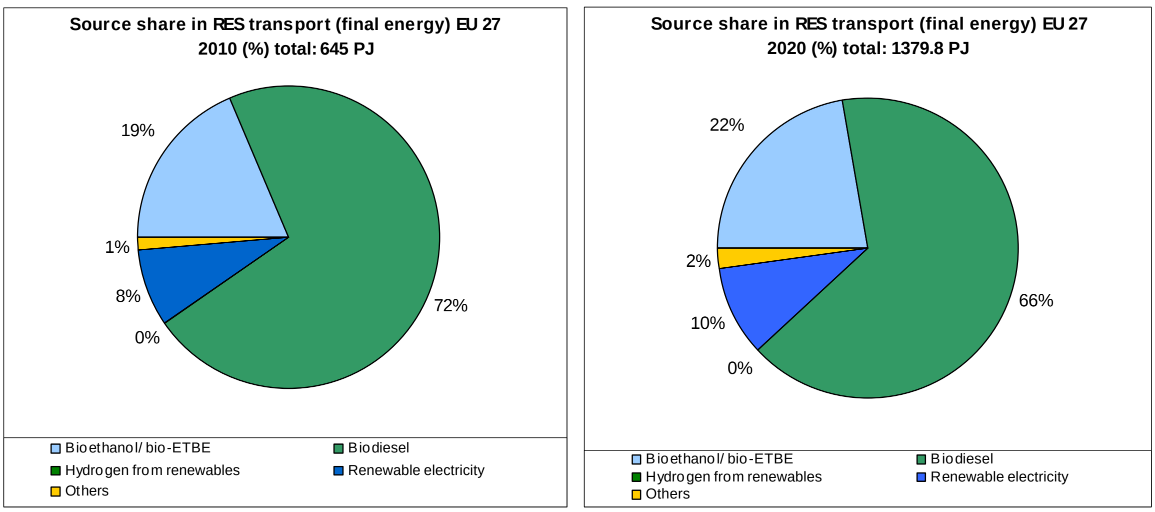

Figure 17: RES transport by source breakdown in 2010 and 2020

The total contribution of RES in 2020 in the EU without double counting will be 1375.8 PJ (32.757 Mtoe) as it is shown in the Table , and 1532 PJ (36.476 Mtoe) with multiple counting of electricity use in road transport and article 21.2 biofuels). Overall, this would represent 11.7% of the energy use in the transport sector, above the 10% binding target.

Wind

The wind resource (onshore and offshore together) triplicates from the year 2010 to 2020 (594.28 PJ to 1786.1 PJ). The share increases from 10.3 to 17.4 % (Figure 15).

The highest wind share within the renewables in 2020 has Ireland with 46.1 %, Malta has 40.2 %, Netherland, UK, Spain has 38 %, 32.9 % and 30.5 % (EL 29.7 %, DE 23.3 %, PT 20.8 %).

Onshore wind

The EU 27 NREAPs described 164.5 GW **onshore wind** energy potential in 2020 (with a share of 77.1 % in the wind energy installed capacity by 2020). The reported installed capacity data corresponds and are the same as the EWEA high scenario data.

The total wind capacity will be 213.39 GW in 2020 growing from 84.9 GW in 2010. The onshore wind capacity changes from 81 GW in 2010 to 164.5 GW in 2020, and the offshore from 2.54 GW 2010 to 41.32 GW in 2020.

Wind has the highest capacity proportion in the RES electricity production in 2020 in Estonia with almost 99 % and in Ireland with 91 %, in NL, UK, MT and PL wind has a capacity share of 74.5, 72.9, 68.5 and 64.3 %.

Offshore wind has the highest proportion in wind capacity in MT, UK, NL with 86.7, 46.6 and 46.3 % in 2020.

Wind has the highest capacity proportion in the RES electricity production in 2010 in Estonia with almost 95.3 % Cyprus and Ireland with 87.2 and 87 %, in DK, UK, NL and LT wind has a capacity share of 77.7, 59.6, 58.6 and 52.5 %.

Offshore wind has the highest proportion in wind capacity in UK, and DK with 25.6 and 18.4 % in 2010.

Wind yearly growth rate changes from 15.6 % to 9.2 %. Offshore wind has the second highest yearly growth rate (higher than 30 % till 2016) until 2020 and the growth increase until 2013.

The **onshore wind** energy reported in the NREAP-s by 2020 is 1237.8 PJ in the EU27, which represents the 12.1 % of the renewable energy mix. (Figure 15).

The onshore wind generation share reported in the NREAP will reach the 70 % of the wind electricity by 2020 and the share of the RES electricity 28.6 % Figure , with a yearly average growth of 8.4 %.

Germany and Spain presented the highest onshore wind energy production by 2020 (with an amount of 262.4 PJ and 254.6 PJ, and represent 41.8 % of the total onshore wind electricity production in the EU 27. With France and UK (144.1 PJ and 123.3 PJ) together these four countries give the 63.4 % of the onshore wind energy.

The highest onshore wind share within the renewables electricity is in Ireland, Greece and Estonia with 73.55 %, 59.1 % and 50.9 %. (**Error! Reference source not found.**). ES, CZ, LT, PL and PT has 47 %, 42.5 %, 42.3 %, 42.3 % and 40.5 %.

The highest onshore wind share within the renewables in 2020 has Ireland wind 39.4 %, Greece, Spain and Portugal has 28.5 %, 27.5 % and 20.5 %

The **offshore wind** energy reported in the NREAP-s by 2020 is 483.08 PJ in the EU27, which represents the 4.7 % of the renewable energy mix. (Figure 15).

Estonia, Latvia Portugal Spain will introduce offshore wind not before 2015, Poland starts just in 2020.

The offshore wind generation share reported in the NREAP will reach the 30 % of the wind electricity by 2020 and the share of the RES electricity 11.2 % (Figure), with a yearly average growth of 29.2 %.

UK and Germany presented the highest offshore wind energy production by 2020 (with an amount of 159.3 PJ and 114.74 PJ), and represent 56.7 % of the total offshore wind electricity production in the EU 27. With France and the Netherland (65 PJ and 68.75 PJ) together these four countries give the 84.4 % of the offshore wind energy.

The highest offshore wind share within the renewables electricity is in Malta, the Netherland and UK with 50 %, 37.8 % and 37.7 %. (**Error! Reference source not found.**). EE and DK has 29.4 % and 25.8 %.

The highest offshore wind share within the renewables in 2020 has Malta with 34.1 %, NL, UK and DK has 22.3 %, 18.54 % and 9.04 %.The biggest relative change compared to 2010 in offshore energy is expected in Germany and Netherland.

Biomass

According to the NREAPs, use of biomass electricity, heating and cooling and biofuels in transport is estimated at about 5,861.5 PJ (140 Mtoe) as final energy in 2020, including biofuels with 1243.9 PJ. Biomass represents the 45.2 % and biofuel the 12.1 % of the renewable energy mix. (Figure 15).

The most important contribution of **biomass for electricity**, heating and cooling and biofuels shall be in Germany with 1,371 PJ (32.8 Mtoe), France with 977.0 PJ (23.3 Mtoe), UK with 634.1 PJ (15.1 Mtoe), Italy with 599.6 PJ (14.3 Mtoe), Sweden with 553.0 PJ (13.2 Mtoe)

The highest biomass share (without the biofuels) within the renewables in 2020 has Latvia, Lithuania, Estonia, Finland and the Czech Republic 77.9 %, 76.4 %, 74 %, 72.1 % and 70.1 %

The expected biomass consumption to reach the proposed targets is higher than the estimated biomass potential, for Belgium, Denmark and the Netherlands, where biomass import should play an important role.

The contribution to electricity made by bioenergy will be 837.7 PJ (231,971 GWh) in 2020, representing 19.4 % of RES electricity. The biomass electricity is expected to increase from 245.1 PJ (69,039 GWh) produced in 2005 to 837.73 PJ (231,971 GWh) in 2020, 3.4 times more than in 2005 (592.63 PJ (162,932 GWh) increase), see Figure .

Germany should remain the leading MS with the highest electricity generation from biomass with 49,457 GWh, which represents the 21.3% of the total biomass electricity in EU27. Next important electricity producers will be UK (26,160 GWh), Italy (18,780 GWh), France (17,171 GWh), Sweden (16,753 GWh) and the Netherlands (16,639 GWh). The first three leading countries in bio-electricity production (Germany, UK and Italy) will contribute with almost 40.7% to the electricity generation in the EU27, while the first five (Germany, UK, Italy, France, Sweden and the Netherlands) will have a share of 55.3% in bio-electricity production in the EU27.

In **biomass heating**, solid biomass will provide 3391.2 PJ (81.0 Mtoe), biogas will provide 187.1 PJ (4.5 Mtoe) and bioliquids will provide 209.3 PJ (5.0 Mtoe) of heating and cooling in 2020. According to the NREAPs submitted by all MS, the proposed target will mean an increase in the use of heating and cooling from biomass from 2,202.3 PJ (52.6 Mtoe) in 2005 to 3,6789.1 PJ (90.5 Mtoe) in 2020, e.g. an increase of 70%.

France is the leading MS with the highest heating and cooling generation from biomass with 668.8 PJ (16,455 ktoe) which represents the 18.2 % of the total H&C from biomass in the EU27. Next important electricity producers will be Germany (475.3 PJ or 11,355 ktoe), Sweden (397.3 PJ or 9,491 ktoe), Finland (276.7 PJ or 6,610 ktoe), Italy (237.3 PJ or 5.670 ktoe) and Poland (207.2 PJ or 4,950 ktoe). The first three leading countries in bio-electricity production (France, Germany and Sweden) will contribute with almost 41.2% to the heating and cooling from biomass in the EU27, while the first five (France, Germany, Sweden, Finland, Italy and Poland) will have a share of 54.8% in biomass heating and cooling production in the EU27.

Biofuel

The final energy from biofuel reported in the NREAP-s by 2020 is 12423.9 PJ in the EU27, which represents the 12.1 % of the renewable energy mix. (Figure 15).

The yearly average growth is 6.62 %, however does not show a stable increase or decrease, it is very variable, which can mean a policy and capital risk.

Germany, UK, France, Spain and Italy presented the highest amount in biofuel by 2020, altogether they represent 65.5 % of the total final biofuel production in the EU 27.

The highest biofuel share within the renewables in 2020 has LU, MT, UK and IE with 55.2 %, 23.5 %, 20.6 % and 20 %.

The NREAPS data show that in 2020 about 463.3 PJ (11.1 Mtoe) biofuels should be imported by the MS in order to reach the 10% binding target. This should represent 37.4% of the biofuel use in the EU in 2020. However, a part of this could come from internal EU trade and a party should be imported from other countries to the EU.

Marine technology

The marine energy reported in the NREAP-s by 2020 is 21.64 PJ in the EU27, which represents the 0.2 % of the renewable energy mix. Between 2010 and 2020 the amount becomes twenty times more (Figure 15). 6 countries UK, France, Portugal Ireland, Spain and Italy reported production in marine energy by 2020, the highest amount is in UK and France with 14.26 and 4.15 PJ, these two countries represent the 85 % of the total marine energy production in the EU 27 (UK alone the 66 %). France was the only Member state with marine energy in 2005 and 2010. There is no large scale commercial application available within the next ten years so the long term technical improvement has to be proved.

Solar energy

The solar resource (thermal and electricity together) quadruplicates from the year 2010 to 2020 (132.9 PJ to 639.22 PJ). The share increases from 2 to 6 % (Figure 15).

In the **solar electricity** the EU 27 counts on PV and CSP as well.

The solar electricity generation is almost five times more in 2020 than in the year 2010 (76.5 PJ to 373.2 PJ). The share increases from 3.3 to 8.63 % (Figure).

The highest solar share within the renewables electricity has Cyprus with 45.4 %; Spain and Germany has 19.8 and 19.1 %, followed by CZ, EL, IT and LU with 14.8 %, 13.2 %, 11.8 and 10.8 % (**Error! Reference source not found.**).

The leading countries with the highest solar electricity generation by 2020 are Germany with around 150 PJ, Spain with 107 PJ, Italy with 40.1 PJ. By 2020 these three countries represent the 80 % of the total electricity of the EU27. Germany keeps his leading role from 2005 on.

The highest **PV** share within the renewables in 2020 has Cyprus with 10.2 %, Germany has 9.3 %, MT 6.75 %, ES 5.6 %, EL 5.1 %. IT and CZ has 3.9 and 3.4 %.

In 2020 in the EU27 there is 89,483 GW installed PV capacity reported.

Germany has the highest production in PV energy by 2020 with an amount of 149.5 PJ, and this country keeps his leading position from 2005 on. In 2020 Germany represents the 50 % of the total PV energy production in the EU 27 (301.1 PJ). Spain, Italy, France and Greece contribute with 51.7 PJ, 34.85 PJ, 21.35 PJ and 10.5 PJ, with these countries the 90 % of the PV production is covered in the EU 27.

The **CSP energy** reported in the NREAP-s by 2020 is 72.09 PJ in the EU27, which represents the 0.7 % of the renewable energy mix. (Figure 15).

The CSP generation share reported in the NREAP will reach the 19.3 % of solar electricity by 2020 and the share of the RES electricity 1.7 %, with a yearly average growth of 28 %. By 2010 the CSP technology is present only in Spain with an amount of 4.13 PJ and Italy with 0.03 PJ. In all the other Member States the technology is later introduced.

Spain, Italy, France, Greece and Portugal presented CSP technology by 2020 (with an amount of 55.45 PJ, 6.14 PJ, 3.61 PJ, 3.51 PJ and 0.81 PJ. Spain alone represents 77 % of the total CSP electricity production in the EU 27.

The highest CSP share within the renewables electricity is in Cyprus and Spain with 19.1 % and 10. 2 %. (**Error! Reference source not found.**).

RES share and trajectory

Most of the EU Member States are optimistic about the way to meet their target from only domestic action and resources (even more optimistic than in the forecast documents). The NREAP documents of the Member States forecast that the EU in 2020 will exceed the 20 % Renewable Energy consumption target with 0.7 %. From the NREAP analysis it can be expected that probably each year the EU will reach a net surplus also in the interim period until 2020.

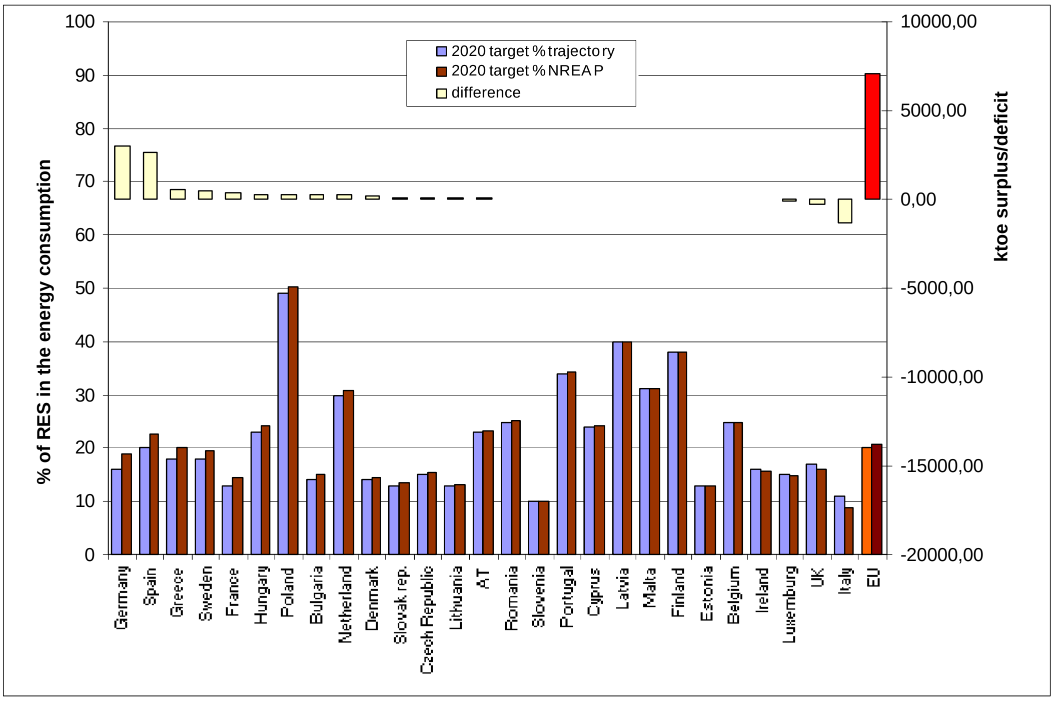

Figure 5: The indicative share of the Renewable Energies and NREAP RES surplus or deficit in EU 27 by 2020

European Commission

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Abstract
These Renewable Energy Snapshots are based on various data providers including *grey data sources* and tries to give an overview about the latest developments and trends in the different technologies. Due to the fact that unconsolidated data are used there is an uncertainty margin which should not be neglected. We have cross checked and validate the different data against each others, but do not take any responsibility about the use of these data.

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