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Renewable Energy Snapshots 2010

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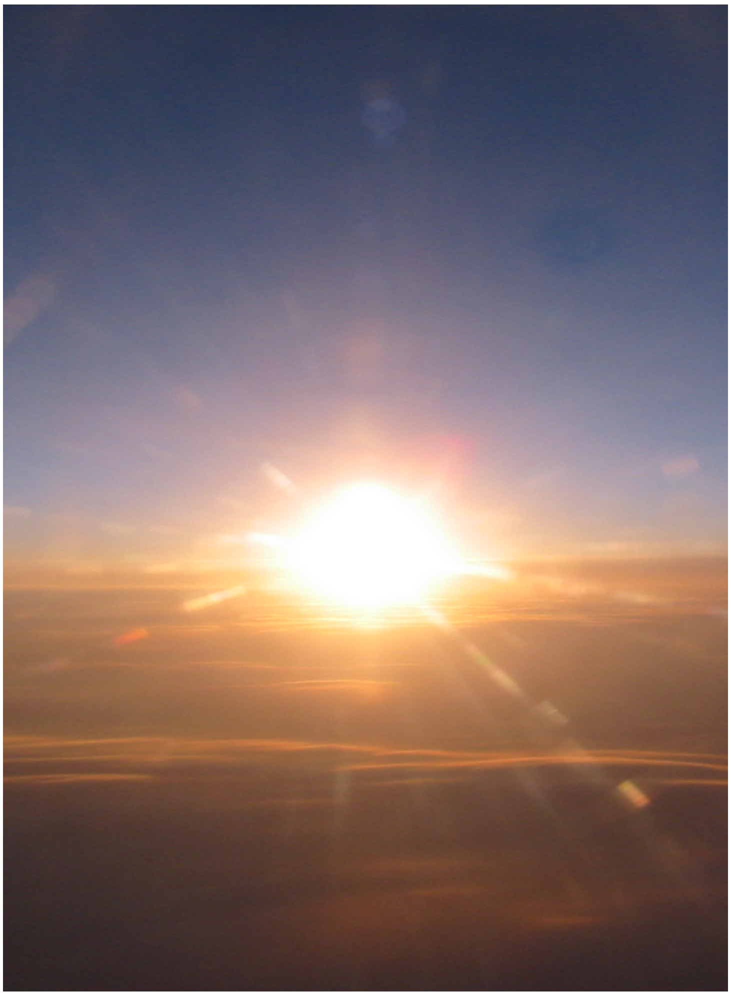

EUR 24440 EN - 2010

EUROPEAN COMMISSION
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JRC 59050

EUR 24440 EN
ISBN 978-92-79-16287-9
ISSN 1018-5593
doi:10.2788/27398

Luxembourg: Office for Official Publications of the European Union

Printed in Italy

Renewable Energy Snapshots 2010

June 2010

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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 27.5 GW of new power capacity was constructed in the EU last year[1] [1]. Out of this, 10.2 GW (38%) was wind power; 6.6 GW (24%) gas fired power stations; 5.8 GW (21%) PV; 2.4 GW (8.7%) coal fired power stations; 580 MW (2.1%) biomass, 570 MW (2.1%) oil; 440 MW (1.6%) waste, 440 MW (1.6%) nuclear, 390 MW (1.4%) hydro and 120 MW (0.4%) CSP.

For the second year **in a row, wind energy is the leading electricity generation technology in Europe and the renewable share of new power installations was 62% in 2009.**

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, June 2010

Arnulf Jäger-Waldau
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1 [1] EWEA, Wind in power – 2009 European statistics, 2 February 2010 and data in the Snapshots

CONTENT

SUMMARY

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 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. On 17 December 2008, the European Parliament gave its backing to the EU's Climate Change Package, which 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 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 2009 about 19.9% (608 TWh) of the total net Electricity Generation (3,042 TWh) came from Renewable Energy sources[2] [1]. Hydro power contributed the largest share with 11.6%, followed by Biomass with 3.5%, Wind with 4.2% and solar with 0.4%.

With these Renewable Energy Snapshots we like to monitor how the development of renewable electricity generation is developing and whether the 2020 targets can be reached.

For electricity generation from Hydro Power (2009: 351 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. These technologies are in a research 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 200 TWh in 2020 up from 108 TWh in 2008. 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 (430 MW in May 2010), but is steadily accelerating. According to the European Solar Thermal Electricity Association

[2] Eurostat, Electricty Statistics –Preliminary data for 2009, Data in focus 14/2010, Eurostat, Energy Statistics 2008 (07 June 2010)

(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 50% to 16 GW in 2009 and for 2010 installations of up to 10 GW are expected[3]. This would result in a capacity almost 9 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 current total European thermal electricity generation capacity (590 GW in 2008) or more than 40% of the current 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 already the number one in newly installed capacities in Europe. With more than 74 GW of cumulative installed capacity in 2009, it exceeded the White Paper target of 40 GW by more than 80%. 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.

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.

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!**

3 Photovoltaic Energy Barometer, Systèmes Solaires, le journal du photovoltaique n° 3 – 2010, April 2010

ENERGY FROM BIOMASS IN THE EUROPEAN UNION

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The total amount of bioenergy[4] produced in the 27 Members states of the European Union was 91,6 Mtoe in 2007 and 97,6 Mtoe in 2008 respectively.

BIOELECTRICITY

The total **installed capacity of bioelectricity** power plant was 21979 GW in 2007 and 23893 GW in 2008; it is resulted from an average yearly increase of 1307 MW/a between 1996 and 2007, as it is shown in Figure 1. From 2003 the yearly average increase has been raised about five times (to 2376 MW/a) than the yearly average between 1996 and 2002 (which was 457 MW/a).

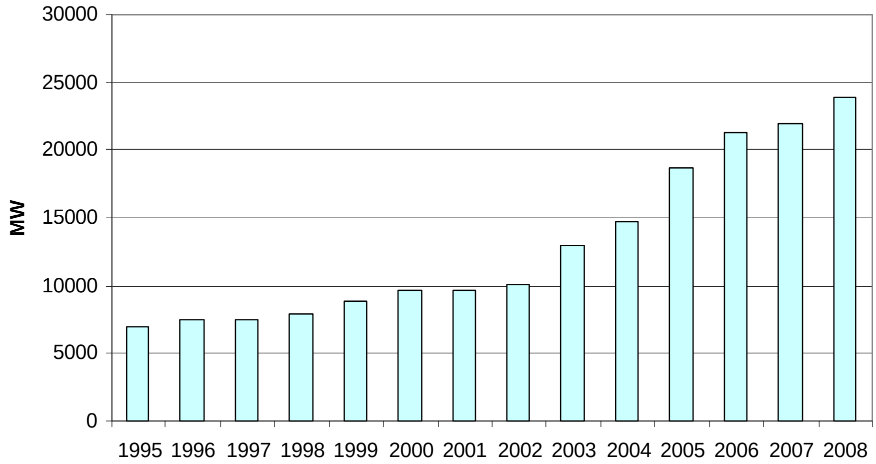

Figure 1: Total bioenergy installed capacity in the EU 27 from 1995 [5].

The share of the bioelectricity installed capacity in the total electricity production reached the 3 % in the last years and this is more than the double of the value before the year 2002 (see Fig 2.).

In the installed capacity wood and wood waste represents the biggest proportion with 58 % (Fig 3.); this concentrates in Italy, Austria, Sweden, Finland with more than 1500 MW in each. The highest amount has Sweden with 2761 MW (Fig 4.).

[4] Bioenergy: bio-heat + bio-electricity + biofuels for transport
[5] Source Eurostat, last update 25/05/2010. Eurostat indicators: Net installed capacity : Municipal solid wastes (117625), Net installed capacity : wood / wood wastes (117626), Net installed capacity : biogas (117627); Product: Electrical Energy (6000)

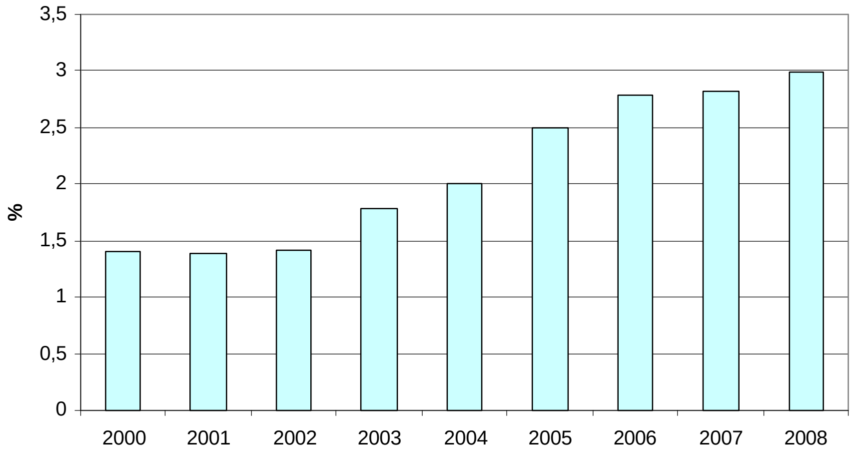

Figure 2: Share of bioenergy in the % of net electricity capacity in the EU27

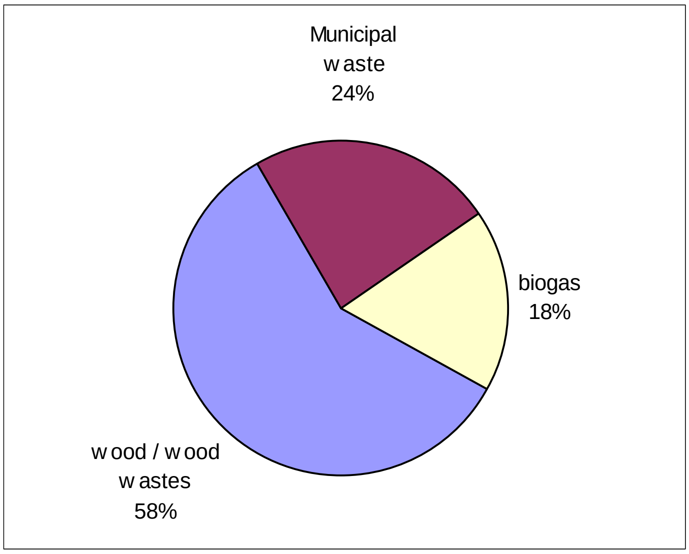

Figure 3: Installed bioelectricity sources in the EU 27 in the year 2008

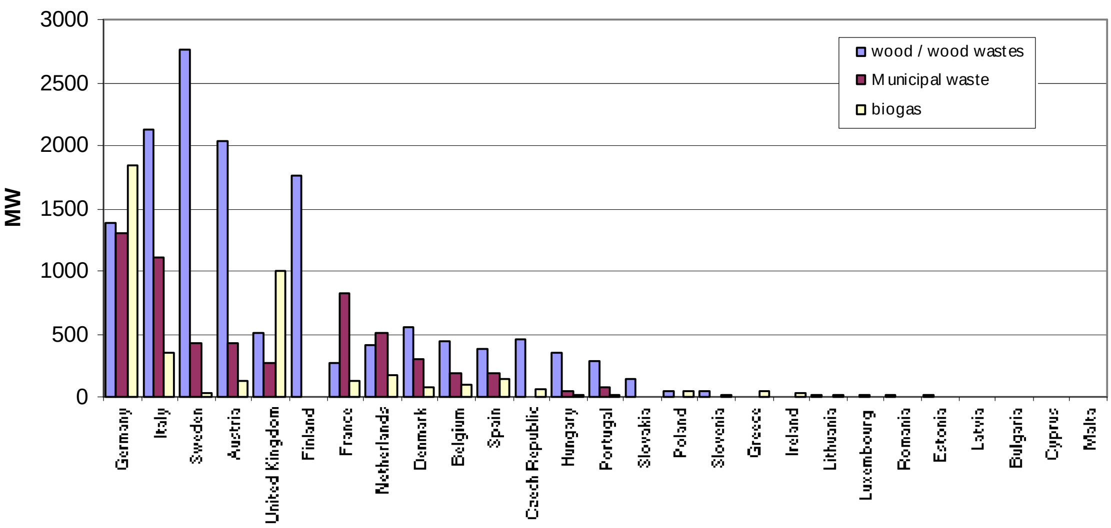

Figure 4: Bioelectricity installed capacity in the EU MS-s by source in 2008

The **produced electricity originated from biomass** was 101 TWh in 2007 and 108 TWh in 2008 in the EU-27 with an average yearly increase of almost 12 % between 1996 and 2008. (Fig. 5). The biggest bioelectricity producer in 2008 was Germany with 27777 GWh followed by Sweden, Finland and UK in a same leading range with the value 11467, 10854 and 10543 GWh respectively (Figure 6). More than the half (59 %) of the production is concentrated in this four states.

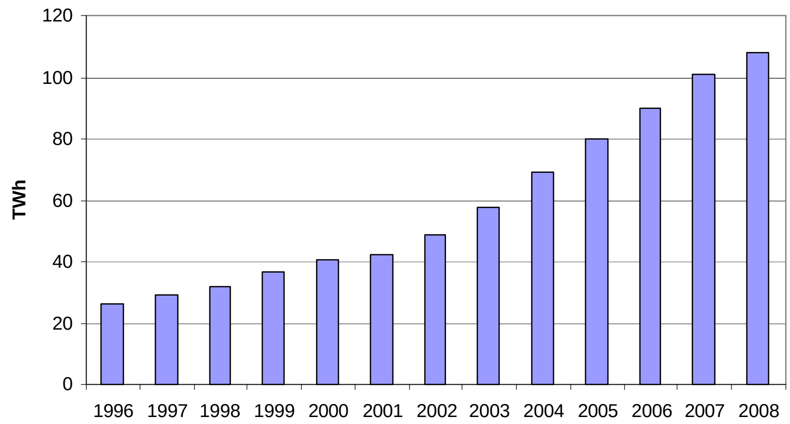

Figure 5: Bioelectricity production in the EU27 from 1996 (Source: [1], [2], [3])[6]

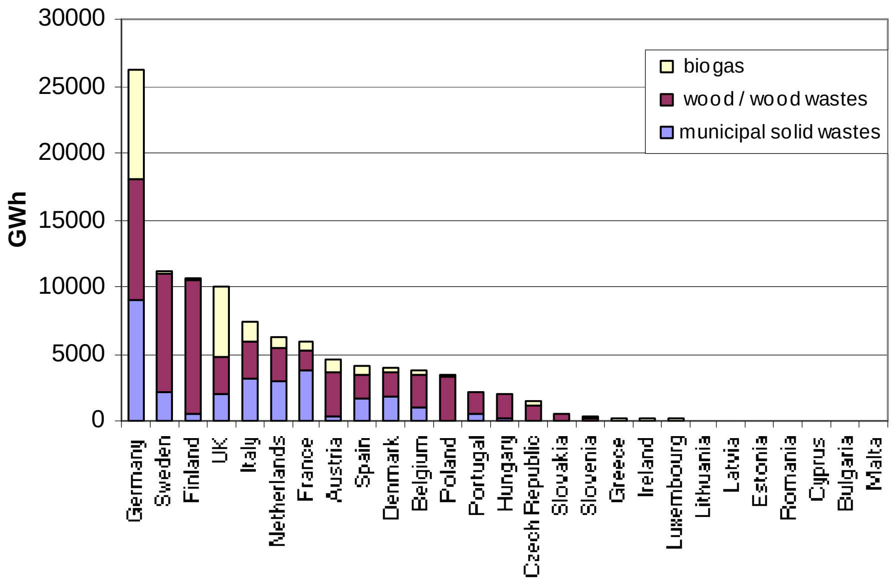

Figure 6: Biolectricity production in the EU27 MS-s in 2008 by categories.[7]

In the electricity production wood/wood waste is the main source with a proportion of 53 % followed by municipal solid waste (28 %). The biogas percentage was 19 % (Fig. 7). In almost half (13) of the member states the wood and wood waste is the leading bioelectricity source, in a small number of countries (Italy, France, The Netherlands, Denmark) the municipal waste and only in the UK, Greece and Ireland the biogas.

[6] Source Eurostat, last update 25/05/2010. Eurostat Energy indicator: Gross electricity generation - Biomass-fired power stations (107011); Product: Electrical Energy (6000)

[7] Source Eurostat, last update 25/05/2010. Eurostat Energy indicator: Gross production from municipal solid wastes (107025), Gross production from wood / wood wastes (107026), Gross production from biogas (107027)EUROBSERVER

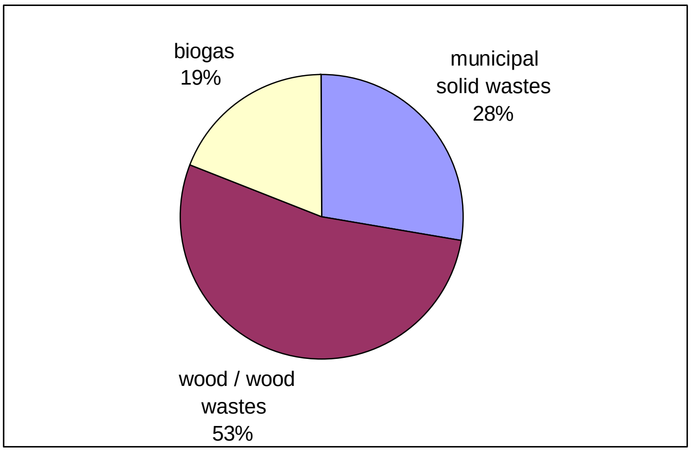

Figure 7: Distribution of the sources in the electricity generation from biomass in the EU27 in 2008

HEAT FROM BIOMASS

Heat produced from biomass was 7,2 Mtoe in 2007 and 7.8 Mtoe in 2008 in the EU27 (Fig. 8). The increase of the bioheat production slowed down between the years 2006 and 2007, 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 1.33, 0.88 and 0.8 Mtoe, respectively (Fig. 9). These for country covers around the three fourth of the EU bioheat production.

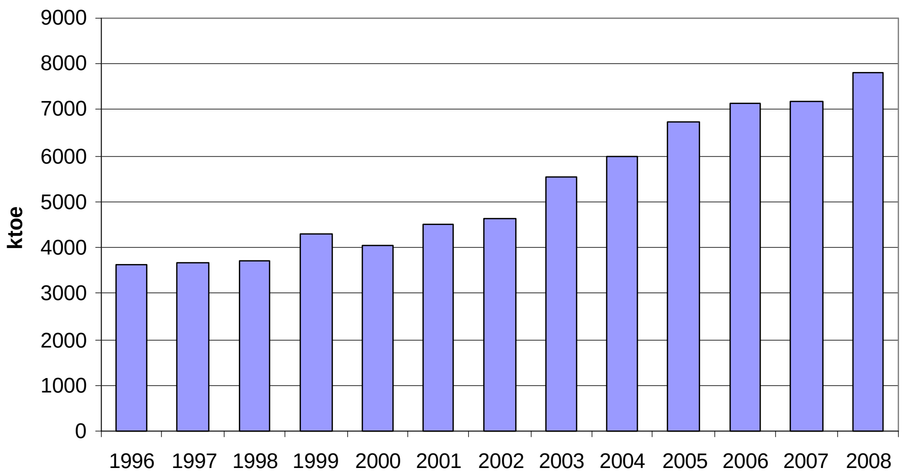

Figure 8: Heat production from biomass in the EU 27 from 1996[8]

The solid form is the main source (covers the 60 %) for the heat production from biomass. The highest proportion is in Finland, France and Latvia (95, 92 and 99 %). The use of solid form in the processing industries in the EU27 average has increased by 10 % between 2007 and 2008. The highest relative increase was in Poland (41 %) followed by Lithuania and Sweden (21 %). (Fig.10.)

[8] Source: Eurostat, last update 25/05/2010. Eurostat Energy indicator: Origin: Biomass (109300), product: derived heat (5200)

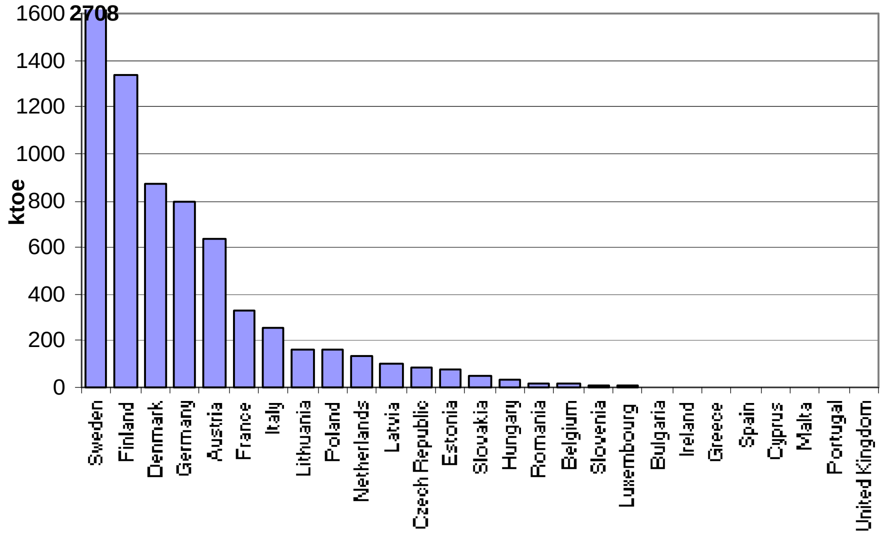

Figure 9: Bioheat production by member states in 2008 (Source: [1] Eurostat)

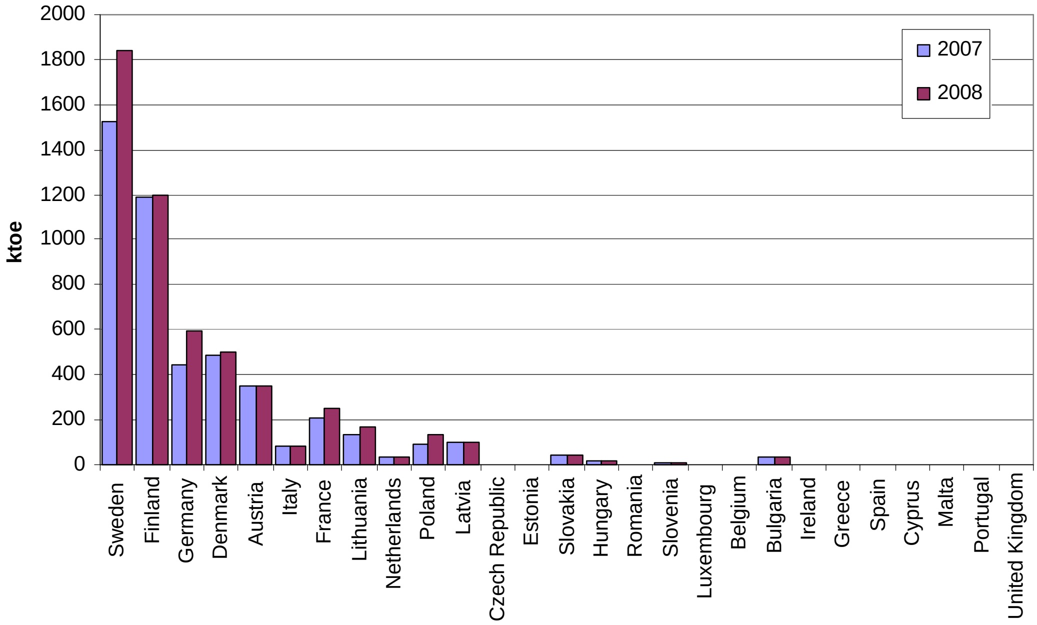

Figure 10: Gross heat production form solid biomass in the processing industries in the EU27[9] (source: [2] EURObserv'ER)

BIOFUELS: SOURCES AND USE

Table 1. summarizes the total flows of liquid biofuels in EU-27 in 2007.

Primary production of biofuels in EU-27 totalled 8.8 Mtoe in 2007. The majority of the produced biofuels is biodiesel (70%) while biogasoline and other liquid biofuels contributed less (12% and 17%, respectively). Imported biofuels provided 1.4 Mtoe while 0.64 Mtoe of biofuels were exported in 2007 summing to a net import balance of 0.77 Mtoe.

[9] Source: EurObserv'ER: Solid biomass barometer. 2009 December. Amount of total heat produced in heat plants and CHP plants.

Almost all biogasoline (i.e., the sum of bioethanol, biomethanol, bio-ETBE and bio-MTBE[10]) 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.

Table 1: Biofuels flows in EU-27 in 2007. Data in ktoe. ([1] Eurostat 2010)[11] [12]

	Biogasoline	Biodiesel	Other liquid biofuels	Total
Primary production	**1115**	**6146**	**1562**	**8824**
Total imports	257	1112	38	1408
Stock change	-41	-96	0	-139
Total exports	147	491	0	638
Net imports	110	621	38	770
Gross inland consumption	**1185**	**6672**	**1600**	**9455**
Input to conventional thermal power stations	0	0	1038	1038
Input to district heating plants	0	0	85	85
Energy available for final consumption	1185	6672	477	8332
Final energy consumption	**1183**	**6629**	**477**	**8288**
Final energy consumption - Industry	0	0	419	419
Final energy consumption - Transport	1183	6587	52	7821
Final energy cons. - Households/Services	0	42	6	48

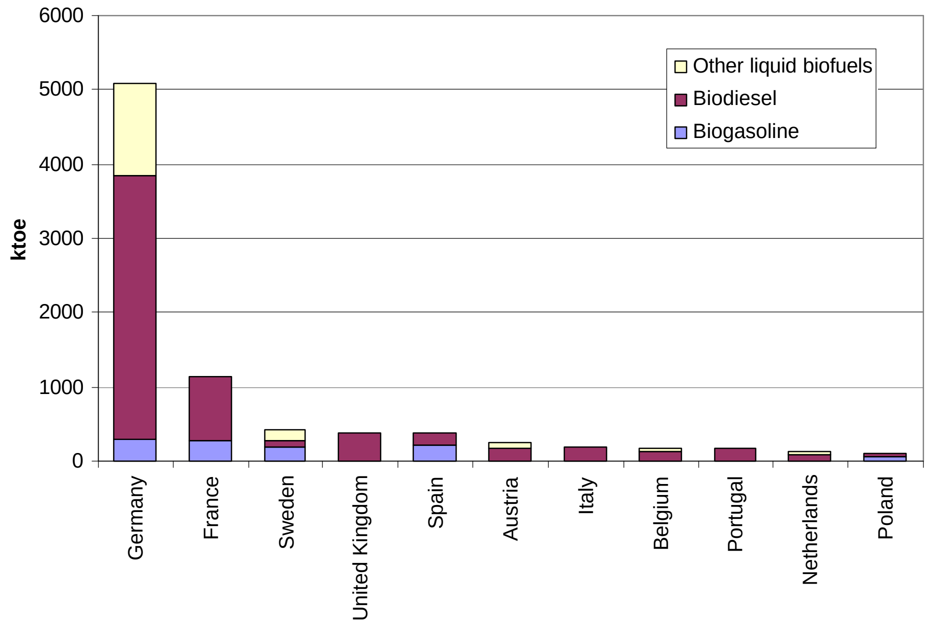

Figure 11: Relevant biofuels producer in EU-27 in 2007. Countries not included in the figure produce less than 100 ktoe[13].

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[10] 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 fules for transport.

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

[12] 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)

[13] Eurostat indicators: Primary production (100100)

In EU-27, Germany is the main biofuel producer with 5.1 Mtoe (58% of EU-27 production) followed by France with 1.1 Mtoe (13% of EU-27 production). Other relevant biofuels producers are shown in Figure 11.

Import/export flows for EU-27 countries are shown in Figure 12. Netherlands and France import slightly more than 300 ktoe of biofuels, in the case of the Netherlands this import is roughly equivalent to three times the domestic production while in case of France it accounts for about 30% of the domestic production. Biodiesel is both produced and imported/exported than biogasoline, while in the case of Spain and United Kingdom, the opposite fluxes of imports and exports almost sum up to zero, but they are opposite each other (Spain imports biogasoline and exports biodiesel. For UK is the opposite.)

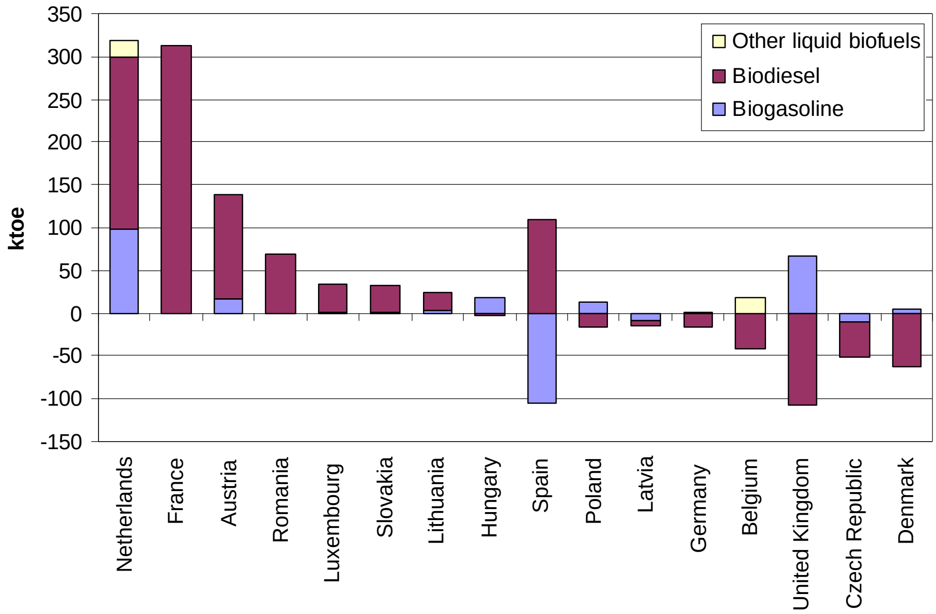

Figure 12: Relevant biofuels importers/exporters in EU-27 in 2007. Countries not included in the figure import and export less than 10 ktoe[14].

Trends in biofuels market

Figure 13 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. Provisional data for 2008 shows how the trend is continuing.

Biofuels in transport sector

In 2007 the consumption of biofuels in the transport sector amounted to 7.8 MToe in EU-27. Biodiesel has been by far the most consumed biofuel with a share of 84.7% while biogasoline accounted for 15.1 %. The use of other biofuels has been very little in 2007 (around 0.2 %).

Germany is still the largest consumer of biofuels in EU-27 (4 MToe with a 50.5% share) but France more than doubled its 2006 consumption reaching a noticeable 1.5 Mtoe accounting for 18.7 % of EU-27 consumption (Figure 14). Spain, UK and the Netherlands follow with a biofuels consumption share ranging between 4 and 5 percent.

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

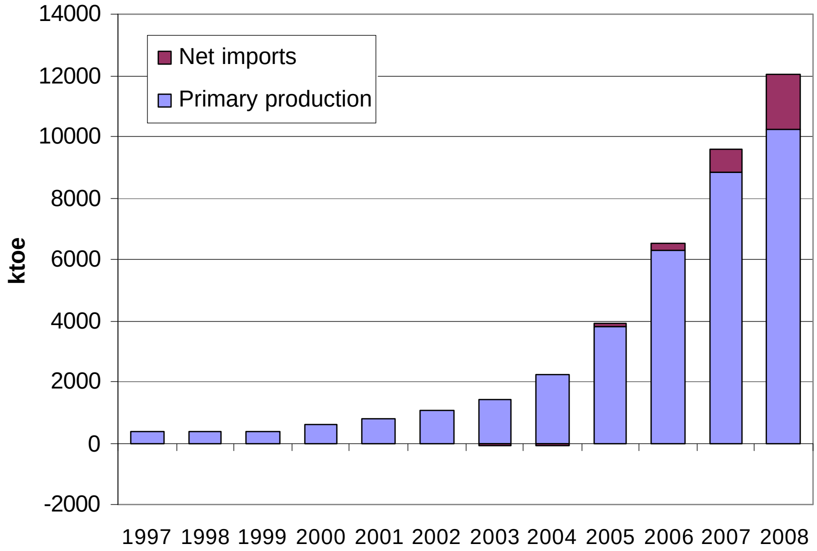

Figure 13: Trends of biofuels production and imports in 1997 – 2008 in EU-27 [15].

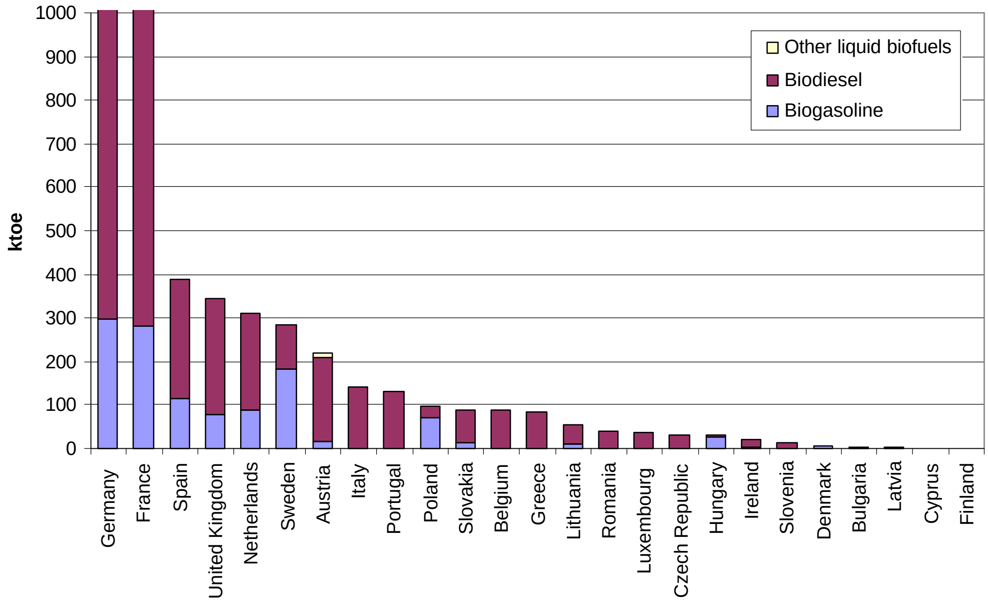

Figure 14: Final energy consumption of biofuels in the transport sector in the EU-27 in 2007 (Eurostat 2007). Germany (3994 ktoe) and France (1473 ktoe) are out of scale for clarity[16]

Figure 15 shows the share of biofuel contribution to the overall energy consumption in transport sector for the EU-27 countries. On average biofuels accounted for 2.1% of the energy consumed in transport in 2007, but the situation is very diverse throughout Europe. More than 6% of energy in Germany's transport sector has been provided by biofuels, the 4.4% in Slovakia and around the 3 % in Sweden, Lithuania and France. Austria (2.4%), Netherlands (2%) and Portugal (1.8%) are close to the

[15] Eurostat indicators: Primary production (100100), net imports (100600)

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

EU-27 average while all the other countries except Luxembourg (1.4%) show a share of biofuel-provided energy in transport below 1%.

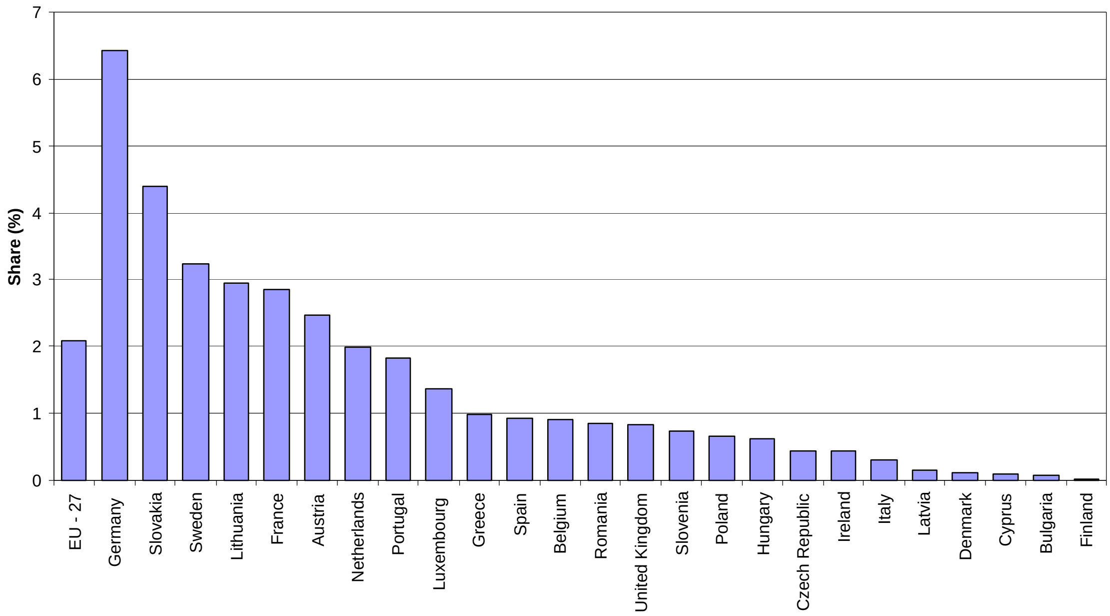

Figure 15: Share of energy consumption in transport provided by biofuels in 2007. (Eurostat 2010 – data for Spain are provisional) [17].

References

[1] Eurostat 2010: Data navigation tree at http://epp.eurostat.ec.europa.eu/, last update 25 May 2010.

[2] EurObserv'ER: Solid biomass barometer. 2009 December.

[3] Data comparison between Eurostat and EurObserv'er. 2009 January

[17] 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)

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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[18], 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 May 2010 CSP plants with a cumulative capacity of about 867 MW were in commercial operation and about 1,170 MW under construction with a planned start of commercial operation until 2012 (Fig. 1). In addition another 8 GW are in an advanced planning stage to be realised until 2015.

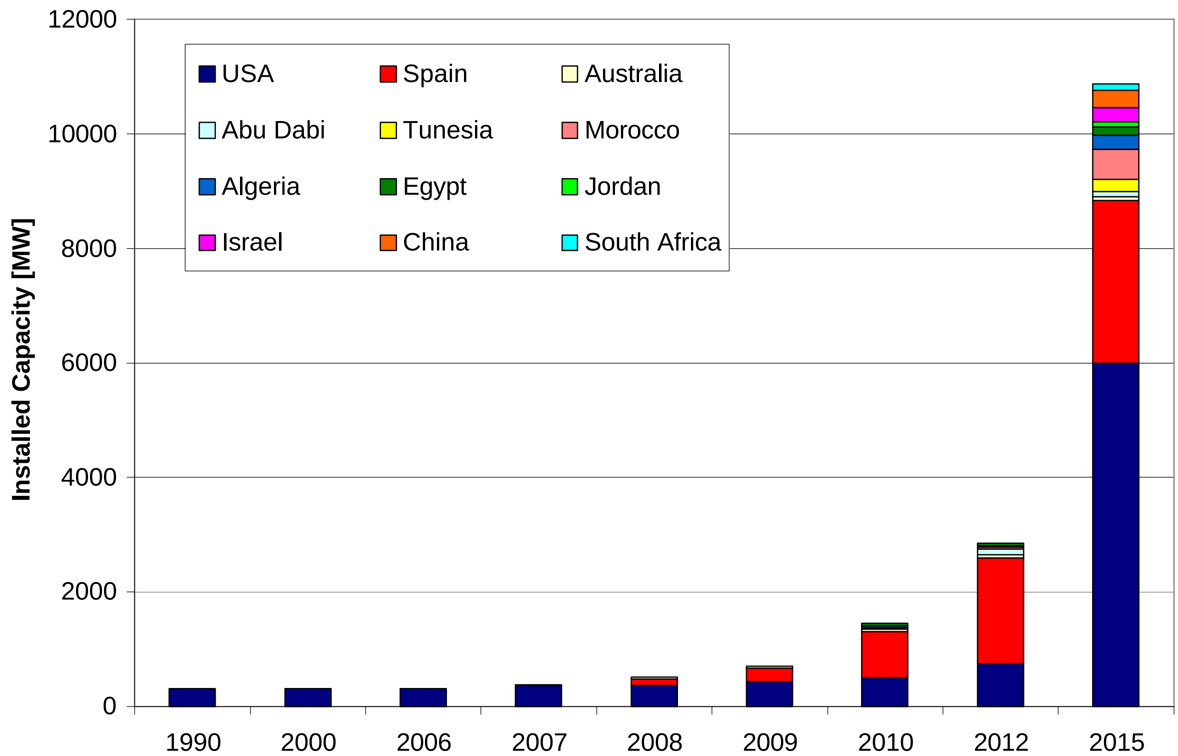

Figure 1: Installed and planned Concentrated Solar Thermal Electricity Plants

18 The capacity figures given are MW_{el} (electric) not MW_{th} (thermal)

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: List of plants in commercial operation

Name of Project and Consortium	Technology	Capacity [MW_{el}]	Start of operation	Investment Volume
SEGS (Mojave Dessert, CA, USA)	parabolic troughs	354	between 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.
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	01/2010	n.a.
Extresol 1; ACS-Cobra-Group/Solar Millenium AG (Torre de Miguel, Spain)	parabolic troughs + 7.5h storage	50	02/2010	€ 300 million
Solúcar Platform – Solnova 1 & 3; Abengoa/Schott Solar (Sanlúcar la Mayor, Spain)	parabolic troughs	100	05/2010	€ 400 million
Total (May 2010)		**867.15**		

Table 2: List of projects currently under construction with projected operation in 2010 [2, 3, 4]

Name of Project and Consortium	Technology	Capacity [MW_{el}]	Start of construction and/or operation	Investment Volume
Archimedes, Sicily, Italy	Gas, Solar + storage	5 solar	Construction 2008 Operation 2010	€ 40 million
La Dehesa, Renovables SAMCA (La Garrovilla, Spain)	parabolic troughs + 7.5h storage	50	Construction 2008 Operation 2010	n.a.
La Florida, Renovables SAMCA (Badajoz, Spain)	parabolic troughs + 7.5h storage	50	Construction 2008 Operation 2010	n.a.
Gemasolar, Terresol Energy (Fuentes de Andalucía, Seville, Spain)	Solar tower with molten salt storage	17 (6,500h/a	construction 2008 Operation: 2010	€ 240 million
Hassi-R'mel I; Algéria (Sonartrach/Abener)	Solar Combined Cycle	150 total, 35 solar	construction 2007 Operation: 2010	€ 320 million
Ain-Ben-Mathar, Morocco (Abengoa/ONE)	Solar Combined Cycle	470 total, 35 solar	construction 2007 Operation: 2010	€ 469 million
Yazd Solar Thermal Power Plant, Iran	Solar Combined Cycle	467 total 17 solar	Construction 2007 Operation 2010	n.a.
Kuraymat; Iberdrola/Mitsui/Solar Millenium; (Kuraymat, Egypt)	Solar Combined Cycle	150 total, 40 solar	construction 2008, Operation 2010	n.a.
Palma de Rio II, Acciona (Palma del Río, Spain)	parabolic troughs	50	Construction 2009 operation 2010	n.a.
Majades I, Acciona (Majadas de Tiétar, Spain)	parabolic troughs	50	Construction 2009 operation 2010	n.a.
Lebrija-1, Solel/Sacyr (Lebrija, Spain)	parabolic troughs	50	construction 2008 operation 2010	$ 400 million
Manchasol 1 & 2, ACS/Cobra Group (Alcazar de San Juan, Spain)	parabolic troughs + 7.5h storage	100	Construction 2008 Operation 2010	n.a.
Solúcar Platform – Solnova 4; Abengoa (Sanlúcar la Mayor, Spain)	parabolic troughs	50	Construction 2008 Operation 2010	n.a.
Martin Next Generation Solar Energy Center, FPL (Indiantown, FL, USA)	ISCC	75 solar	Construction 2009 Operation 2010	$ 480 million
Total		**624**		

Most of the CSP projects currently under construction are located in Spain. A total of 2.4 GW of capacity is already approved for feed-in incentives and are within the new imposed 500 MW annual cap until 2013. 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 [5]. More than 100 projects are currently in the planning phase mainly in Spain, North Africa and the USA.

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

Name of Project and Consortium	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
Palma de Rio I, Acciona (Cordoba, Spain)	parabolic troughs	50	construction 2009 operation 2011	€ 240 million
Helioenergy 1 & 2 Abengoa (Écija, Sapin)	parabolic troughs	100	construction 2009 operation 2011	n.a.
El Reboso II, Bogaris (La Puebla del Río, Spain)	parabolic troughs	50	Construction 2009 operation 2011	€ 220 million
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
Victorville 2 Voctorville, CA (USA)	gas fired + parabolic troughs	553 total with 50 solar	Application approved 2008 start of operation 2011	$ 450 million
Total		**550**		

In the US, more than 4.5 GW of CSP plants are currently under power purchase agreement contracts and almost 10 GW are in the planning stage. The different contracts specify when the projects have to start delivering electricity between 2010 and 2014. Table 4 lists those US projects which have already filed applications with the Californian Energy Commission, the Bureau for Land Management (BLM) or are in an advanced planning stage [6, 7].

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 [8]. The budget envelope proposes CTF co-financing of $ 750 million (€ 600 million[19]), 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.

[19] Exchange rate 1 € = 1.25 $

Table 4: List of US projects in application stage [6, 7]

Name of Project and Consortium	Technology	Capacity [MW_{el}]	Scheduled year of completion
Alpine Sun Tower, eSolar (Lancaster, CA, USA)	tower	92	Operation 2012
New Mexico SunTower, NRG Energy/ eSolar (Santa Teresa, NM, USA)	tower	92	Operation 2012
Solana Abengoa Solar, Gila Bend, AZ (USA)	parabolic troughs + 6h storage	280	Site approval 08/08 Operation 2013
Ivanpah 1, 2 & 3, Ivanpah Solar, San Bernardino, CA (USA)	solar tower + gas-fired start-up boiler	100 100 200	Application filed to CA Energy Commission 08/07
Beacon Solar Energy Project, Kern, CA (USA)	parabolic troughs	250	Application filed to CA Energy Commission 03/08
Imperial Valley - Solar Two, phase 1 & 2, Tessera Solar (Imperial, CA, USA)	stirling engines	300 600	Application filed to CA Energy Commission 06/08
Palmdale City of Palmdale, CA (USA)	gas fired + parabolic troughs	617 total 62 solar	Application filed to CA Energy Commission 08/08
San Joaquin Solar 1 & 2 Fresno, CA (USA)	biogass fired backup + parabolic troughs	53 (106) solar	Application filed to CA Energy Commission 11/08
Calico Solar One, phase 1 & 2; Tessera Solar (Barstow, CA, USA)	stirling engines	500 350	Application filed to CA Energy Commission 12/08
Genesis Solar Energy Project, Genesis Solar (Riverside County, CA, USA)	parabolic troughs	250	Application filed to CA Energy Commission 08/09
Blythe Solar Power Project, Solar Millennium, LLC ; Chevron Energy Solutions (Blythe, CA, USA)	parabolic troughs	250	Application filed to CA Energy Commission 08/09
Palen Solar Power Project, Solar Millennium, LLC ; Chevron Energy Solutions (Riverside County, CA, USA)	parabolic troughs	500	Application filed to CA Energy Commission 08/09
Ridgecrest Solar Power Project, Solar Millennium, LLC (Riverside County, CA, USA)	parabolic troughs	250	Application filed to CA Energy Commission 08/09
Rice Solar Energy Project, Rice Solar Energy LLC/ SolarReserve LLC (Rice, CA, USA)	parabolic troughs	150	Application filed to CA Energy Commission 10/09
Crescent Dunes Solar Energy Project, Solar Reserve (Tonopah, NV, USA)	tower	180	Bureau of Land Management NOI 11/09
Amargosa Farm Road Solar Power Project, Solar Millenium (Nye County, NV, USA)	parabolic troughs	500	Bureau of Land Management Draft EIS 03/10
Sonoran Solar Energy Project, NextEra (Maricopa County, AZ, USA)	parabolic troughs	375	Bureau of Land Management Draft EIS 04/10

Within just a few years, the CSP industry has grown from negligible activity to over 2 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 build a commercial-scale plant three 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.

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.

SNAPSHOT ON EUROPEAN PHOTOVOLTAICS IN WORLD-WIDE COMPARISON

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Production data for the global cell production[20] in 2009 vary between 10.5 GW and 12 GW (Fig. 1). This is again an increase of 40% to 50% compared to 2008. The significant uncertainty in the data for 2009 is due to difficult market situation, which was characterised by a declining market environment in the first half of 2009 and an exceptional boom in the second half of 2009.

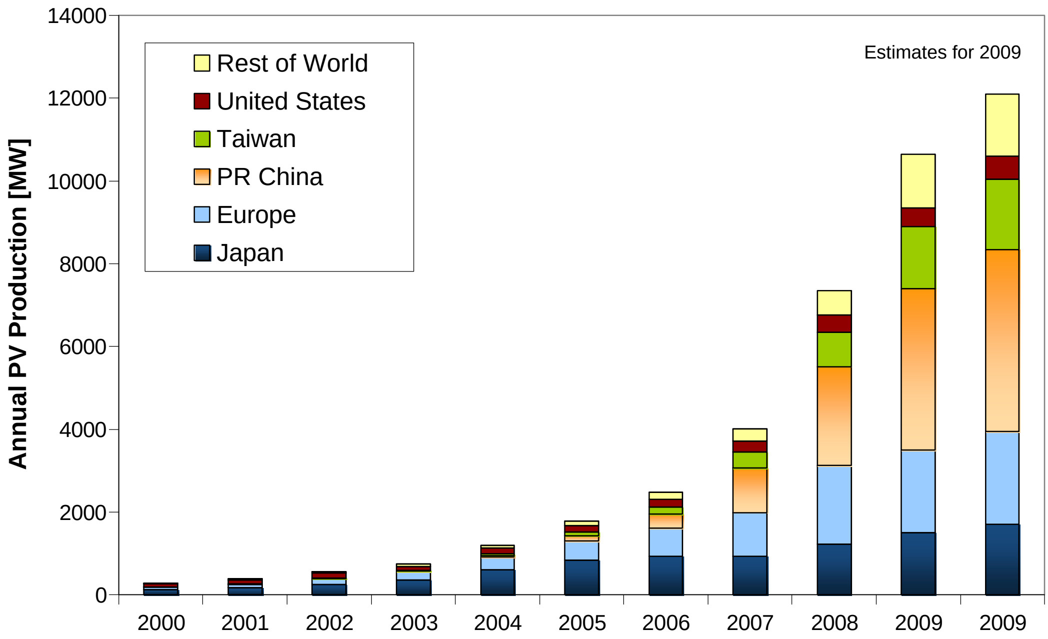

Figure 1: World-wide PV Production from 2000 to 2009
Data Source: PV News [1], Photon International [2] and own analysis

Since 2000, total PV production increased more than 30 fold with annual growth rates between 40% and 80%. The most rapid growth in annual production over the last five years could be observed in China and Taiwan, which now account for about 50% of worldwide production.

The announced 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

[20] **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.

the respective companies and no third source info were used. The cut-off date of the used info was April 2010.

It is important to note, that production capacities are often announced, taking into account different operation models such as number of shifts, operating hours per year, etc. In addition the announcements of the increase in production capacity do not always specify when the capacity will be fully ramped up and operational. This method has of course the setback that a) not all companies announce their capacity increases in advance and b) that in times of financial tightening, the announcements of the scale back 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 final numbers.

If all these ambitious plans can be realised by 2015, China will each have about 31% of the worldwide production capacity of 67 GW followed by Europe (18%), Taiwan (18%) and Japan (14%) (Fig. 2) [3, 4].

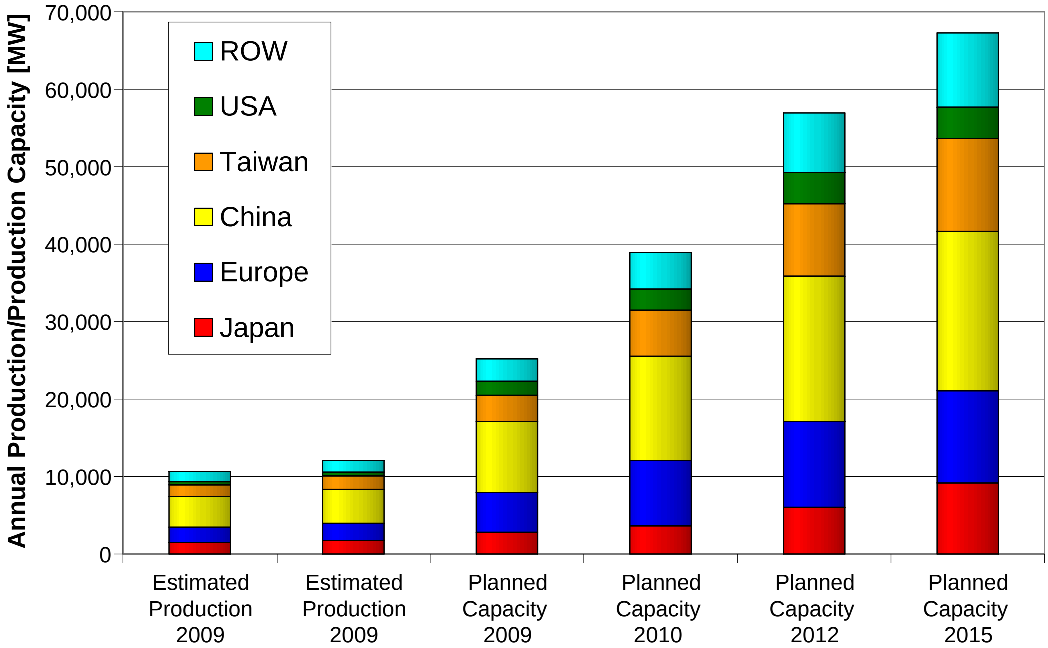

Figure 2: World-wide PV Production 2009 with future planned production capacity increases

All these ambitious plans to increase production capacities at such a rapid pace depend on the expectations that markets will grow accordingly. This however is the biggest uncertainty as can be seen with the market estimates for 2010 which vary between 9 GW and 24 GW with a consensus value in the 11 to 12 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 is still the main technology and had around 80% market shares in 2009. Polycrystalline solar cells still dominate the market (45 to 50%) even if the market shares are slowly decreasing since 2003. The massive capacity increases for both technologies are followed by the necessary capacity expansions for polysilicon raw material.

The rapid growth of the PV industry since 2000 led to the situation where between 2004 and early 2008, the demand for ***polysilicon*** outstripped the supply from the semiconductor industry. Prices for purified silicon started to rise sharply in 2007 and in 2008 prices for polysilicon peaked around 500 $/kg and consequently resulted in higher prices for PV modules. This extreme price hike triggered a massive capacity expansion, not only of established companies, but many new entrants, as well. In 2009 more than ninety percent of total polysilicon for the semiconductor and photovoltaic industry was supplied by seven companies: Hemlock, Wacker Chemie, REC, Tokuyama, MEMC, Mitsubishi and Sumitomo. However, it is estimated that now about seventy producers are present in the market.

The massive production expansions as well as the difficult economic situation led to a prices decreased throughout 2009 reaching about 50–55 $/kg on average by year's end. Prices are expected to continue to drop over the next three years, but at a much slower rate levelling in the 40 to 50 $/kg range in 2012.

For 2009 about 88,000 metric tons of solar grad silicon production were reported, sufficient for around 11 GW under the assumption of an average materials need of 8 g/Wp [5]. China produced about 18,000 metric tons or 20% fulfilling about half of the domestic demand [6]. According to the Chinese Ministry of Industry and Information Technology about 44,000 metric tons of polysilicon production capacity was reached with a further 68,000 metric tons capacity under construction in 2009.

Projected silicon production capacities available for solar in 2012 vary between 140,000 metric tons from established polysilicon producers, up to 185,000 metric tons including the new producers [7] and 250,000 metric tons [8]. The possible solar cell production will in addition depend on the material use per Wp. Material consumption could decrease from the current 8 g/Wp to 7 g/Wp or even 6 g/Wp, but this might not be achieved by all manufacturers.

More than 150 companies are involved in the thin-film solar cell production process, ranging from R&D activities to major manufacturing plants. The first 100 MW thin-film factories became operational in 2007. If all expansion plans are realised in time, thin-film production capacity could be 20 GW or 36% of the total 56 GW in 2012 and 23 GW or 34% in 2015 of a total of 67 GW (Fig. 3). The first thin-film factories with GW production capacity are already under construction for various thin-film technologies.

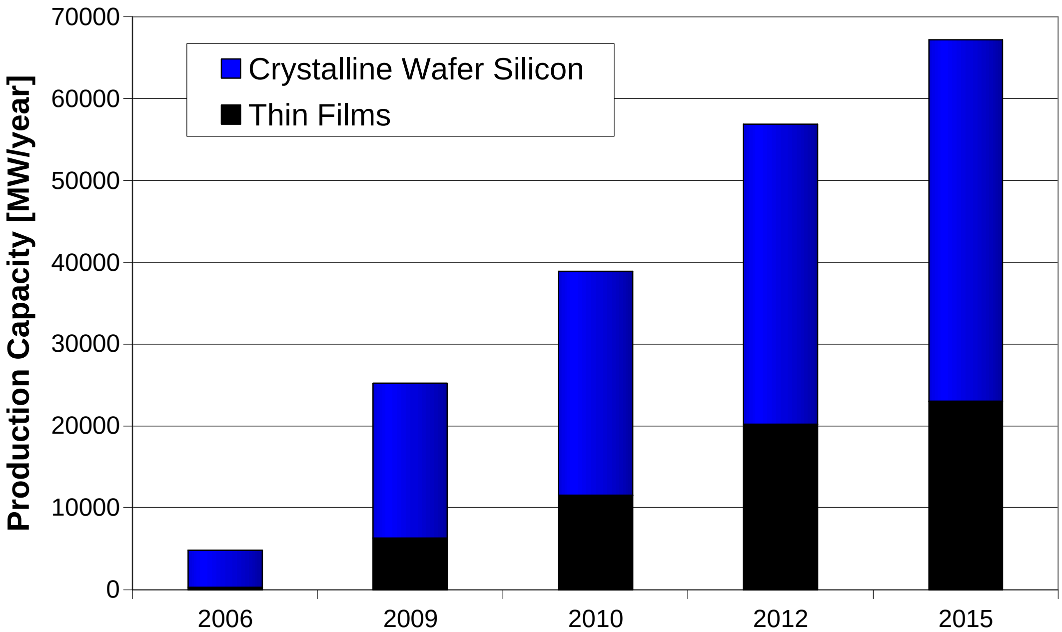

Figure 3: 2006 and planned PV Production capacities of Thin-Film and Crystalline Silicon based solar modules.

One should bear in mind that only one fourth of the over 150 companies have already produced thin-film modules on a commercial scale in 2009.

More than 100 companies are silicon based and use either amorphous silicon or an amorphous/microcrystalline silicon structure. 30 companies announced to use $Cu(In,Ga)(Se,S)_2$ as absorber material for their thin-film solar modules, whereas 9 companies use CdTe and 8 companies go for Dye & other materials.

Concentrating Photovoltaics (CPV) is an emerging market with approximately 17 MW cumulative installed capacity at the end of 2008. There are two main tracks – either high concentration > 300 suns (HCPV) or low to medium concentration with a concentration factor of 2 to approx. 300. In order to maximise the benefits of CPV, the technology requires high Direct Normal Irradiation (DNI) and these areas have a limited geographical range – the "Sun Belt" of the Earth. The market share of CPV is still small, but an increasing number of companies are focusing on CPV. In 2008 about 10 MW of CPV were produced, market estimates for 2009 are in the 20 to 30 MW range and for 2010 about 100 MW are expected.

2009 was the year of speculations about a contracting or increasing photovoltaic market. The latest market estimates in spring 2010 came as a surprise for most people. The current estimates are between 7.1 and 7.8 GW, as reported by various consultancies (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.

After a slow start, the markets began to pick up pace in the second quarter, but the real boom happened in the last quarter when in Germany alone, according to the German Federal Network Agency, 1.46 GW of new capacity were added.

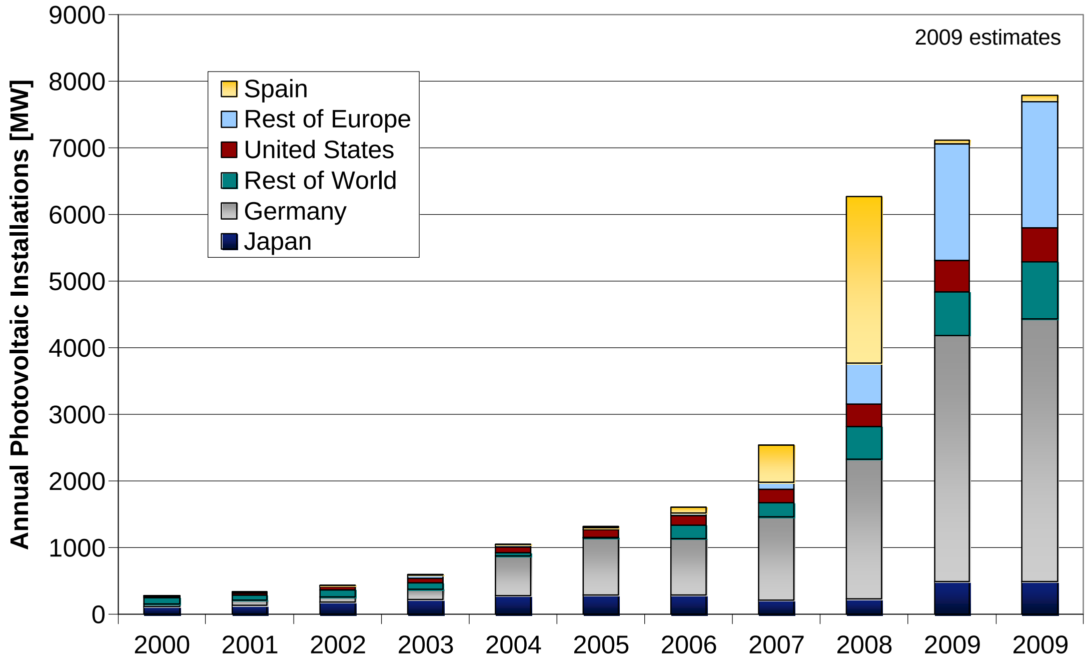

Figure 4: Annual Photovoltaic Installations from 2000 to 2009
(data source: EPIA [9], Eurobserver [10] and own analysis)

With a cumulative installed of 16 GW the European Union is leading in PV installations with a little more than 70 % of the total world wide 22 GW of solar photovoltaic electricity generation capacity at the end of 2009.

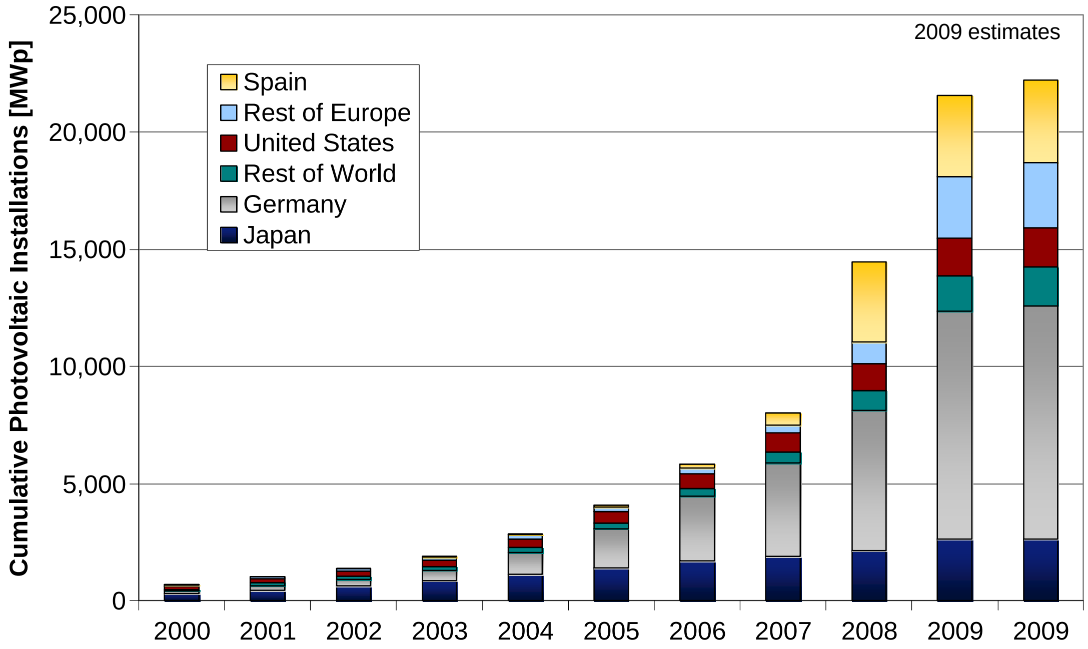

Figure 5 Cumulative Photovoltaic Installations from 2000 to 2009
(data source: EPIA [9], Eurobserver [10] and own analysis)

The growth scenario for Europe, based on the 2001 to 2009 growth rate – taking the Spanish installations in 2008 as an exception – predicts, that more than 22 TWh of electricity could be generated in 2010. This would be about 0.7% of the EU 27 total net production of electricity of 3,042 TWh in 2009.

Important!

1) Please note, that the 2009 production are estimates.
2) Please note that the announced production capacity increases have quite an uncertainty due to the fact that some companies quote maximum capacity (4 shifts 365 days/year) and others are only quoting capacity under real operation conditions. Also the time when they actually start operating are quite different. Some companies announce the time of ready installation, others only when they are fully operational.
3) 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.
4) On Average, 1,000 MW of PV systems produce 1 TWh of electricity annually.

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SNAPSHOT ON EUROPEAN SOLAR HEAT

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Solar thermal

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

The total market for glazed collectors in the 27 EU Member States and Switzerland increased with 2.9 GWth of new capacity (4.27 million m^2 of collector area). The total capacity in operation at the end of 2009 reached 22.1 GWth (31.6 million m^2 of collector area). The various national markets developed quite differently from one another. The German market has more than doubled while the demand for solar thermal technology increased strongly in smaller markets also, such as Ireland, Poland and Portugal.

Annual market data is available from National Energy Agencies and collected by ESTIF[21]. EU projects have been supporting the development of reliable databases for solar thermal collectors [8]. Usually information is available in m^2 and kWth 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 kWth (kilowatt thermal) and have agreed to use a factor of 0.7 kW_{th}/m^2 to convert square meters of collector area into kWth.

Concerning solar thermal systems the market in 2009 did again well. In some countries solar thermal technology has become an obligation for construction of new buildings. 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.

Evacuated Tube Collectors take about 11% of the total collector sales in 2009 and keeps trend with the flat plate collector market. By far, most of the systems are used for Domestic Hot Water (90%). Other applications are space heating (in almost all cases these are combined systems) and pool water

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heating (mostly by unglazed collectors). Table 1 gives figures for flat plate (glazed) and vacuum collectors.

EurObserver (ESTIF data) and Eurostat figures differ slightly (around 3%) for installed solar thermal capacity mainly to differences in some figures from national databases [7].

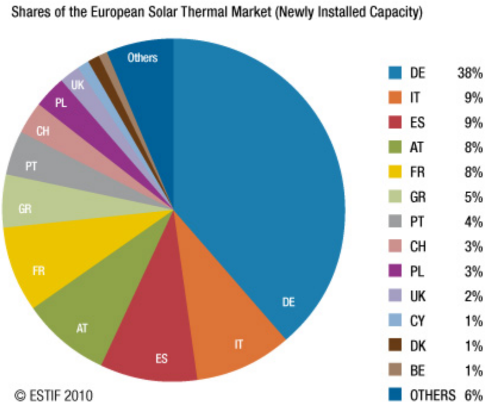

Figure 1. Market share in 2009.

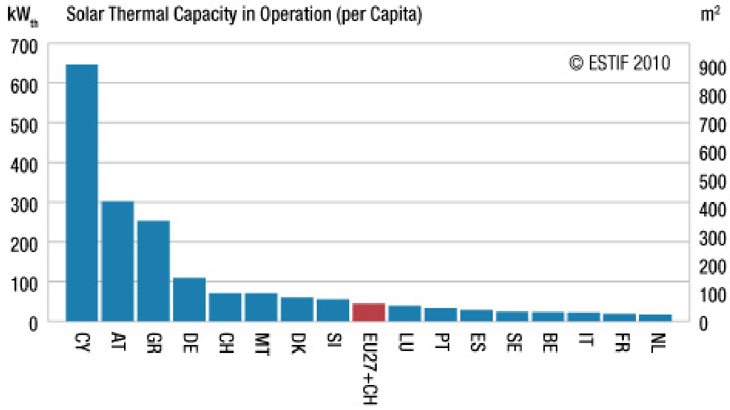

Figure 2. EU Solar Thermal Capacity

Table 1. Figures for flat plate (glazed) and vacuum collectors for the most recent years.

	In Operation[2]		Market (=Newly Installed)						Annual Evolution of the Market
	2009		2007	2008	2009				2009/2008
	Total Glazed		Total Glazed	Total Glazed	Total Glazed	Flat Plate	Vacuum Collectors	Total Glazed	Total Glazed
	m^2	kW(th)	m^2	m^2	m^2	m^2	m^2	kW(th)	%
Austria	3596874	2517812	281000	347703	356544	348786	7758	249581	3%
Belgium	290847	203593	65000	62200	50700	45500	5200	35490	-18%
Bulgaria	127900	89530	2500	25500	25000	23750	1250	17500	-2%
Switzerland	768707	538095	65576	112833	146750	136500	10250	102725	30%
Cyprus	735200	514640	60000	60000	55000	53000	2000	38500	-8%
Czech Republic	211220	147854	25000	35000	40000	30000	10000	28000	14%
Germany	12709000	8896300	940000	2100000	1615000	1430000	185000	1130500	-23%
Denmark	472780	330946	23000	33000	54500	52000	2500	38150	65%
Estonia*	2420	1694	350	500	450	60	390	315	-10%
Spain	1802166	1261516	275000	434000	391000	375000	16000	273700	-10%
Finland*	26973	18881	25000	4100	4000	2800	1200	2800	-2%
France[3]	1959100	1371370	330000	388000	335000	324000	11000	234500	-14%
Greece	4074200	2851940	283000	298000	206000	204500	1500	144200	-31%
Hungary	82590	57813	20648	11000	25000	17000	8000	17500	127%
Ireland	107760	75432	15000	43610	33360	20740	12620	23352	-24%
Italy	2006230	1404361	330000	421000	400000	350000	50000	280000	-5%
Lithuania	2200	1540	300	300	200	50	150	140	-33%
Luxemburg*	27200	19040	3000	3600	4700	3650	1050	3290	31%
Latvia*	1740	1218	210	210	180	40	140	126	-14%
Malta*	40860	28602	5500	6000	5500	5500	0	3850	-8%
Netherlands	407341	285139	19900	25000	44000	44000	0	30800	76%
Poland	509860	356902	68147	129632	144184	106514	37670	100929	11%
Portugal	493340	345338	52000	86000	174390	173040	1350	122073	103%
Romania*	114300	80010	6500	8000	20000	11000	9000	14000	150%
Sweden	310517	217362	25465	26813	21310	13125	8185	14917	-21%
Slovenia	159300	111510	12000	16000	22000	17000	5000	15400	38%
Slovakia	108750	76125	9000	13500	13500	11600	1900	9450	0%
United Kingdom	475020	332514	54000	81000	89100	51975	37125	62370	10%
EU27+ Switzerland	31624644	22137251	2974596	4772501	4277618	-	-	2.994.333	-10%

Notes

2 Capacity "in operation" refers to the solar thermal capacity built in the past and deemed to be still in use. ESTIF assumes a time of use of 20 years 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 torn down, or the use of the building has changed.

3 The figures shown here relate to France Metropolitan only. In the French Overseas Departments and Territories $49MW_{th}$ (70 000m^2) were newly installed in 2007.

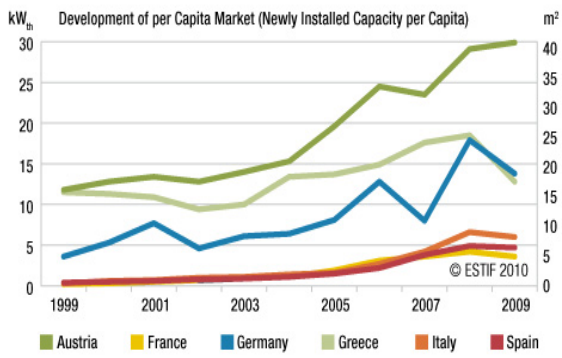

Figure 3. Market development.

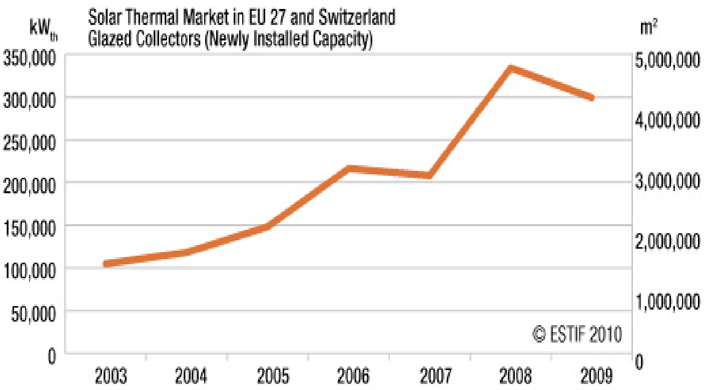

Figure 4. EU Solar Thermal Market

In 2009, the top five countries accounted for ¾ of the total –(Germany, Austria, Spain, Italy and France). Note that Greece has moved to the sixth place. From the big EU countries, only Poland is not yet seen amongst the top solar thermal markets.

Despite their strong growth in recent years, the market in France and Italy still is only at 22 kWth per 1000 capita, while EU average is around 40 kWth. From the fast growing markets, Slovenia and Denmark have just surpassed the EU average.

The market development might be hampered by the economic crisis. The market will stay with the forecast of 38 m^2 behind the White Paper [1] target of 100 million m^2 total glazed collector area.

Further information

Heat dominates energy end use. Empirical data from final energy consumption shows that heat takes about half of the total consumption.

Table 2: Final energy consumption. Data Source: Elaborated data from Eurostat

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

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.

Solar thermal provides in general low temperature heat and in addition could assist to cooling [9].

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 CO_2 emissions.

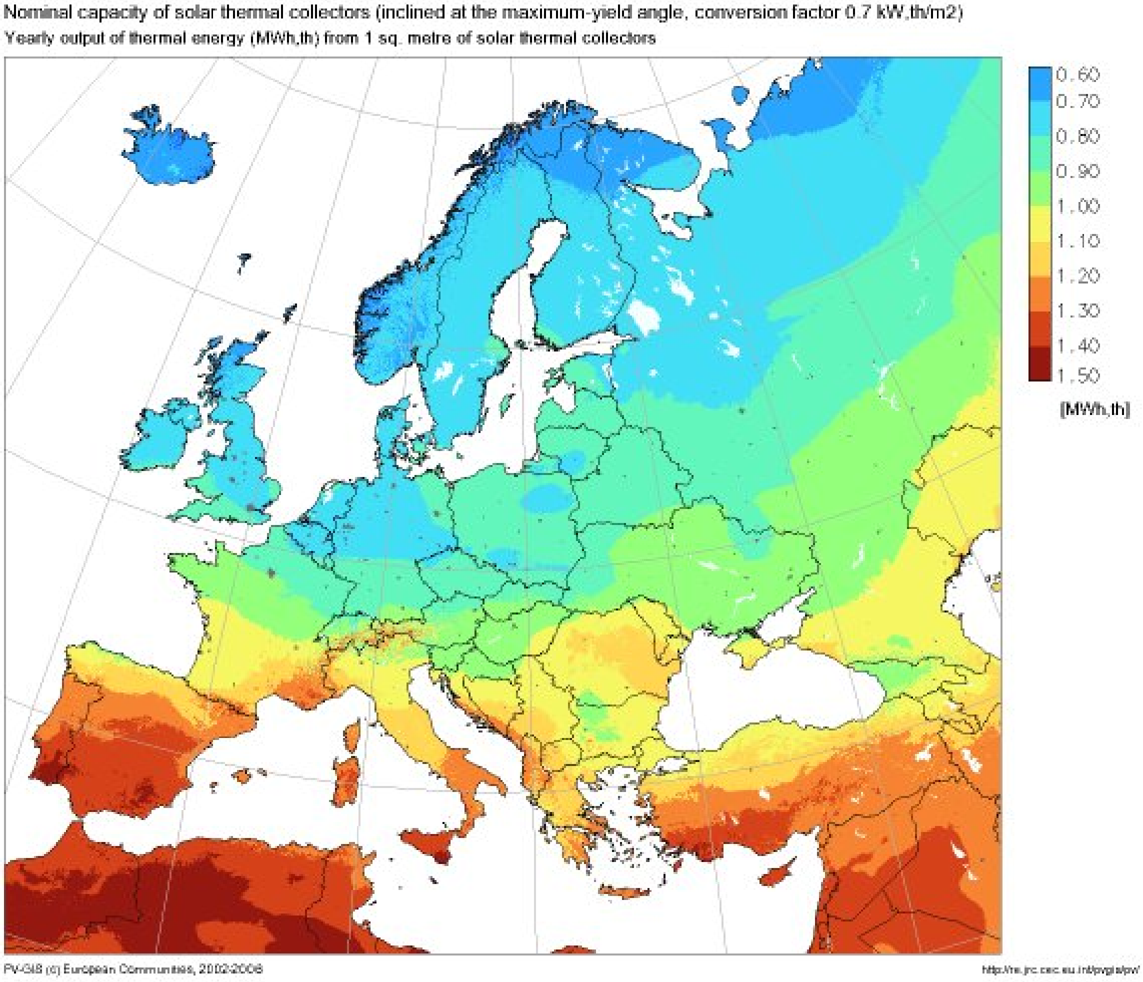

Figure 5: Yearly global irradiation at optimal inclination for solar energy applications. See also Ref 4 and 5

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 m^2 of solar collectors than in Southern Europe to achieve the same capacity. 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 more efficiency in the winter than in the summer months.

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Snapshot on European Wind Energy in World-Wide Comparison

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In 2009, 38 GW of new wind turbine capacity went into operation bringing the world wide total installed wind capacity to 160 GW (Fig. 1). The total value of new generation equipment installed in 2008 is estimated to be about € 50 billion [1]. The United States kept its first place in overall installed capacity, with 35.2 GW followed by China (26 GW), which for the second year in a rowagain more than doubled its total installations, Germany (25.7 GW) and Spain (19.1 GW). China more than doubled its total installations in 2008, bringing its overall wind capacity to 12.2 GW and moved ahead of India with 9.6 MW. The total installed wind capacity at the end of 2009 can produce about 340 TWh of electricity or 2% of the global electricity demand.

The European Union Member States added 10,163 MW and reached a total installed capacity of 74,767 MW [2]. Other European countries and Turkey added 418 MW, bringing the total wind installations in Europe and Turkey to 76,152 MW.

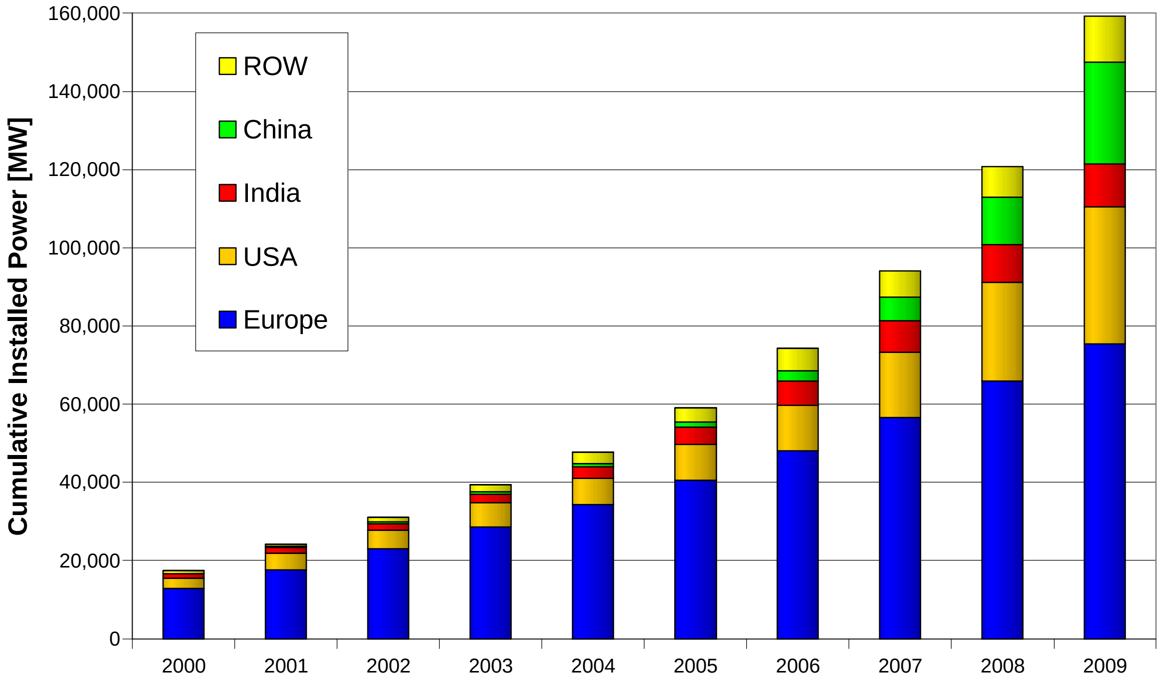

Figure 1: Cumulative world-wide installed Wind Power capacity from 1990 to 2009
Data Source: GWEC, WWEA [1, 2, 3]

Seven countries added capacities of more than 1 GW in 2009: China (13.8 GW), United States of America (9.9 GW), Spain (2,460 MW), Germany (1,920 MW), India (1,340 MW), France (1,120 and Italy (1,110 MW). Another four countries added 500 MW or more: Canada (950 MW), United Kingdom (897 MW), Portugal (673 MW) and Sweden (512 MW).

In 2008 Europe (8.9 GW), North America (8.9 GW) and Asia (8.6 GW) had about equal market shares. This changed and for the first time Asia experienced the strongest increase in installed wind power capacity and was the biggest market with 15.9 GW, mainly due to the massive increase of Chinese installation followed by North America (10.9 GW) and Europe (8.4 GW). The addition of 15.9 GW in 2009 increased the continent's total capacity by 65% to over 40 GW.

In 2009, the European Union's wind capacity grew by 15.7 %, and can now produce approximately 165 TWh of electricity in an average wind year, equal to 5.5% of the total 2009 EU 27 electricity consumption [4]. The German and Spanish markets still represent 43% of the EU market, but there is a continuous trend towards more diversification

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 2009 a total of 82 countries used wind energy on a commercial basis and 49 out of them increased their installations in that year. The European market accounted for about 27% of the total new capacity, a significant percentage decrease from the 75% in 2004.

In 2009 454 MW of offshore wind capacity were added increasing the total installed capacity to almost 2 GW or 1.2% of the total wind capacity worldwide.

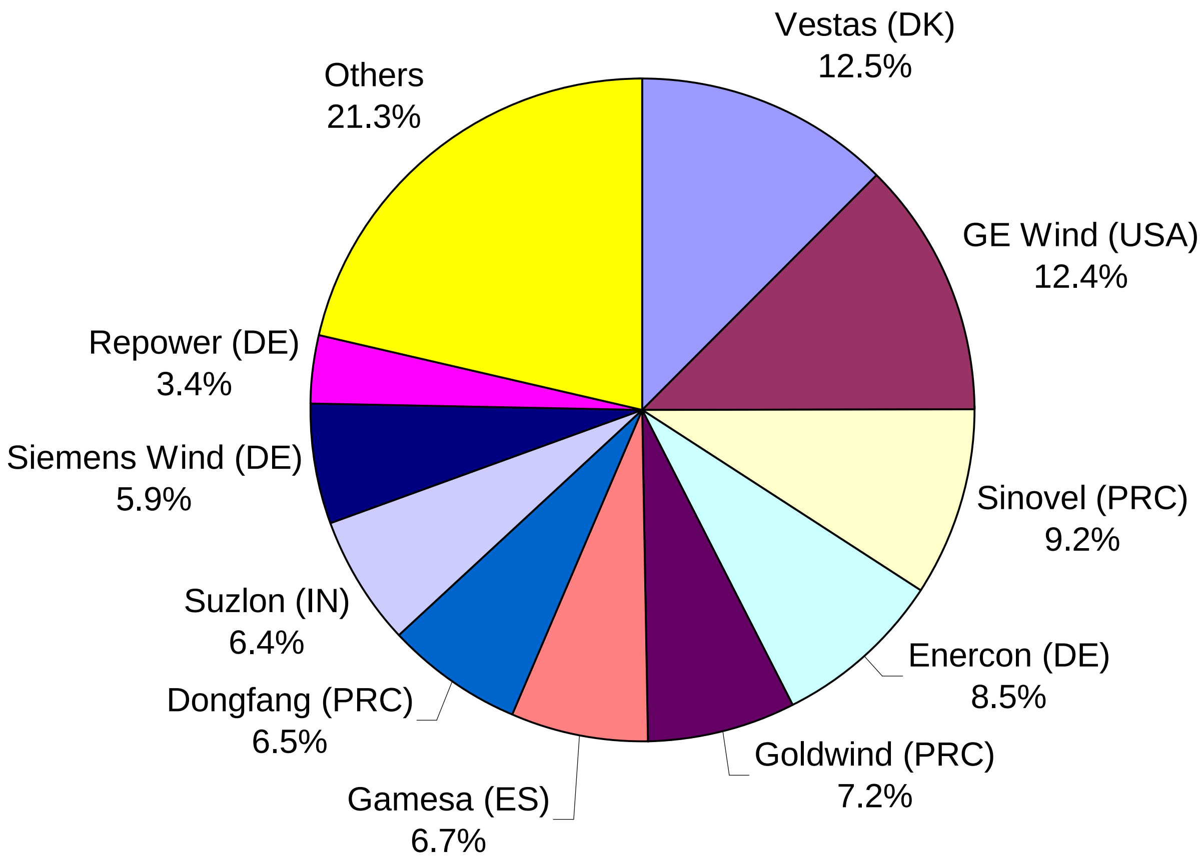

Figure 2: Market shares of manufacturers 2009 (38.1 GW installations) [5]

3 of the top 10 wind turbine manufacturers are from the People's Republic of China and there are more than 70 companies involved in wind equipment manufacturing [5, 6]. So far most of the Chinese wind turbines are only sold inside China, but a number of players have already announced to expand

outside China in the future. The major reasons is the overcapacity and fierce competition within the domestic market where the total quoted manufacturing capacity of the leading three companies in China exceeds 12 GW or more than 90% of the 2009 installations. 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 and bring down the costs for wind electricity in China.

At the end of 2009 the 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, will be surpassed in 2010 and the discussions for the "10-Year Plan for Green Energy Future" point towards a much higher 100 – 150 GW target.

In 2009 the European Wind Energy Association (EWEA) has 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.

According to the World Wind Energy Association, the sector provided 550,000 direct and indirect jobs and has more than doubled its employment figures within the last four 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 in 2008 (74 GW) could deliver about 165 TWh of electricity in an average wind year, equal to 5.5% of the total 2009 EU 27 electricity consumption. However, real production depends on the annual wind conditions and can vary by at least ± 10%.

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The renewable Energy National Action Plans – Analysis of the Forecast Documents

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The Directive 2009/28/EC requires Member States to adopt a National Renewable Energy Action Plan (NREAP) and to submit to the European Commission by 30 June 2010 using a template in accordance with Article 4 of the Directive.

Already all Member States have prepared their forecast documents[22] [1] and submitted them in accordance with the Article 4(3) of Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources [2].

The forecast documents indicate the estimated excess production from renewable energy sources compared to the indicative trajectory which could be transferred to the other Member States and the estimated demand for energies from renewables to be covered by means other than domestic production until 2020. It had to be stated also how big is the estimated potential for joint projects until 2020.

Results of the analysis

Most of the EU Member states are optimistic on the way to meet their target from only domestic action and resources. The forecast documents of the Member States resulted that the EU in 2020 will exceed the 20 % Renewable Energy consumption target with 0.3 %. From the forecast analysis it can be expected also that the EU probably each year will reach a net surplus also in the interim period until 2020 as it is presented in the Figure 1.

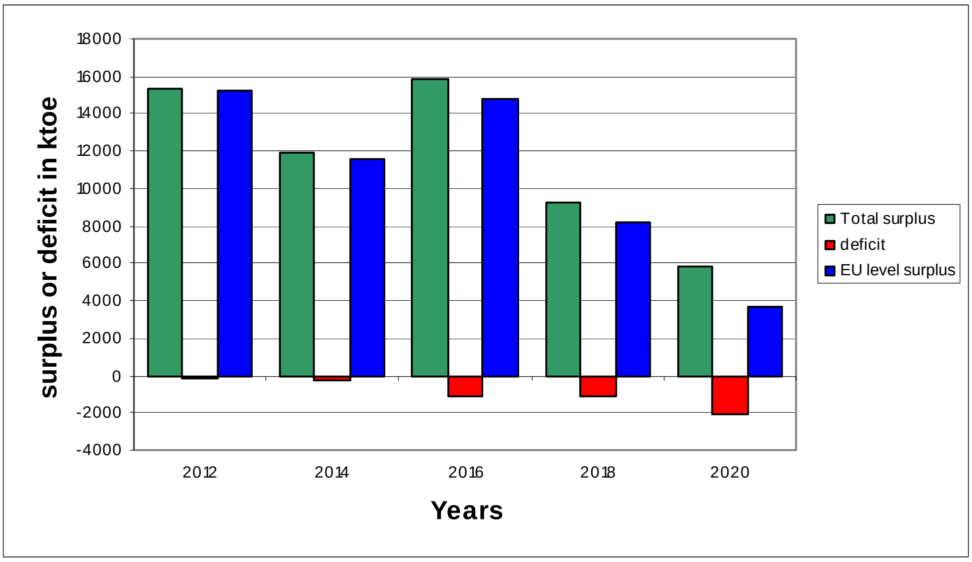


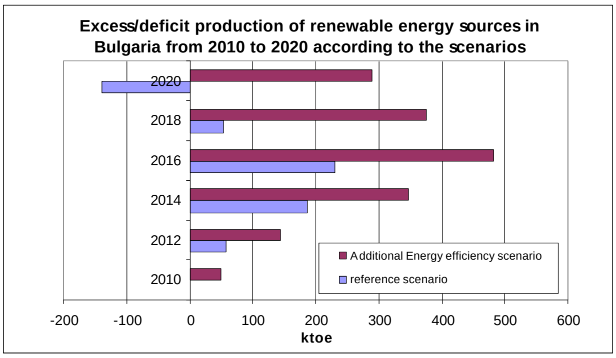
Figure 1: The RES surplus or deficit between 2010 an 2020 in the EU27

[22] The forecast documents are available on the Commission Transparency Platform, established in conformity with Article 24 of the Directive.
http://ec.europa.eu/energy/renewables/transparency_platform/forecast_documents_en.htm

Energy consumption Scenarios

The Member States prepared their forecast taking into account the Additional energy efficiency scenario and also in some cases the Reference Scenarios, some of them presented the numbers in both cases: many Member States emphasized that the projected targets can be reached only applying the energy efficiency measures. The difference between the two scenarios is shown in the case of Bulgaria in the Figure 2.

The main renewable energy resources are the biomass, hydro and wind, seven Member States (Bulgaria, Romania, Latvia, Finland, Italy, Sweden, Hungary) announced biomass as the main renewable energy resource. Bulgaria, Romania and Portugal emphasised also hydro energy and Latvia and Sweden wind energy.



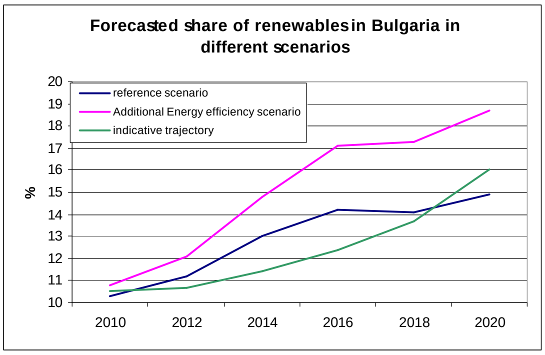


Figure 2: The excess/deficit production and the share of RES in the energy consumption in the case of different scenarios

Surplus

9 Member states - Bulgaria, Spain, Greece, Sweden, Slovakia, Germany, Poland, Lithuania and Estonia - announced **surplus** by the year 2020 as it is presented in Figure 3.

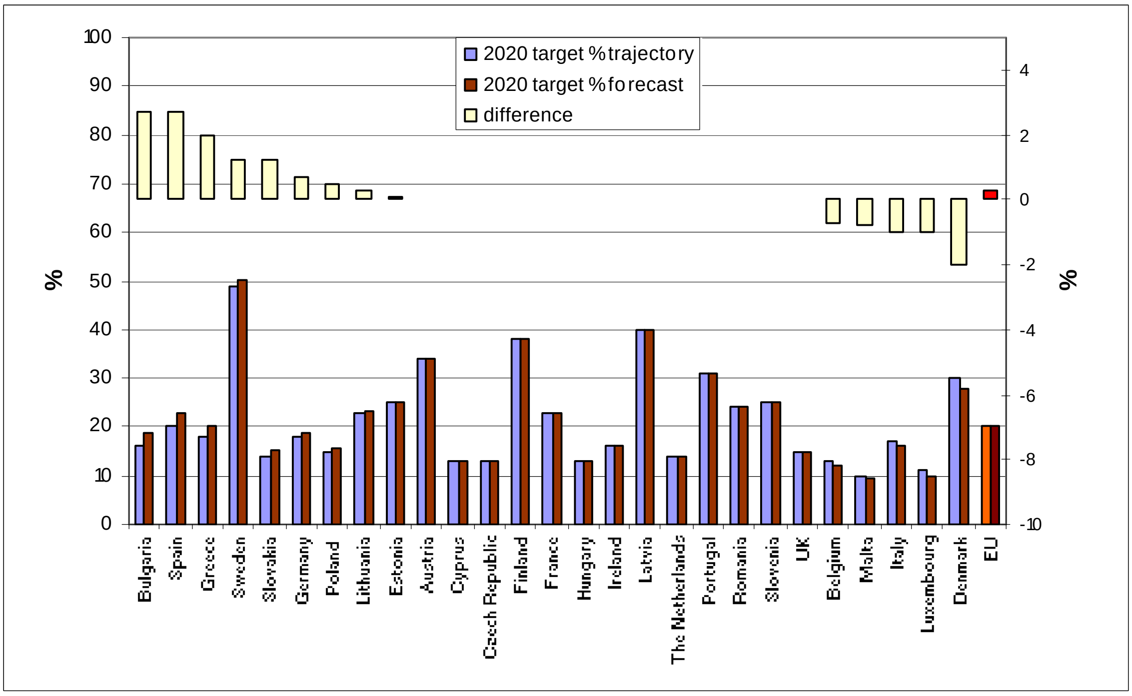


Figure 3: The indicative and forecasted share of the Renewable Energies in the EU 27 by 2020

Bulgaria and Spain has the highest percentage in relative values with 2.7 % - only by taking into account the Additional Energy efficiency Scenario. The highest surplus in absolute term has Germany and Spain with 1387 and 2700 ktoe respectively.

Demand

5 Member states - Belgium, Malta, Italy, Luxembourg, Denmark – forecasted **deficit** in 2020, the highest deficit proportion is in Denmark with – 2 %, this represents -337 ktoe. Italy has the highest absolute deficit with a -1170 ktoe (-1 %).

Interim surplus and deficit

Two countries projected interim **deficit** UK and Italy, although UK reported also surplus in the years 2017-2018 (Fig. 4.).

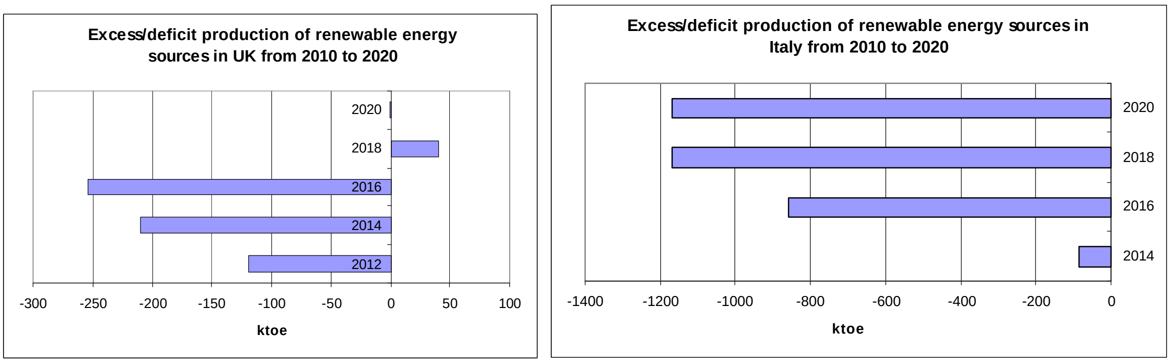


Figure 4. Interim deficit

4 Member States (Belgium, Denmark, Malta and UK) forecasted **surplus** compared to the **interim** targets within the period between 2010 and 2020 until 2018 (Fig 5.).

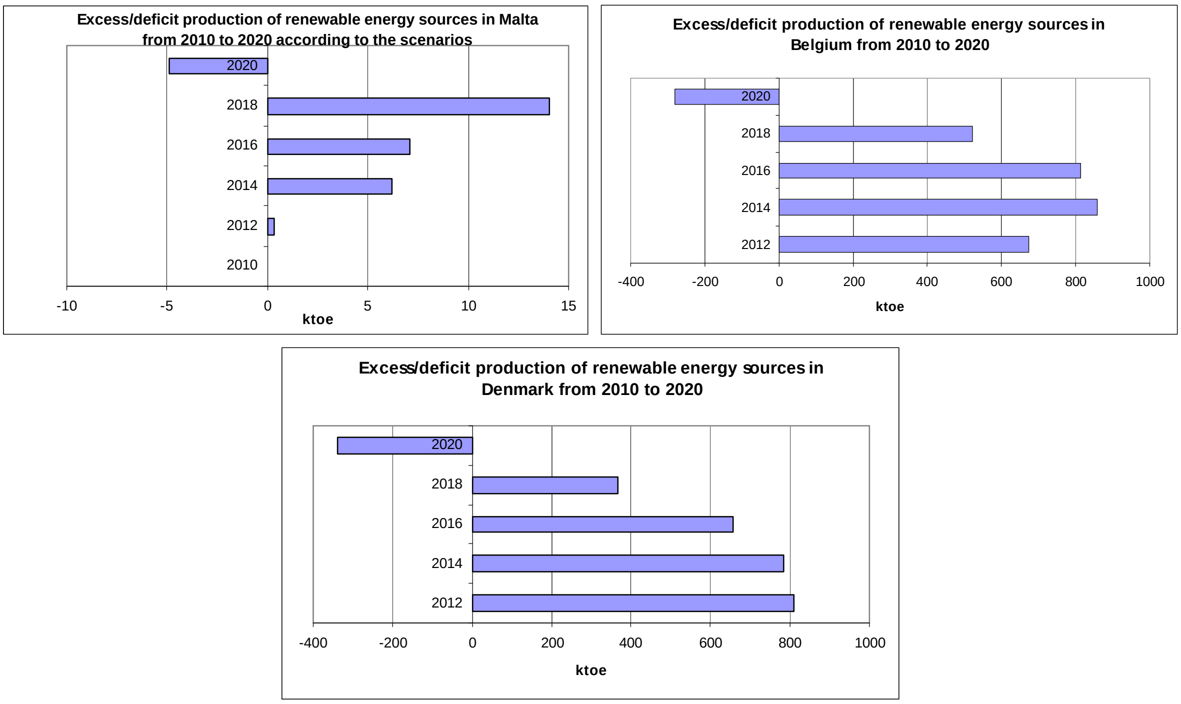


Figure 5: Interim surplus

The cooperation mechanism

The member states can use cooperation mechanisms to help with their surplus or meet their deficit. 13 member states are willing to use the **Joint projects**, and 8 using the **statistical transfer**. The most involved resource in the joint projects is wind and biomass in power generation. Joint project related to offshore wind parks is by Latvia, Ireland, Germany, UK, Sweden in the Baltic area, to hydro energy by Romania and Bulgaria in the Danube and the Black sea area. Greece plans also joint project in the electricity generation sector.

Joint project with the third countries was announced by Spain and Italy in solar energy (Mediterranean Solar Plan-also affecting France import) and using the existing electricity links in the Balkan area. Joint electricity certification scheme will be used by Sweden with Norway.

Sectorial use break down

Some Member States already provided forecast on the sectorial breakdown of the RES development until 2020. Among these countries the highest share of renewable electricity was in Portugal and Malta and Ireland (Figure 6.) and that of heating and cooling in Bulgaria, Slovakia, Sweden and Cyprus. The biggest development of the share of the transport sector is expected in Ireland.

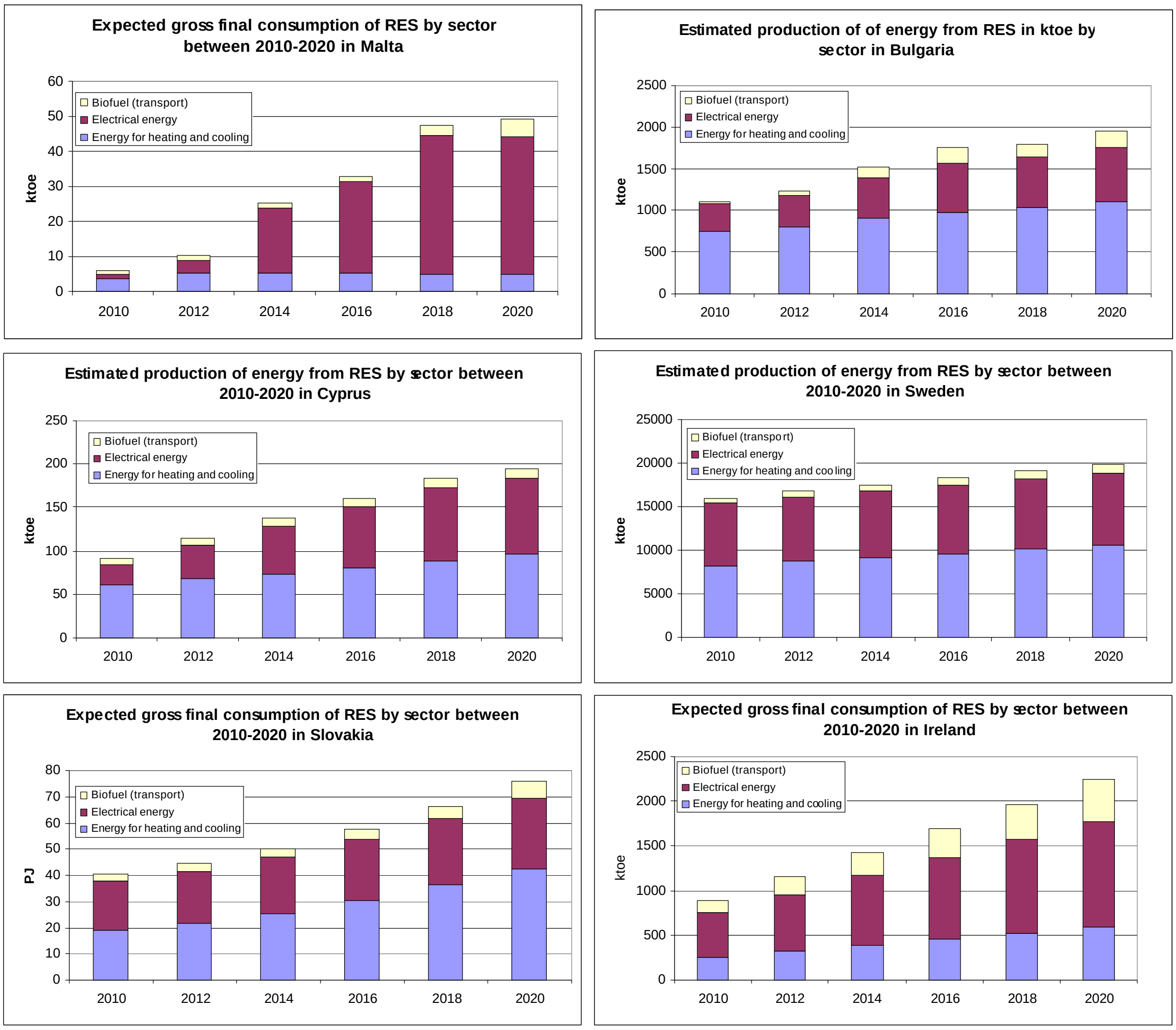


Figure 6: Forecasted sectorial breakdown of RES final consumption in some member states

Critical factors

Many of the Member States reported about critical factors which are the barriers in reaching the targets or which need development in order to achieve a better performance of the targets.

Among the obstacles some countries mentioned their peripherical and isolated geographical situation (Portugal and Cyprus) and restrictions in interconnection capacity; that is why they expressed the need of **development in interconnections**.

Italy mentioned as a barrier that the use of electricity links is not ruled out, so is better to exploit new links. General need is the **modernization of electrical grids** (PT), the **reinforcement of grid infrastructure** and electricity interconnection and offshore wind development (IR). As the proportion of electricity from renewable energy sources is around 35 % in the EU there is a general need to improve the stability of the European electricity grid which requires **new infrastructure**.

In some of the countries smaller growth is expected in the electricity production because of the low technical potential for electricity production.

However it is a good potential of offshore wind resource, the implementations depends mainly on the **development of** infrastructures for integration wind energy to the grid.

The member states are aware of the economic recession to the demand on energy but the consequences and the duration is still not foreseeable and therefore it is not expressed in the forecasts.

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[1] The forecast documents are available on the Commission Transparency Platform, established in conformity with Article 24 of the Directive. 2010 http://ec.europa.eu/energy/renewables/transparency_platform/forecast_documents_en.htm

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European Commission

EUR 24440 EN – Joint Research Centre – Institute for Energy
Title: Renewable Energy Snapshots 2010
Author(s): Hans Bloem, Marta Szabo, Fabio Monforti-Ferrario and Arnulf Jäger-Waldau
Luxembourg: Office for Official Publications of the European Communities
2010 – 46 pp. – 21 x 29.7 cm
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN 978-92-79-16287-9
doi:10.2788/27398

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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LB-NA-24440-EN-C

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ISBN 978-92-79-16287-9