PROGRESS

promotion and growth of renewable energy sources and systems

Final report

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Foreword

This Final Report presents the main findings of the project PROGRESS, Promotion and Growth of Renewable Energy Sources and Systems. The PROGRESS project is supported by the European Commission, DG Energy and Transport, under contract no. TREN/D1/42-2005/S07.56988.

Partners in the PROGRESS project are Ecofys (the Netherlands), Fraunhofer ISI (Germany), Energy Economics Group (Austria), Lithuanian Energy Institute (Lithuania) and Seven (Czech Republic). More information on PROGRESS is available at www.res-progress.eu.

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Executive summary

Introduction

The PROGRESS project was initiated to provide the European Commission, Directorate General Energy and Transport (DG TREN), with inputs for analysis of the degree of achievement of 2010 national and Community targets under the 2001 Renewable Electricity Directive. These inputs include market analysis of renewable energy sources, status quo on policies to promote renewable energy in Member States, analysis of administrative and grid barriers to promoting renewable energy sources, and analysis of the implementation of a system of Guarantee of Origin in Member States. The project provided inputs to the European Commission's *Renewable Energy Road Map (COM(2006) 848)* and the *Proposal for a Directive on the promotion of the use of energy from renewable energy sources (COM(2008) 19)* and are also published therein.

The EU-27 aims to achieve a renewable electricity (RES-E) share of 21% in 2010. The starting point was 13.9% RES-E in the EU-15 in 1997, which corresponds to 12.8% in 1997 in the now expanded EU-27. In order to achieve this target, Directive 2001/77/EC introduced *indicative* national targets for RES-E which differ across Member States. The Directive also established a guarantee of origin (GO) regime and addressed barriers to market entry faced by RES-E.

In 2003 the EU adopted a Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EC). The Directive sets *indicative* targets or Member States of 2% biofuels (by energy content) in 2005 and 5.75% in 2010. To date no specific targets are set at the EU level for renewable heat.

The year 2007 was a year of important policy decisions for the future of renewable energies in Europe. On 9 March 2007 the Council of the European Union agreed on a *binding* 2020 target of 20% of renewable energy sources. With this decision the EC's view was confirmed as expressed in the Renewable Energy Road Map (COM (2006) 848 final) as published some weeks ahead on 10 January 2007. An agreement on a minimum target of 10% biofuels in 2020 was also taken. On 23 January 2008 the European Commission published formal proposals for a new Renewable Energy Directive (COM (2008) 19 final) which confirms these targets and also breaks the overall 20% RES target down into individual *binding* Member State RES targets.

Progress of renewable energy penetration in the EU

Electricity

RES-E has grown by 30% in the EU-27, from 371 TWh in 1997 to 477 TWh in 2006, with hydropower remaining the dominant source of RES-E. Hydropower's dominance is however slowly decreasing due in part to below average rainfall in recent years, but also to continuous increases in deployment of other 'new' renewable energy sources such as wind and biomass. In 2006, hydropower represented only 64% of RES-E generation in the EU-27.

Figure 1 shows the historical development of 'new' RES-E generation from 1990 to 2006 in the EU-27. The observed average annual growth rate of RES-E, excluding hydropower, in the period 1997 to 2006 is 19%, compared to 3% when hydropower is included. Strong growth of several renewable energy sources can be observed. Electricity from onshore wind showed an average annual growth rate of 30% over the period. Offshore wind is expected to grow rapidly in the coming years. Electricity from biogas has also grown strongly, by 19% per year on average from 1997 to 2006. The highest average annual growth rate in this period was realised by solar photovoltaics (PV), which grew on average by an impressive 56% over this nine year period.

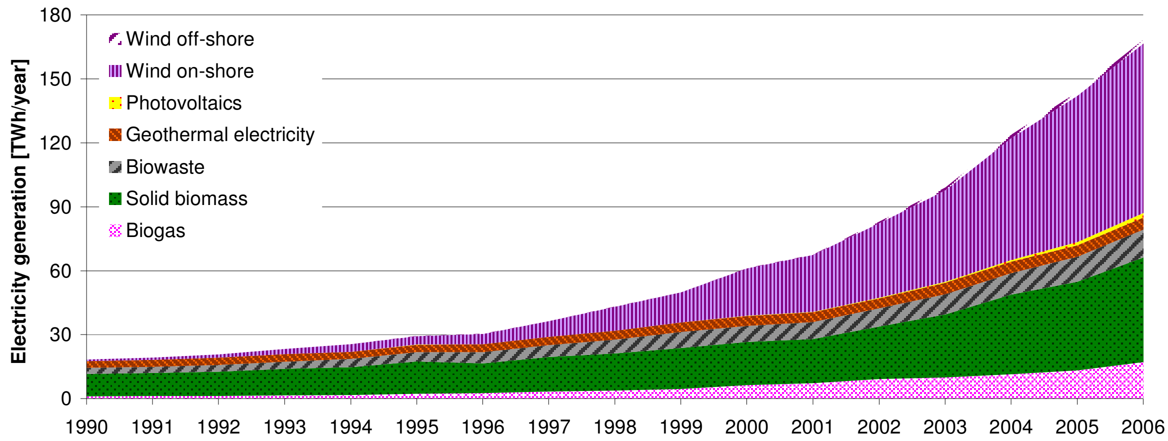

Figure 1: Historical development of electricity generation from 'new' RES-E in the EU-27 from 1990 to 2006

Despite strong growth in new renewable sources, the contribution of RES-E to gross electricity consumption in the EU-27 in 2006 was only 13.7%, still a fair way from the 2010 target of 21%. This is due in part to low rainfall in 2006 which strongly impacts the electricity output from hydropower, but also to increasing overall electricity consumption in the EU.

Heat

Overall progress made in the EU in heat generation from renewables (RES-H) is very modest: between 1997 and 2005 heat output has shown an average annual growth rate of only 2% for the EU-27. The main contributor to RES-H is biomass heat, with solar thermal and geothermal technologies also contributing a small amount.

Unlike RES-E and Biofuels, RES-H has to date received little policy attention at either the EU or Member State level. The new Renewable Energy Directive proposal however broadens the scope of Community level renewables targets to explicitly include renewable heating and cooling, and this is likely to lead to increased focus on this sector in the coming years.

Biofuels

Between 1997 and 2006 biofuel consumption has shown an average annual growth rate of 33%, with growth taking off particularly strongly in 2005: EU biofuel consumption grew by 63% in 2005 and 2006. However, the contribution of biofuels to transport fuels in the EU-27 was only 1.1% in 2005 and 1.8% in 2006, which means the interim target of 2% by 2005 as formulated in the 2003 Biofuels Directive was not met and there is still a long way to go to reach the 5.75% target in 2010.

Biodiesel currently dominates the European biofuel sector, with 72% of biofuels consumed in 2006 being biodiesel and only 16% bioethanol. Similarly biofuel production in the EU is also currently dominated by biodiesel.

Progress towards 2010 targets

Renewable energy overall

Under Business as Usual (BAU) assumptions the share of RES in EU gross energy consumption is estimated to be 8.9% in 2010, which would mean that the RES primary target of 11.5% would not be reached.

Electricity

BAU projections modelled here show that present policies result in a RES-E share of 18.5% in 2010, implying a shortage of 12% of the 2010 target of 21%. The reasons relate to both insufficient support policies in some Member States, and appropriate policies being implemented too late to contribute strongly towards 2010 targets. Insufficient support policies also includes barriers in some countries, typically administrative barriers, insufficient spatial planning or prohibited grid access.

In addition strong growth of gross electricity consumption in the EU offsets progress made with respect to RES-E generation. In absolute terms the difference between 2010 BAU projections (661.5 TWh) and the 2010 target of the White Paper (675 TWh) is 2%, which is significantly lower than the gap of 12% in terms of electricity consumption.

Heat

The projected overall progress of RES-H up to 2010 is very moderate due to limited policy support to date. BAU projections indicate a production of 71 Mtoe RES-H by 2010. Biomass heat in particular lags behind the target of the 1997 White Paper, while also solar thermal heat progresses more slowly than expected. Only geothermal energy are projected to reach the White Paper target, mainly due to the comparatively fast development of ground coupled heat.

Biofuels

The estimated consumption of biofuels in the EU is expected to more than double in the time period 2005 to 2010, increasing from 3.2 Mtoe in 2005 to 8.4 Mtoe in 2010. Despite this strong increase the indicative target as set by the 2003 Biofuels Directive of 5.75% biofuels by 2010 looks unlikely to be met: in 2010 the contribution of biofuels to road transport fuels is estimated to be 2.6 %. Expectations are that the net import of biofuels into the EU will increase and contribute 29% to EU biofuel consumption by 2010.

It is important to note that the BAU projections for biofuels are sensitive with respect to the assumed oil price. Assuming a high price scenario for fossil energy sources, the biofuel share would rise to 3.8% in 2010 or 12.1 Mtoe.

Scenario to reach 20% renewable energy in 2020

The PROGRESS project provides an assessment and in-depth analysis on the effects of a 20% RES target in terms of primary energy demand in the year 2020 using the ***Green-X*** model. One main scenario and a set of sensitivity cases have been analysed to obtain a thorough understanding of the possibilities for long-term RES targets and the associated costs and benefits. Further details of the methodology are set out in chapter 3. The research, involving all sectors of renewable energies (i.e. electricity, heat and transport) within the European Union, concentrates on the following:

- Identification of the technology-portfolio of a 20% RES target for the sectors electricity, heat and transport - meeting criteria such as cost-effectiveness and future perspectives;
- Determining the additional generation costs of 20% renewable energy ;

- Determining the avoided (costs of) fossil fuel use and benefits in terms of security of supply;
- Calculating the avoided CO_2 emissions;
- Identifying the country-specific RES deployment;
- Analysing the impact of the main key reference input parameters such as primary energy prices and development of energy demands on costs and benefits and the above mentioned modelling outputs.

The outcomes of this assessment served as a major input for the European Commission's Renewable Energy Roadmap (COM (2006) 848 final) and are also published therein. An update of this scenario work was also undertaken during 2007 in light of proposals for a binding 20% RES target for 2020. The updated analysis takes into account in particular:

- an extension of the geographical scope (i.e. EU-27 instead of EU-25);
- the incorporation of the agreed minimum target of 10% for biofuels; and
- the consideration of the modified definition of the overall RES target (i.e. 20% in terms final instead of primary energy demand).

Deployment of RES up to 2020

The deployment of solely new RES plants (installed in the period 2005 to 2020) in the *20%-RES-by-2020 main case* is shown in Figure 2 in terms of energy output by sub-sector (electricity, heat and biofuels). To meet the 20% target, large increases are required in all three sectors. Total generation from new RES installations in the period 2005 to 2020 achieves an impressive amount of 177.5 Mtoe by 2020 – representing two thirds of total RES output by 2020 or almost a doubling of current RES generation.

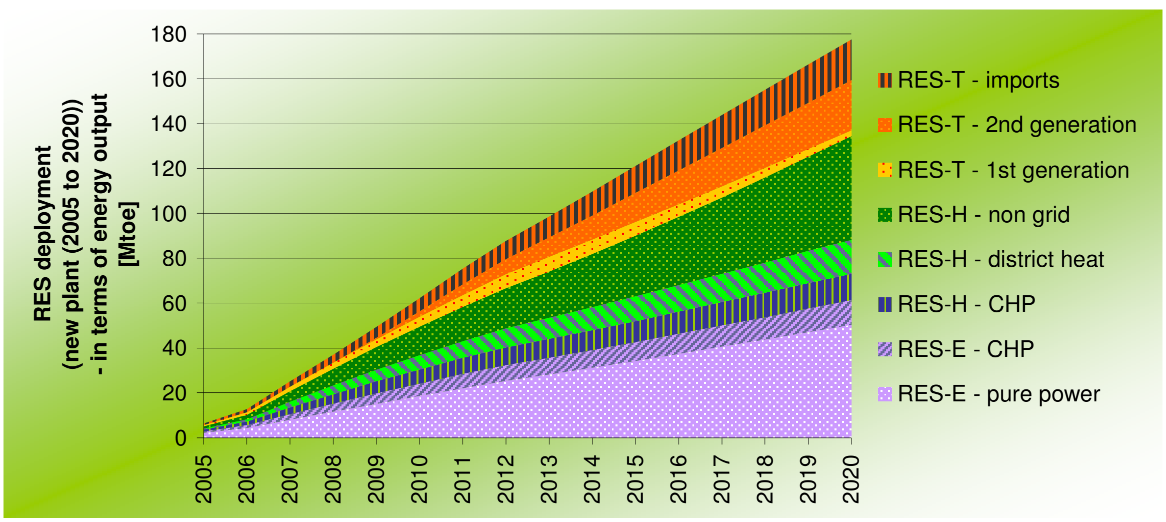

Figure 2 Deployment of new RES (installed 2005 to 2020) in terms of energy output until 2020 within the EU-25

The highest contribution both in terms of energy output as well as primary energy is projected for RES-E, especially for pure power generation options such as wind energy (all together covering 28% of total energy output of new RES installations (2005 to 2020) by 2020), but also RES-CHP acts as a major contributor (13%).

The most prominent conclusions from the detailed technology-level analysis of the *20%-RES-by-2020 main case* scenario are:

- The bulk of RES-E in 2020 will be produced by technologies that are currently already close to the market: Large-scale hydro (319 TWh/yr), solid biomass (195 TWh/yr), onshore wind (266 TWh/yr), offshore wind (157 TWh/yr), biogas (80 TWh/yr), small hydro (57 TWh/yr) and biowaste (31 TWh/yr) together will contribute about 95% to RES-E production.
- However, also novel RES-E options with huge future potentials such as PV (23 TWh/yr), solar thermal electricity (11 TWh/yr) or tidal & wave (14 TWh/yr) enter the market and achieve a steadily growing share – if, as assumed, market stimulation is set in a proper manner.
- In the heat sector solar thermal heat and heat pumps achieve a strong deployment, steadily growing over the whole investigated period, and finally account for almost one quarter of RES-H generation by 2020.
- Biomass plays a crucial role in meeting RES targets. In the *20%-RES-by-2020 main case* co-firing of biomass refers to 58 TWh/yr in electricity production. Biomass will become even more important for the development of RES-H. In 2020 about 75% of total RES-H generation comprises biomass and biowaste. Besides co-firing and CHP also modern small-scale biomass heating systems are a major contributor.
- In the *20%-RES-by-2020 main scenario* 88% of the domestic potential of solid biomass (193 Mtoe) is used and another 28 Mtoe is imported. Imports consist of 9.7 Mtoe forest products and residues and 18.1 Mtoe of biofuels.

The 2007 update of the scenarios according to the new target definition (in terms of final instead of primary energy) results in slightly less emphasis on overall RES exploitation - i.e. the required RES contribution by 2020 drops from 262 to 235 Mtoe (both in terms of final energy). This change is also reflected in the sectoral contribution where a slight shift from biofuels and heat to electricity is notable, affecting especially the deployment of those RES technologies representing the marginal options on the market. Figure 3 shows the predicted breakdown of RES output by sector in 2020.

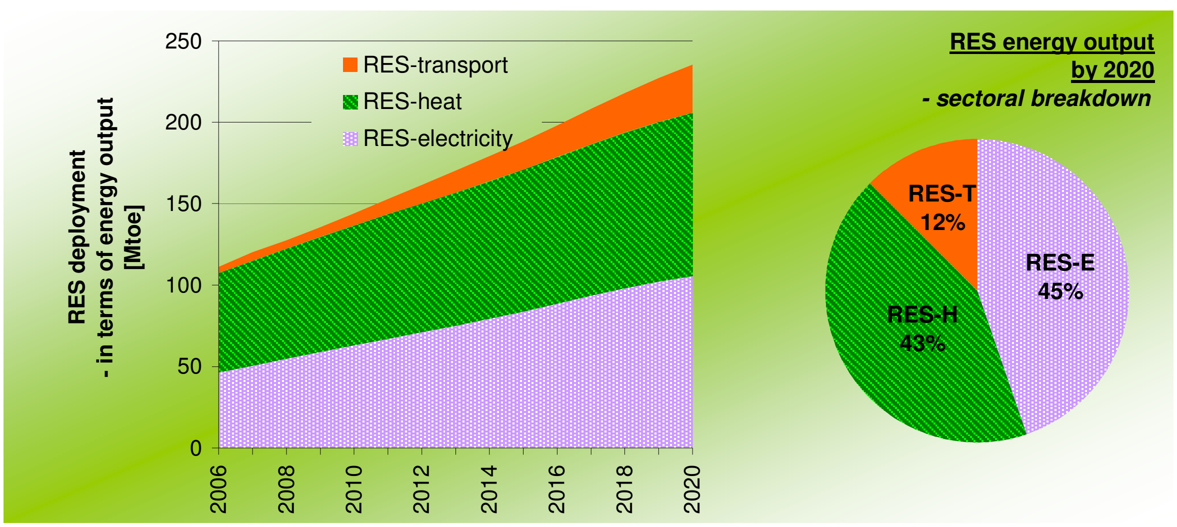

Figure 3 Update: Evolution of renewable energy sources up to 2020 in terms of final energy within the EU-27

Impact on CO_2 emissions

The additional RES deployment in the *20%-RES-by-2020 main case* reduces CO_2 emissions by 708 Mt/yr in 2020, which corresponds to 14% of total EU-25 GHG emissions in 1990 (Kyoto baseline). CO_2 emission reductions due to total RES deployment in 2020 amount to 1,090 Mt, or 21% of total EU-25 GHG emissions in 1990. Figure 4 shows the development of avoided CO_2 emissions over time in the electricity, heat and biofuels sectors.

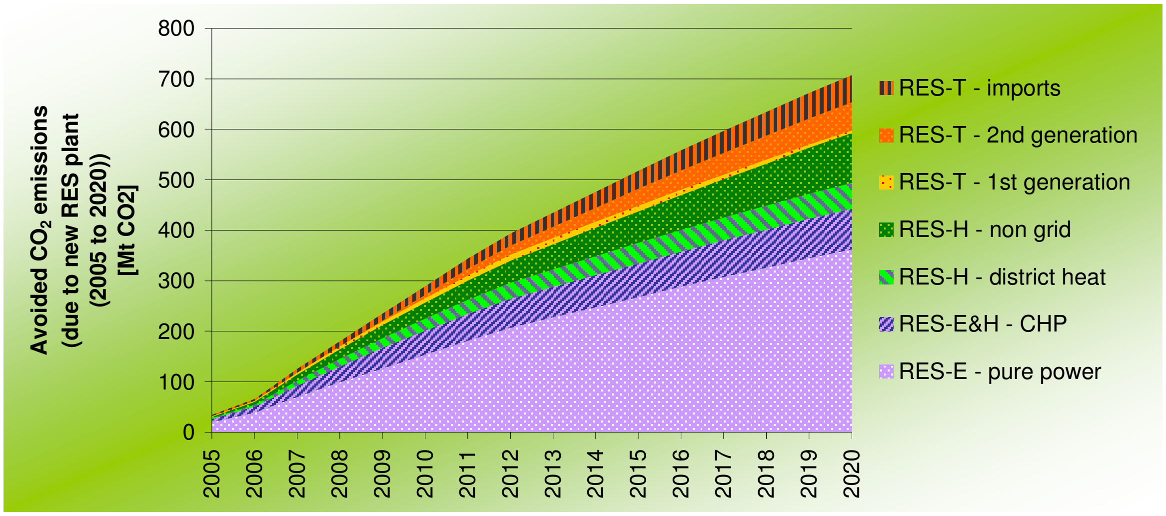

Figure 4 Avoided CO_2 emissions from new RES deployment (2005-2020)

Impact on security of supply

The increased RES deployment in the *20%-RES-by-2020 main case* reduces fossil fuel demand and therewith is an important element in improving the security of energy supply in Europe. In 2020 the avoided oil consumption due to new RES capacities installed between 2005 and 2020 equals 12% of both total EU oil consumption and import needs. In the case of gas, it equals 20% of total EU gas consumption in 2020 or 24% of default gas import needs, respectively. In the year 2020 a total of 50 billion € per year can be saved on fossil fuels due to additional RES deployment in the period 2005-2020.

Financial impact

The increased RES deployment in the *20%-RES-by-2020 main case* will lead to investments of 672 billion €, almost evenly spread over the period 2005-2020. Of this amount 308 billion € will be invested in pure RES-E (46%), 269 billion € in pure RES-H (40%), 53 billion € in RES-CHP (8%) and 42 billion € in RES-T (6%).

The cumulative additional generation costs for the period 2005-2020 amounts to 287 billion €. This means that on average the additional generation costs are 17.9 billion € per year throughout this period. Figure 5 shows the additional annual generation costs for new RES plants according to three scenarios to reach 20% RES by 2020, as well as three BAU scenarios.

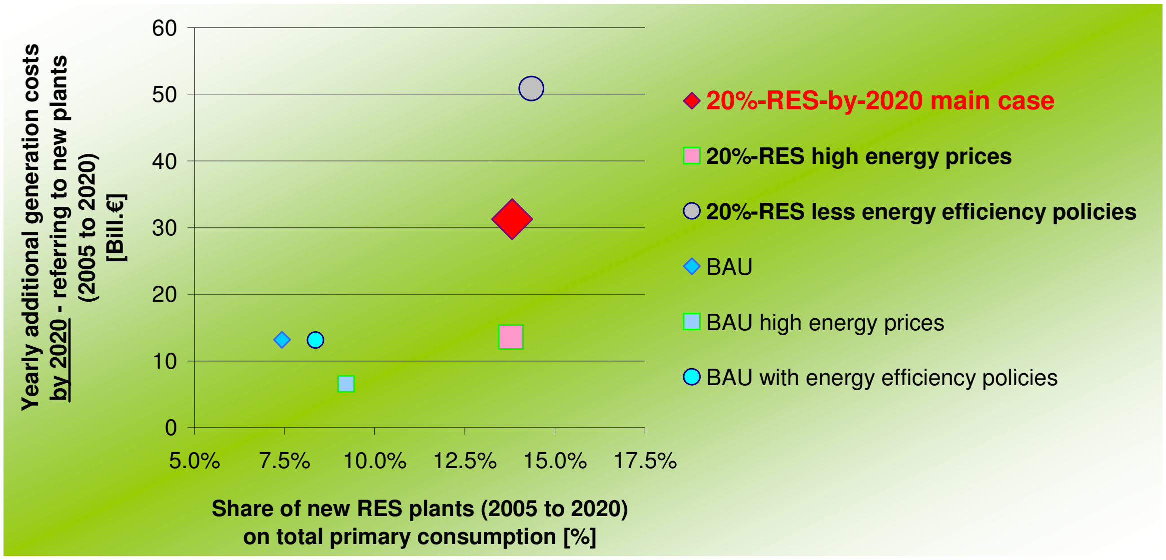

Figure 5 Additional RES generation costs by 2020 for achieving 20% RES by 2020 as well as under BAU conditions (assuming a continuation of current RES policies) under changing parameters

Barriers to the development of renewable energy

A stakeholder consultation was carried out to identify the most important existing barriers to the development of RES-E. The enquiry focused on barriers related to problems with permission procedures and grid issues.

The majority of respondents perceived the permission and the grid connection procedures they face in their countries to be too complex and above all too lengthy. Both procedures are regulated at the national level and sometimes even differ between the regions inside a country. Other crucial issues are a high number of authorities involved in application procedures and a lack of coordination between them and the promoter.

According to some stakeholders, the standards concerning grid connection are adapted to the requirements of large conventional power plants and disregard particular characteristics of RES plants (i.e. smaller plant size, intermittency of power output, availability of RES in areas with a weak grid infrastructure, etc.). In addition, cost estimates for grid connection and extension are predominantly judged to be in-transparent and partly discriminatory towards RES-E.

Consequently stakeholders call for streamlining, simplification and harmonisation of existing permission procedures. The introduction of a one-stop agency is seen as a possible solution for the major administrative problems. Regarding grid issues, stakeholders propose the Community to increase regulation of grid related permission procedures by standardisation, the increase of transparency and the simplification of permit procedures by using internet applications.

Design and use of systems of Guarantee of Origin

An analysis was carried out of the systems of Guarantee of Origin (GO) of electricity produced from renewable energy sources in all 27 EU Member States, plus the systems of Norway, Switzerland and Iceland.

Current status of implementation

A GO system is currently operational in 16 EU Member States, plus in Norway and Switzerland. The system in Iceland was expected to be put in service by the end of 2007. The remaining 11 EU Member States do not yet have an operational system in place.

Issuing Bodies for the GO are typically either the electricity regulator or Transmission System Operator (TSO). Only 3 Member States have not yet appointed an Issuing Body. Currently 13 EU Member States have a central registry for GO in operation, as well as Norway and Switzerland. Another 6 Member States are planning to introduce a central GO registry.

Design of the GO system

The design of the GO system includes key aspects like the transferability and redemption of GO within the system. We can conclude that so far the principle of redemption of a GO has not been introduced in the majority of countries; currently only 11 Member States operate a redemption system, which includes all Member States with a GO system standardised according to EECS (European Energy Certificate System). GO systems without redemption pose a serious risk of double use of a GO.

Design of the GO

The GO systems currently implemented in Europe have different formats and designs from country to country. Differences are the amount of electricity a GO represents, the period of validity of a GO, the exact format of the GO (electronic or paper version), and whether GOs are earmarked for financial support or not.

The different GO designs hinder mutual recognition and international trade of GOs between Member States. Several countries have decided to develop a standardised GO system under EECS.

Use of the GO

In approximately half of the countries where a GO system is currently in operation, a legal framework or guidelines have been set up obliging or recommending the use of GOs for disclosure of the renewable part of the fuel mix. From July 2007 onwards six countries have regulation in force which states that only GOs can be used to demonstrate the renewable part of the fuel mix disclosure. In 5 others guidelines have been issued which recommend the use of GOs for disclosure purposes.

In a few countries the GO has been attributed an additional role: the GO serves as the mandatory proof for supply of green electricity to consumers in the voluntary market. This ensures consumers that the green electricity they voluntarily buy has not been sold twice. To our view, without a standardised GO system, including redemption, consumers of green electricity cannot be guaranteed that the green electricity has not been used somewhere else.

GO and support systems

The position of the GO within the financial support system in place needs to be defined. In general, regardless of the type of financial support instrument in place, one can distinguish two approaches:

a. A freely tradable GO is given to the generator on top of the financial support. This means that the GO can still be used once financial support has been granted.
b. The GO is embedded in the financial support system. Different ways to do this are being applied throughout the various GO systems. A GO can be automatically redeemed upon allocation of financial support, or a GO can become intransferable once financial support has been granted.

1 Progress of renewable energy penetration in the EU

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This chapter provides an overview of the development of renewable energy sources in the EU since 1997 in the sectors electricity, heat and transport fuels. Aggregated data for RES-E and Biofuels in the figures and tables are provided up to 2006 as this is the most recent year for which data for all countries and technologies were available at time of writing of this document. RES-H data are provided up to 2005.

1.1 Progress of RES-E penetration

Renewable energy sources play an increasingly important role in European energy supply. Electricity generation from renewable sources (RES-E) grew by 30% from 371 TWh in 1997 to 477 TWh in 2006 in the EU-27. An overview of the historical development of electricity generation from renewable energy sources from 1990 to 2006 is presented in Figure 6. Hydropower is the dominant renewable energy source, representing about 90% of all RES-E generation in 1997, but its dominance has been slowly decreasing over the past years due in part to below average rainfall in some years, but also to continuous increases in deployment of other ‘new’ renewable energy sources such as wind and biomass. In 2006, hydropower represented only 64% of RES-E generation in the EU-27.

The contribution of RES-E to gross electricity consumption in the EU-27 in 2006 was 13.7%, only slightly higher than the figure of 12.8% in 1997 despite the positive developments in the RES-E sector, which can be explained by two reasons. First of all, the contribution of hydropower in 2006 was lower than in 1997 due to below average rainfall, which strongly affects the overall RES-E generation figure. Assuming normal climatic conditions, the contribution of RES-E as a share of electricity consumption in 2006 was 14.6%. Secondly, overall electricity consumption in the EU has grown by more than 15% since 1997, largely offsetting the newly realised deployment of renewable energy since then. If electricity consumption would have remained at 1997 levels, the actual contribution of RES-E in 2006 would have been 17%. Taking normal climatic conditions into account, the RES-E share in 2006 would have been 18.1% assuming 1997 levels for gross electricity consumption.

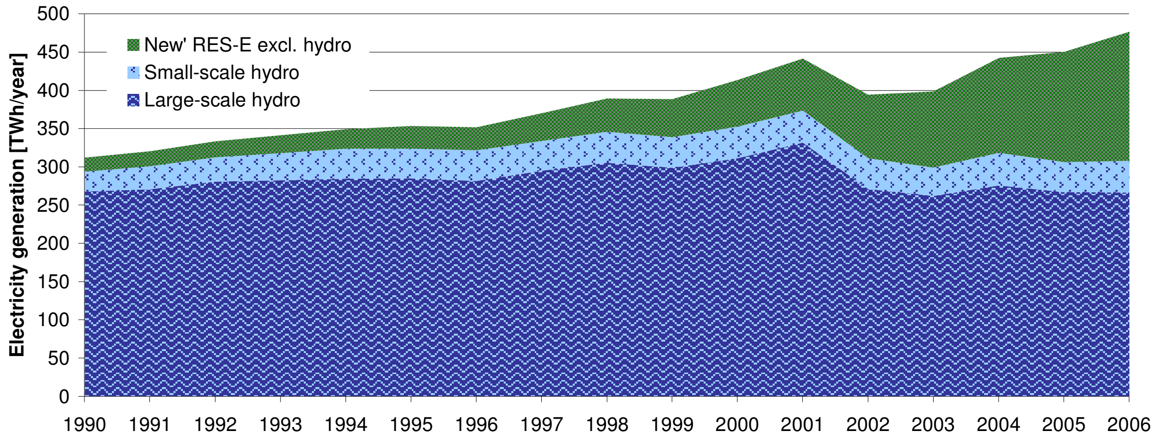

Figure 6: Historical development of electricity generation from RES-E in the European Union (EU-27) from 1990 to 2006.

In order to avoid the influence of variable rain conditions on the picture, Figure 7 presents the development of electricity generation over the time period from all renewable sources except hydropower. A strong growth of several renewable energy sources over the last decade can be observed.

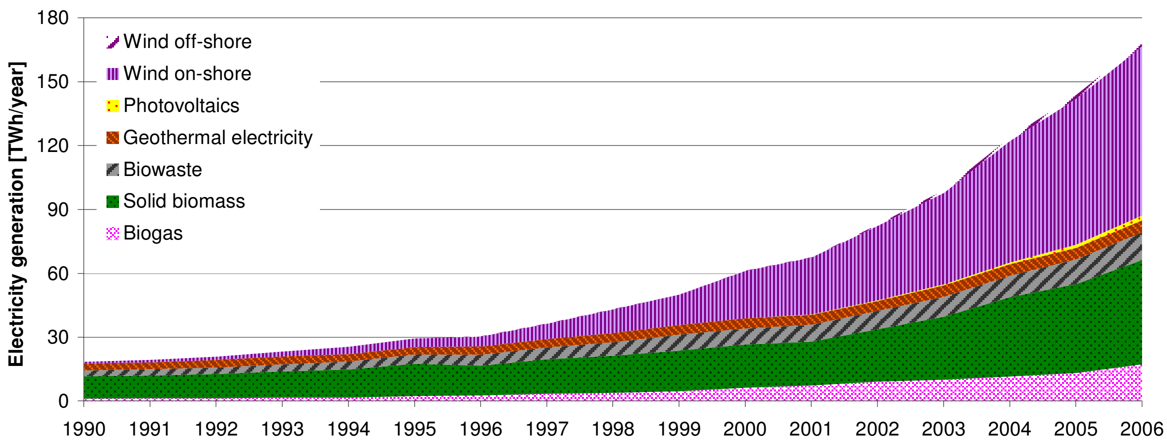

Figure 7: Historical development of electricity generation from 'new' RES-E in the European Union (EU-27) from 1990 to 2006.

Electricity production from onshore wind equalled 79 TWh in 2006 compared to 7 TWh in 1997, which implies a spectacular average annual growth rate of 30% throughout this period. Offshore wind, though still relatively small in absolute terms, is starting to take off in several countries and is expected to grow rapidly in the coming years. In 2007 wind continued its impressive growth, with the addition of over 8,500 MW new capacity, resulting in an overall capacity of about 56,500 MW by the end of 2007. Also electricity generation from biogas has grown strongly, by 19% per year on average from 1997 to 2006. The highest average annual growth rate in this period has been realised by solar photovoltaics (PV), which grew on average by an impressive 56% over this nine year period, from 0.04 TWh in 1997 to 2.2 TWh in 2006. An overview of the development of each RES-E technology from 1997 to 2006 is provided in Table 1.

The average annual growth rate of RES-E excluding hydropower in the period 1997 to 2006 is 19%.

Table 1. Electricity generation from renewable energy sources in the EU-27 in 1997 and 2006

	1997 [GWh]	2006 [GWh]	Average annual growth 1997-2006 [%]	2006 normalised [GWh]
Biogas	3.49	17.30	19%	17.30
Solid Biomass	16.25	49.14	13%	49.14
Biowaste	5.48	12.92	10%	12.92
Geothermal electricity	3.96	5.69	4%	5.69
Hydro large-scale	294.96	266.72	-1%	297.09[1]
Hydro small-scale	39.00	41.35	1%	43.00
Photovoltaics	0.04	2.23	56%	2.23
Solar thermal electricity	0.00	0.00	-	0.00
Tide & Wave	0.57	0.52	-1%	0.52
Wind on-shore	7.26	79.48	30%	92.05
Wind off-shore	0.07	1.84	44%	2.53
Total RES-E	**371.07**	**477.19**	**3%**	**522.47**
Total RES-E excl. hydro	**37.11**	**169.12**	19%	**182.39**

1.2 Progress of RES-H penetration

Table 2 shows the generation of heat from renewable energy sources (RES-H) in the EU-27 in 1997 and 2005.

Table 2. Heat generation from renewable energy sources in the EU-27 in 1997 and 2005

	1997 [Mtoe]	2005 [Mtoe]	Average annual growth 1997-2005 [%]
Biomass heat	47.81	55.81	2%
Solar thermal heat	0.32	0.68	10%
Geothermal heat incl. heat pumps	0.72	1.58	10%
Total RES-H	**48.86**	**58.07**	2%

Overall progress made in the EU in heat generation from biomass is very modest: since 1997 heat output from biomass has grown by only 17% to 56 Mtoe in 2005, corresponding to an average annual growth rate in the period 1997-2005 of only 2% for the EU-27. Only three countries showed an average annual growth rate of biomass heat higher than 10%, i.e. Bulgaria (15%), Czech Republic (18%) and Slovak Republic (71%).

Solar thermal heat generation doubled from 0.3 Mtoe in 1997 to 0.7 Mtoe in 2005. In general, solar thermal heat has developed modestly, the overall EU growth rate in the period 1997-2005 being 10% per year. Only a few Member States have realised (slightly) higher average annual growth rates in this period, i.e. Germany (18%), UK (22%), Netherlands (18%), Italy (14%) and Spain (13%).

[1] Normalised figures for large scale and small scale hydropower refer to installed capacities of the year 2005.

Geothermal heat generation was 1.6 Mtoe in 2005, including heat generation by heat pumps. The annual growth of geothermal heat generation corresponds to 12% on average in the period from 1997 to 2005. Average annual growth rates of around 30% or more have been realised by Sweden (+100%), Austria (48%) and Finland (28%).

Overall one can conclude that developments in the heat sector have been modest up to now and are clearly lagging behind growth rates realised in the electricity sector and – more recently – in the biofuels sector. It should be noted that the RES-E Directive has been in place since 2001 and the majority of Member States have formulated a clear framework for support of RES-E since then. The Biofuels Directive of 2003 has meant an important stimulus to the creation of support frameworks for the production and consumption of biofuels in Member States, while RES-H has up to now been lacking a clear integrated support framework both at the European and national level.

1.3 Progress of biofuels penetration

An overview of the consumption of liquid biofuels in the EU-27 in 1997 and 2006 is provided in Table 3.

Table 3. Consumption of liquid biofuels in EU-27 in 1997 and 2006

	1997 [Mtoe]	2006 [Mtoe]	Average annual growth 1997-2006 [%]
Biofuels	0.41	5.38	33%

Biodiesel currently dominates the European biofuel sector, with 72% of biofuels consumed in 2006 being biodiesel and only 16% bioethanol (see Figure 8). Accordingly, in most Member States biodiesel is the dominant biofuel production, except for Spain, Sweden, Finland, Hungary and the Netherlands where bioethanol is leading.

Between 1997 and 2006 biofuel consumption has grown with an annual growth rate of 33% on average. Adoption of the Biofuels Directive in 2003 has led to a strong enhancement in the formulation of biofuel support policies, resulting in new market opportunities. Especially since 2005 biofuel consumption has been taking off: EU biofuel consumption grew by 63% in 2005 and 2006, with both biodiesel and bioethanol contributing to this expansion. However, there is still a long way to go as the contribution of biofuels to transport fuels in the EU-27 was only 1.1% in 2005 and 1.8% in 2006, which means the interim target of 2% by 2005 as formulated in the 2003 Biofuels Directive was not met, although 2006 figures came close to the share targeted for 2005.

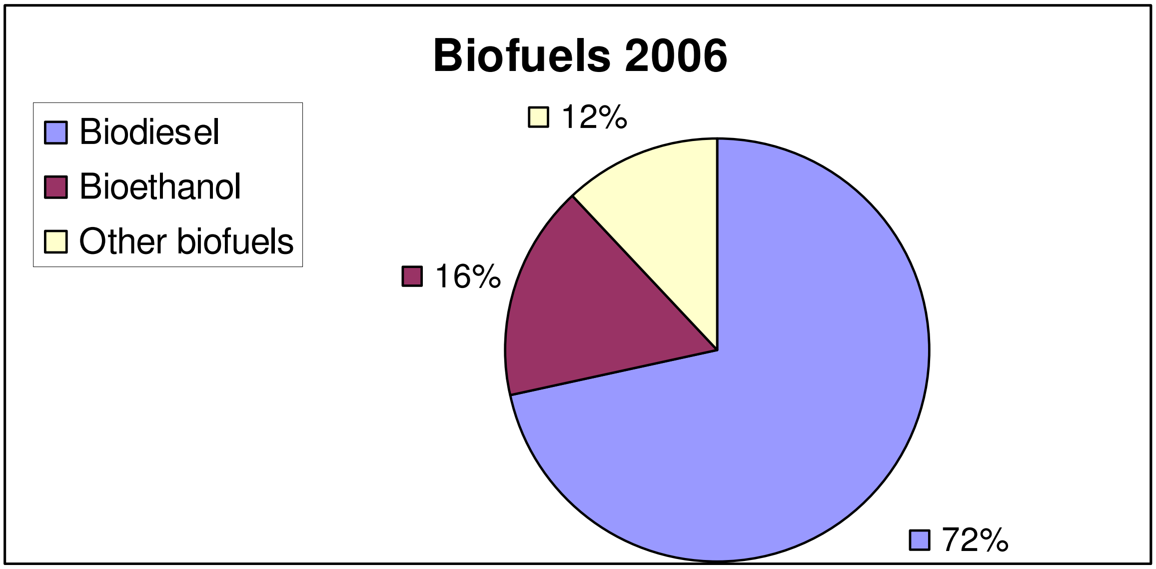

Figure 8: Breakdown of different types of biofuels in total EU-27 consumption in 2006

1.4 Development of electricity in several renewable sectors

1.4.1 Wind

The European Union, which officially expanded by 10 countries in May 2004, and a further 2 in January 2007, remains the undisputed global leader in wind power with 70% of globally installed wind power capacity within her boundaries.

Since 2000 wind power capacity has increased by more than 150% in the EU-27. New wind power represents more than half of the new electricity generating capacity in the EU, whereas the other half is mainly contributed by conventional thermal power stations[2] . The unprecedented growth of European wind power is illustrated by the fact that the White Paper target of 40,000 MW installed capacity by 2010 was already achieved by the end of 2005, having reached an installed capacity of 40,455 MW in the EU-27. The excellent performance of the wind sector has pushed the industry to upgrade its target to 75,000 MW in 2010.

An overview of electricity generation by wind from 1990 to 2006 is provided in Figure 9 (EU-15) and Figure 10 (new EU-12). Generation in the EU-15 increased from 7.4 TWh in 1997 to 79.0 TWh in 2006, while progress in the EU-12 was from 4.4 GWh in 1997 to 445 GWh in 2006.

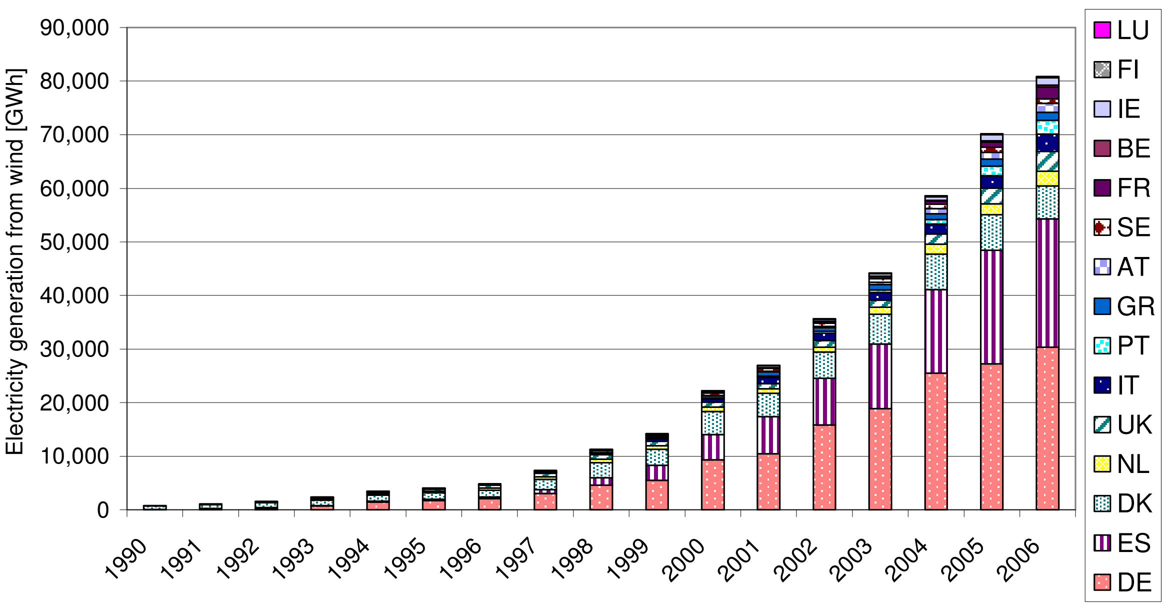

Figure 9: Historical development of electricity generation from wind in the EU-15 Member States from 1990 to 2006.

[2] "Wind powered electricity generating capacity increased by over 150% in the EU25 since 2000", Eurostat news release 66/2006, 22 May 2006

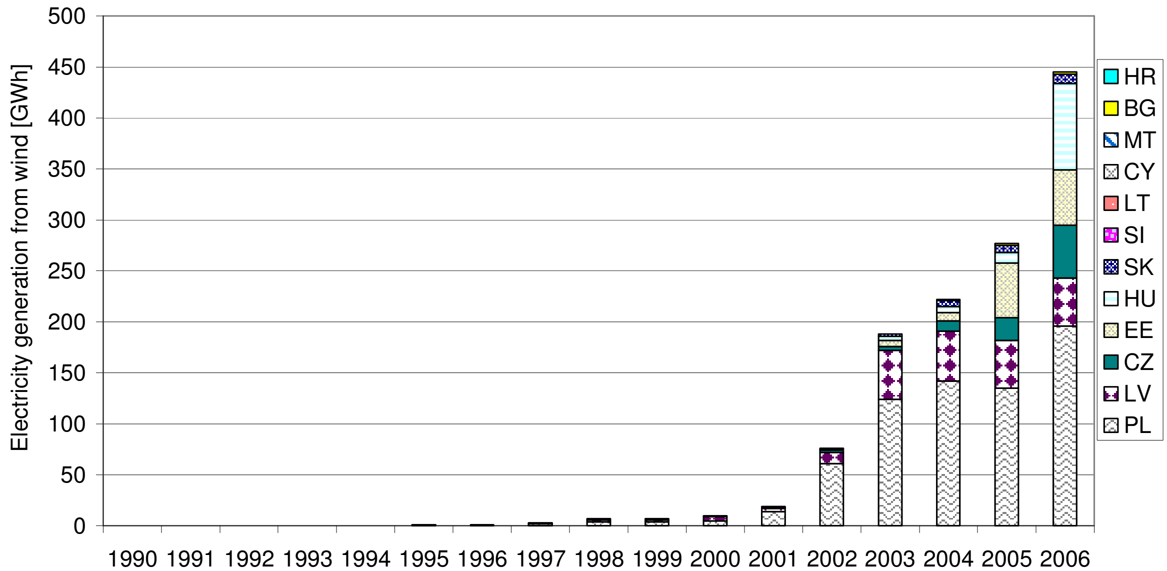

Figure 10: Historical development of electricity generation from wind in the EU-12 Member States from 1990 to 2006.

Germany, Spain and Denmark remain the leading countries as far as electricity generation from wind is concerned, but these three countries are no longer the only ones contributing to the development of wind energy in the EU. With Germany, Spain and Denmark all showing a decrease of relative growth in 2005 and 2006 compared to earlier years, this decrease was compensated by new capacities erected in other countries such as Portugal, Italy and the UK. Also France showed a considerable increase of installed wind power in 2006, although administrative barriers continue to form a threat to real solid uptake of wind energy. The development of wind energy in the new Member States remains very modest up to now.

Offshore wind

Many Member States have a large unexploited potential for offshore wind energy. Currently five Member States have offshore wind parks in operation: Denmark, Ireland, the Netherlands, Sweden and the UK. A short overview of offshore wind initiatives of Member States is provided.

Denmark has been the global leader in offshore wind and has more than 400 MW installed capacity. Two new offshore wind parks of 200 MW each will come into operation in the coming years.

In the UK offshore wind is growing fast. Currently 404 MW of offshore wind is in operation, and a further 460 MW is under construction. In addition, over 2,700 MW new offshore capacity has been granted a consent.

The Netherlands has currently 108 MW of offshore wind capacity in operation, while a further offshore wind park with a total capacity of 120 MW will come into operation before 2010.

Ireland has currently 25 MW installed offshore wind capacity. Sweden has 133 MW of installed capacity and a further 30 MW in planning.

The first German offshore wind park (60 MW) is foreseen before 2010 near the island of Borkum.

In France there are no offshore wind parks so far, but one project of 105 MW is currently under development.

1.4.2 Biomass

Three fractions contribute to the total biomass electricity generation: solid biomass, biogas and the biodegradable fraction of municipal solid waste. The first two forms of biomass have shown the strongest growth in recent years in the EU, as can be seen in Figure 11.

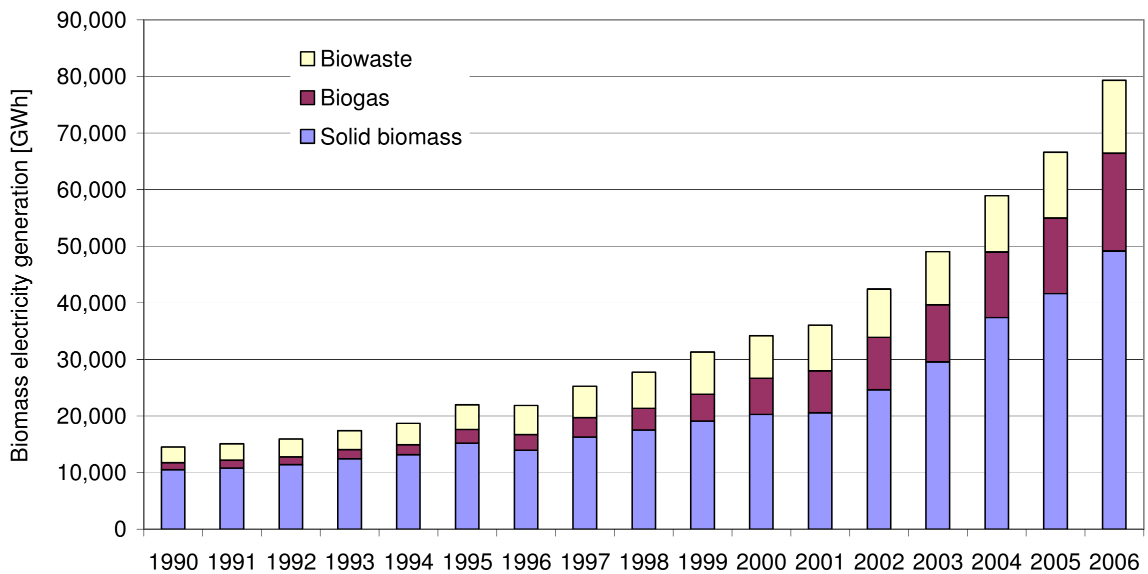

Figure 11: Historical development of electricity generation from solid biomass, biogas and municipal solid waste in the EU-27 Member States from 1990 to 2006.

Solid biomass

Electricity from solid biomass is generated based on the combustion of forestry and agricultural products and residues in thermal power stations.

As is well known, the development of electricity from solid biomass is lagging behind expectations at the EU level even though it is cost efficient in countries where sufficient exploitable wood waste potentials exist. The development in the EU-15 and the EU-12 is shown in Figure 12 and Figure 13below respectively. Progress since the year 2002 has accelerated significantly, over which time almost 40 TWh additional generation has been realised. The largest contributors to the total biomass RES-E generation are Finland and Sweden, followed by Germany, Spain, the UK, Denmark, Austria and the Netherlands. Very significant growth during the years 2005 and 2006 was achieved in Germany and the Netherlands.

The main barrier to the development of this RES-E source is often infrastructure-related rather than economic. Since solid biomass represents the cheapest RES-E source in some countries, such as Finland and Sweden, it attracts the largest share of RES-E investment. Certainly the long term traditions in the biomass sector and the importance of the forestry industry combined with the fact that most plants are large scale industrial units operating in CHP mode are strong success factors for the development of the biomass electricity sector in Scandinavian countries. The development in Germany is mainly driven by medium scale generation units up to 20 MW. Due to the specific support for CHP an increasing share of biomass plant is operating in cogeneration mode. Some countries (Austria, Belgium, Italy, Netherlands, UK, Czech Republic, Estonia, Hungary, Poland, Slovenia and Slovak Republic) allow for the option of co-firing solid biomass in conventional power plants. As can be seen from the Hungarian example this option allows particularly high growth rates.

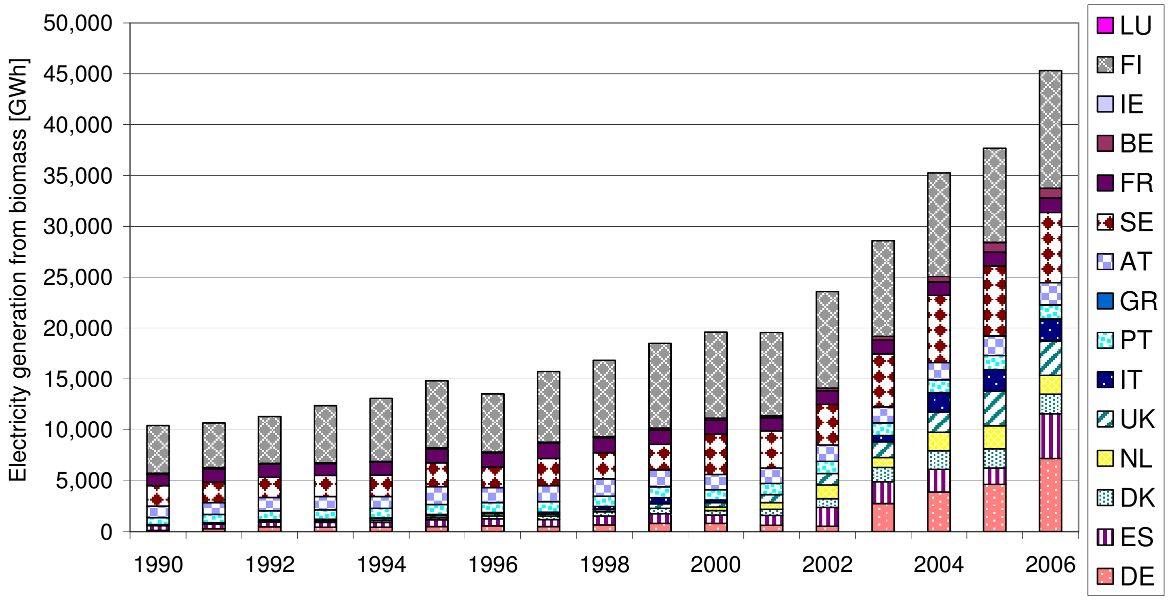

Figure 12: Historical development of electricity generation from solid biomass (excluding municipal solid waste) in the EU-15 Member States from 1990 to 2006.

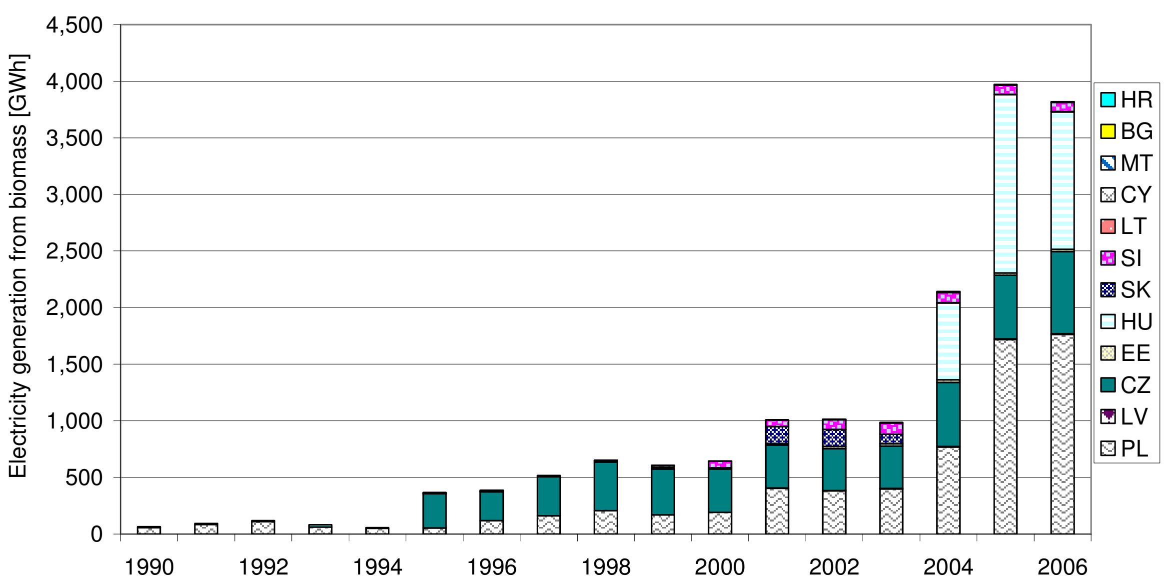

Figure 13: Historical development of electricity generation from solid biomass (excluding municipal solid waste) in the EU-12 Member States from 1990 to 2006.

Biogas

Over the past years, energy exploitation of biogas has been developing in different Member States. About 17.3 TWh of electricity was generated based on biogas in 2006 in the EU-27. Biogas plants offer good opportunities to be operated in CHP mode, however the heat consumption from biogas plants is statistically not well documented. In countries with centralised large scale biogas installations like Denmark the CHP share of biogas plants can be rather high.

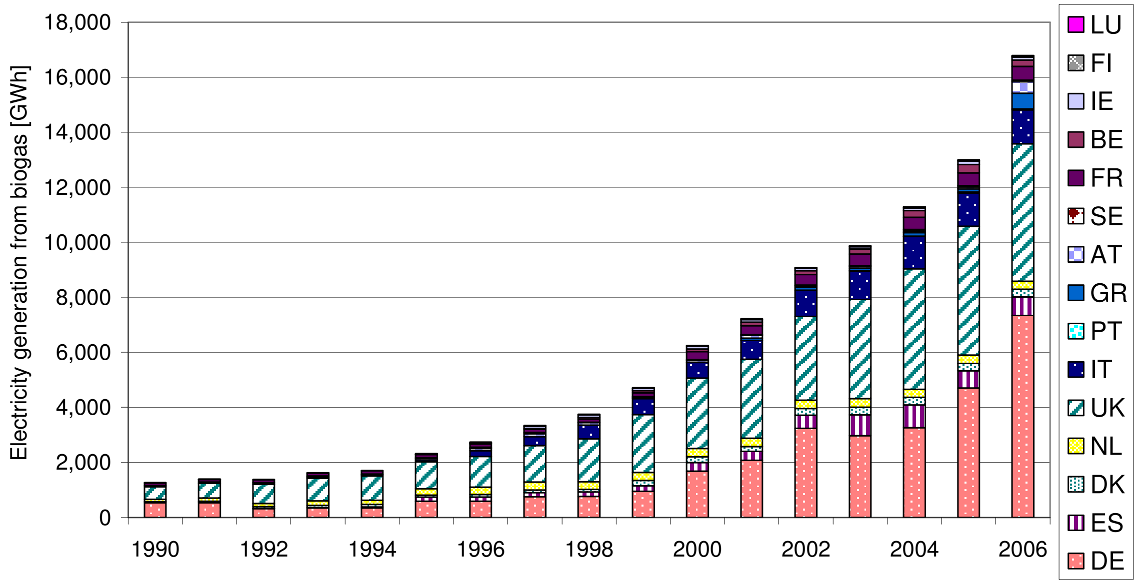

Figure 14: Historical development of electricity generation from biogas in the EU-15 Member States from 1990 to 2006.

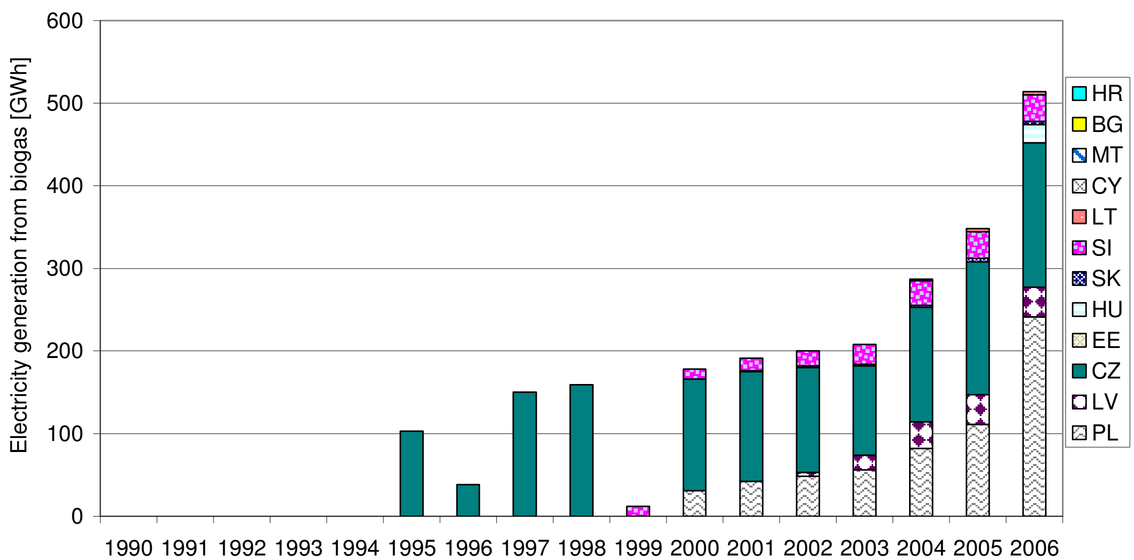

Figure 15: Historical development of electricity generation from biogas in the EU-12 Member States from 1990 to 2006.

Germany and the UK are the leading countries in Europe, showing biogas exploitation of about 7,300 GWh and 5,000 GWh of electricity generation, respectively. These figures correspond to about 80 kWh per inhabitant per year. If the rest of the EU 27 were to install the same rate per capita as the UK has now, the RES-E generation would then increase to a total of 37 TWh. This corresponds to the equivalent of 1 percentage point of the overall 21% target.

Large differences between Member States exist with respect to the share of the three options of primary fuel input: landfill gas, sewage gas and agricultural biogas. Whereas the share of the three options is rather balanced in Germany and Austria, landfill gas is clearly the dominant option in the UK, Italy and Belgium.

The so-called “secondary instruments” (see COM 675) linked to waste treatment and its environmental benefits are crucial for the development of this sector. Energy exploitation of biogas is not only a question of energy production but a question of waste treatment and environmental considerations.

The reinforcement of European regulations concerning limitations and taxation of dumping is pushing decision-makers to find solutions to treat organic waste as soon as it is collected.

1.4.3 Photovoltaic solar energy

Total installed PV capacity in the EU-27 has been growing at an unprecedented average annual growth rate of 72% over the six years, from 127 MWp in 2000 to 3,308 MWp at the end of 2006. The major share (94%) of currently installed capacity is grid-connected PV. In 2006, 1,228 MWp new capacity was installed, a growth of almost 100% compared to 2005, when 645 MWp was installed in the EU. Installed capacity in 2005 and 2006 could have been even more if there had not been a shortage of silicon on the market.

The impressive growth of the total installed PV capacity in Europe is especially a German success story: 92% of currently installed PV capacity in the EU-27 is in Germany, i.e. 3,031 MWp. This installed capacity makes Germany the undisputed world leader in PV, even in absolute terms. The installed capacity per capita in Germany is even more impressive, being 37 Wp/inhabitant, which is much higher than in any other EU Member State, except for Luxembourg which has 51.5 Wp/inhabitant installed (23 MWp installed). Other Member States with a relatively high installed capacity per capita are the Netherlands (2.8 Wp/inhabitant and 46 MWp installed), Austria (3.2 Wp/inhabitant and 26 MWp installed) and Spain (2.5 Wp/inhabitant and 103 MWp installed). For comparison: Japan (128 million inhabitants) has an installed capacity of 11.1 Wp/inhabitant, while the USA (291 million inhabitants) has an installed capacity of 1.6 Wp/inhabitant.

Electricity generation from PV in the EU-27 increased from 700 GWh in 2004 to nearly 2,300 GWh in 2006, although PV generation remains almost entirely in the EU-15. The development of electricity generation in the period 1990 to 2006 in the EU-25 is depicted in Figure 16. One can clearly observe the strong growth of PV penetration over the last decade, as well as the domination of the German market.

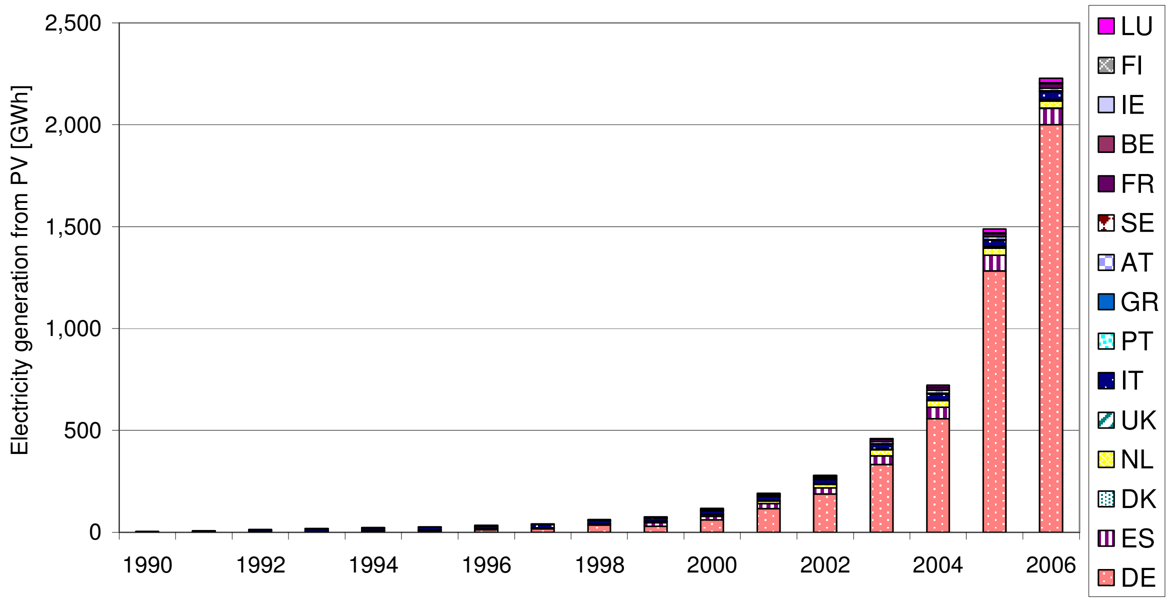

Figure 16: Historical development of electricity generation from PV in the EU-15 Member States from 1990 to 2006.

PV roof programmes have been rather successful in the development of this sector. A good support scheme, a simplified regulation on building integration, and low voltage connection have made this high technology sector develop in a few countries.

PV is mainly a decentralised technology. When installed on the roofs of a building, its electricity presents advantages of substituting 3 times the primary energy and saving transmission and distribution losses. The PV sector is characterised by a high technology component, a modular nature and a high long term potential.

1.4.4 Geothermal energy

At the end of 2005, installed geothermal electrical capacity in the EU-27 was 845 MWe, which represents 9% of the global installed geothermal electricity capacity of 8,911 MWe at the end of this year. The operating capacity of geothermal installations in the EU-27 was about 10% lower than the total installed capacity. A lower operating capacity may be due to maintenance and insufficient steam production. Overall electricity generation from geothermal sources was 5.5 TWh in the EU-27 in 2005.

In the EU, electricity production from geothermal sources is currently mainly used in Italy, Portugal (Azores) and France, see Figure 17. Undisputed European leader is Italy, with a total installed capacity of 811 MWe, which is over 95% of all installed capacity in the EU-27. Italian geothermal capacity is concentrated around three sites only. Plans exist to build an additional 100 MWe in Italy in the near future. In Portugal, geothermal installed capacity is located on the Azores, spread over five installations with a combined capacity of 18 MWe. France put a new geothermal plant of 10 MWe into operation in 2004, boosting total installed capacity from 4.7 MWe in 2003 to 14.7 MWe at the end of 2005.

Apart from these leading countries, new developments can be observed in Austria and Germany. Austria's current capacity is 1.2 MWe. Additional capacity of 5 MWe is planned by 2010. In Germany, a pilot plant of 200 kWe is now in operation. Plans exist for an additional capacity of 20 MWe.

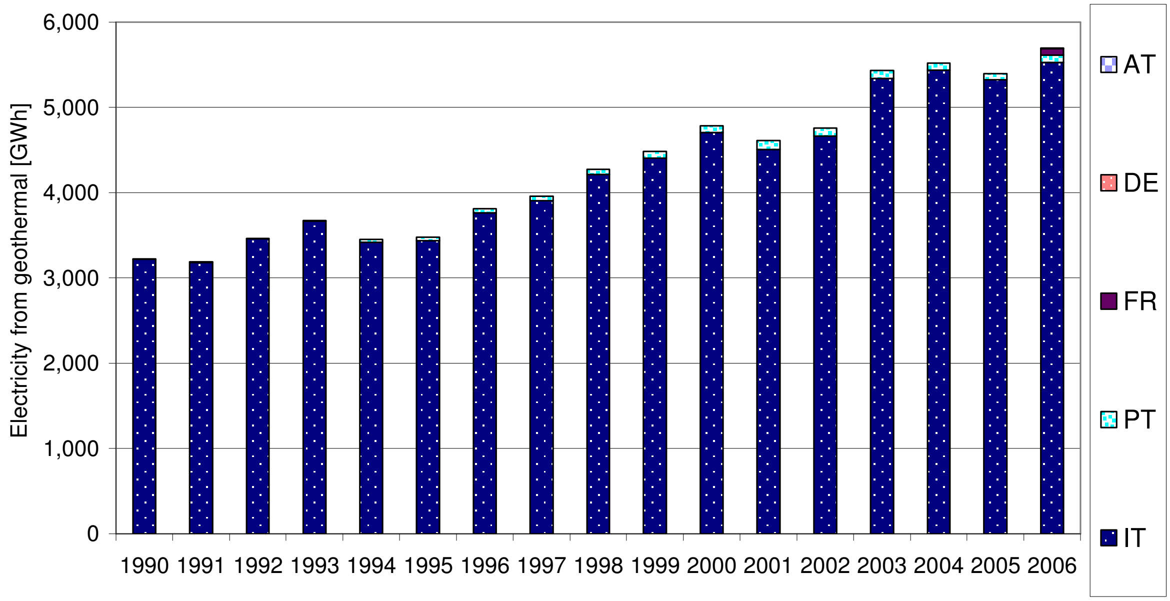

Figure 17: Historical development of electricity generation from geothermal sources in the EU-15 Member States from 1990 to 2006.

2 Progress towards 2010 targets

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This chapter provides projections of the development of renewable energy in the sectors electricity, heat and transport fuels under the assumption that the current renewable energy framework would continue until at least the year 2010. Thus, the assumption is that no significant changes in currently implemented support schemes in Member States will occur, allowing us to analyse the progress towards the 2010 targets, identify gaps in the current policy framework and analyse where additional efforts are needed.

2.1 Perspective of RES-E penetration in 2010

The progress of the EU-27 Member States under BAU assumptions towards the 2010 targets set in the RES-E Directive is shown in Table 4.

Table 4. Estimated RES-E penetration in EU-27 in 2010 according to BAU scenario

		2005	2010 (BAU)	2010 target (RES-E Directive)
Share of RES-E in gross demand	[%]	13.7%	18.5%	21.0%
RES-E generation - breakdown by RES-E option				
Hydro large-scale	[TWh]	267.0	314.8	300
Hydro small-scale	[TWh]	39.4	49.0	55
Wind onshore	[TWh]	68.6	132.5	80 [1]
Wind offshore	[TWh]	1.8	9.6	
Biogas	[TWh]	13.3	24.4	230 [2]
Solid biomass	[TWh]	41.6	95.1	
Biowaste	[TWh]	11.7	21.5	
Geothermal electricity	[TWh]	5.4	7.2	7
Photovoltaics	[TWh]	1.5	4.2	3
Solar thermal electricity	[TWh]	0.0	1.2	n.a.
Tide & wave	[TWh]	0.0	2.1	n.a.
RES-E total	**[TWh]**	**450.4**	**661.5**	**675**
of which RES-CHP	[TWh]		94.7	n.a.

Source: Green-X

[1] Projection for sum of onshore and offshore wind
[2] Projection for sum of biogas, solid biomass and biowaste

BAU projections show that present policies result in a RES-E share of 18.5% in 2010, implying a shortage of 12% of the 2010 target of 21.0%. The reasons are twofold. In some Member States insufficient policies for the promotion of RES-E have been implemented, or in some cases appropriate policies have been implemented too late in order to meet 2010 targets.[3] Secondly, strong growth of the gross electricity consumption in EU Member States offsets progress made with respect to RES-E generation[4.] In absolute terms the difference between 2010 BAU projections (661.5 TWh) and the 2010 target of the White Paper (675 TWh) is 2%, which is significantly lower than the gap of 12% in terms of electricity consumption. This underlines the fact that the strong growth of gross electricity consumption in the EU is a key factor for the present gap between the BAU scenario and the 2010 target of the RES-E Directive. The conclusion is simple, and significant: enhanced rational use of energy will result in a higher contribution of RES-E as a share of the overall EU electricity supply[5].

When evaluating the progress of individual RES-E technologies, the picture is diverse. Considering normal hydrological conditions, hydropower has grown slightly since 1997, and the BAU scenario is in line with projections made for hydropower in the 1997 White Paper. Wind energy has developed very well in the EU over the past years. Expected electricity output from wind in 2010 is almost twice the projections formulated in 1997. For biomass the situation is the opposite: under BAU assumptions the contribution of biomass in 2010 is only slightly more than half as predicted in the White Paper. The gap in biomass growth therewith is the most important reason for not meeting the overall RES-E goal in 2010. However, biomass electricity generation has developed more rapidly during the last three years indicating a possible acceleration of the progress. In addition, the BAU scenario indicates that geothermal electricity will not develop enough to meet the White Paper projection, whereas for PV BAU assumptions estimate higher penetrations compared to the White Paper.

2.2 Perspective of RES-H penetration in 2010

The projected overall progress of RES-H up to 2010 is very moderate due to limited policy support. BAU projections indicate a production of 71 Mtoe RES-H by 2010. In particular progress in bioheat lags behind the target of the 1997 White Paper, while also solar thermal heat progresses more slowly than expected. Only for the case of geothermal energy (incl. heat pumps) the White Paper target will be reached, mainly due to the comparatively fast development of ground coupled heat.

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[3] Insufficiency of RES-E support policies does not only refer to the financial incentives offered, as in this respect much progress has been achieved recently. It has to be seen from a holistic viewpoint, as nowadays deficits are becoming apparent with regard to suitable measures for reducing non-economic barriers for RES-E such as long lead times due to administrative barriers, insufficient spatial planning or prohibited grid access.

[4] Gross electricity demand for the BAU scenario was taken from the 2007 update of European Energy and Transport - Trends to 2030. Assuming the demand scenario from the original 2003 European Energy and Transport - Trends to 2030, the RES-E share in 2010 is 1.2% higher, i.e. 19.7%.

[5] Assuming energy efficiency measures to be implemented as preconditioned in the corresponding energy efficiency scenario from the 2007 update of European Energy and Transport - Trends to 2030, the RES-E share in 2010 is not significantly higher in the short term, i.e. 18.6% instead of 18.5%, but in the mid to long term large differences become apparent (i.e. 27.5% by 2020 compared to 23.7%).

Table 5. Estimated RES-H penetration in EU-27 in 2010 according to BAU scenario

		2005	2010 (BAU)	2010 target (White Paper)
Share of RES-H in gross demand	[%]	10.1%	11.7%	
Biomass	[Mtoe]	55.81	67.7	75
Solar Thermal Collectors	[Mtoe]	0.68	1.2	4
Geothermal (incl. heat pumps)	[Mtoe]	1.58	1.9	1
RES-H total	**[Mtoe]**	**58.07**	**71.0**	**80**

Source: Green-X

2.3 Perspective of biofuels penetration in 2010

Estimated biofuels developments of the EU-27 Member States under BAU assumptions are shown in Table 6.

Table 6. Estimated biofuels penetration in EU-27 in 2010 according to BAU scenario

		2005	2010 (BAU)	2010 target[1]
Share of RES-T on diesel and gasoline consumption	[%]	1.1%	2.6%	5.75%
RES-T total	**[Mtoe]**	**3.2**	**8.4**	

Source: Green-X

[1] Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, 8 May 2003

The estimated consumption of biofuels in the EU is expected to more than double in the time period 2005-2010, increasing from 3.2 Mtoe in 2005 to 8.4 Mtoe in 2010. Despite this strong increase the indicative target as set by the 2003 Biofuels Directive of 5.75% biofuels by 2010 will not be met: in 2010 the contribution of biofuels to road transport fuels is estimated to be 2.6 %. It should be noted that under BAU assumptions the import of biofuels will increase too: whereas the net balance of import-export of biofuels into the EU was marginal in 2005, expectations are that the net import of biofuels will increase and contribute 29% to EU biofuel consumption by 2010.

It is important to realise that the BAU projections for biofuels are rather sensitive with respect to the assumed oil price. Assuming a high price scenario[6] for fossil energy sources, the biofuel share would rise to 3.8% in 2010 or 12.1 Mtoe.

2.4 Perspective of RES penetration in 2010

The estimated development of overall renewable energy in the EU-27 Member States under BAU assumptions is shown in Table 7. The BAU assumptions are that the currently implemented support schemes in Member States will continue until at least the year 2010 without significant changes.

[6] In the standard BAU an oil price of 54.4 $/boe is assumed in 2010, the high price sensitivity is based on an oil price of 76.4 $/boe (all figures in 2005 currency units).

Table 7. Estimated RES penetration in EU-27 in 2010 according to BAU scenario

		2005	2010	2010 target [1,2]
Share of RES total / Eurostat convention	[%]	6.95%	8.9%	11.5%
RES total / Eurostat convention	[Mtoe]	125.8	165.9	182

Source: Green-X

[1] Energy for the future: renewable sources of energy, White Paper for a Community Strategy and Action Plan COM(97)599 final, 26 November 1997

[2] Targets were originally formulated for the EU-15

Under BAU assumptions the share of RES in EU gross energy consumption is estimated to be 8.9% in 2010, which means that the RES primary target of 11.5% (Eurostat convention) would not be reached[7]. Assuming an energy efficiency scenario[8] until 2010, the RES share would amount to 9.0% under the Eurostat convention – i.e. a marginal increase of the RES share due to minor differences also in the underlying demand patterns in the short term.

Several reasons for not reaching the 2010 target of renewable energy can be identified. On reason is that heat generation from RES has still been poorly developed in virtually all Member States. Current policies are insufficient to unlock the potentials for heat generation from renewables available in the EU.

If we look at the type of renewable sources, it is clear that the development of biomass sources stays behind very much. Additional efforts are needed to significantly increase the contribution of biomass to EU energy supply. On the other hand, wind energy has proven to provide a substantial contribution to EU electricity supply, while promising developments such as offshore wind are ongoing, both the result of the implementation of consistent and solid support measures for RES by several Member States. Other Member States have implemented insufficient policies for the promotion of RES so far, or in some cases appropriate policies have been implemented too late in order to meet 2010 targets.

Gross energy consumption in the EU has increased considerably over the past years. This significantly offsets the achieved progress of renewable energy in the EU. Similar as for RES-E, the gap towards the target is much higher in terms of RES as a share of energy consumption compared to the absolute penetration of RES. In relative terms, the estimated gap with the 2010 target of 11.5% is 22.6%, while in absolute terms the gap with a targeted penetration of 182 Mtoe is 8.8%. The growing energy consumption calls for two measures: increased exploitation of all available renewable energy sources and dedicated efforts in the field of energy efficiency.

[7] When considering RES developments in terms of substitution principle a RES share of 12.3% occurs. Consequently, the target of 14.6% will not be met either. However, in the case of substitution principle the relative distance to target is smaller than for the Eurostat convention, as the actual contribution of wind energy will be higher and biomass contribution will be lower compared to the White Paper.

[8] European Energy and Transport - Scenarios on energy efficiency, 2007 update

3 Scenario of reaching a 20% share of renewable energy sources in 2020

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The objective of the analysis is to facilitate informed decision making on future RES targets and policy. This is done by developing a cost-effective RES portfolio suitable for practical policy implementation by analysing (cost) implications of key policy choices. Results are reliable as well as fully comparable to other recent work conducted in this topic area – i.e. DG Environment's study "Economic analysis of reaching a 20% share of renewable energy sources in 2020 *(RES 2020 – Least cost)*" (EC, DG Environment, ENV.C.2/SER/2005/0080r) as well as recent PRIMES modelling as illustrated in "Scenarios on energy efficiency and renewables" (EC, DG TREN, 2006), conducted by NTUA.

In order to optimally support policy making, it was explicitly decided not to develop a completely new scenario approach, but to base modelling on the well known ***Green-X*** model and to use widely accepted data from PRIMES and FORRES 2020[9] as recently applied in the "RES 2020 – Least cost" study as major inputs.

The study provides an assessment and in-depth analysis on the effects of a 20% RES target in terms of primary energy demand in the year 2020. One main scenario and a set of sensitivity cases have been analysed to obtain a thorough understanding of the possibilities for long-term renewable energy targets and the costs and benefits associated with these targets. The research, involving all sectors of renewable energies (i.e. electricity, heat and transport) within the European Union, concentrates on the following:

- Identification of the technology-portfolio of a 20% RES target for the sectors electricity, heat and transport - meeting criteria such as cost-effectiveness and future perspectives;
- Determining the additional generation costs of 20% renewable energy ;
- Determining the avoided (costs of) fossil fuel use and benefits in terms of security of supply;
- Calculating the avoided CO_2 emissions;
- Identifying the country-specific RES deployment;
- Analysing the impact of the main key reference input parameters such as primary energy prices and development of energy demands on costs and benefits and the above mentioned modelling outputs.

The outcomes of this assessment served as a major input for the European Commission's Renewable Energy Roadmap (COM (2006) 848 final) and are also published therein. In line with recent policy decisions at the European level, an update of this work was undertaken throughout 2007. Thereby, the geographical scope was extended (i.e. EU-27 instead of EU-25) and the minimum target of 10% for biofuels was taken into account as well as the modified definition of the overall RES target (i.e. 20% in terms of final instead of primary energy demand). Key results of this analysis are illustrated in section 3.10 at the end of this chapter.

[9] Analysis of the Renewable Energy Sources' evolution up to 2020, project conducted by Fraunhofer Isi, EEG, Ecofys, REC and KEMA, Tender No. TREN/D2/10-2002.

3.1 Methodology

3.1.1 Green-X model

The quantitative analysis is centred around the well known ***Green-X*** model[10]. The model allows a comparative, quantitative analysis of interactions between RES, conventional energy and combined heat and power (CHP) generation, demand-side management (DSM) activities and CO_2 reduction, both in the EU as a whole, as well as for individual Member States. The model forecasts the deployment of RES under various scenarios regarding supporting policy instruments, the availability of resources and generation technologies as well as energy, technology and resource price developments.

The ***Green-X*** model matches demand and supply of energy sources. Demand is based on the EU energy outlook. Supply is described by means of a cost-resource curve built up in two parts:

- A static cost resource curve that describes the relationship between technical available potentials and the corresponding costs of utilisation of this potential;
- A dynamic cost resource curve, which is based on the static cost resource curve including dynamic parameters such as technological change (using the concept of experience curves or expert judgment) and the dynamic barriers for the implementation, determining the yearly available RES potential. The dynamic curve is endogenous to the model and determined annually.

Figure 18 provides an overview of the ***Green-X*** model. For a detailed description of the ***Green-X*** model see www.green-x.at .

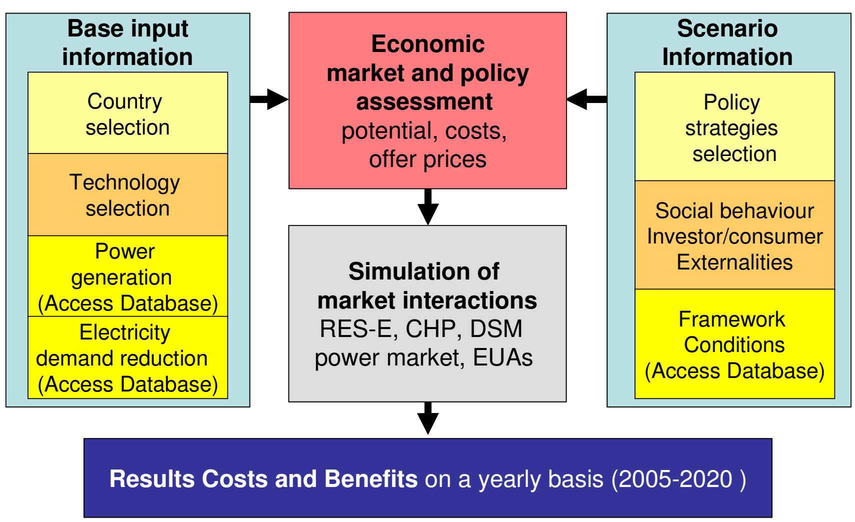

Figure 18 Overview of the computer model ***Green-X*** (electricity sector)

3.1.2 Modelling approach

The key approach in the modelling calculations conducted by the application of the ***Green-X*** model is that all Member States immediately (i.e. from 2007 onwards) apply efficient & effective support policies for RES, setting incentives at the technology level, accompanied by strong energy efficiency measures to reduce the overall growth of energy demand as projected by NTUA (i.e. the PRIMES efficiency case as of 2006).

[10] The Green-X model is originally developed under Microsoft Windows by EEG in the EC-funded project Green-X (5th FWP – DG Research, Contract No: ENG2-CT-2002-00607). For more details see: http://www.green-x.at

Results with regard to the overall cost for meeting 20% RES by 2020 are presented in terms of additional generation costs, that is, the total costs of generation per energy output minus the reference cost of energy production per unit of energy output. To avoid underestimation of the resulting cost with regard to an enhanced RES-deployment, negative additional costs appearing at the technology level by country are not counted – i.e. set to zero.[11]

This approach differs to that in the study "Economic analysis of reaching a 20% share of renewable energy sources in 2020" (EC, DG Environment, ENV.C.2/SER/2005/0080r), where a purified least-cost portfolio of renewable energies is identified for meeting 20% RES by 2020. In contrast to that, this analysis explicitly builds on the currently implemented policy framework. Embedded in the real-world policy context, it aims to demonstrate the practicability and consequences of facing the challenge of 20% RES by 2020. The application of effective & efficient support instruments, which set necessary incentives at the technology level, aims to identify an optimal sectoral allocation of the overall target and provides the depiction of a corresponding technology-portfolio.

This analysis explicitly builds on the outcomes of the FORRES 2020 study as well as on PRIMES modelling. Note that a detailed depiction of all key input parameters is provided in the following section, 3.2.

[11] Negative additional cost appearing within one sector may compensate the additional cost in another, which leads to a misinterpretation of the overall associated societal transfer cost. Moreover, negative cost of conventional supply options are also not taken into account as conventional reference prices reflect the marginal cost and not the average. Consequently, to come up with a fair comparison it has been finally decided to neglect such cost.

3.2 Scenario parameters and sensitivity cases

3.2.1 Overview on investigated cases

The modelling analysis starts with the description of the reference scenario. The so-called *20%-RES-by-2020 main case* describes a scenario of the future deployment of renewable energies in the European Union based on pro-active energy policy support. The key modelling approach is that all Member States immediately (i.e. from 2007 on) apply *efficient & effective* support policies for RES, setting incentives at the technology level in all energy sectors (i.e. electricity, heat and transport), accompanied by strong energy efficiency measures to reduce the overall growth of energy demand. The finally presented main scenario represents the outcome of an extended scenario analysis, where a large variation of applied technology and country-specific support policy settings led to a variety of scenarios which were evaluated on criteria such as cost effectiveness and practical implementation. It depicts the outcome of this extended evaluation process. With regard to the overall development of energy demands clear reference is given to PRIMES modelling, where the recently conducted PRIMES efficiency case (as of April 2006) forms the base of this investigation.

The costs and benefits of RES are largely affected by variations in key parameters such as energy demand and energy prices. Next to the *20%-RES-by-2020 main case* sensitivity investigations have been conducted to analyse in detail the impact of these key parameters. Modelling results show to what extent the costs of achieving the target are influenced by variations in these parameters. In particular the following sensitivity scenarios are discussed:

- *Less energy efficiency policies*: Sensitivity analysis is made to quantify the synergies between ambitious energy efficiency policies and achievement of renewable energy targets set in relative terms – i.e. defined as percentage of corresponding demands.
- *Higher energy prices*: World-market energy fuel prices have been very volatile over the last years. Obviously the additional generation costs of renewable energy are largely affected by the variations in world-market fuel prices. Accordingly, the applied sensitivity analysis aims to quantify this sensitivity to the variations in primary energy price assumptions.

The sections below describe the parameters used for the scenario runs. They compare assumptions in the *20%-RES-by-2020 main case* with assumptions taken in the sensitivity cases. Overall a conservative approach has been taken in terms of assumptions e.g. with respect to technology learning of RES technologies.

3.2.2 Overview on key parameters

In order to ensure maximum consistency with existing EU scenarios and projections the key input parameters of the *20%-RES-by-2020 scenarios* are derived from PRIMES modelling and from the FORRES 2020 study – similar to the approach as used in the "RES 2020 – Least cost" study. Table 8 shows which parameters are based on PRIMES and which have been defined for this study. More precisely the PRIMES scenarios used are:

- The European Energy and Transport Trends by 2030 / 2005 / Baseline
- The European Energy and Transport Trends by 2030 / 2006 / Efficiency Case (13.5% demand reduction compared to baseline)

Table 8 Main input sources for scenario parameters

Based on PRIMES	Defined for this study (in line with "RES 2020 – Least cost")
Sectoral energy demand	20% target
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost (FORRES, incl. biomass)
CO_2 intensity of sectors	RES potential (FORRES)
	Biomass import restrictions
	Technology diffusion
	Learning rates

In six out of seven sensitivity cases only one parameter is changed, all other parameters remain as in the *20%-RES-by-2020 main case*. In one sensitivity case the combined effect of *Higher energy prices & Accelerated technological learning* is analysed. An overview of the main scenario parameters and the sensitivity cases conducted is shown in Table 9 below.

Table 9 Overview of parameters in the *20% RES by 2020 main scenario* and the sensitivity cases

Parameter	*20% RES by 2020* main scenario	Sensitivity case	Title of sensitivity case
Energy demand / energy efficiency policy	*PRIMES energy efficiency* scenario	*PRIMES baseline* scenario (On average 13.5% less energy efficient compared to the *PRIMES energy efficiency* scenario)	*Less energy efficiency policies*
Energy prices	*PRIMES reference prices*	*PRIMES high energy price* scenario	*Higher energy prices*

3.2.3 Energy demand

The energy consumption data for the *20%-RES-by-2020 main case* are based on the PRIMES energy efficiency scenario, which assumes a 13.5% increase in energy efficiency compared to the PRIMES baseline scenario. In one sensitivity case the impact of significantly lower energy efficiency efforts is analysed. The energy demand data used in this sensitivity case correspond to the data used in the PRIMES baseline scenario. Table 10 provides the energy consumption parameters for the *20%-RES-by-2020 main case* and the sensitivity case with *Less energy efficiency policies*.

Table 10 Energy consumption parameters

Parameter	***20%-RES-by-2020 main scenario*** 2005	2010	2020	***Less energy efficiency policies*** (sensitivity case) 2010	2020
Total consumption in TWh	20314	20739	20033	21418	22617
(Eurostat convention) ***(Mtoe in brackets)***	(1755)	(1796)	(1723)	(1842)	(1945)
Gross electricity consumption in TWh	3206	3390	3390	3509	4030
Gross heat consumption in TWh	6860	6975	6785	7160	7560
(Mtoe in brackets)	(590)	(600)	(583)	(616)	(650)
Gross consumption of transport fuels in TWh ***(Mtoe in brackets)***	4119	4261	4207	4353	4642
	(296)	(311)	(312)	(313)	(332)

Note: Data for total consumption was initially taken from *PRIMES* (*efficiency* respectively *baseline*), but had to be endogenously corrected within ***Green-X*** due to the differing RES penetration. Expressed figures refer to the output of the ***Green-X*** model runs - i.e. the *20%-RES-by-2020 main case* (left) respectively the sensitivity case on less energy efficiency policies (right).

Please note that *Gross heat consumption* as expressed in Table 10 summarises the final residual demand for energy of all relevant economic activities, i.e. comprising the sectors of industry, service and agriculture as well as the residential sector. Residual in that sense as it excludes consumption of electricity, transport fuels and, besides district heat supply, inputs to other transformation processes as well as non-energetic uses.[12]

3.2.4 Conventional supply portfolio

The conventional supply portfolio, i.e. the share of the different conversion technologies in each sector, has been based on the PRIMES forecasts on a country specific basis. These projections on the portfolio of conventional technologies have an impact in particular on the calculations done within this study on the avoidance of fossil fuels and CO_2 emissions. As it is at least out of the scope of this study to analyse in detail which conventional power plant would actually be replaced by for instance a wind farm installed in the year 2014 in a certain country (i.e. either a less efficient existing coal-fired plant or possibly a new high-efficient combined cycle gas turbine), the following assumptions are taken:

- Keeping in mind that, besides renewable energies, fossil energy represents the marginal generation option that determines the prices on energy markets, it was decided to stick at the country level to the sector-specific conventional supply portfolio projections as provided by PRIMES. Sector- as well as country-specific conversion efficiencies, as derived on a yearly base, are used to get a sound proxy to calculate from derived renewable generation figures back to the amount of avoided primary energy. Assuming that the fuel mix stays unaffected, avoidance can be expressed in units of coal or gas replaced.
- A similar approach is chosen with regard to the avoidance of CO_2 emissions, where yearly changing average country- as well as sector-specific CO_2 intensities of the fossil-based conventional supply portfolio form the basis.

[12] Electricity and transport fuel consumption was excluded to avoid double counting.

In the following the derived data on aggregate conventional conversion efficiencies and the CO_2 intensities characterising the conventional reference system are presented.

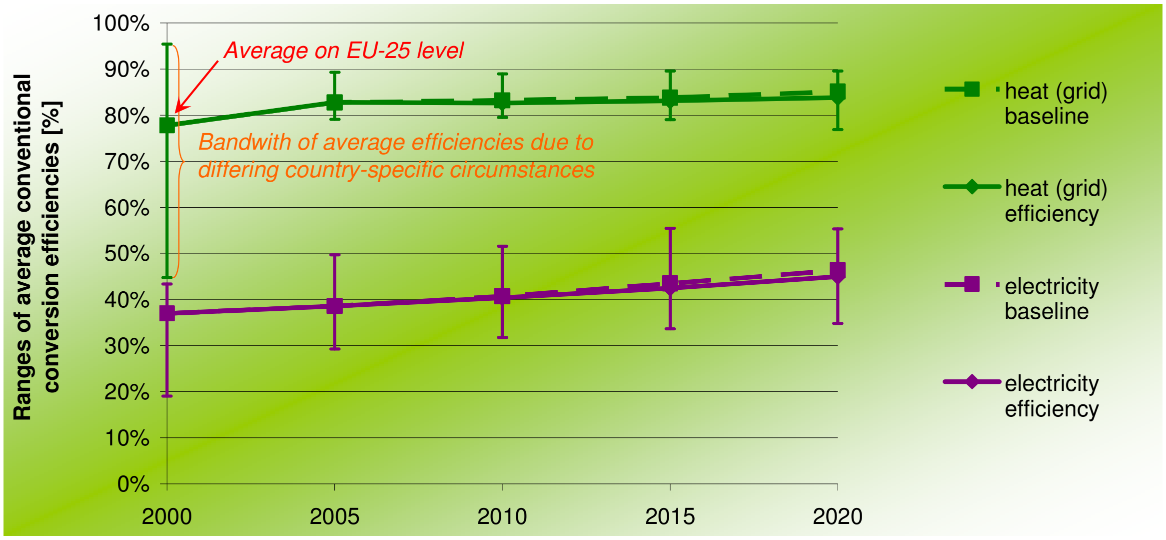

Figure 19 Country-specific average conversion efficiencies of conventional (fossil-based) electricity and grid-connected heat production in the EU-25. (source: PRIMES scenarios)

Figure 19 shows the dynamic development of average conversion efficiencies as projected by PRIMES for conventional electricity generation as well as for grid-connected heat production. Thereby, conversion efficiencies are shown for both the PRIMES baseline and PRIMES efficiency case. Error bars indicate the range in country-specific average efficiencies between EU member states. For the transport sector, where efficiencies are not explicitly expressed in PRIMES results, the average efficiency of the refinery process to derive fossil diesel and gasoline was assumed to be 95%.

The corresponding data on country- as well as sector-specific CO_2 intensities of the conventional energy conversion system are shown in Figure 20. Error bars again illustrate the variation over countries.

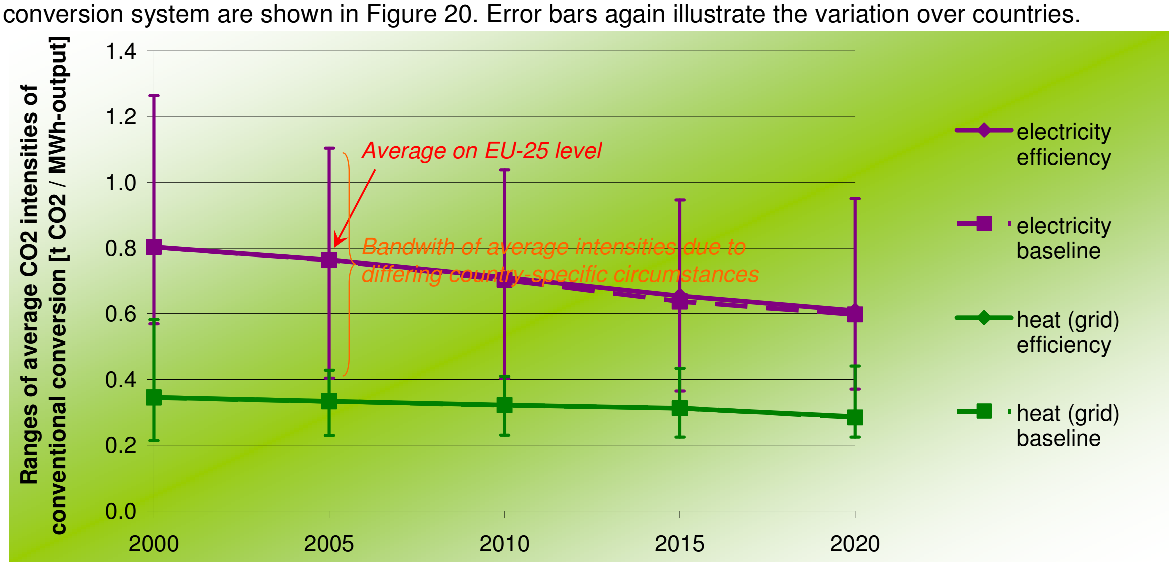

Figure 20 Country-specific average sectoral CO_2 intensities of the conventional (fossil-based) energy system in the EU25. (source: PRIMES scenarios)

Note: The differences between the PRIMES efficiency and baseline case for non-grid heat and transport are very small and therefore not shown

3.2.5 Fossil fuel and reference energy prices

National reference energy prices used in this analysis are based on the primary energy price assumptions as used in the EU energy outlook. Compared to current energy prices the price assumptions in the PRIMES energy efficiency and baseline scenario are low for the later years up to 2020. The reference oil price for instance goes up to 48 $ per barrel while actual world market prices in the last year have fluctuated between 55 and 78 $ per barrel. A sensitivity analysis is therefore conducted for *Higher energy price* assumptions, taken from the PRIMES high energy price scenario. Figure 21 provides the development of energy prices assumed in both cases, while the exact prices can be seen in Table 11.

Table 11 Primary energy price assumptions in \$2005/boe (source: PRIMES scenarios)

Baseline	2005	2010	2015	2020
Oil	54	44.59	44.95	48.08
Gas	30.31	33.86	34.22	36.99
Coal	13.32	12.53	13.38	14.1

High price	2005	2010	2015	2020
Oil	54	61.86	67.58	77.61
Gas	30.31	36.84	44.71	53.03
Coal	13.32	13.63	14.19	16.29

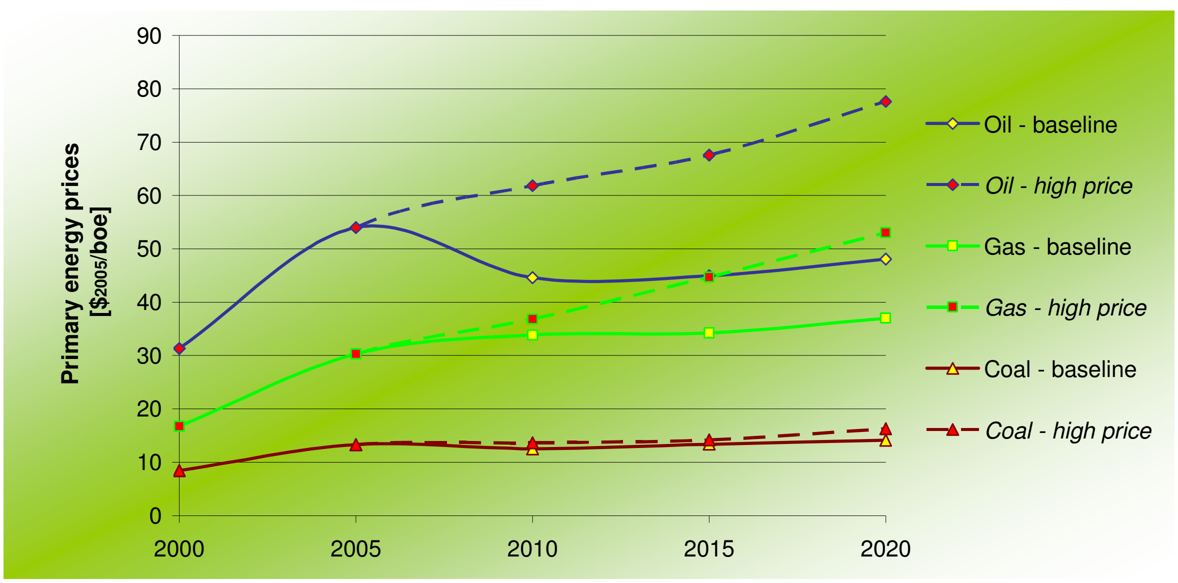

Figure 21 Primary energy price assumptions (source: PRIMES scenarios)

Reference prices for the electricity sector are taken from the ***Green-X*** model. Based on the primary energy prices, the CO_2 price and the country-specific power sector, the ***Green-X*** model determines country-specific reference electricity prices for each year in the period 2005-2020. Reference prices for the heat and transport sector are based on primary energy prices and the typical country-specific conventional conversion portfolio. All reference prices are provided in Table 12. Note that heat prices in the case of grid-connected heat supply from district heating and CHP plant do not include the cost of distribution – i.e. they represent the price directly at defined hand over point.

Table 12 Reference prices for electricity, heat and transport fuels

in €/MWh output	2005	2010	2015	2020
Electricity price	52.1	54.9	49.6	48.6
Heat price (grid)	28.3	29.3	30.3	30.6
Heat price (non-grid)	50.5	51.2	51.6	53
Transport fuel price	42	40.1	37.8	41

3.2.6 CO_2 prices

The CO_2 price in the *20%-RES-by-2020 main case* is exogenously set at 20 €/t, again similar to existing EU scenarios. Actual market prices (for 2006 EU Allowances) have fluctuated between 7 and 30 €/t in the period January-July 2006, with averages fluctuating roughly between 15 and 20 €/t. In the model, it is assumed that the CO_2 price is directly passed through to electricity prices. This is done on a fuel-specific basis, based on PRIMES CO_2 emission factors.

Increased RES-deployment can have a CO_2 price reducing effect as it reduces the demand for CO_2 reductions. As RES-deployment should be anticipated in the EU Emission Trading System and the CO_2 price in the *RES2020*–scenarios is exogenously set, this effect is not included, which represents a rather conservative approach.

3.2.7 RES potential

A broad set of different renewable energy technologies exists today. Obviously, for a comprehensive investigation of the future development of RES it is of crucial importance to provide a detailed investigation of the country-specific situation – e.g. with respect to the potential of the certain RES in general as well as its regional distribution and the corresponding generation cost. Major efforts have been taken recently within the FORRES 2020 study to assess Europe's RES resource base in a comprehensive manner. Consequently, this project directly builds on these consolidated outcomes as presented in the Commission's Communication 'The share of renewable energy'.

Within the ***Green-X*** model, supply potentials for all main technologies for RES-E, RES-H and RES-T are described in detail.

- RES-E technologies include biogas, biomass, biowaste, onshore wind, offshore wind, small-scale hydropower, large-scale hydropower, solar thermal electricity, photovoltaics, tidal & wave energy, and geothermal electricity.
- RES-H technologies include heat from biomass (subdivided into log wood, wood chips, pellets, and district heating), geothermal heat and solar heat.
- RES-T options include traditional biofuels such as biodiesel and bioethanol, advanced biofuels as well as the impact of biofuel imports.

The potential supply of energy from each technology is described for each country analysed by means of *dynamic cost-resource curves*. Dynamic cost curves are characterised by the fact that the costs as well as the potential for electricity generation / demand reduction can change each year. The magnitude of these changes is given endogenously in the model, i.e. the difference in the values compared to the previous year depends on the outcome of this year and the (policy) framework conditions set for the simulation year.

Realisable mid-term potentials form the base for the overall approach. This potential describes the maximal achievable potential assuming that all existing barriers can be overcome and all driving forces are active. Thereby, general parameters such as market growth rates and planning constraints are taken into account. It is important to mention that this potential term must be seen in a dynamic context – i.e. the realisable potential has to refer to a certain year. Within the purpose of this study 2020 has been chosen.

The following figures illustrate – by example for the electricity sector – the potential contribution of RES in the electricity sector within the EU-25 up to the year 2020 by considering specific resource conditions in each country. Thereby, in accordance with the general modelling approach, a clear distinction is made between existing RES plants (installed up to the end of 2004 – i.e. the *achieved potential* in 2004) and future RES options – the *additional mid-term potential*. More precisely, Figure 22 depicts the achieved and additional mid-term potential for RES-E in the EU-15 by country (left) as well as by RES-E category (right). A similar picture is shown for the new member states (EU-10) in Figure 23. It is notable that in both figures no future potential is indicated for biomass, as its allocation to the sectors of electricity, heat or transport is not explicitly predetermined in the applied modelling approach.

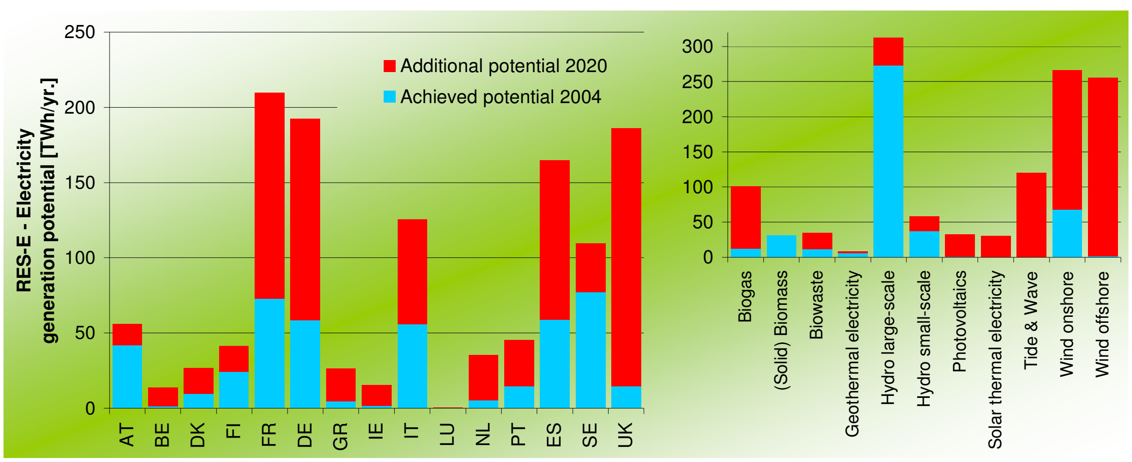

Figure 22 Achieved (2004) and additional mid-term potential 2020 for electricity from RES in the EU-15 – by country (left) and by RES-E category (right)

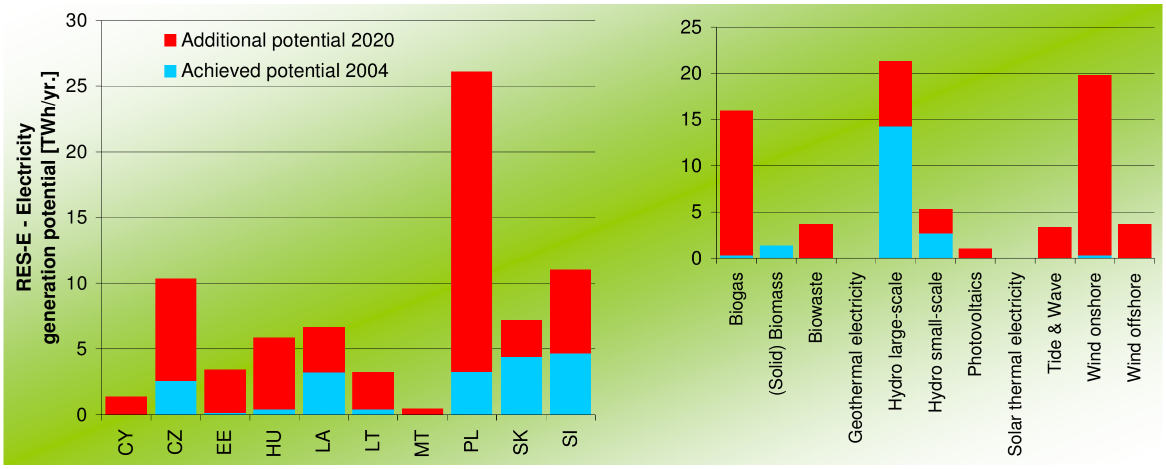

Figure 23 Achieved (2004) and additional mid-term potential 2020 for electricity from RES in EU-10 countries – by country (left) and by RES-E category (right)

The availability of biomass and the allocation of biomass resources across sectors are crucial as this energy is faced with high expectations with regard to its future potentials. The total domestic availability of solid biomass was set at 221 Mtoe/yr. Biomass data has been cross-checked with DG TREN, EEA and the GEMIS database.[13] In the *20%-RES-by-2020 main case* we assume that biomass can be imported to the European market. Specifically:

- Solid biomass in the form of wood products and wood residues can be imported to a maximum of 30% of the total additional primary input of forestry biomass.
- Liquid biofuel in the form of ethanol and biodiesel products can be imported to a maximum of 30% corresponding to a default case based on solely domestic biofuel supply.

In this context, Figure 24 indicates the dynamic evolution of the identified biomass primary potentials at the EU-25 level, whilst Table 13 shows a detailed breakdown of corresponding fuel costs for the considered biomass options, including agricultural products / energy crops (e.g. rape seed & sunflower, miscanthus), agricultural residues (straw), forestry products (e.g. wood chips), forestry residues and biowaste.

[13] For example the recent EEA report "How much bio-energy can Europe produce without harming the environment?" gives 235 Mtoe in 2020 for total biomass under the assumption of significant ecological constraints on biomass use.

Table 13 Breakdown of fuel cost and corresponding primary potentials by fuel category

Solid biomass - Primary potentials & corresponding fuel cost by 2020	Realisable mid-term potential for 2020 in terms of primary energy	Fuel cost ranges (2005)		
		Minimum	Maximum	Weighted average
	[Mtoe/yr.]	[€/MWh-p]	[€/MWh-p]	[€/MWh-p]
AP1 - rape & sunflower	75.8	32.3	40.4	37.2
AP2 - maize, wheat (corn)		26.6	33.2	30.6
AP3 - maize, wheat (whole plant)		29.8	29.8	0.0
AP4 - SRC willow..		27.4	32.9	29.2
AP5 - miscanthus		27.1	34.1	30.0
AP6 - switch grass		17.9	31.9	25.9
AP7 - sweet sorghum		31.0	40.9	40.9
Agricultural products - TOTAL		**17.9**	**40.9**	**31.9**
AR1 – straw	27.9	12.2	14.7	13.4
AR2 - other agricultural residues		12.2	14.7	13.5
Agricultural residues - TOTAL		**12.2**	**14.7**	**13.4**
FP1 - forestry products (current use (wood chips, log wood))	51.9	17.8	22.3	20.6
FP2 - forestry products (complementary fellings (moderate))		19.1	23.8	21.7
FP3 - forestry products (complementary fellings (expensive))		25.8	32.3	29.4
Forestry products - TOTAL		**17.8**	**32.3**	**23.0**
FR1 - black liquor	47.8	5.6	7.7	6.0
FR2 - forestry residues (current use)		6.3	8.6	7.0
FR3 - forestry residues (additional)		12.5	17.1	13.9
FR4 - demolition wood, industrial residues		5.0	6.8	5.9
FR5 - additional wood processing residues (sawmill, bark)		6.3	8.6	6.9
Forestry residues - TOTAL		**5.0**	**17.1**	**6.9**
BW1 - biodegradable fraction of municipal waste	17.2	-3.8	-3.8	-3.8
Biowaste - TOTAL		**-3.8**	**-3.8**	**-3.8**
FR6 - forestry imports from abroad	9.7	16.0	16.8	16.8
Solid biomass - TOTAL	**230.3**	**-3.8**	**40.9**	**16.2**
… of which domestic biomass	**220.6**	**-3.8**	**40.9**	**16.4**

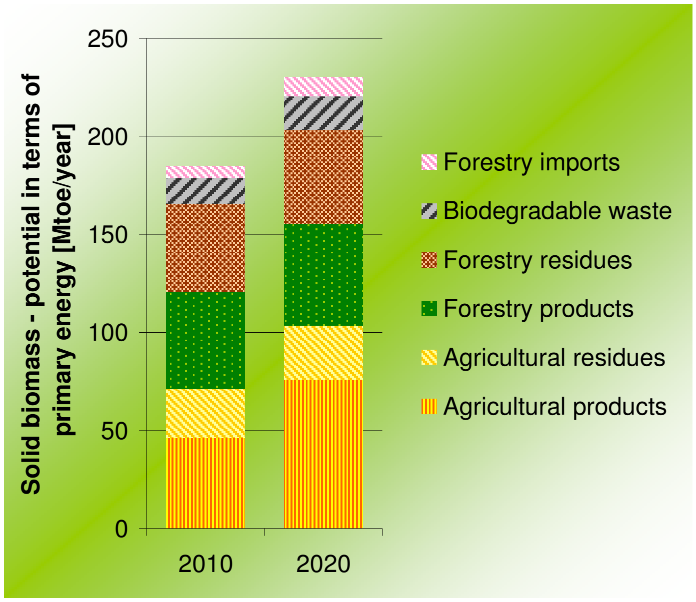

Figure 24 Biomass potentials in terms of primary energy for the years 2010, 2020

3.2.8 RES cost

Parameters on long-term cost developments of RES in the *20%-RES-by-2020 main case* are based on the FORRES 2020 project. Costs are adapted endogenously on the basis of technology-specific learning rates. Exceptions to this rule are the cost developments specified for novel RES options such as solar thermal and tidal and wave energy, for which expert cost forecasts are used.

Note that the analysis uses a quite detailed level of specifying costs and potentials. The analysis is not based on average costs per technology. For each technology a detailed cost-curve is specified for each year, based on so-called cost-bands. These cost-bands summarise a range of production sites that can be described by similar cost factors. For each technology a minimum of 6 to 10 cost bands is specified by country. For biomass at least 50 cost bands are specified for each year in each country.

Economic conditions of the various RES technologies are based on both economic and technical specifications, varying across the EU countries.[14] Figure 25 depicts the typical current bandwidth of *long-run marginal generation costs*[15] per technology for the electricity sector. A corresponding depiction is shown in Figure 26 for the heat sector, whilst Figure 27 indicates the cost of biofuels. In this context, for the calculation of the capital recovery factor a default setting is applied with respect to payback time (15 years) and weighted average cost of capital (6.5%).

The broad range of costs for several RES technologies reflects variations in resource- (e.g. for photovoltaics or wind energy) or demand-specific conditions (e.g. full load hours in the case of heating systems) within and

[14] Note that in the model ***Green-X*** the calculation of generation costs for the various generation options is done by a rather complex mechanism, internalised within the overall set of modelling procedures. Thereby, band-specific data (e.g. investment costs, efficiencies, full load-hours, etc.) is linked to general model parameters as interest rate and depreciation time.

[15] Long-run marginal costs are relevant for the economic decision whether to build a new plant or not.

between countries as well as variations in technological options such as variations in plant sizes and/or conversion technologies.

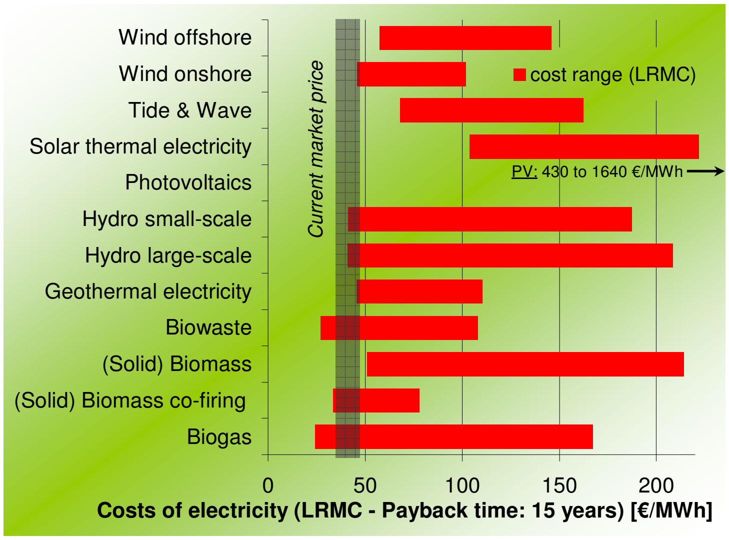

Figure 25 Long-run marginal generation costs (for the year 2005) for various RES-E options in EU countries.

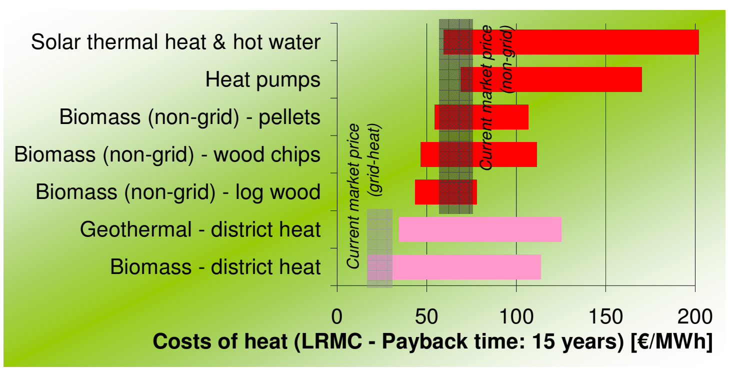

Figure 26 Long-run marginal generation costs (for the year 2005) for various RES-H options in EU countries.

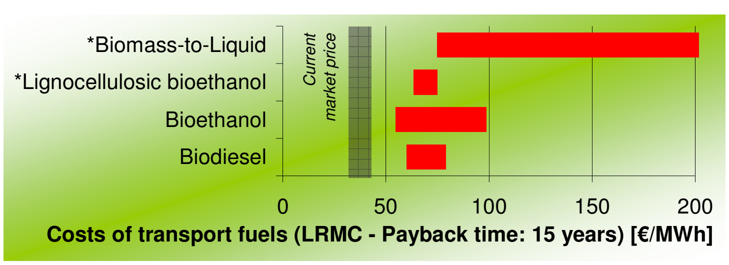

Figure 27 Long-run marginal generation costs (for the year 2005) for various RES-T options in EU countries.

The data illustrated refer to new RES plants and are in accordance with the *additional realisable mid-term potentials* as specified in Section RES potential. For hydropower (large- and small-scale) and wind onshore non-harmonised cost settings are applied, i.e. country-specific data on investment costs and where suitable also O&M costs are used. For all other RES-E options harmonised cost settings are applied across the EU. The ranges expressed for economic and technical parameters in these instances refer to differences in plant sizes (small- to large-scale) and/or conversion technologies applied. All data on investment costs, O&M-costs and efficiencies refer to the default start year of the simulations, i.e. 2005, and are expressed in $€_{2005}$.

Prices for imported biomass are set exogenously:

- The price of imported wood is set on a country specific basis, indicating trade constraints and transport premiums. A European average figure of 17 €/MWh occurs at present.
- The price of imported biofuels is assumed to equal a European average of 62 €/MWh.

3.3 Deployment of renewable energy sources up to 2020

This section presents the main results obtained from the modelling calculation for the *20%-RES-by-2020 main case*. Where results are very sensitive to changing parameters, the respective results from the sensitivity analysis are also given.

Figure 28 illustrates the sectoral contribution of renewable energy in terms of primary energy at the EU-25 level for the period 2005 to 2020. Note that all data as presented therein is based on the Eurostat convention, referring to the *20%-RES-by-2020 main case*. Facing this challenge means to achieve a tripling of current RES-deployment to about 338 Mtoe[16] by 2020. Looking at the sectoral breakdown it is notable that RES-electricity and RES-heat contribute in equal terms, each achieving a share of 41% of total RES deployment by 2020. But also biofuels have to accelerate deployment largely – the goal of 18% by 2020 represents a huge challenge compared to the current situation.

In case of less energy efficiency policies, i.e. when the future growth of energy demand more or less continues to follow historical trends (as projected in the PRIMES baseline case), achievement of 20% RES by 2020 will only be feasible with strongest efforts. As indicated in the sensitivity case on less energy efficiency policies, an additional renewable deployment of 42 Mtoe is required to still meet the target, i.e. about 12.5% more RES-primary compared to the reference case.

[16] The corresponding figure based on the substitution principle is 430 Mtoe.

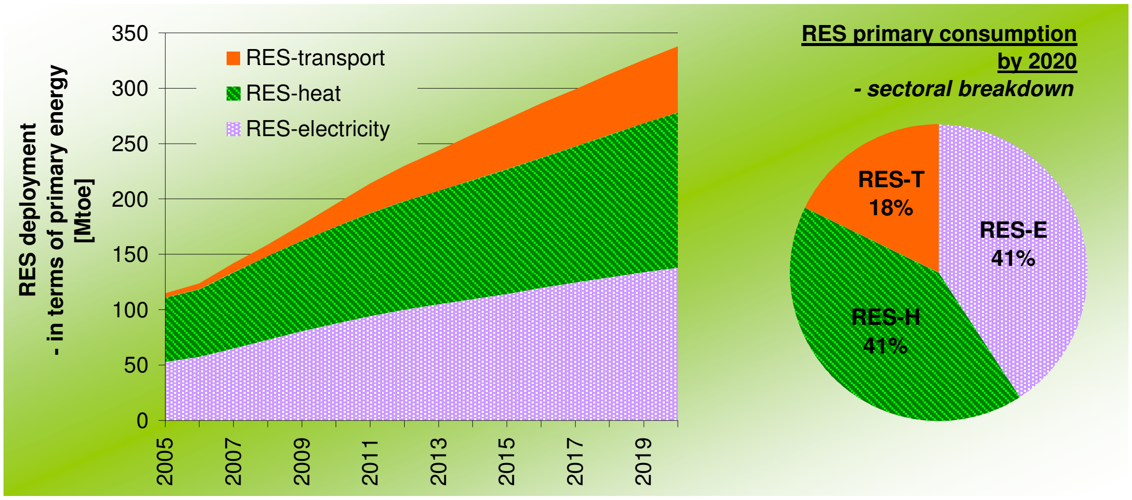

Figure 28 Evolution of renewable energy sources up to 2020 in terms of primary energy (based on Eurostat convention) within the European Union (EU-25)

Figure 29 indicates the corresponding data in terms of final energy. As indicated therein, from at present about 96 Mtoe a rise to 262 Mtoe by 2020 has to be achieved. As a consequence of lower conversion efficiencies in the case of biomass electricity generation or biofuel conversion, compared to heating, electricity (38%) and biofuels (16%) end up with a lower contribution compared to their primary shares, whilst RES-heating comprises the major share of 46%.

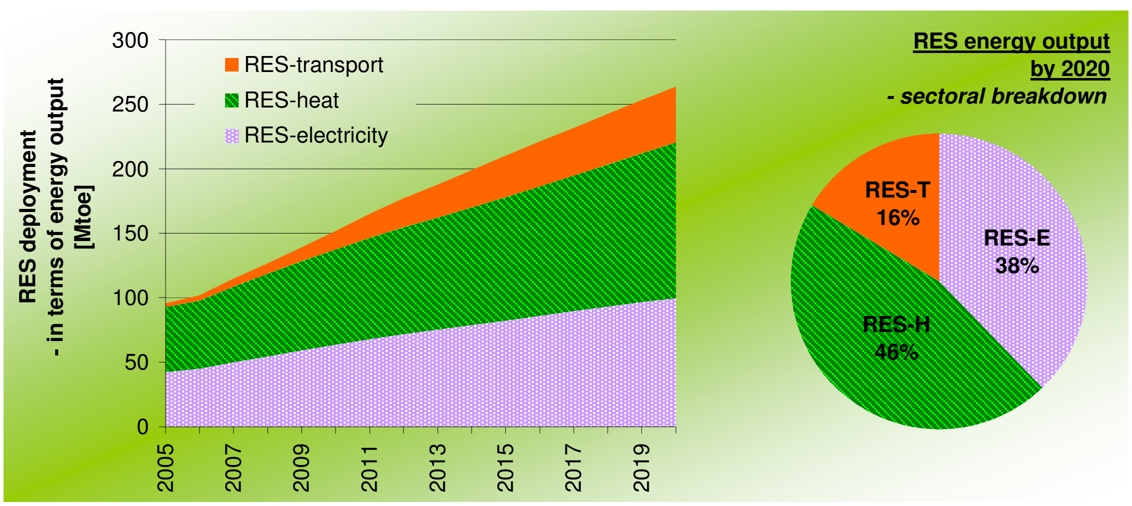

Figure 29 Evolution of renewable energy sources up to 2020 in terms of final energy within the European Union (EU-25)

The projected sectoral contribution can be analysed best by depicting deployment on sectoral level in relative terms – i.e. by indicating the deployment of RES-E, RES-H and RES-T as shares of corresponding gross demands. In this context, Table 14 gives an overview of results for 2010 and 2020. Although the share of renewable electricity stays below projections of the “RES 2020 – Least cost” study (42% by 2020), it can still be observed that RES-E shall contribute largely (34% of corresponding gross demand) to the achievement of the 20% RES target. The share of biofuels in transport fuel demand remains comparatively low in the first years, but reaches 12% in 2020.[17] Figure 30 illustrates the development in the share of RES over time. Results on the sector-, technology- and country-specific RES deployment and technology-specific costs are provided in the next sections.

Table 14 Share of renewable energies in electricity, heat and transport fuel demand

% deployment				**European Union 25**
	2005	2010	**2020**	
Share of RES-E on electricity demand	15%	22%	**34%**	
Share of RES-H on heat demand	9%	12%	**21%**	
Share of RES-T on transport fuel demand	1%	4%	**12%**	
Share of RES on primary demand	7%	11%	**20%**	*(Eurostat convention)*
	10%	15%	**24%**	*(Substitution principle)*

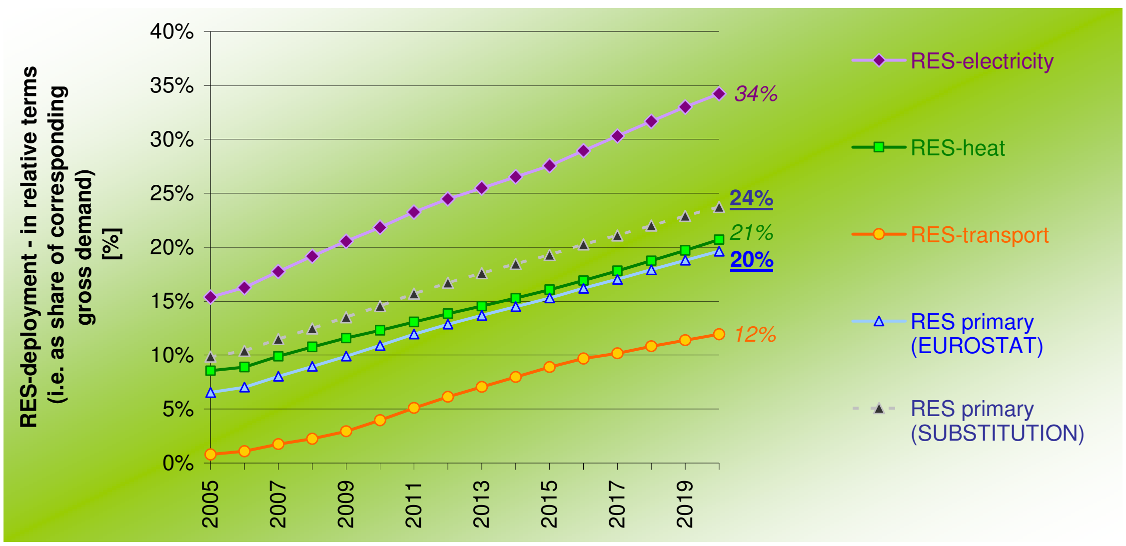

Figure 30 Deployment of RES-E, RES-H, RES-T and RES in total as shares of corresponding gross demands up to 2020 within the European Union (EU-25)

[17] This study compares biofuel production to the total transport fuel demand (excluding electricity), while the target setting in the biofuels directive is based on diesel and gasoline demand. In 2020 diesel and gasoline consumption makes up 83% of total transport fuel demand according to the PRIMES efficiency scenario. 12% of total transport fuel demand would correspond to 14% of road transport demand.

3.4 Sector- and technology-specific deployment up to 2020

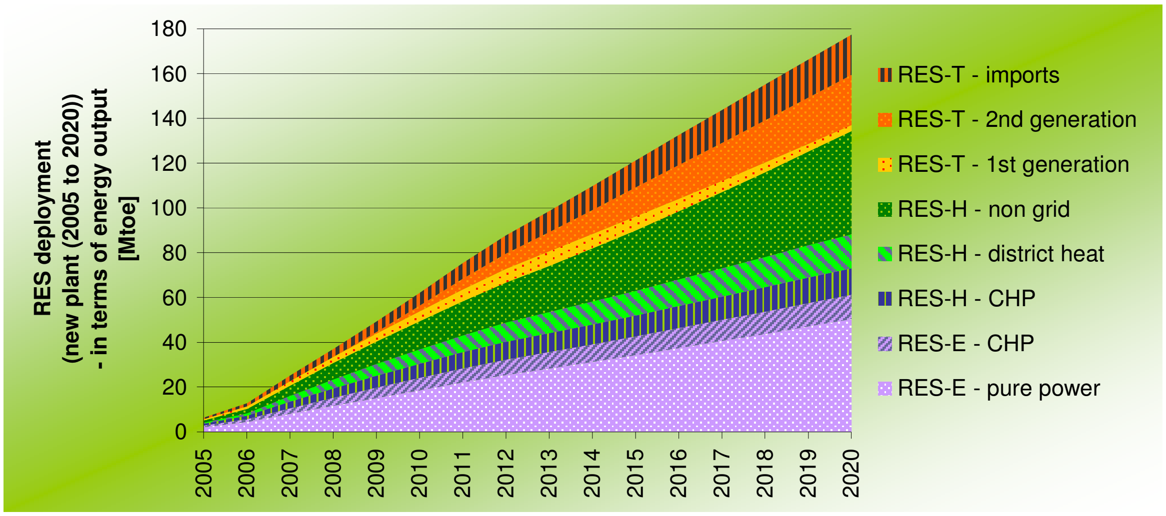

Figure 31 Deployment of new RES (installed 2005 to 2020) in terms of energy output until 2020 within the European Union (EU-25)

The deployment of solely new RES plants (installed in the period 2005 to 2020) in the *20%-RES-by-2020 main case* is shown in Figure 31 in terms of energy output[18] by sub-sector. To meet the 20% target, large increases are required in all three sectors. The results show that pro-active RES support will lead to a stimulation of RES-markets more or less equally among all sectors. Total generation from new RES installations in the period 2005 to 2020 achieves an impressive amount of 177.5 Mtoe by 2020 – representing two thirds of total RES output by 2020 or almost a doubling of current RES generation. However, this figure would have to rise by 27 Mtoe if we fail to limit overall demand growth (*Less energy efficiency policies*).

The highest contribution both in terms of energy output as well as primary energy is projected for RES-E, especially for pure power generation options such as wind energy (all together covering 28% of total energy output of new RES installations (2005 to 2020) by 2020), but also RES-CHP acts as a major contributor (13%).

Besides RES-E, the non-grid heat market for RES, comprising residential and industrial biomass heating as well as solar thermal heating & hot water supply and heat pumps takes off fast if well supported. Among all sub-sectors it achieves the second largest deployment in absolute terms, holding a share of 26% on total energy output of cumulative new installations by 2020. This underpins that the cost-effective achievement of RES targets requires an immediate strong growth of RES-H, which would need to be reflected by an appropriate policy framework.

[18] According to the applied terminology energy output equals final energy demand in the cases of heat and transport, whilst for RES-E generation it refers to gross consumption.

In terms of growth rates RES-T faces a huge increase, but in absolute terms it will become an important contributor to achieve the 20% target especially in the later years when also advanced conversion technologies such as lignocellulosic bioethanol are ready to enter the market.

The following figures illustrate the projected penetration of RES on technology level for the *20%-RES-by-2020 main case* whilst Table 15 lists the corresponding data in a detailed manner, indicating besides generation also technology-specific sectoral shares as well as average growth rates.

Some of the most prominent conclusions drawn from this table include:

- The bulk of RES-E in 2020 will be produced by technologies that are currently already close to the market: Large-scale hydro (319 TWh/yr), solid biomass (195 TWh/yr), onshore wind (266 TWh/yr), offshore wind (157 TWh/yr), biogas (80 TWh/yr), small hydro (57 TWh/yr) and biowaste (31 TWh/yr) together will contribute about 95% to RES-E production.
- However, also novel RES-E options with huge future potentials such as PV (23 TWh/yr), solar thermal electricity (11 TWh/yr) or tidal & wave (14 TWh/yr) enter the market and achieve a steadily growing share – if, as assumed, market stimulation is set in a proper manner.
- In the heat sector solar thermal heat and heat pumps achieve a strong deployment, steadily growing over the whole investigated period, and finally account for almost one quarter of RES-H generation by 2020.
- Biomass plays a crucial role in meeting RES targets. In the *20%-RES-by-2020 main case* co-firing of biomass refers to 58 TWh/yr in electricity production. Biomass will become even more important for the development of RES-H. In 2020 about 75% of total RES-H generation comprises biomass and biowaste. Besides co-firing and CHP also modern small-scale biomass heating systems are a major contributor.
- In the *20%-RES-by-2020 main scenario* 88% of the domestic potential of solid biomass (193 Mtoe) is used and another 28 Mtoe is imported. Imports consist of 9.7 Mtoe forest products and residues and 18.1 Mtoe of biofuels.

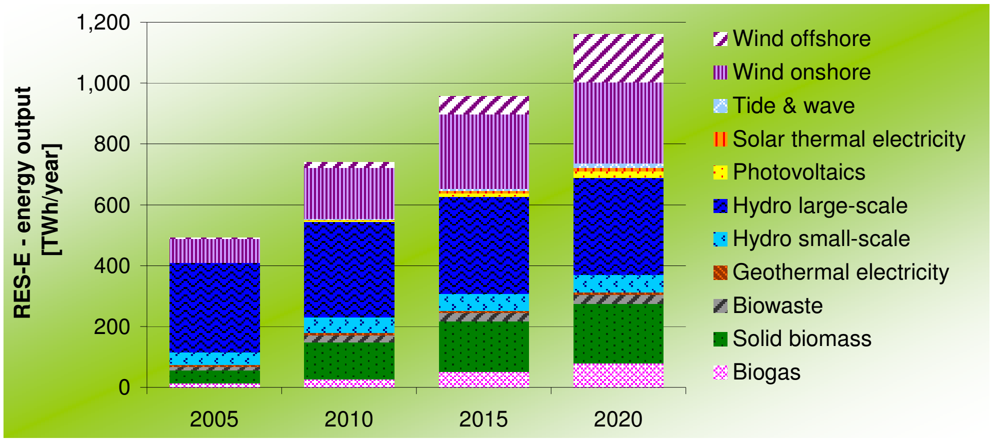

Figure 32 RES-E generation up to 2020 in the European Union (EU-25)

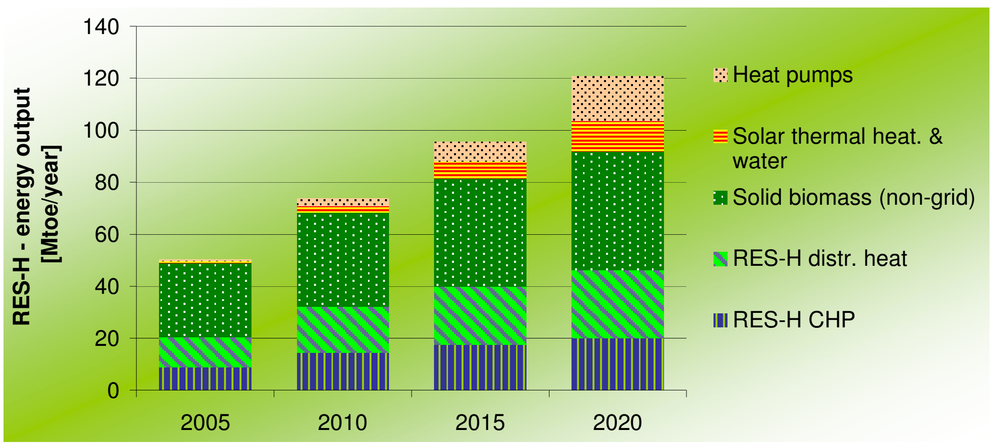

Figure 33 RES-H generation up to 2020 in the European Union (EU-25)

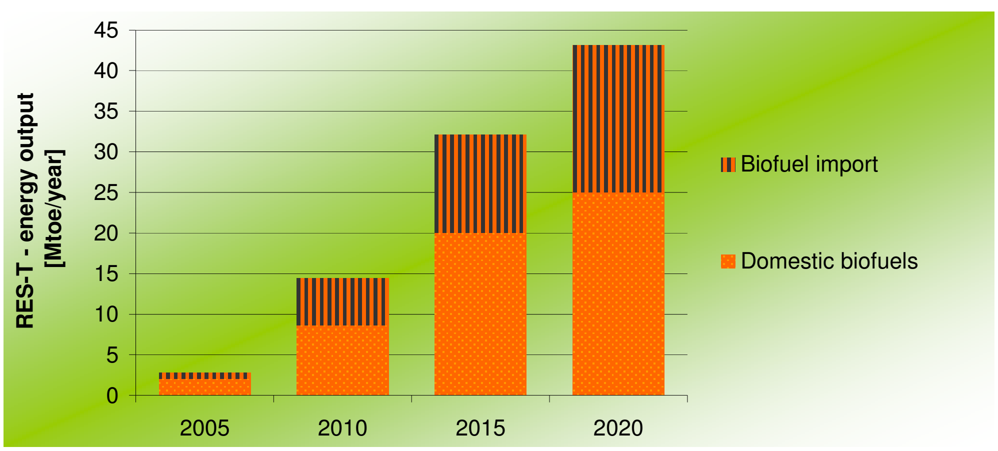

Figure 34 RES-T production and import up to 2020 in the European Union (EU-25)

Table 15 RES penetration at detailed technology level in the *20%-RES-by-2020 main case* (2005-2020)

RES-E	**Electricity generation** [Unit]	2010	2015	2020	***Share** of total RES-E [%]* 2010	2020	**Average yearly growth** [%] 05-10	10-15	15-20	**05-20**
Biogas	[TWh]	28	52	80	*4%*	*7%*	14.2%	13.1%	9.1%	**12.1%**
Solid biomass	[TWh]	122	167	195	*16%*	*17%*	23.7%	6.5%	3.2%	**10.8%**
Biowaste	[TWh]	23	27	31	*3%*	*3%*	11.9%	3.6%	2.7%	**6.0%**
Geothermal electricity	[TWh]	7	7	8	*1%*	*1%*	3.5%	0.2%	0.3%	**1.3%**
Hydro large-scale	[TWh]	313	318	319	*42%*	*27%*	1.3%	0.3%	0.0%	**0.6%**
Hydro small-scale	[TWh]	52	55	57	*7%*	*5%*	5.0%	1.2%	0.5%	**2.3%**
Photovoltaics	[TWh]	5	13	23	*1%*	*2%*	37.6%	19.9%	12.7%	**23.0%**
Solar thermal electricity	[TWh]	2	8	11	*0%*	*1%*	62.0%	32.6%	7.0%	**32.0%**
Tide & wave	[TWh]	3	7	14	*0%*	*1%*	56.3%	18.4%	14.3%	**28.4%**
Wind onshore	[TWh]	169	244	266	*23%*	*23%*	16.5%	7.7%	1.7%	**8.5%**
Wind offshore	[TWh]	17	59	157	*2%*	*14%*	39.8%	29.0%	21.5%	**29.9%**
RES-E total	**[TWh]**	**740**	**957**	**1,160**			**8.5%**	**5.3%**	**3.9%**	**5.9%**
RES-E CHP	[TWh]	99	132	162	*13%*	*14%*	18.1%	6.0%	4.2%	**9.3%**
share on gross demand	[%]	**22%**	**28%**	**34%**						

RES-H	**Heat generation** [Unit]	2010	2015	2020	***Share** of total RES-H [%]* 2010	2020	**Average yearly growth** [%] 05-10	10-15	15-20	**05-20**
Biogas (grid)	[Mtoe]	0.1	0.2	0.4	*0%*	*0%*	49.3%	25.1%	15.6%	**29.3%**
Solid biomass (grid)	[Mtoe]	27.0	33.9	39.6	*37%*	*33%*	9.9%	4.7%	3.1%	**5.9%**
Biowaste (grid)	[Mtoe]	4.5	5.1	5.6	*6%*	*5%*	7.6%	2.6%	1.9%	**4.0%**
Geothermal heat (grid)	[Mtoe]	0.7	0.8	0.8	*1%*	*1%*	6.8%	2.0%	1.7%	**3.5%**
Solid biomass (non-grid)	[Mtoe]	36.1	41.6	45.5	*49%*	*38%*	4.7%	2.9%	1.8%	**3.1%**
Solar therm. heat.	[Mtoe]	2.7	6.5	11.8	*4%*	*10%*	34.4%	19.7%	12.5%	**21.9%**
Heat pumps	[Mtoe]	2.7	7.5	17.1	*4%*	*14%*	30.5%	22.7%	18.0%	**23.6%**
RES-H total	**[Mtoe]**	**73.7**	**95.6**	**120.8**			**7.9%**	**5.3%**	**4.8%**	**6.0%**
RES-H CHP	[Mtoe]	14.6	17.6	20.1	*20%*	*17%*	10.0%	3.9%	2.6%	**5.5%**
RES-H distr. heat	[Mtoe]	17.7	22.3	26.3	*24%*	*22%*	9.2%	4.8%	3.3%	**5.7%**
RES-H non-grid	[Mtoe]	41.5	55.6	74.4	*56%*	*62%*	6.7%	6.0%	6.0%	**6.2%**
share on gross demand	[%]	**12%**	**16%**	**21%**						

RES-T	**Biofuel generation** [Unit]	2010	2015	2020	***Share** of total RES-T [%]* 2010	2020	**Average yearly growth** [%] 05-10	10-15	15-20	**05-20**
Domestic biofuels	[Mtoe]	8.6	20.1	25.0	*60%*	*58%*	32.8%	18.3%	4.5%	**11.2%**
Biofuel import	[Mtoe]	5.8	12.0	18.1	*40%*	*42%*	53.4%	15.7%	8.5%	**24.4%**
RES-T total	**[Mtoe]**	**14.4**	**32.1**	**43.1**			**39.1%**	**17.3%**	**6.1%**	**20.1%**
share on gross demand	[%]	**4%**	**9%**	**12%**						
share on diesel and gasoline demand	*[%]*	*4.8%*	*10.8%*	*14.4%*						

3.5 Exploitation of biomass

Figure 35 provides a sectoral breakdown of total biomass exploitation in the period 2005-2020 in the *20%-RES-by-2020 main scenario*. In the first years the dominant use of biomass is in (residential) non-grid connected heat production. Slightly CHP takes over the leading position, whilst holding a rather constant share of around 30% of total biomass exploitation throughout 2020. While small-scale (residential) heating systems increase slowly in absolute terms, their share drops due to fast increasing exploitation in other sub-sectors. Notably the biofuel market increases strongly after 2010, comprising also advanced second generation biofuels such as lignocellulosic bioethanol and BtL, making use of modern forms of energy crops in the years after 2010. Pure power generation remains at a constant level (11-13% of total biomass exploitation).

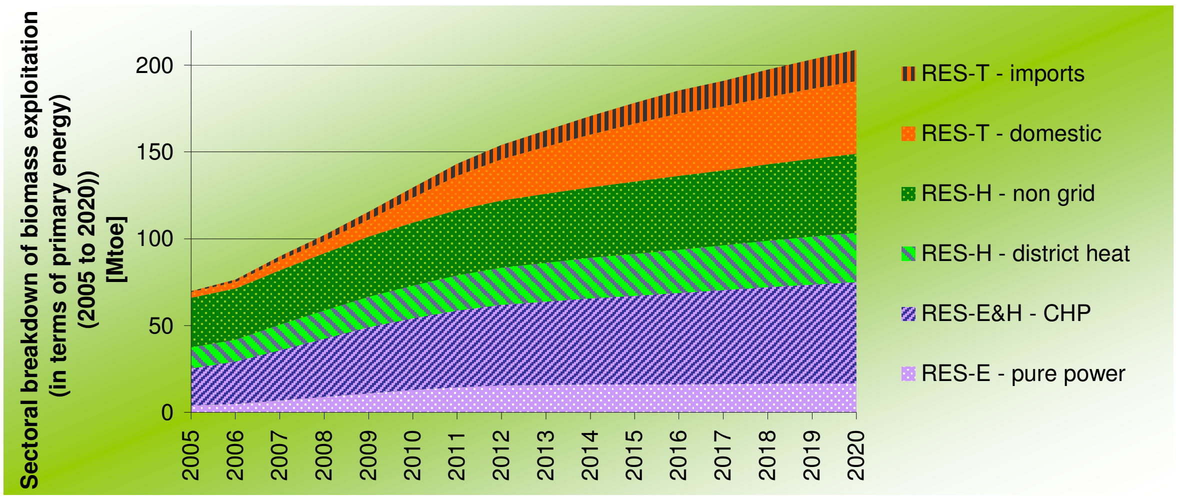

Figure 35 Sectoral breakdown of the biomass exploitation in terms of primary energy for the period 2005 to 2020

3.6 Country-specific deployment up to 2020

Current RES deployment varies largely among EU Member States. The same applies to the potential and cost for additional RES deployment. This obviously affects the additional country-specific RES deployment shown in the modelling results. A large variation in contributions towards the overall target can be recognised. Table 16 provides the development of the RES share for all Member States to 2020 in the *20%-RES-by-2020 main case.*

The model results show that in order to reach a 20% share of RES in the EU strong efforts are needed in every Member State. As potentials and costs for additional RES deployment differ across Member States, the contribution of individual Member States to an overall share of 20% RES in the *20%-RES-by-2020 main case* does as well.

Table 16 Share of RES production in demand (primary (based on Eurostat convention), electricity, heat, transport fuels) for EU-25 in the *20%-RES-by-2020 main case*

	% RES-primary		% RES-E		% RES-H		% RES-T	
Country breakdown	2010	2020	2010	2020	2010	2020	2010	2020
Austria	28%	35%	65%	70%	25%	34%	5%	11%
Belgium	4%	9%	6%	13%	4%	9%	2%	8%
Denmark	23%	45%	48%	86%	22%	33%	5%	27%
Finland	29%	44%	34%	48%	37%	49%	4%	36%
France	10%	19%	19%	37%	18%	30%	5%	11%
Germany	8%	16%	16%	30%	7%	15%	4%	10%
Greece	10%	20%	18%	29%	16%	28%	4%	10%
Ireland	7%	22%	18%	44%	6%	14%	3%	13%
Italy	12%	18%	24%	27%	11%	19%	3%	8%
Luxembourg	2%	6%	5%	7%	2%	6%	1%	5%
Netherlands	4%	9%	10%	21%	2%	6%	2%	7%
Portugal	21%	32%	43%	56%	27%	37%	3%	10%
Spain	13%	21%	31%	40%	12%	18%	3%	12%
Sweden	34%	49%	61%	75%	51%	65%	4%	20%
United Kingdom	5%	13%	10%	29%	4%	8%	2%	8%
Cyprus	4%	11%	8%	22%	9%	18%	2%	6%
Czech Republic	8%	14%	10%	19%	8%	15%	7%	13%
Estonia	21%	41%	15%	32%	37%	67%	4%	29%
Hungary	9%	22%	8%	15%	10%	23%	8%	29%
Latvia	32%	52%	47%	54%	34%	52%	9%	63%
Lithuania	18%	43%	10%	29%	32%	40%	9%	67%
Malta	3%	8%	7%	15%	7%	28%	2%	6%
Poland	12%	22%	11%	21%	14%	22%	9%	27%
Slovakia	9%	15%	20%	21%	8%	15%	5%	18%
Slovenia	19%	30%	37%	51%	24%	36%	1%	4%
EU 25	**10.9%**	**19.6%**	**21.8%**	**34.2%**	**12.3%**	**20.7%**	**3.9%**	**11.9%**

3.7 Impact on CO_2 emissions

The additional RES deployment in the *20%-RES-by-2020 main case* reduces CO_2 emissions by 289 Mt/yr in 2010, 518 Mt/yr in 2015 and 708 Mt/yr in 2020. The CO_2 emission reduction of 708 Mt in 2020 corresponds to 14% of total EU 25 GHG emissions in 1990[19], whereas CO_2 emission reductions due to total RES deployment in 2020 is 1,090 Mt, or 21% of total EU 25 GHG emissions in 1990.

Figure 36 shows the development of avoided CO_2 emissions over time in the sectors electricity, heat and biofuels.

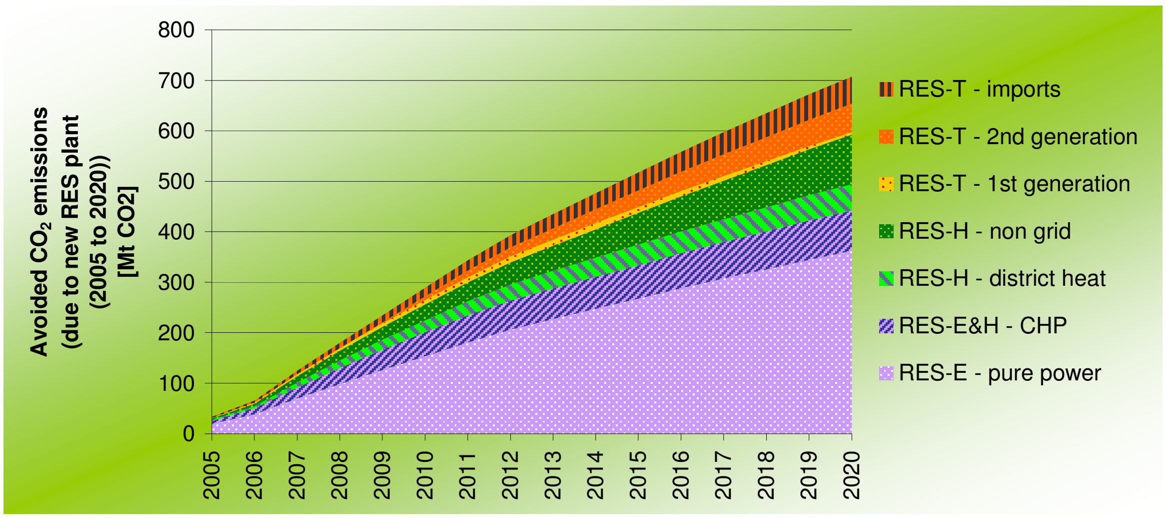

Figure 36 Avoided CO_2 emissions from new RES deployment (2005-2020)

Note that 2nd generation biofuels are more efficiently produced than 1st generation biofuels and thus avoid more CO_2 per litre.
For biofuel imports CO_2 emissions during production are not considered as they occur in the exporting countries.

[19] GHG emissions in 1990, the base year of the Kyoto Protocol, were 5,231 Mt CO_2 equivalent according to EEA Technical Report No 6/2006: Annual European Community greenhouse gas inventory 1990–2004 and inventory report 2006.

Table 17 provides the exact figures of avoided CO_2 emissions and a comparison with the sensitivity variants.

Table 17 Avoided CO_2 emissions due to RES plant installed 2005-2020 (sub-sector specific)

Avoided CO_2 emissions - due to NEW RES plant (installed 2005 to 2020)	[Unit]	2005	2010	2015	2020	2010	2020
RES-E - pure power	[Mt CO_2]	19.7	153.6	267.6	362.1	**53%**	**51%**
RES-E&H - CHP	[Mt CO_2]	6.1	47.4	66.5	80.3	**16%**	**11%**
RES-H - district heat	[Mt CO_2]	2.1	24.0	40.7	51.9	**8%**	**7%**
RES-H - non grid	[Mt CO_2]	2.6	31.6	62.6	98.6	**11%**	**14%**
RES-T - 1st generation	[Mt CO_2]	1.2	8.6	11.9	4.9	**3%**	**1%**
RES-T - 2nd generation	[Mt CO_2]	0.0	6.8	32.7	56.0	**2%**	**8%**
RES-T - imports	[Mt CO_2]	2.0	17.2	35.8	53.8	**6%**	**8%**
RES-total	[Mt CO_2]	**33.7**	**289.2**	**517.9**	**707.6**	**6,267** (2005-2020 cumulative)	

Comparison with sensitivity investigations:

… in case of *high energy prices*		2005	2010	2015	2020	**2005-2020 cumulative**
RES-total	[Mt CO_2]	**33.7**	**286.2**	**514.2**	**704.4**	**6,218**
Deviation to default case	*[%]*	*0%*	*-1%*	*-1%*	*0%*	*-1%*

… in case of *less energy efficiency policies*		2005	2010	2015	2020	**2005-2020 cumulative**
RES-total	[Mt CO_2]	**33.7**	**324.8**	**603.9**	**833.2**	**7,247**
Deviation to default case	*[%]*	*0%*	*12%*	*17%*	*18%*	*16%*

For the *High energy prices* case the difference with the *20%-RES-by-2020 main case* in terms of avoided CO_2 emissions is virtually zero. In case of *Less energy efficiency policies* more RES would be produced to reach 20% RES resulting in an increase of avoided CO_2 emissions by 18% in 2020.

3.8 Impact on security of supply

The increased RES deployment in the *20%-RES-by-2020 main case* reduces fossil fuel demand and therewith is an important element in improving the security of energy supply in Europe. In 2020 the avoided oil consumption due to new RES capacities installed between 2005 and 2020 equals 12% of both total EU oil consumption and import needs. In the case of gas, it equals 20% of total EU gas consumption in 2020 or 24% of default gas import needs, respectively. In the year 2020 a total of 50 billion € per year can be saved on fossil fuels due to additional RES deployment in the period 2005-2020. The three tables below provide the results of the *20%-RES-by-2020 main case* in terms of avoided fossil fuels and the corresponding avoided fossil fuel expenses.

Table 18 Avoided fossil fuels due to new RES plant installed 2005-2020 (in energy units and monetary terms)

Avoided fossil fuels - due to NEW RES plant (installed 2005 to 2020)

... in energy units - by fuel						Share of total [%]	
by year	[Unit]	2005	2010	2015	2020	2010	2020
Avoided hard coal	[MtSKE]	5.0	40.3	67.1	88.1	***30%***	***24%***
Avoided lignite	[MtSKE]	1.6	9.9	13.8	17.6	***7%***	***5%***
Avoided oil	[Mtoe]	2.8	26.9	56.6	76.0	***28%***	***30%***
Avoided gas	[Bill.m3]	4.1	43.4	87.2	134.4	***35%***	***40%***
Avoided fossil fuels - total	**[Mtoe]**	**10.6**	**95.0**	**179.3**	**251.9**	**2,155**	

... in monetary terms - in total		2005	2010	2015	2020	**2005-2020 cumulative**
Avoided fossil fuels - total	[Bill.€]	1.8	16.2	32.8	49.9	**397**
... as share of GDP	[% of GDP]	**0.02%**	**0.15%**	**0.27%**	**0.37%**	*0.20%*

Comparison with sensitivity investigations:

... in case of *high energy prices*		2005	2010	2015	2020	**2005-2020 cumulative**
Avoided fossil fuels - total	[Bill.€]	1.8	19.9	45.6	75.0	**547**
... as share of GDP	[% of GDP]	**0.02%**	**0.18%**	**0.37%**	**0.55%**	*0.28%*
Deviation to default case	*[%]*	*0%*	*23%*	*39%*	*50%*	*37%*

... in case of *less energy efficiency policies*		2005	2010	2015	2020	**2005-2020 cumulative**
Avoided fossil fuels - total	[Mtoe]	**10.6**	**107.2**	**208.5**	**293.1**	**2,484**
Deviation to default case	*[%]*	*0%*	*13%*	*16%*	*16%*	*15%*
Avoided fossil fuels - total	[Bill.€]	1.8	18.3	37.9	57.2	**453**
... as share of GDP	[% of GDP]	**0.02%**	**0.17%**	**0.31%**	**0.42%**	*0.23%*
Deviation to default case	*[%]*	*0%*	*13%*	*16%*	*14%*	*14%*

Table 19 Avoided fossil fuels due to new RES plant installed 2005-2020 (in energy units) as share of default gross consumption and import needs

% - referring to corresponding gross consumption	**2005**	**2010**	**2015**	**2020**
Avoided coal (solids)	1%	12%	21%	29%
Avoided oil	0%	4%	8%	12%
Avoided gas	1%	7%	13%	20%
% - referring to corresponding net import				
Avoided coal (solids)	4%	24%	38%	50%
Avoided oil	0%	4%	9%	12%
Avoided gas	1%	11%	17%	24%

The amount of avoided fossil fuels and related avoided fossil fuel expenses due to increased RES production are obviously very sensitive to the energy prices assumed in the scenario. *Higher energy prices* would increase the amount of avoided fossil fuel expenses over the period 2005-20 by 37% compared to the *20%-RES-by-2020 main case*.

With its large and increasing dependency on imported fossil fuels the EU is quite vulnerable to price increases on the world market for fossil fuels. Renewables clearly can form an important element of reducing this vulnerability. This is illustrated by the large amounts of fossil fuel expenses potentially saved by increased penetration of renewables as well as the high sensitivities of these expenses to energy price increases. Avoided fossil fuel expenses could be used as a first indicator to the increase of financial support to RES in the coming years, potentially increased with a risk avoidance premium to reflect mitigation against further price increases.

3.9 Financial impact

Investment needs

The increased RES deployment in the *20%-RES-by-2020 main case* will lead to investments of 672 billion €, almost evenly spread over the period 2005-2020. Of this amount 308 billion € will be invested in pure RES-E (46%), 269 billion € in pure RES-H (40%), 53 billion € in RES-CHP (8%) and 42 billion € in RES-T (6%).

Table 20 Investment needs for new RES (installed 2005 to 2020) in the EU-25 in the *20%-RES-by-2020 main case*

Capital expenditure in NEW RES plant (installed 2005 to 2020)						
-	[Unit]	05-10	11-15	16-20	**2005-2020 cum.**	
RES-E - pure power	[Bill. €]	100.5	97.8	110.1	**308.4**	**46%**
RES-E&H - CHP	[Bill. €]	29.0	12.4	11.3	**52.7**	**8%**
RES-H - district heat	[Bill. €]	8.5	5.4	4.6	**18.6**	**3%**
RES-H - non grid	[Bill. €]	53.9	76.6	120.2	**250.7**	**37%**
RES-T - 1st generation	[Bill. €]	3.7	2.0	0.1	**5.9**	**1%**
RES-T - 2nd generation	[Bill. €]	7.9	15.7	12.1	**35.7**	**5%**
RES-total	**[Bill. €]**	**203.6**	**209.8**	**258.5**	**671.9**	

Additional cost for meeting 20% RES by 2020

Table 21 provides an overview of additional annual generation costs for the years 2005, 2010, 2015 and 2020. The cumulative additional generation costs for the period 2005-2020 amounts to 287 billion €. This means that on average the additional generation costs are 17.9 billion € per year throughout this period.

Table 21 Additional generation costs in the *20%-RES-by-2020 main case* (2005 to 2020)

Additional generation cost for <u>NEW</u> RES plant (installed 2005 to 2020)								
... in absolute terms (Bill. €)							**2005-2020**	
by year	[Unit]	2005	2010	2015	2020		**cumulative**	
RES-E - pure power	[Bill. €]	0.5	3.2	8.2	11.0		93.0	**32%**
RES-E&H - CHP	[Bill. €]	0.2	0.6	1.4	1.4		14.6	**5%**
RES-H - district heat	[Bill. €]	0.0	0.7	0.8	1.0		11.6	**4%**
RES-H - non grid	[Bill. €]	0.5	3.2	5.2	7.5		68.6	**24%**
RES-T - 1st generation	[Bill. €]	0.1	1.2	1.5	0.4		15.9	**6%**
RES-T - 2nd generation	[Bill. €]	0.0	1.8	4.3	5.5		44.8	**16%**
RES-T - imports	[Bill. €]	0.2	1.5	3.2	4.5		37.9	**13%**
RES-total	[Bill. €]	**1.5**	**12.3**	**24.6**	**31.3**		**286.5**	

<u>Comparison with sensitivity investigations:</u>

... in case of *high energy prices*		2005	2010	2015	2020	**2005-2020 cumulative**
RES-total	[Bill. €]	**1.5**	**9.5**	**14.2**	**13.6**	**169.5**
Deviation to default case	*[%]*	*0%*	*-23%*	*-42%*	*-57%*	*-41%*

... in case of *less energy efficiency policies*		2005	2010	2015	2020	**2005-2020 cumulative**
RES-total	[Bill. €]	**1.5**	**18.1**	**39.7**	**50.8**	**427.0**
Deviation to default case	*[%]*	*0%*	*47%*	*61%*	*63%*	*49%*

Note that data for the year 2005 are modelling results which do not necessarily match with actual data.

Generation costs of new RES plants expressed per unit of generation in the period 2005-2020 are provided in Table 22. The average additional generation costs over the period 2005-2020 are 17.4 €/MWh.

Table 22 Additional generation costs per unit of generation in the *20%-RES-by-2020 main case* (2005 to 2020)

Additional generation cost for <u>NEW</u> RES plant (installed 2005 to 2020)						
... as premium per MWh$_{RES\text{-}generation}$						**2005-2020**
by year	[Unit]	2005	2010	2015	2020	**average**
RES-E - pure power	[€/MWh]	18.1	14.7	20.6	18.8	17.4
RES-E&H - CHP	[€/MWh]	10.4	4.6	6.6	5.1	5.5
RES-H - district heat	[€/MWh]	5.1	10.0	6.3	5.8	8.5
RES-H - non grid	[€/MWh]	43.5	21.8	16.5	13.9	25.1
RES-T - 1st generation	[€/MWh]	19.7	22.3	21.3	14.0	20.1
RES-T - 2nd generation	[€/MWh]	n.a.	64.1	28.6	21.1	38.1
RES-T - imports	[€/MWh]	21.2	22.8	23.0	21.2	22.3
RES-total	[€/MWh]	**19.4**	**17.0**	**17.5**	**15.1**	**17.4**

Figure 37 provides an overview of the cumulative additional generation costs for new RES plants in the period 2005-2020 according to three scenarios to reach 20% RES by 2020 as well as three BAU scenarios. *High energy prices* reduce the cumulative additional generation costs for reaching 20% RES by 41% up to 170 billion € compared to the *20%-RES-by-2020 main case*. On the other hand, *Less energy efficiency policies* lead to an increase of 49% up to 427 billion € of cumulative additional generation costs compared to the *20%-RES-by-2020 main case*.

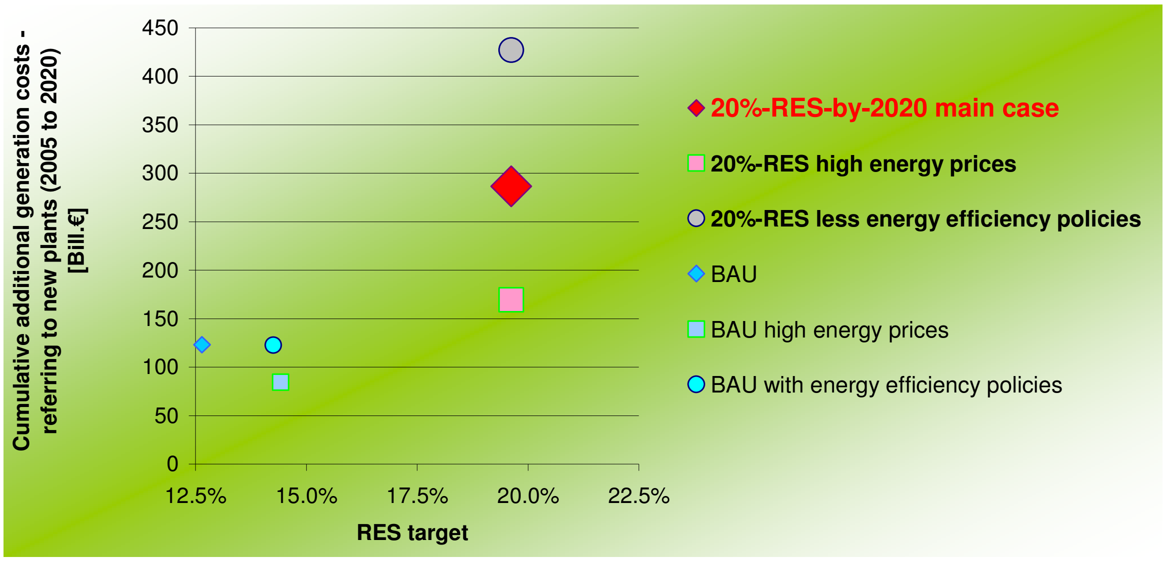

Figure 37 Cumulative additional RES generation costs for achieving 20% RES by 2020 as well as under BAU conditions (assuming a continuation of current RES policies) under changing parameters

The picture in the year 2020 is provided by Figure 38, which shows the additional generation costs in this year for new RES plants according to three scenarios to reach 20% RES by 2020 as well as three BAU scenarios.

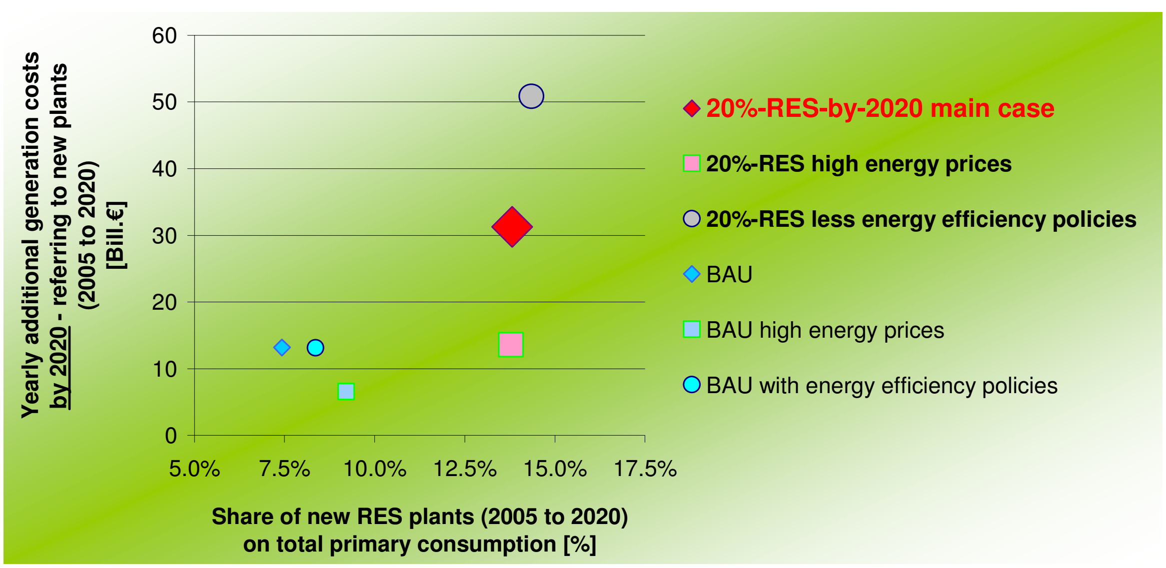

Figure 38 Additional RES generation costs by 2020 for achieving 20% RES by 2020 as well as under BAU conditions (assuming a continuation of current RES policies) under changing parameters

3.10 Scenario Update: 20% RES in terms of final energy

The year 2007 was a year of important policy decisions for the future of renewable energies in Europe. Of highlight in this respect - the agreement of the Council of the European Union on a binding 2020 target of 20% of renewable energy sources as set on 9 March 2007. With this decision the EC's view was confirmed as expressed in the Renewable Energy Road Map (COM (2006) 848 final)[20] as published some weeks ahead on 10 January 2007, insisting on the importance to assure the long term perspective for renewable energies with a view to forming a more sustainable future. In this context, also an agreement on a minimum target of 10% for 2020 regarding the share of biofuels in diesel and gasoline demand was taken. Following this endorsement, the overall 20% target for RES had to be broken down into national RES targets, which emphasised the need for further sound, quantitative analyses.

Consequently, an update of the scenario work as documented before was undertaken throughout 2007. In more detail this comprised:

- an extension of the geographical scope (i.e. EU-27 instead of EU-25);
- the incorporation of the agreed minimum target of 10% for biofuels; and
- the consideration of the modified definition of the overall RES target (i.e. 20% in terms final instead of primary energy demand).

Besides this updates of the input data with regard to the achieved RES deployment (i.e. 2005 instead of 2004) and energy demand developments (i.e. PRIMES energy efficiency scenario of 2007 instead of 2006) were also undertaken, accompanied by intensive feasibility cross-checks at the European and national level – in order to provide a most recent and reliable depiction of the required future RES deployment. In the following we focus on the highlights of this update as undertaken within the scope of a follow-up activity to this project (www.futures-e.org).[21]

Update: Required deployment of renewable energy sources up to 2020

Moving from 20% RES in terms of primary energy to final energy means slightly less emphasis on overall RES exploitation. As illustrated in Figure 39 in quantitative terms the new target definition corresponds to a required RES contribution of 235 Mtoe in terms of final energy by 2020. A simple comparison with the previous figure (i.e. 262 Mtoe – see sub-section 3.3) indicates 27 Mtoe less new RES deployment compared to the former target definition (in terms of primary energy).[22] This change is also reflected in the sectoral contribution where a slight shift from biofuels and heat to electricity is notable, affecting especially the deployment of those RES technologies representing the marginal options on the market.

[20] The Renewable Energy Road Map (COM (2006) 848 final) was published on the 10th of January 2007 as part of the integrated energy and climate change package "Energy for a changing world". This proposed comprehensive package of measures aimed to establish a new Energy Policy for Europe to combat climate change and boost the EU's energy security and competitiveness. The package of proposals set a series of ambitious targets on greenhouse gas emissions and renewable energy and aimed to create a true internal market for energy and strengthen effective regulation.

[21] The update of the comprehensive modelling work as presented in the previous sub-sections was undertaken within the ongoing European research project futures-e, supported by the European Commission, DG TREN within the Intelligent Energy for Europe programme. For further details we refer to www.futures-e.org.

[22] For a detailed comparison of these two scenarios other important changes have to be taken into account – especially the updated demand projections as applied as input to the scenario work as well as the extended geographical scope.

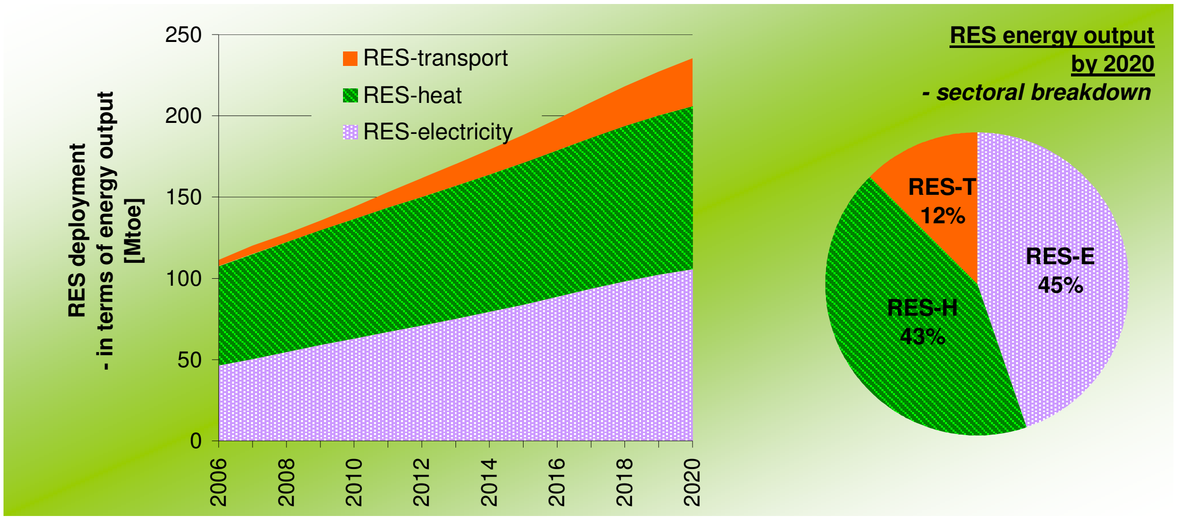

Figure 39 Update: Evolution of renewable energy sources up to 2020 in terms of final energy within the European Union (EU-27)

Table 23 provides more insights into the sectoral contribution to achieve the overall RES target by depicting the shares of RES-E, RES-H and RES-T on their corresponding sectoral demands for 2010 and 2020. As stated above, both renewable electricity and also renewable heat represent the largest contributors. For RES-E in particular this would imply an increase of its relative contribution (i.e. expressed as share on gross electricity demand) from currently around 16% (2006) to 35% by 2020 – an increase of more than 118%. In the case of RES-H this equals a doubling of the present contribution to meet the demand for heating and cooling – i.e. an increase from 10% (2006) to 20% by 2020. Finally, the agreed (minimum) target for biofuels of 10% by 2020 as a share of the demand for diesel and gasoline is preconditioned.[23]

Table 23 Update: Share of renewable energies in electricity, heat, transport fuel and final energy demand

% deployment				European Union 27
	2006	2010	2020	
Share of RES-E on electricity demand	16%	21%	**35%**	
Share of RES-H on heat demand	10%	12%	**20%**	
Share of RES-T on transport fuel demand	1%	2%	**8%**	
Share of RES on final demand	**9%**	**11%**	**20%**	
Share of RES on primary demand	7%	10%	**18%**	*(Eurostat convention)*
	11%	13%	**26%**	*(Substitution principle)*

Update: Technology breakdown

The required deployment of RES technologies, in particular new installations within the period 2006 to 2020 is illustrated in Figure 40 and discussed next:

- In line with above, the highest contribution is expected to come from the bulk of renewable electricity technologies: In total 64 Mtoe (or 47.5% of the new RES installations in total) appear as a lump sum for

[23] This study compares biofuel production to the total transport fuel demand (excluding electricity), whilst the 2020 target for biofuels refers to solely the demand for diesel and gasoline. In 2020 diesel and gasoline demand makes up 83% of total transport fuel demand according to the recent PRIMES efficiency scenario (as of 2007). Consequently, 8% of total transport fuel demand corresponds to 10% of diesel and gasoline demand.

new RES-E installations in total. Both onshore and offshore wind energy are major contributors in this respect, whereby a high growth (32% on average per year) is needed for offshore. Besides wind, biomass and biogas aim to gain similar emphasis with slightly less contribution in absolute terms but facing a period of stable growth.

- With regard to renewable heat both grid-connected and decentralised technologies are projected to deliver 42 Mtoe (corresponding to 31.2% of the total exploitation of new RES installations). In the case of grid-connected heat supply biomass CHP plants represent the largest contributors, whilst in the non-grid sector modern small-scale biomass heating systems are of dominance. Besides this, solar thermal collectors for heat & hot water supply are also expected to face a period of high and stable growth.
- Finally, biofuels are expected to expand their deployment by 29 Mtoe, corresponding to 21.3% of new RES in total.

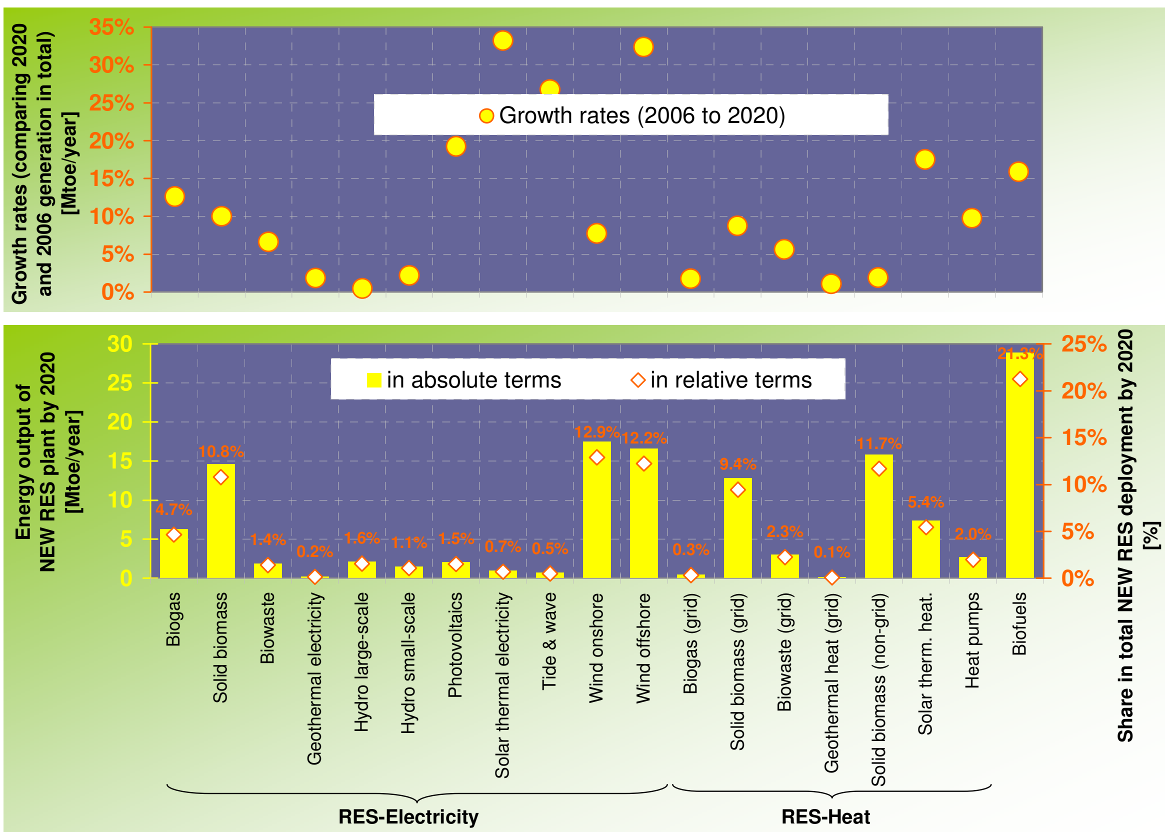

Figure 40 Update: Technology-breakdown for new RES installations in the period 2006 to 2020 within the European Union (EU-27) – in absolute and relative terms (below) as well as corresponding growth rates (above)

Update: Country breakdown

As stated previously, current RES deployment as well as the potentials and the corresponding cost of future RES options differ among EU Member States. In the modelling, an efficient and effective resource exploitation is assessed from the European perspective, where similar technology-specific RES support is preconditioned for all countries. As a consequence from above, a large variation in the country-specific contributions towards the overall target can be recognised, reflecting the national resource conditions and corresponding exploitation constraints. In this context, Figure 41 depicts the resulting country-specific deployment of RES (in total) by 2020 expressed as share of final energy demand. Additionally, Figure 42 provides a similar depiction for the corresponding new RES deployment (as installed in the period 2006 to 2020).[24]

The resulting country-specific RES shares for 2020 differ from the recently proposed national 2020 RES targets, with which the European Commission aimed to allocate the resulting burden in a fair manner across Member States. Hence, this emphasises the need for suitable accompanying flexibility mechanisms to allow the achievement of national RES targets in an efficient and effective manner.

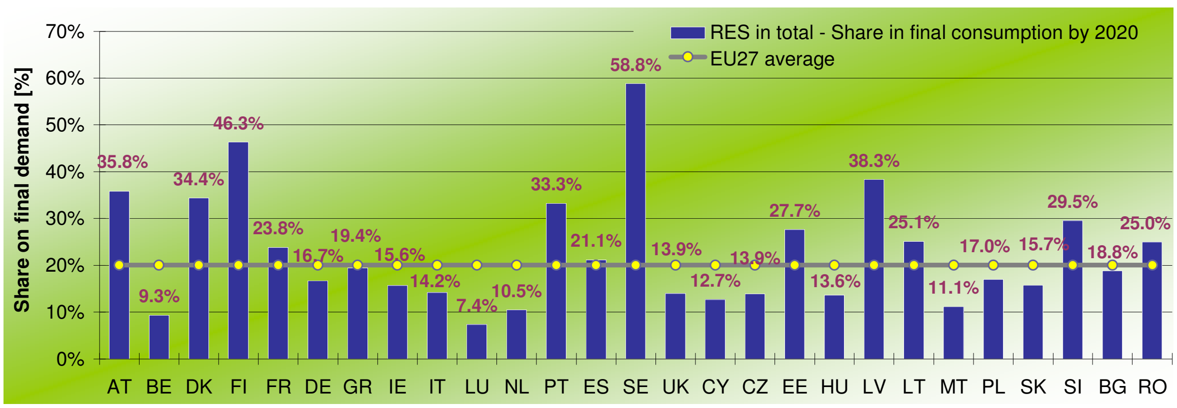

Figure 41 Country-specific deployment of RES (in total) by 2020 expressed as share on final energy demand

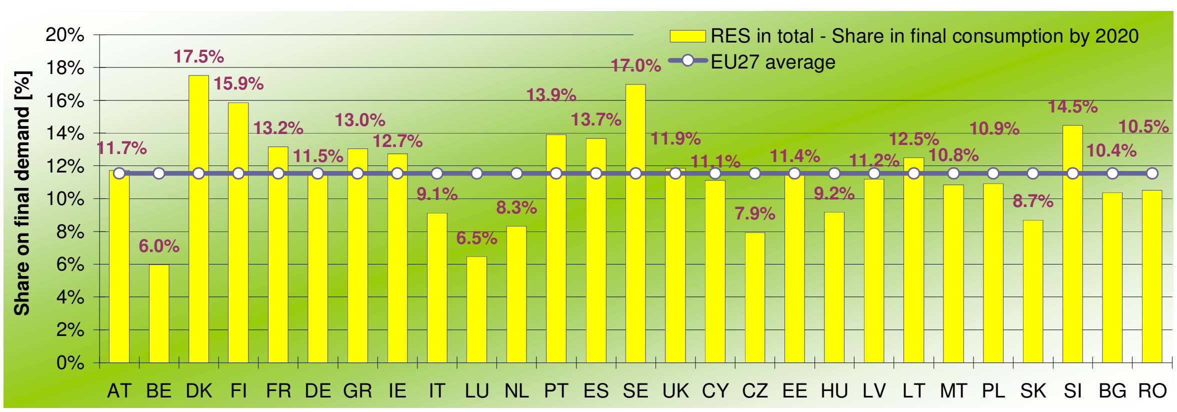

Figure 42 Country-specific deployment of new RES (installed 2006 to 2020) by 2020 expressed as share of final energy demand

[24] Please note that for both depictions with regard to biofuels the country-specific 2020 minimum target (10%) is incorporated. Biofuels are accounted in the country where they are consumed and not where they are produced.

3.11 Concluding remarks

RES policies should be supported by a strong energy efficiency policy

In the absence of strong energy efficiency policies energy demand is higher and more RES is required in order to achieve the targeted share of 20%. Consequently, in that case more expensive RES technologies have to be utilised and the average yearly additional generation cost increase from 17.9 to 26.7 billion €. This underpins the importance of energy efficiency policy and RES policy to work as complementary tools for creating a more sustainable energy system in an economically efficient way.

RES as an important contribution to meeting EU GHG reduction targets

A strong expansion of renewable energy can be an important element in European GHG reduction policies. The deployment of new RES installations in the period 2005 to 2020 as projected in the *20%-RES-by-2020 main case* results in a total reduction of CO_2-emissions by 708 Mt/yr in 2020, which corresponds to 14% of EU-25 GHG emissions in 1990.

Increased RES deployment brings large benefits to EU security of supply

The increased RES-deployment due to new RES installations in the *20%-RES-by-2020 main case* leads to a reduction in fossil fuel demand of yearly 252 Mtoe by 2020. Oil imports can be reduced by 12%, gas imports by 24% and coal imports even by 50%. This will significantly increase the EU's security of supply. In 2020 50 billion € can be saved on fossil fuels, which corresponds to 0.37% of GDP. In the sensitivity case with *Higher energy prices* saved expenses for fossil fuel in the period 2005-20 would increase by another 37%. In that situation the 20% target could be achieved at considerably lower cost, which illustrates the ability of RES to protect the EU economy against rising fossil fuel prices. The financial support provided to increase the support of RES in the coming years should reflect these benefits to EU's supply security.

Increased penetration of RES does have a price...

The *20%-RES-by-2020 main case* requires additional generation cost of yearly 17.9 billion € on average in the period 2005 to 2020. The costs are strongly influenced by energy price assumptions. Whereas assumptions in the *20%-RES-by-2020 main case* are much below current prices (e.g. an oil price of 48 $/boe in 2020), a sensitivity analysis that reflects current prices (*Higher energy prices* with oil price of 78 $/boe in 2020) reduces additional generation cost to yearly 10.6 billion € on average.

… but the resulting electricity prices by 2020 may not rise largely

A significant part of additional generation costs and costs for grid extension and system operations are recovered by the reduction of wholesale electricity prices obtained from increased RES-E generation.

Strong growth is needed in all three sectors

A 20% share of renewable energies in the year 2020 cannot be reached without strong increases in all three sectors: renewable electricity, heat and biofuels. The future policy framework should address this need for growth in all sectors. The current policy framework does include an extensive set of supporting mechanisms for RES-E and to some extent for biofuels, but the current limited and dispersed support for RES-H needs to be addressed if renewable heating is to play its essential role as part of the renewable mix.

A wide range of technologies has to be supported

Even a policy approach based on pure cost minimisation would still need to support a wide range of technologies: large-scale hydropower, solid biomass (for generation of both heat and power) and onshore wind power will be complemented by large amounts of offshore wind power, biogas and small hydropower. Associated costs vary largely between technologies and over time. Consequently, any future policy framework has to address this sufficiently by providing technology-specific support to the various RES options.

Efforts are needed in all Member States

All model results show that important contributions from all Member States are required to meet a 20% RES target in time. Thus, if some Member States fail to exploit their potentials, meeting the target will become increasingly difficult and also more expensive.

The RES policy framework needs an integrated perspective on the use of biomass

Biomass is a crucial element of RES policy, used in all three sectors (RES-E, RES-H and RES-T). In the *20%-RES-by-2020 main case* the larger part of domestic biomass potential is used. Additional biomass imports contribute to keeping costs low.

4 Barriers to the development of renewable energy

Mario Ragwitz, Anne Held, FRAUNHOFER ISI

4.1 Introduction

A stakeholder consultation was carried out in order to identify the most important existing barriers to the development of RES-E on behalf of the European Commission, DG TREN. The enquiry focused on barriers related to problems with permission procedures and grid issues[25]. The questionnaire was sent out in the form of an electronic questionnaire. The PROGRESS team received 52 valid responses from 21 EU countries, as shown in Figure 43. Results have to be interpreted carefully, taking into account the modest number of respondents. Hence, interpretations represent indications or viewpoints from the stakeholders rather than a reflection of the real situation in the different countries.

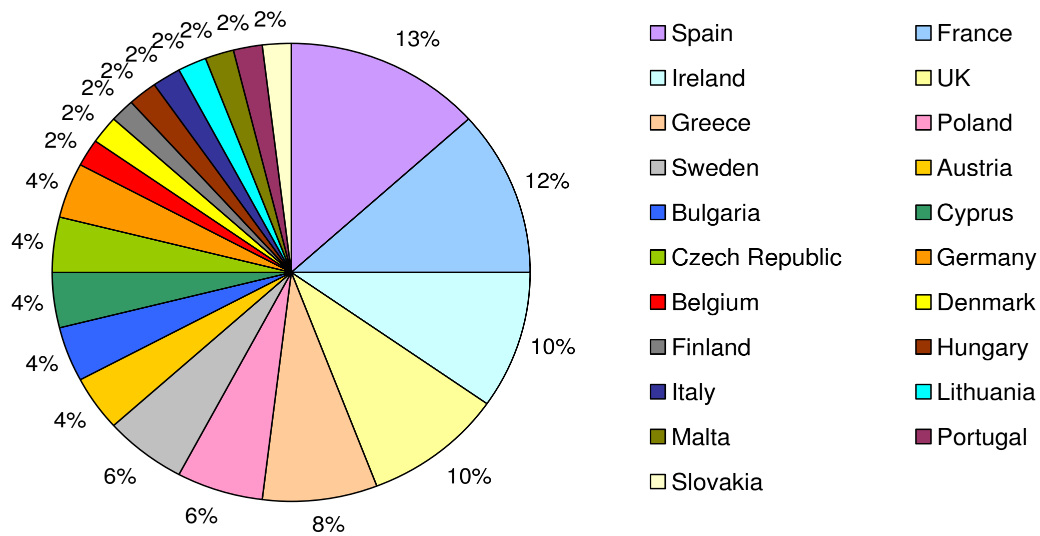

Figure 43Breakdown of responses by country

[25] Information about other topics such as social and financial barriers to RES-development was provided within the project OPTRES (www.optres.fhg.de).

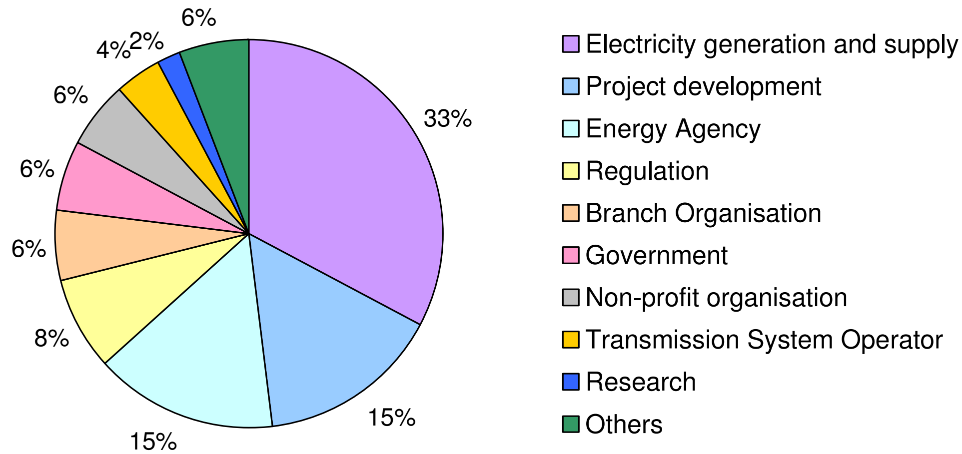

Figure 44Breakdown of responses depicted by main activity

As for the main activity of respondents, the major part (one third) of the answers originate from stakeholders in the electricity generation and supply sector. Project developers and energy agencies each represented 15 % of the respondents. The rest of the answers were provided by various stakeholder types, such as branch organisations, governmental institutions, NGOs, TSOs, and research institutes.

4.2 Barriers related to permission procedures

In this chapter, the points of view of stakeholders regarding the current existing problems with permission procedures, including building and environmental permits, are described in order to identify the crucial elements that impede further development of renewable energy sources. The aim is to get a picture of how many authorities have to be contacted to get a building permit and to identify the organisations responsible for causing bottlenecks. Then we asked for the average lead time for the authorisation procedure and for the rate of permit rejections.

Barriers related directly to grid connection issues are dealt with separately in chapter 4.3.

4.2.1 Number of authorities involved

The procedures to obtain the necessary building permits for a RES-E plant are not harmonised across the EU. Thus, the number and type of responsible authorities that have to be contacted differ significantly among EU Member States. The average number of authorities which must be contacted, according to the responses to the enquiry, amounts to 9.5 authorities. This result indicates existing problems with a relatively high number of authorities involved in order to get a building permit.

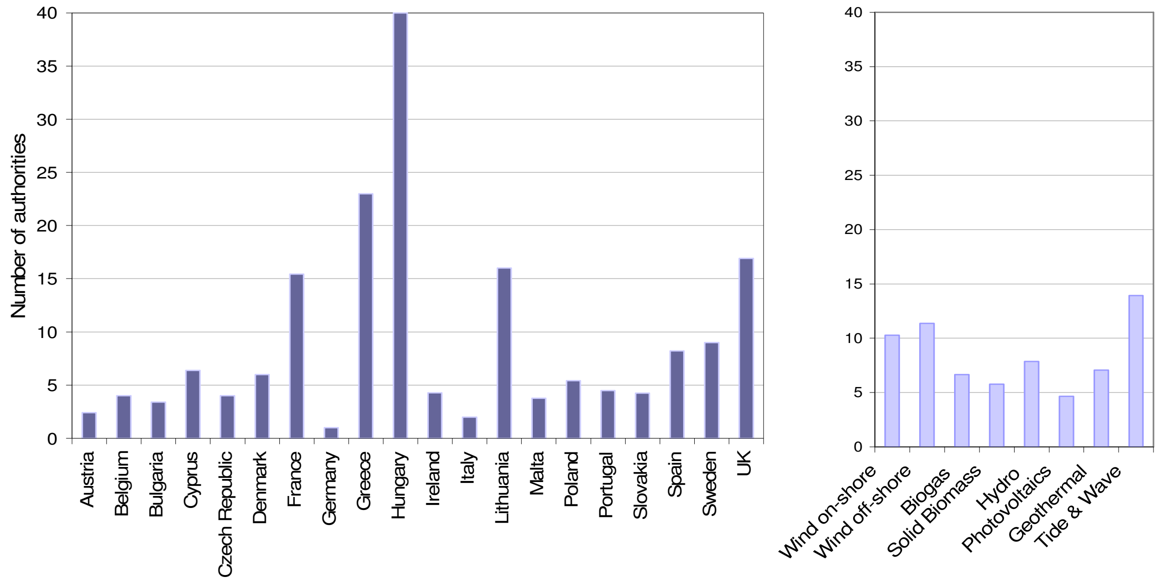

Figure 45 Average number of authorities involved in the permission procedure

Nevertheless, observing Figure 45 it can be seen, that in 9 of the 20 countries the average number of authorities amounts to a value below five. According to the responses, **Hungary**, **Greece** and **France** are countries with a higher number of authorities involved than most of the other European countries. The Greek government has tackled the problem of a complicated permission procedure by streamlining environmental permission procedures. They set strict limits of 6 months for involved authorities to grant or deny permits. Two central bodies were set up in order to coordinate the overall licensing process and a regime of strict follow-up procedures for holders of generation authorisation in order to avoid license trading. It still has to be proven whether the recently improved conditions lead to an improvement of the framework situation for RES-E development in Greece. In the French case the number of authorities to be involved varies significantly depending on the technology. The answers state that between 2 and 4 institutions have to be contacted for PV, whereas wind energy and tide & wave require the involvement of 25 authorities.

Corresponding to the results of the enquiry, **Germany**, **Austria** and **Italy** represent the countries with the lowest number of authorities involved.

Respondents from the **United Kingdom** stated that authorisations require contacting 12 statuary organisations and about 20 non-statuary organisations on the mainland, whereas more contacts are necessary in Northern Ireland. The lack of time limits for responses from these organisations is identified as the main problem.

In **Poland** the number of bodies involved depends on the capacity of the individual project.

In **Belgium** and in **Spain**, respondents stated that the administrative authorisation procedure depends on the region and is not harmonised inside the countries.

4.2.2 Identification of bottleneck organisations

This section shows a specification of the bodies the respondents considered to be the main bottlenecks to obtaining the necessary permits to build and operate a RES-E plant (Table 24). This does not mean implicitly that these institutions really do represent the main bottlenecks, but that they were perceived as such by the stakeholders consulted within this questionnaire.

Table 24 Name of organisations perceived as the main bottlenecks

Country	Organisation	Respective Technology
AT	• Provincial governments	Hydro
	• Economic Feasibility of Project	All
BE	• Building permit	Wi-On
BG	• NEK (National Electric Company)	All
	• Ministry of Environment	All
CY	• Department of Town Planning and Housing	Wi-On
	• Urban Planning Authority	All
	• Ministry Council	All
CZ	• Authority of buildings	All
	• Environmental activists	Wi-On
DK	• Skov- og naturstyrelsen (Danish Forest and Nature Agency)	Wi-On
	• Local municipalities	Wi-On
FR	• Méteo France (civil radars)	Wi-On
	• Ministry of Defence (army radars)	Wi-On
	• Ministry of ecology and sustainable development (MEDD)	Wi-On, Hydro
	• Local and national NGOs against wind power	Wi-On
	• Fishermen Associations	Hydro
	• Ministry of the Economy, Finance and Industry	Geo
	• Ministry of the Environment	Geo
	• Ministry in Charge of Civil Infrastructures (DDE)	Geo
	• Architectes des bâtiments de France	PV
	• Electricité de France	All
DE	• Environmental departments	
	• Utilities	
	• Affected groups public demands	
	• Military	
GR	• RAE (Regulatory Authority for Energy)	All
	• HTSO (Hellenic Transmission System Operator)	All
	• Forest Authorities	All
	• Ministry for the Environment (E.Y.M.E.)	Wi-On, PV, Hydro
	• Archaeological Authorities	All
	• Tourist Development Directorate	All
	• Zoning Authorities	All
	• Municipalities	All
HU	• MEH (Hungarian Energy Office)	All
IE	• ESB Networks (DSO, TAO, DAO)	All
	• Commission for Energy Regulation	All
	• Eirgrid (TSO)	All
	• Department of Communications, Marine and Natural Resources	All
	• The Planning Appeals Board	Wi-On
	• Planning Authorities	Wi-On

Country	Organisation	Respective Technology
MT	• Malta Environment & Planning Authority	All
	• Malta Resources Authority	Wi-On
	• Malta Tourism Authority	Wi-Off
	• Malta Roads Department	All
	• Malta Maritime Authority	Wi-Off
	• Enemalta Corporation	All
	• Armed Forces of Malta	Wi-On
	• Department of Civil Aviation	Wi-Off
PL	• Chief of Province, Environmental dept.	Wi-On
	• Polish Transmission System Operator	Wi-On
	• Local Distribution System Operator	Wi-On
	• PSE- Operator (TSO)	Wi-On
PT	• Instituto do Ambiente	Hydro
	• DGGE (Direcção Geral de Energia e Geologia)	All
SK	• Regional Environmental Office	Hydro
	• Municipality	Wi-On
ES	• Coastal Authorities	Tide & Wave, Wi-On, Wi-Off
	• Dirección General de Industria y Energía (Industry and Energy Authority)	All
	• Distribution companies	PV
	• Electricity Utility	All
	• Environment Authority	All
	• Ministry for the Environment	PV, Hydro
	• Hydraulic Administration	Hydro
	• Ministry of Industry	PV
	• Local authorities	PV, Biomass
	• Red Electrica Española (TSO)	All
	• Regional authorities	PV
	• Regional governments	PV
	• Sevillana-Endesa	PV
	• Water Authority	Hydro
SE	• National Defence	Wi-Off
	• Environmental Protection Agency	Wi-On
	• Defence Authorities	Wi-Off
	• Fisheries Agency	Wi-Off

Country	Organisation	Respective Technology
UK	• Crown Estate	Tide & Wave
	• DNOs (Distribution Network Operators)	All
	• DTI (Department of Trade and Industry)	All
	• Fisheries Committee	Hydro
	• Forestry Commission	Wi-On
	• Historic Scotland	Wi-On
	• Local Planning Authorities	All
	• Local Planning Authority Environment and Heritage Service Police Service Northern Ireland	Wi-On
	• Local Planning Authority Local Council Transmission Owner/Operator Distribution	Wi-Off
	• Local Planning Authority Transmission Owner/Operator Distribution Network Owner	Wi-On, Wi-Off
	• Ministry of Defence	All
	• NGET (National Grid)	All
	• Scottish Environment Protection Agency	All
	• Scottish Executive	All
	• Scottish Natural Heritage	All
	• Statutory consultees	All

4.2.3 Knowledge about procedures for the whole licensing chain

Stakeholders were asked whether they feel that the procedures for the whole licensing chain are clear and well established. In total 61 % of the respondents judge the existing licensing procedures to be clear and well established. The main outcome of this question was that the majority of procedures are known, but they remain too lengthy.

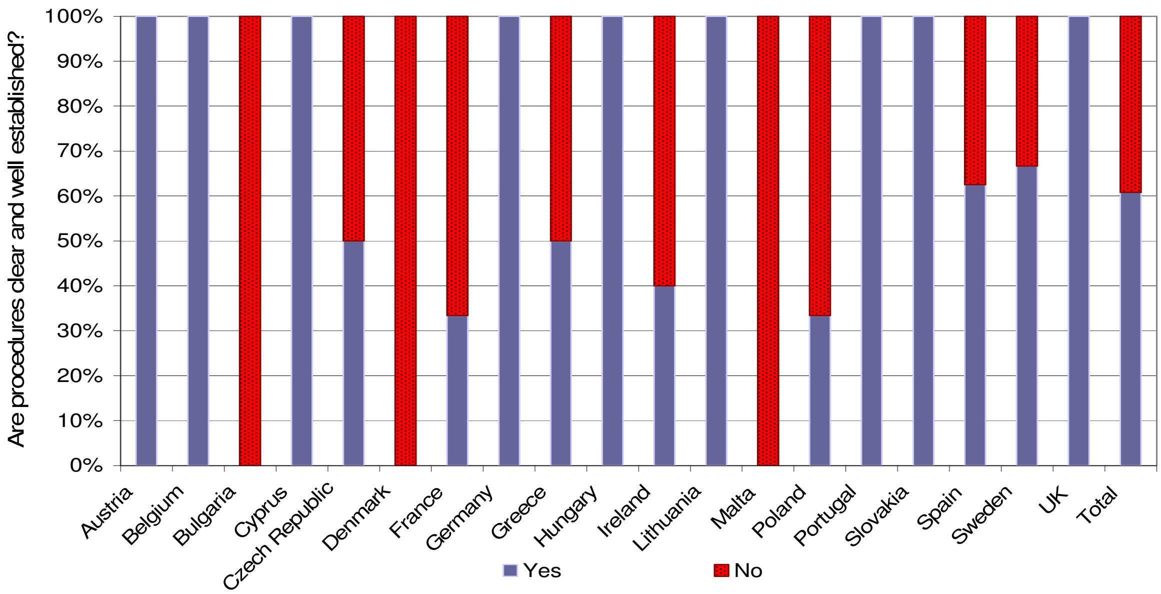

Figure 46 Stakeholder judgement whether procedures for licensing are clear and well established

Respondents from **Austria**, **Belgium**, **Cyprus**, **Germany**, **Hungary**, **Lithuania**, **Portugal**, **Slovakia** and the **UK** perceived the procedures for licensing to be clear and well established. Nevertheless, there is also criticism from these countries. One German respondent stated that the system is missing a time limit for the demand of the licences and also for the date of the decision. Although the British respondents consider the rules to be transparent in general, it is commented that there might be confusions concerning the rules for offshore wind and biomass technologies and that the procedures are too lengthy and complicated. Additional delays for Northern Ireland are expected for the near future, since the licensing regime there is being changed.

Comments from **France** are that procedures are clear, but tend to be lengthy and complex.

According to an argument from **Greece**, the new licensing procedure from summer 2006 provides a detailed set of regulatory provisions addressing almost all matters of the licensing procedure, but there are still several legislative measures that have to be prepared concerning, for example, spatial planning.

It seems that iterative procedures and a missing communication and acceptance between the official bodies represents a mayor problem in **Ireland**, for example as time limits set by one institution are not always acknowledged by the others.

In **Spain**, the differing regulations in the 17 regional governments represent a problem for understanding the licensing procedures, and evaluation criteria are not harmonised. Missing legislation for new technologies as well as missing knowledge in the institutions are mentioned as crucial problems.

Legislation for licensing in **Poland** is judged to be unclear and not adapted to the requirements for wind turbines.

4.2.4 Average lead time for the authorisation procedure

In the next question we asked for the average lead time for the authorisation procedure including the time horizon from the beginning of the first planning steps until start of plant construction. In general, the lead times for authorisation procedures are perceived to be too long in most cases.

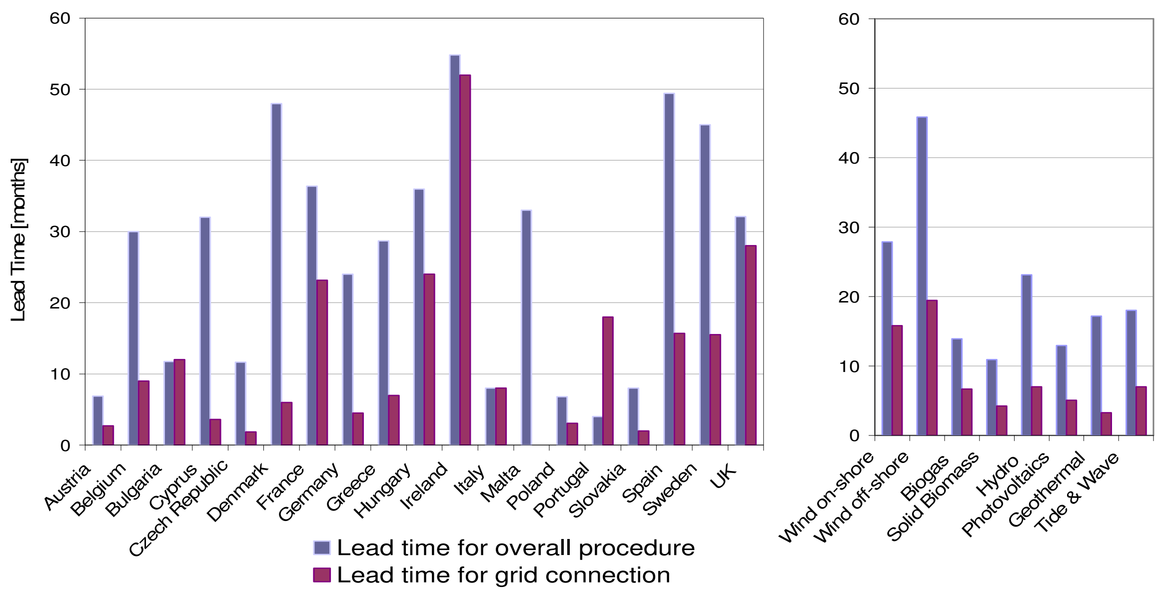

Figure 47 Average lead time for overall authorisation procedure and for grid connection

The figures reported are partially based on experience, but some will be necessity be estimates, in particular in the cases of offshore wind power or tide and wave power, where few full experiences with authorisation procedures exist.

Exceptionally high lead times for the authorisation procedure were reported from **Ireland**, where the authorisation for offshore wind might take at least 5 years. The connection agreements are identified as the main obstacle in general for the procedures in Ireland. Figure 47 shows that the average lead time for grid connection can be very high and therefore represents a significant bottleneck. Other countries with a high perceived lead time are **Spain**, **Denmark**, **Sweden**, **France** and the **UK**. According to the results of the enquiry **Austria**, **Italy**, **Poland** and **Slovakia** turn out to be countries with relatively short lead times, below two years. Observing technology-specific differences, lead times in general seem to be relatively high for wind offshore and comparably low for biomass technologies.

In **Spain** exceptionally high lead times were identified for hydro (>48 months). Here the most time-consuming permit seems to be the water use concession from the ministry of environment (18 to 60 months), followed by the grid connection (6 to 24 months). As compared to that, PV only needs 5 to 18 months for the permission. Most of the time-consuming process is in general needed for the Environmental Impact Assessment and the grid connection. Nevertheless, it was also stated, that the time for grid connection authorisation can be quite short if the required infrastructure is already available. For the grid connection authorisation a maximum response time of one month seems to exist theoretically, but even though, it is still commented that there are some delays.

One **Greek** respondent told of two cases where the authorisation procedure took seven years. It is stated that lead times do not depend on the technology, but on the size of the plant. The lead time for smaller plants tends to be shorter than for larger projects.

According to comments from a respondent referring to the **British** system, the lead times in Northern Ireland seem to be higher than on the mainland with an increasing trend due to an increasing number of grid connection requests. The lead time in the **UK** for wind onshore apparently depends on whether ministerial approval is required or only approval at the local level. Therefore projects in excess of 50 MW, which require ministerial approval, tend to take longer time for authorisation. It is proposed by a respondent to facilitate the early connection of RES-E projects while the required 'deep network reinforcements' are completed. The respondent recommends that grid reinforcements are required in the UK in order to shorten the lead times.

The main bottleneck in **Ireland** is reported to be the access to the electricity grid. Apparently there are backlogs of projects awaiting grid connections. It is proposed that the TSO initiates known transmission bottleneck upgrades as early as possible.

In **Sweden** it seems to be a problem that there are broad possibilities to appeal against decisions and the number of appeals is increasing. Therefore, the anticipation of lead time results in real difficulty, and a high level of uncertainty is created.

4.2.5 Average rate of permit rejections

For the planning of the construction of a RES-E plant not only the duration of the permission procedure is relevant, but in particular whether the result is positive or not. Thus, an indication of the average rate of permit rejections, as reported by respondents, is shown in Figure 48 below.

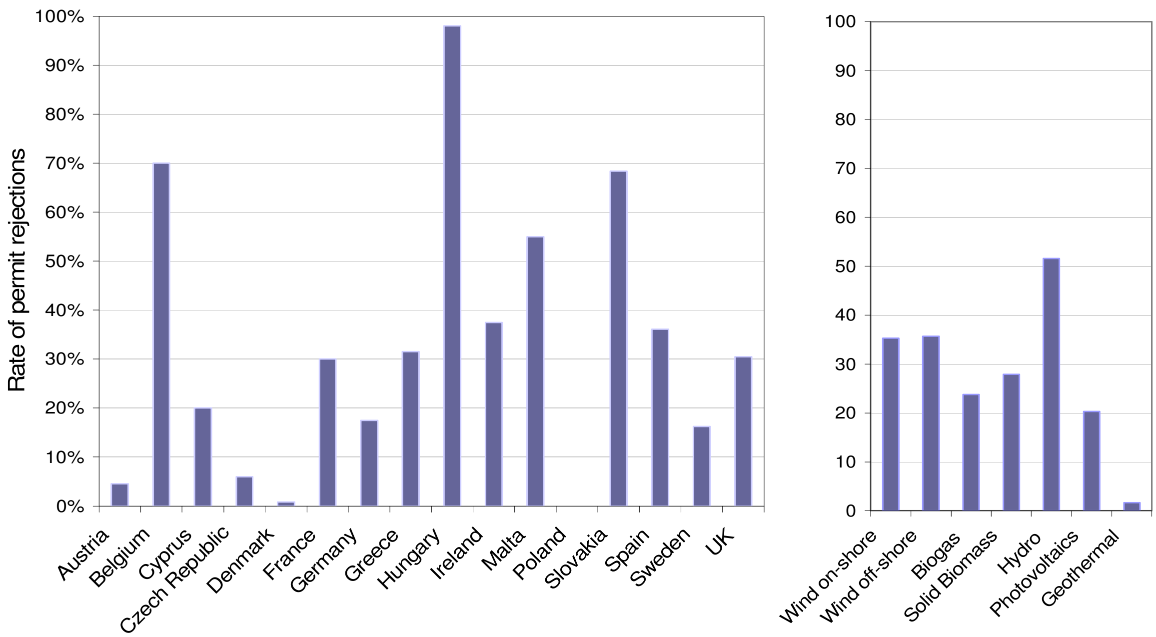

Figure 48 Average rate of permit rejections

In total the average rate of permit rejection is 30 %. However, for countries such as **Hungary**, **Belgium** and **Slovakia** rejection rates exceeding 65 % are indicated by the respondents. According to one statement 124 wind turbine licences were rejected by the **Hungarian** Energy Office. In most of the cases, missing grid capacity represents a crucial factor for rejections. The reason for denying the permission for offshore projects in **Belgium** is that there is competition between projects for the same area and that projects are situated too close to the coast.

The problem in **Spain** seems to be the lead time and not the rejection rate. Nevertheless, the main reason for hydro power rejections was reported to be the Environmental Impact Assessment. A Spanish respondent states that civil servants sometimes refuse to act to approve RES projects, since they cannot be accused of doing anything wrong in this way.

In **Cyprus**, the denial of permissions occurs due to limitations in grid capacity.

In **Germany**, the rate of rejections apparently might be reduced by organising preliminary meetings with the responsible institutions.

The **Greek** stakeholders complain about local governments with respect to permit rejections, since these governments sometimes claim ownership of areas and their exploitable natural resources themselves. In addition to this, too high a number of applicants for receiving construction permission is identified as one cause for permit rejections.

Whilst about 30 % of onshore wind projects are rejected under the initial planning process in the **UK**, the majority of these (2/3) are generally approved after an appeal process.

In the **UK**, **Malta** and **Ireland**, visual impacts on the landscape are stated as a reason for rejections. Comments about the Swedish system complain of defence and security issues with regard to offshore plants. In addition nature preservation and landscape issues represent a crucial reason for rejections in the area of wind onshore.

4.3 Barriers related to grid issues

RES-E plants face particular problems concerning grid issues as compared to conventional power plants due to the characteristics of some RES-E plants, including for example the intermittency of power output or smaller plant sizes. This section aims to identify the existing grid-related problems impeding a stronger market development of renewable electricity. In a first step, respondents were asked to state whether RES-E plants were connected to the transmission or the distribution grid. Then, stakeholders were asked to indicate the share of projects for which insufficient grid capacity represents a major problem. The last part of this section deals with the character of the grid-related problems, looking first at issues related to grid connection and then to grid extension issues.

4.3.1 Voltage level of grid connection

Figure 49 shows to which voltage level the RES-E plants are connected to, according to the results of the questionnaire.

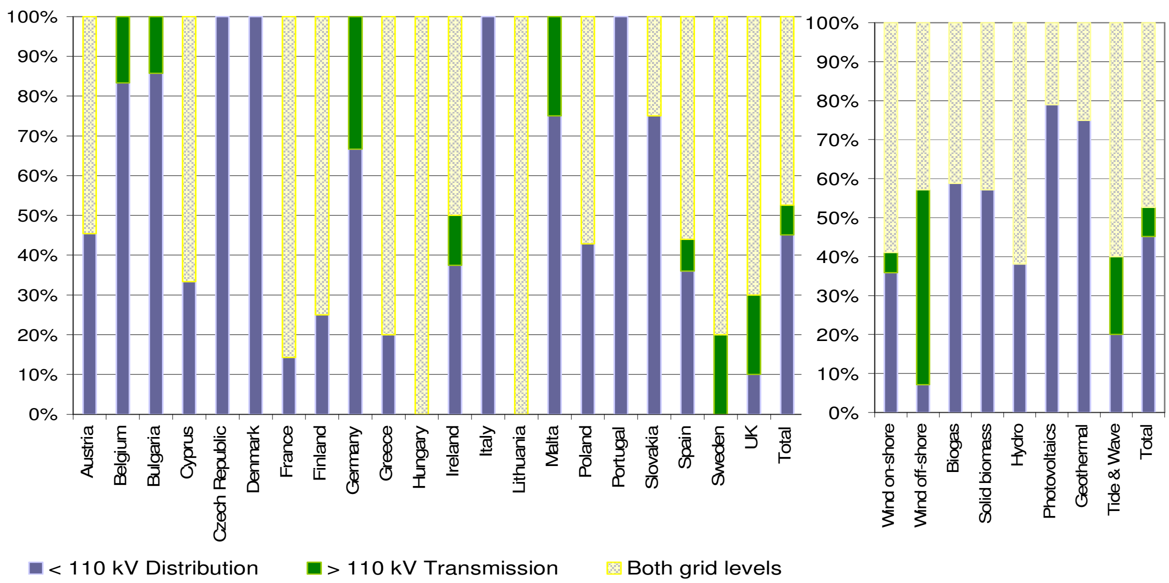

Figure 49 Voltage level of grid connection

Overall 45 % of the respondents stated that their plants were connected to the distribution grid, 8 % named exclusively the transmission grid, and 47 % connected their plants to both grid levels. In particular offshore plants are frequently connected to the transmission grid. Usually the voltage level depends on the capacity of the RES-E plants.

In **Greece** for example, plants of up to 100 kW are connected to a 230 V low-voltage grid, plants between 100 kW and 20 MW are connected to a 20 kV medium-voltage grid, and plants exceeding a capacity of 20 MW are connected to a 150 kV high-voltage grid. In **Hungary**, grid connections are realised on a 23kV level or on a 135 kV level. Onshore wind in **Ireland** is connected at 10 kV, 20 kV, 38 kV and 110 kV, and offshore wind at 38kV or 110kV. RES plants in the UK are said to be connected at 22 kV or 132 kV. A **Spanish** statement says that 50 % of the RES plants are connected to the distribution network and 50 % to the transmission network, with an expected increase of the transmission network share.

4.3.2 Projects for which insufficient grid capacity represents a major problem

Within the questionnaire it was asked whether the stakeholders consider that insufficient grid capacity represents a major problem for their projects.

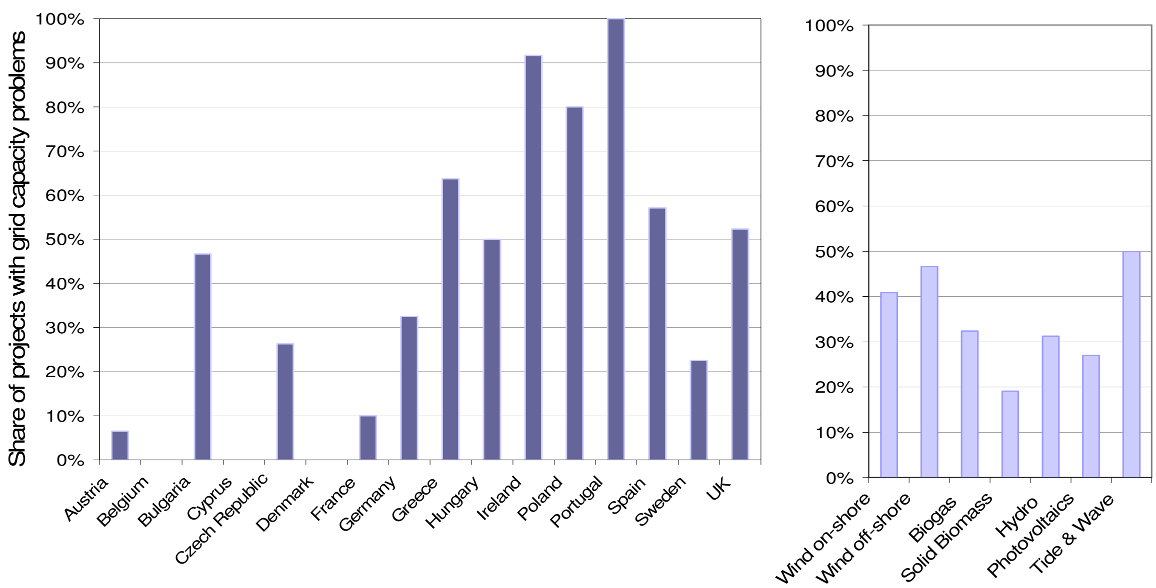

Figure 50 Share of planned projects for which insufficient grid capacity represents a major problem

According to the enquiry results, **Portugal**, **Ireland**, **Poland**, **Greece** and the **UK** are countries where in more than 50 % of the planned projects a serious problem exists with the existing grid capacity.

The viewpoint from **Cyprus** holds that the generation licences issued by the regulator take into account the existing grid capacity. Similarly a **Finish** comment states that a power plant is generally not foreseen for a location without sufficient grid capacity. For **Greece**, it is stated that there are generally more problems with grid capacity if the plants are to be connected to the mainland power grid than for plants on the Greek islands. Another problem is identified in **Scotland** as well as in **Ireland**, where locations with favourable wind regimes (e.g. Western coast of Ireland) are combined with a weak grid infrastructure due to low population density. For **Spain** it is stated that interconnections to France are too weak and that grid problems represent an important problem for instance in Northern Spain in the region of Zaragoza.

One respondent suggests introducing a more flexible approach to connection offers for the **UK** by making more capacity offers than physically available, since not all the offers will progress. In addition it is criticised that the system operator does not recognise the intermittent nature of renewable generation and it is proposed to adapt the rules for connections to the characteristics of RES.

The problem of too little grid capacity is tackled in **Ireland** as follows: the projects are connected on a 'non-firm basis' until the required grid reinforcements are realised. It is commented that RES producers might have to deal with a decrease in the electricity output due to the grid constraints. In the future this problem is expected to escalate if regulations do not change. Grid congestion does not represent a major problem in Northern Ireland yet, but it is expected to be a problem from 2008. It is stated, that there is a general under-investment in the transmission structure in the whole of the British Isles. The respondent states that there is a big potential to accelerate the process between identification of a transmission inadequacy and the realisation of the new transmission line or reinforcement.

4.3.3 Issues related to grid connection

In this section, stakeholders were asked whether the existing framework conditions for grid connection represent a barrier for market development of RES-E. They had to comment on whether cost estimates for grid connection are transparent and/or discriminatory for RES-E.

One of the crucial and frequently commented on problems is the missing provision of cost breakdowns reflecting the work that has to be provided for the grid connection.

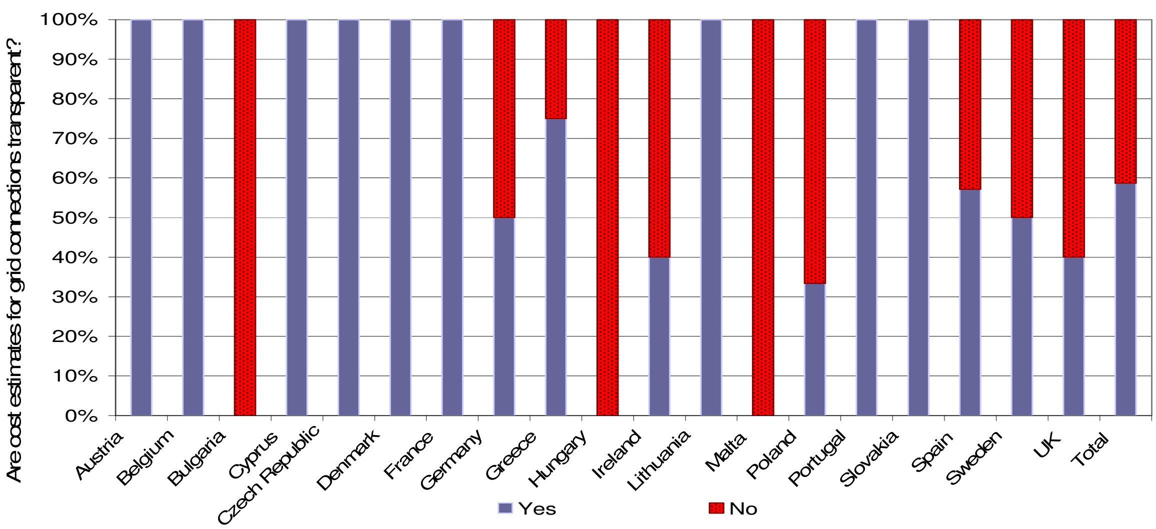

Figure 51 Are cost estimates for grid connections provided by transmission/ distribution operator transparent?

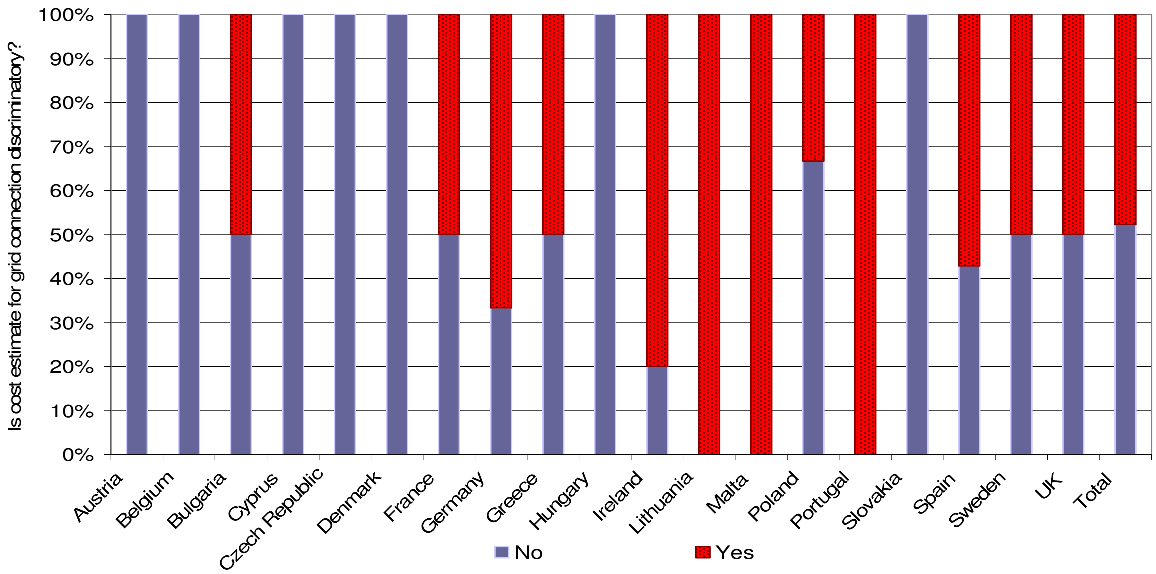

Figure 52 Are cost estimates for grid connection provided by transmission/ distribution operator discriminatory?

Observing Figure 51 and Figure 52, one can see that scarcely 60 % of total respondents judge cost estimates for grid connection to be transparent and 52 % criticise grid connection costs for being discriminatory. In **Austria**, **Belgium**, **Cyprus**, **Czech Republic**, **Denmark** and **Slovakia** 100 % of the respondents believe that grid connection costs are transparent as well as non-discriminatory. Countries where the situation concerning transparency of grid connection costs was assessed to be rather unfavourable are **Bulgaria**, **Hungary**, **Malta** and **Poland**. Most of the respondents from **Ireland**, **Lithuania**, **Malta, Portugal** and **Spain** perceive grid connection costs to be discriminatory for RES-E.

One positive example of grid connection conditions for RES-E is **Belgium** where cost reductions are offered to RES-E. In **Cyprus**, 50 % of the grid connection costs have to be borne by the RES-E producer and the remaining part is paid by the Transmission System Operator. Hence, grid connection costs are considered to be transparent and non-discriminatory. The **Polish** regulation also foresees that part of the grid connection costs are to be covered by the operator.

Grid connection costs have apparently become more transparent in the last years in **France**, but it is stated that costs are high and have to be borne by the electricity generator.

In **Germany** cost estimates are stated to exist, but seem to be published quite late.

Grid connection costs in **Greece** are judged as non-transparent, since cost estimations do not necessarily represent the real costs. In order to avoid this uncertainty for investors a ministerial decision setting maximum limits on the connection costs is in process.

For **Ireland** it is commented, that costs and their calculation basis are not transparent before application. In addition costs differ significantly for the accepted connections. Grid connection costs are perceived as discriminatory against RES-E, since existing conventional plants do not have to pay for grid connection. Connections for RES-E even sometimes include uncompensated constraints that have to be accepted.

According to another comment from a respondent from the Republic of Ireland the TSO, EirGrid, refuses the provision of cost breakdown information.

According to the responses, the **Spanish** costs for grid connection do not seem to be really clear. If published, costs are evidently calculated according to real connection costs and have to be accepted by RES project developers. In addition it is stated that vertically integrated utilities discriminate RES-E projects. It is proposed to establish an official procedure for determining the costs in order to avoid discrimination against RES-E.

In **Sweden**, the situation depends on the grid company, but the existing legislation is currently under revision.

Comments from the **UK** consider that grid connection costs are not transparent, since no adequate breakdown of the costs associated with the works is provided. Respondents feel that costs are discriminatory, since RES availability often goes ahead with a weak infrastructure and RES-E producers have to bear all the grid-related costs.

4.3.4 Issues related to grid extension

If RES-E is connected to the grid, it is sometimes necessary to undertake extensions of the existing electricity network. In this section, stakeholders reveal their opinions about the framework conditions for RES-E if grid extensions are required.

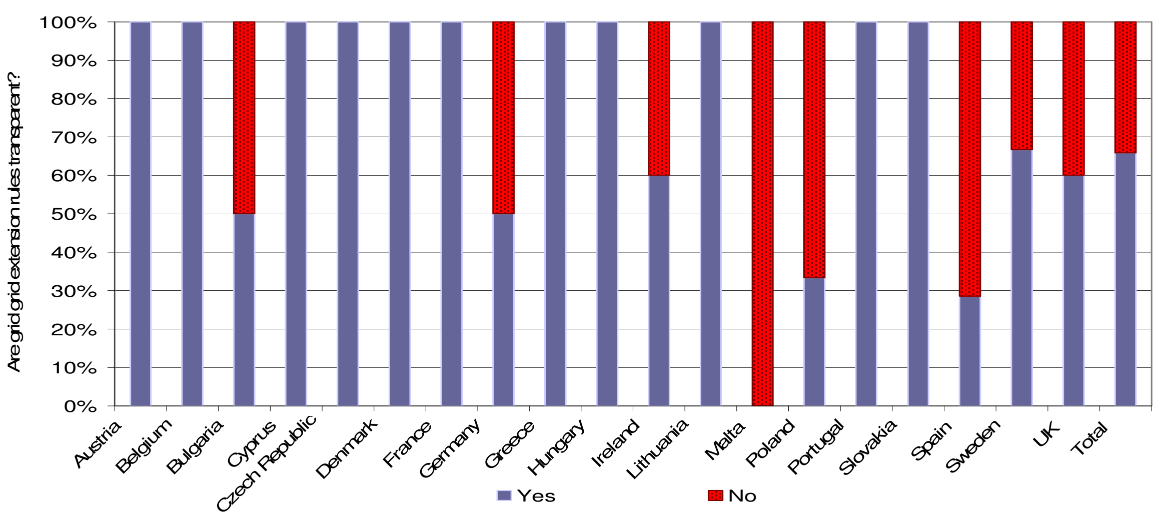

Figure 53 Are cost estimates for grid extension provided by transmission/ distribution operator transparent?

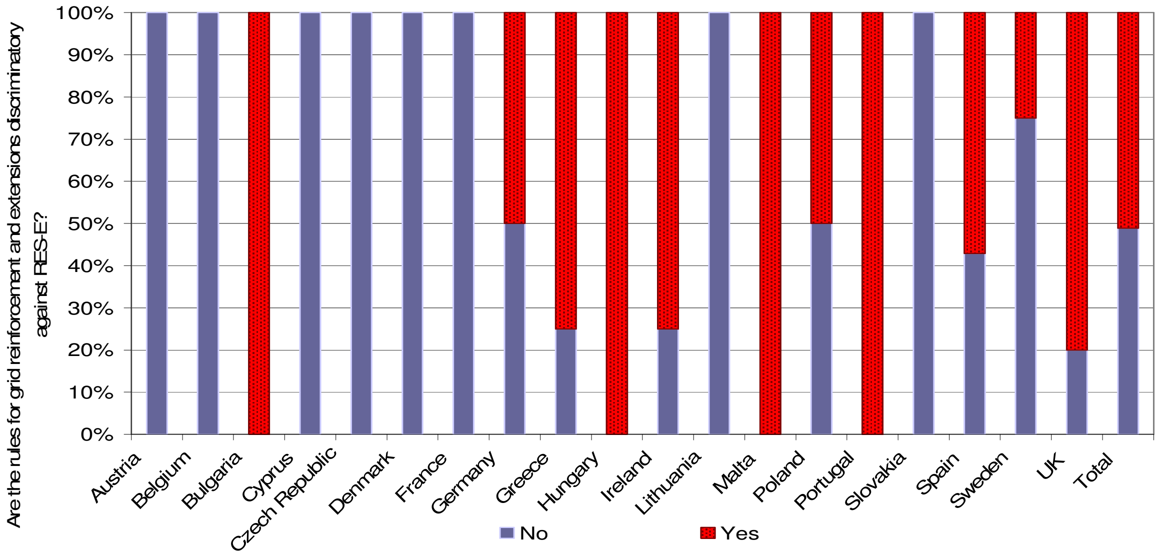

Figure 54 Are cost estimates for grid extension provided by transmission/ distribution operator discriminatory?

The assessment of the framework conditions for grid extension shows a similar picture as regarding grid connection.

In **Hungary**, cost estimations are considered transparent, but since RES-E generators pay the whole cost for extension of the grid including the substation of the operator, grid extension rules are perceived to be discriminatory against RES-E. As compared to that a respondent from **Poland** characterises the cost estimation as non-transparent but non-discriminatory.

A **Swedish** viewpoint is that there are the same rules for all electricity generators which might result in being disadvantageous for RES-E, as RES-E plants are often located in areas with a weak grid capacity leading to inherently higher grid extension costs.

It is mentioned for the **Spanish** case that extension costs do not have to be borne by the producer for reinforcements of the transmission grid, but they do for the distribution grid. Thereby, the electricity generator apparently has to accept the proposed costs. Stakeholders from Spain report that grid extensions for conventional electricity generation technologies were borne by a public funding scheme before market liberalisation.

Concerning grid extension conditions in **Greece**, the grid connection process was dominated by the incumbent utilities, but it is planned to strengthen the role of the System Operator in the future. The following problem is identified by a Greek stakeholder: Apparently only the first RES-E project developer who needs a grid extension in a certain area has to pay for the grid extension and other RES-E producers may thereby benefit from the grid expenses of the first one.

In the **UK** rules appear to be reasonably transparent, but the conditions are judged to be inadequate and open to manipulation. It is commented that the current grid connection system follows an "invest and connect" approach, but that an "invest and manage" philosophy would be preferred. That means that plants are connected to the existing grid and then the upgrade is realised subsequently.

One stakeholder state, that on the **Irish** market the time for obtaining grid offers amounts to 90 days for conventional plants, whereas connection procedures for RES-E plants can take up to several years due to the "Group Processing Scheme". This represents an obvious discrimination of RES-E compared to conventional power plants. Another problem reported from Ireland is that current grid connection practices are better suited to the characteristics of large conventional power plants. Currently, RES-E plants are connected on a "non-firm" basis. In this way the direct connection to the grid might be carried out in about two years but RES-E generators have to face curtailment uncertainties until the required reinforcement works are completed. Since construction lead times of RES-E plants tend to be significantly shorter than for conventional plants with construction lead times closer to reinforcement lead times, RES-E plants are relatively more affected by this delay in "deep reinforcement".

4.4 Necessity for reinforcement of Community Legislation

At the end of the questionnaire stakeholders were asked whether they consider a reinforcement of community legislation necessary and were given the opportunity to suggest improvements to the existing situation.

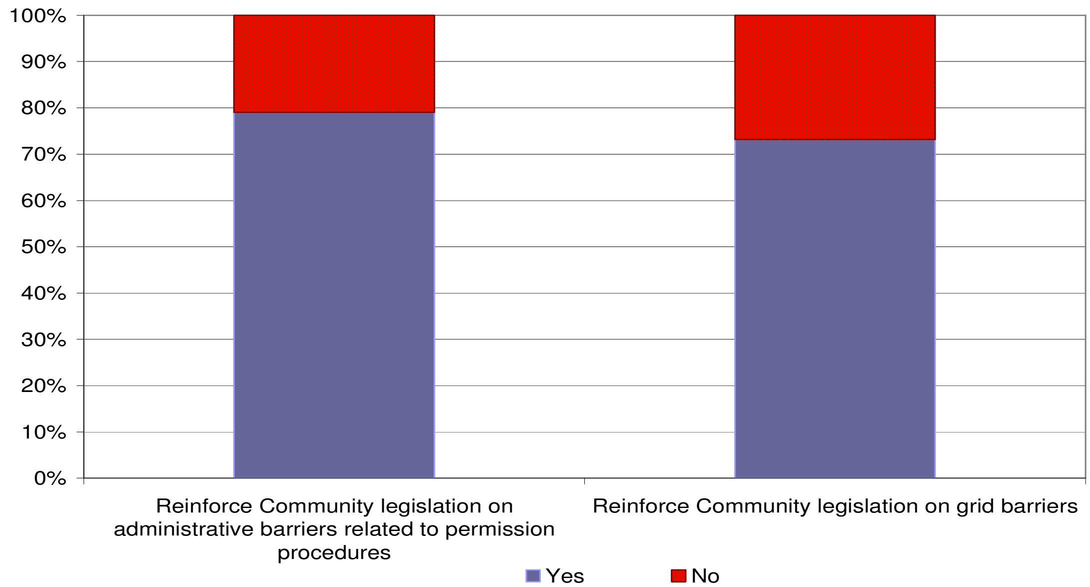

Figure 55 Is a reinforcement of community legislation necessary?

Looking at Figure 55, one can see that the clear majority (almost 80 %) of the respondents evaluate the community's legislation on administrative barriers and grid barriers to be improvable.

The following improvement possibilities concerning the permission procedure have been identified by stakeholders:

→ **Streamlining and simplification of complex procedures**

→ **Shortening the time for obtaining a licence by, for example, setting maximum time limits for responses**

- → **Introduction of a "one-stop" agency for submitting applications**
- → **Improvement of communication between authorities**
- → **Harmonisation of permitting procedures at least at the country level**
- → **Creation of more planning security to applicants**
- → **Homogenisation of evaluation criteria for permissions**
- → **Community should push the improvement or simplification of administrative procedure, since there is no pressure from the countries**

A general impression was that administrative barriers are not predominantly related to EU legislation but to practical problems and national or even local legislations.

Concerning the barriers related to grid issues the following suggestions were provided:

- → **Standardisation of technical and operational aspects of grid connection procedure**
- → **Increase of transparency in the process**
- → **Introduction of internet-based permit procedures**
- → **Penalising authorities if there are delays**
- → **Restriction of grid connection costs**

5 Design and use of systems of guarantee of origin

Rogier Coenraads, Gemma Reece, Ecofys

This section presents an overview of the implementation and use of the guarantee of origin of electricity produced from renewable energy sources in EU Member States, Norway, Switzerland and Iceland. The analysis was carried out in the period April - June 2007. Data provided are up-to-date up to mid-June 2007.

5.1 Implementation of the guarantee of origin

Legal basis for the implementation of the guarantee of origin is the Renewable Electricity Directive (2001/77/EC), which requires each EU Member State to implement a system of guarantees of origin for electricity produced from renewable energy sources. Article 5 of the Directive states that "Member States shall, not later than 27 October 2003, ensure that the origin of electricity produced from renewable sources can be guaranteed as such within the meaning of this Directive".

5.1.1 Current status of implementation

Member States have started implementing national systems for the guarantee of origin. In addition to EU Member States, also Norway, Switzerland and Iceland have decided to introduce a system of guarantees of origin in line with Directive 2001/77/EC. An overview of the current status of implementation of the system of guarantee of origin in each country is depicted in Table 25. The analysis comprises a total of 32 systems of guarantee of origin, i.e. 26 EU Member States having one system of guarantee of origin, 3 systems in Belgium (Flanders, Wallonia and Brussels) and the systems of Norway, Switzerland and Iceland.

A system of guarantee of origin is currently operational in 16 EU Member States, while in 11 EU Member States the system has not been put in place yet. In Norway and Switzerland a GO system is up and running as well, while the system in Iceland is expected to be put in service not later than the end of 2007.

Issuing Bodies for the GO are typically either the electricity regulator or Transmission System Operator (TSO). 13 Member States have appointed the regulator as Issuing Body for the GO, while 8 Member States have given this role to the TSO. Only 3 Member States, i.e. Cyprus, Hungary and Latvia, have not yet appointed the Issuing Body.

Table 25. Implementation of GO in EU Member States, Norway, Switzerland and Iceland

	Legislation	Issuing Body appointed?		GO system in operation?
		Type	Name	
Austria	yes	regulator	E-Control	yes
Belgium, F	yes	regulator	VREG	yes
Belgium, W	yes	regulator	CWaPE	yes
Belgium, B	yes	regulator	BRUGEL	yes
Bulgaria	yes	regulator	SEWRC	no
Cyprus	no	*n.a.*	*n.a.*	no
Czech Republic*	yes	electricity market operator	OTE	yes
Denmark*	yes	TSO	Energinet.dk	yes
Estonia	yes	TSO	Eesti Energia	no
Finland	yes	TSO	Fingrid Oyj	yes
France	yes	TSO	RTE	yes
Germany	yes	verifiers	Öko-Institut	yes
Greece*	yes	regulator	RAE	no
Hungary*	under preparation	*n.a.*	*n.a.*	no
Ireland*	yes	regulator	CER	yes
Italy*	yes	electricity market operator	GSE	yes
Latvia	under preparation	*n.a.*	*n.a.*	no
Lithuania	yes	TSO	JSC Lietuvos Energija	yes
Luxembourg*	yes	regulator	ILR	no
Malta	yes	regulator	MRA	no
Netherlands*	yes	TSO	CertiQ	yes
Poland*	yes	regulator	URE	yes
Portugal	under preparation	TSO (planned)	REN (planned)	no
Romania	under preparation	regulator	ANRE	no
Slovakia	yes	regulator	ÚRSO	yes
Slovenia	yes	regulator	Energy Agency of the Republic of Slovenia	yes
Spain*	yes	regulator	CNE	no
Sweden*	yes	TSO	Svenska Kraftnät	Official GO (PDF): yes EECS GO: yes
UK	yes	regulator	OFGEM	yes
Norway	yes	TSO	Statnett	yes
Switzerland	yes	TSO	swissgrid	yes
Iceland*	yes	TSO	Landsnet	no
	yes: 27 **under preparation: 4** **no: 1**	**regulator:15** **TSO: 11**		**yes: 20** **no: 12**

n.a. = not available

Table notes:

Czech Republic: Operátor trhu s elektřinou (OTE) is the public Electricity Market Operator which acts as Issuing Body. It was established next to the already existing Energy Regulator.

Denmark: Energinet.dk was established in 2005 by a merger of Eltra (TSO of Western Denmark) and Elkraft System (TSO of Eastern Denmark)

Greece: RAE (Regulative Authority for Energy) is responsible for the enactment of the system of guarantees of origin and its assurance mechanism. The TSO (Hellenistic Transmission System Operator, HTSO) is responsible for the electricity supplied to the systems directly or through the network. The Network Operator of the islands not connected to the mainland's interconnected system is responsible for the electricity supplied to the network of these islands. The Centre for Renewable Energy Sources (CRES) is responsible for the electricity produced by autonomous stations that do not supply the System or the Network. Source: Law 3468/2006

Hungary: GO system is not in place, but it will be introduced in the near future under the provisions of the new Electricity Act which may come in force on the 1st of January 2008. Detailed rules are under preparation.

Ireland: an annual GO certificate (non-transferable) is issued stating how many MWh have been generated

Italy: in October 2006 GRTN (Gestore della Rete di Trasmissione Nazionale) became GSE (Gestore di Servizi Elettrici). GSE is the electricity market operator. Nowadays, the TSO in Italy is Terna

Luxembourg: detailed implementation rules for the GO are currently being drafted

Netherlands: CertiQ is a subsidiary of Tennet

Poland: the Polish Regulatory Office (URE) is the Issuing Body; the GO registry is run by the Polish Power Exchange (TGE)

Spain: GO registry will be put in operation not later than 1 December 2007

Sweden: in case financial support has been received (i.e. an El-Cert has been issued), the official GO is issued by the TSO, Svenska Kraktnät, in PDF format in a PDF registry which may be printed by the producer. The PDF file can be printed as many times the producer wishes and it is not transferable. If no financial support (not eligible for El-Cert) has been received, a GO is inserted in the EECS GO registry and can be transferred to another holder. If a plant receives an EECS GO, the PDF format GO is blocked.

Iceland: GO system is expected to be operational end 2007

Table 26 provides further details on the appointed Issuing Body for GOs and on the GO registry. Where available, a weblink to the GO registry is provided. Distinction is made between registries which are fully publicly available, and registries which are not fully publicly available.

As shown in Table 26, in most cases where a central GO registry is in place, it can be accessed via the internet. Typically only GO account holders can log in to the system to access the true GO registry. Only the GO registries of France, Lithuania and the UK can be accessed on-line by the general public.

Table 26. Overview GO registries in EU Member States, Norway, Switzerland and Iceland

Country	Issuing Body	Website IB	GO registry: publicly available?	Remarks GO registry
Austria	E-Control	www.e-control.at	GO registry (https://www.stromnachweis.at) not publicly available	Use of national registry obligatory for RES-E which received support. For other RES-E the registry can be used voluntarily.
Belgium, Flanders	VREG (Vlaamse Reguleringsinstantie voor de Elektriciteits- en Gasmarkt)	www.vreg.be	GO registry (http://certificatenbeheer.vreg.be) is not publicly available	
Belgium, Wallonia	CWaPE (Commission wallonne pour l'énergie)	www.cwape.be	GO registry not publicly available	
Belgium, Brussels	BRUGEL (Brussels Gas Electricity)	www.brugel.be	GO registry not operational	
Bulgaria	SEWRC (State Energy and Water Regulatory Commission)	www.dker.bg/	GO registry will be put into operation end 2007	Publicly available GO registry, which will be placed on the SEWRC web page
Cyprus	*n.a.*	*n.a.*	*n.a.*	
Czech Republic	OTE (Operátor trhu s elektřinou)	www.ote-cr.cz	No central GO registry in place	
Denmark	Energinet.dk	www.energinet.dk	GO registry not publicly available	Apart from the central GO registry, a GO can be issued in paper and PDF file format as well
Estonia	Eesti Energia	www.energia.ee	GO registry not operational	
Finland	Fingrid	www.fingrid.fi	GO registry (https://www.grexcmo.com) not	Issuing GOs and maintaining the GO registry has been

Country	Issuing Body	Website IB	GO registry: publicly available?	Remarks GO registry
			publicly available	outsourced to Grexel. Grexel issues GOs on behalf of Fingrid
France	RTE (Gestionnaire du Reseau de Transport d'Electricite)	www.rte-france.com	GO registry publicly available on http://www.rte-france.com/htm/fr/offre/offre_garanties_registre.jsp	RTE updates the public accessible register once a month
Germany	Öko-Institut	www.oeko.de	GO registry (http://de.logactiv.com) not publicly available	
Greece	RAE (Regulatory Authority of Energy) HTSO (Hellenistic Transmission System Operator) CRES (Centre for Renewable Energy Sources)	www.rae.gr www.desmie.gr www.cres.gr	GO registry not operational	Law 3468/2006 appoints the issuing bodies. A ministerial decision (subject to opinion of RAE) needs to be passed to install the GO procedure.
Hungary	*n.a.*	*n.a.*	*n.a.*	
Ireland	CER (Commission for Energy Regulation)	www.cer.ie	GO registry not operational	The adoption of the GO system is a matter for the Department of Communications, Marine and Natural Resources.
Italy	GSE (Gestore di Servizi Elettrici)	www.grtn.it	GO registry not publicly available	
Latvia	*n.a.*	*n.a.*	*n.a.*	
Lithuania	JSC Lietuvos Energija	www.lpc.lt/en	GO registry publicly available on www.lpc.lt/lt/main/klm	

Country	Issuing Body	Website IB	GO registry: publicly available?	Remarks GO registry
Luxembourg	ILR (Institut Luxembourgeois de Regulation)	www.ilr.etat.lu	GO registry not yet operational	
Malta	MRA (Malta Resources Authority)	www.mra.org.mt	GO registry not operational	
Netherlands	CertiQ	www.certiq.nl	GO registry not publicly available	
Poland*	TGE (Towarowa Giełda Energii)	www.polpx.pl	GO registry (https://rejestr.tge.pl) is not publicly available	
Portugal	REN (Rede Eléctrica Nacional)	www.ren.pt	*n.a.*	
Romania	ANRE (Autoritatea Nationala de Reglementare in domeniul Energiei)	www.anre.ro	*n.a.*	
Slovakia	ÚRSO (Regulatory Office for Network Industries)	www.urso.gov.sk	No central GO registry in place	
Slovenia	Energy Agency of the Republic of Slovenia	www.agen-rs.si/en	GO registry not publicly available	
Spain	CNE (Comisión Nacional de Energía)	www.cne.es	GO registry will be put into operation not later than 1 December 2007	
Sweden	Svenska Kraftnät Grexel (EECS GO)	www.svk.se www.grexel.com	Official GO (PDF): no GO registry EECS GO: GO registry in place (https://www.grexcmo.com - not publicly available)	Svenska Kraftnät issues the PDF-files for Elcert plants Issuing EECS GOs and maintaining the EECS GO registry has been outsourced to Grexel.
UK	OFGEM (Office of Gas and Electricity Markets)	www.ofgem.gov.uk	GO registry is publicly available on www.regoregister.ofgem.gov.uk	
Norway	Statnett	www.statnett.no	GO registry not publicly available	

Country	Issuing Body	Website IB	GO registry: publicly available?	Remarks GO registry
Switzerland	swissgrid	www.swissgrid.ch	GO registry not publicly available up to date, public access planned for late 2007	
Iceland*	Landsnet	www.landsnet.is	GO registry not yet operational	

n.a. = not available

Table notes:
Poland: the Polish Regulatory Office (URE) is the Issuing Body; the GO registry is run by the Polish Power Exchange (TGE)
Iceland: GO registry is expected to be operational not later than last quarter of 2007

The Issuing Body is always responsible for the GO registry, but does not necessarily need to operate it himself. In Germany for example the registry is operated by Logactiv a company based in the UK. Another example is the co-operation of Austria, Denmark, Finland, Norway, Slovenia and Sweden in one central registry: RECSCMO (https://www.recscmo.org). This type of co-operation saves money and the Issuing Bodies can therefore offer their services for low tariffs. Finland and Sweden have outsourced their GO registry to Grexel (https://www.grexcmo.com).

Most of the GO registries are originally based on the RECS system. In most cases the registries are combined and also serve the RECS system. Within the regulations of the AIB the GO system and the RECS system exclude each other, so it is impossible for members of the AIB to issue double certificates. If the GO is also available for the RECS system the GO is ‘flagged’. This opens the possibility to transfer a GO to a RECS system (being non-GO). The other way around is not possible and it is not possible to transfer a GO to a RECS system.

Most registries publish statistics: total volumes of issued, transferred and redeemed GOs. The published statistics never make individual trades visible for reasons of privacy of the market players.

5.1.2 Design of the system of guarantee of origin

The design of the system of guarantee of origin differs from country to country. Table 27 summarises the implementation of key aspects of systems of guarantee of origin: central registry, transferability and redemption of the guarantee of origin.

Redemption has not been defined in Article 5 of the RES-E Directive. In order to ensure that a GO is used only once, i.e. in order to prevent double use and counting of one unit of electricity from renewable energy sources produced, the principle of redemption is crucial.

AIB and EECS

Within the Association of Issuing Bodies (AIB) several Issuing Bodies from different countries co-operate and promote the use of a standardised system for energy certificates. The AIB and RECS International have developed a standardised system of the guarantee of origin: the European Energy Certificate System (EECS). EECS is based on harmonised structures and procedures, including a standard format for the interface between national registries, facilitating international trade in standardised guarantees of origin without the danger of double counting and double selling.

Table 27. Design of the system of guarantee of origin

	Central GO registry in operation?	**GO transferable?**	**Redemption mechanism implemented?**	**Issuing Body member of AIB for GO?**	**GO standardised according EECS?**
Austria	yes	yes	Nat. electronic registry: yes Paper GO: no	yes	yes
Belgium, F	yes	yes	yes	yes	yes
Belgium, W*	yes	yes	yes	planned	planned
Belgium, B*	planned	yes	no	planned	planned
Bulgaria	planned	no	no	no	no
Cyprus	no	*n.a.*	*n.a.*	no	no
Czech Rep.	no	no	no	no	no
Denmark	yes	yes	yes	yes	yes
Estonia	planned	*n.a.*	*n.a.*	no	no
Finland	yes	yes	yes	yes	yes
France*	yes	no	no	no	no
Germany*	yes	yes/no	yes	yes	yes
Greece	planned	*n.a.*	*n.a.*	no	no
Hungary	no	*n.a.*	*n.a.*	no	no
Ireland	no	no	no	no	no
Italy*	yes	yes	no	no	no
Latvia	no	*n.a.*	*n.a*	no	no
Lithuania*	yes	yes	yes	no	no
Luxembourg	planned	no	*n.a.*	no	no
Malta	planned	*n.a.*	*n.a.*	no	no
Netherlands	yes	yes	yes	yes	yes
Poland	yes	yes	yes	no	no
Portugal	no	*n.a.*	*n.a.*	no	no
Romania	no	*n.a.*	*n.a.*	no	no
Slovakia	no	*n.a.*	no	no	no
Slovenia*	yes	yes	yes	planned	planned
Spain	planned	yes	yes	no	no
Sweden	Official GO (PDF): yes EECS GO: yes	Official GO (PDF): no EECS GO: yes	Official GO (PDF): no EECS GO: yes	Official GO (PDF): no EECS GO: yes	Official GO (PDF): no EECS GO: yes
UK	yes	yes	no	no	no
Norway	yes	yes	yes	yes	yes
Switzerland*	yes	yes	yes	planned	planned
Iceland	no	*n.a.*	*n.a.*	no	no
	yes: 16 **planned: 7**	**yes: 17**	**yes: 14**	**yes: 8** **planned: 4**	**yes: 8** **planned: 4**

n.a. = not available

Table notes:
Belgium, Wallonia: GO are standardised according to EECS and recognition is in progress: application has been submitted to AIB and formal acceptance is expected in December 2007. Until then, transferability of GO is temporarily frozen.
Belgium, Brussels: GO will be standardised according to EECS (including the implementation of a redemption mechanism) and recognition is in progress: application will be submitted to AIB and formal acceptance is expected in December 2007. Until then, transferability of GO is temporarily frozen.
France: GO is not transferable; RECS certificate is transferable
Germany: GOs are tradable, unless financial support has been received.
Italy: GOs can only be transferred to another holder together with the physical electricity
Lithuania: According to the rules on the issue of GOs, a GO can be transferred from RES-E producer to the supplier which bought electricity according to bilateral contracts if the RES-E is not supported. Tradability of GO to other holders is not defined.
Slovenia: AIB accreditation for compliance with EECS is expected end 2007
Switzerland: AIB accreditation for compliance with EECS is ongoing

Currently 13 EU Member States have a central registry for GO in operation, as well as Norway and Switzerland. Another 6 Member States and the Brussels region are planning to introduce a central GO registry.

In the majority of the GO systems currently in operation, GOs can be transferred from one holder to another holder. However, in Bulgaria, Czech Republic, France, Ireland and Luxembourg GOs cannot be transferred, while in Germany, Italy and Sweden restrictions exist on the transferability of a GO. For example, in Germany the transferability of GOs is restricted to GOs where no financial support was granted. In case financial support was received, the GOs cannot be transferred anymore. Another type of restriction of transferability of GOs exists in Italy, where GOs can only be transferred to another holder together with the physical electricity.

The principle of redemption of a GO has not been introduced in the majority of countries. Only 14 GO systems were found to have introduced redemption. From the EU Member States, 11 Member States have a GO system with redemption. All countries which have an EECS GO system have introduced redemption, as this is a requirement of EECS. Apart from the GO systems which have or will adopt EECS, only Lithuania, Poland and Spain have implemented redemption as well. In our view, GO systems without redemption have a serious risk of double use (e.g. for disclosure or for the supply of green electricity) of one single GO. Therefore, we think systems which have not introduced redemption pose a serious risk for the European internal market for GOs.

Currently 17 Issuing Bodies co-operate in the AIB. Some countries only co-operate within EECS for RECS (France, Ireland, Italy, Luxembourg, Portugal, Slovenia, Spain), while eight countries (Austria, Belgium (Flanders), Denmark, Finland, Germany, Netherlands, Norway and Sweden) are issuing GOs according to EECS. The Belgian regions of Wallonia and Brussels, and Slovenia and Switzerland are in the process of adopting the EECS standard.

Article 5 of Directive 2001/77/EC leaves design of the national system of guarantee of origin to each individual country.

Details on the design of the GO in EU Member States, Norway and Switzerland can be found in Table 28.

As can be observed, the systems of guarantee of origin have different formats and designs from country to country. Differences are the amount of electricity a GO represents, the period of validity of a GO once it has been issued and whether GOs are earmarked or not. Earmarking is used to indicate whether financial support has been paid to a unit of RES-E. In some cases an earmark is also used to indicate whether the certificate can be used as a RECS certificate.

In practice, two methodologies prevail regarding the standard unit of a GO. The first methodology is to issue GOs for a specified amount of electricity generated. The most common unit is 1 MWh, which is used by 11 systems. On the other hand, one GO can be issued for all electricity which was generated during a specified period of time, for example one month. In this case the GO does not represent a standard amount of electricity in terms of kWh or MWh, but has a variable size. Six systems were found to issue GOs according to this methodology.

The validity of a GO has not been defined in most systems of guarantee of origin. In practice this means that the GO is valid for an unlimited period of time, until it is redeemed upon use of the GO (in cases in which redemption has been implemented). Four GO systems (Poland, Sweden, Norway and Switzerland) have explicitly indicated that the validity of a GO is unlimited (until redemption). Five countries, i.e. Belgium, Netherlands, Slovakia, Slovenia and Spain, have limited the validity of a GO to a specified period. After this period the GO automatically expires.

The systems of guarantee of origin in 7 EU Member States were found to apply an earmark on a GO to indicate whether financial support has been granted. Within the group of countries which have a feed-in/premium tariff instrument in place, Denmark, Germany, Netherlands, Slovenia, Norway and Switzerland apply earmarking to show the status of the GO towards the financial support scheme in place.

Within the group of countries with a quota obligation, Belgium, Sweden and the UK apply earmarking.

Another approach is to automatically redeem the GO when financial support is granted. This approach is applied by Lithuania, Luxembourg and Poland. This means that once financial support has been received, the GO is not available and cannot be used anymore for other purposes. Indirectly the same principle is applied in Germany as well, where the Renewable Energy Source Act (chapter 18) states if financial support has been received a GO cannot be transferred to another holder.

Table 28. Design of the guarantee of origin

	Standard unit used in practice	**Validity of GO**	**Earmarking of GO? (financial support and/or RECS)**	**Remarks**
Austria	1 MWh	not defined	*n.a.*	GO can be issued in both paper and electronic version
Belgium, Flanders	1 MWh	5 years	Certificates are earmarked whether they can be used for GO (y/n) and whether they can be used as green certificate under the quota obligation (y/n)	
Belgium, Wallonia	1 MWh	until 31 December of following year (n+1)	GOs are earmarked whether financial support has been granted or not	A GO can be a RES-GO, a CHP-GO or both a RES-&-CHP-GO.
Belgium, Brussels	1 MWh	until 31 December of following year (n+1)	GOs will be earmarked whether financial support has been granted or not	
Bulgaria*	no standard unit, but variable size	not defined	Not relevant: GOs are not tradable. Based on GO preferential price is paid to RES producer.	
Cyprus	*n.a.*	*n.a.*	*n.a.*	
Czech Republic*	not defined	not defined	not defined	
Denmark*	no standard unit, but variable size	not defined	GOs are earmarked whether financial support has been granted or not	Apart from the central GO registry, a GO can be issued in paper and PDF file format as well
Estonia	1 MWh	*n.a.*	not defined	
Finland	1 MWh	not defined	no	The GO is issued either in paper format or electronically in the GO registry
France	no standard unit, but variable size	n.a.	no	
Germany	not defined	not defined	GOs are earmarked whether financial support has been granted or not. GOs which have received support may not be transferred to another holder.	Format not defined, which implies that both paper and electronic GOs can be issued
Greece	*n.a.*	*n.a.*	*n.a.*	
Hungary	*n.a.*	*n.a.*	*n.a.*	

	Standard unit used in practice	Validity of GO	Earmarking of GO? (financial support and/or RECS)	Remarks
Ireland	*n.a.*	*n.a.*	*n.a.*	
Italy*	no standard unit, but variable size	not defined	no earmarking	
Latvia	*n.a.*	*n.a*	*n.a*	
Lithuania	1 kWh	not defined	No earmarking: GOs are automatically redeemed when financial support has been received	GOs generated by non-eligible RES-E sources can be issued in paper format instead of electronically. Until now (June 2007) no paper format GOs have been issued in practice.
Luxembourg	no standard unit, but variable size	*n.a.*	No earmarking: GOs which are submitted to the national authority to qualify for financial support, will be redeemed.	
Malta	*n.a.*	*n.a.*	*n.a.*	
Netherlands	1 MWh or a multiple of 1 MWh	1 year	A GO certificate has two earmarks: (1) eligible for support (y/n) , (2) can the certificate also be used as a RECS certificate ?(y/n)	
Poland	no standard unit, but variable size	unlimited	No earmarking for support. All GOs can be used for fulfilment of the quota obligation. When used for the quota obligation, the GO is automatically redeemed.	
Portugal	1 MWh	*n.a.*	*n.a.*	
Romania	*n.a.*	*n.a.*	*n.a.*	
Slovakia	1 MWh	1 year	*n.a.*	
Slovenia	1 kWh or a multiple of 1 kWh	5 years	GO has earmark whether financial support has been received or not	

	Standard unit used in practice	Validity of GO	Earmarking of GO? (financial support and/or RECS)	Remarks
Spain	1 kWh or a multiple of 1 kWh	GOs issued for energy generated in year n-1 will be cancelled automatically on 31 March of year n+1	No earmarking whether financial support has been received or not	
Sweden	Official GO (PDF): no standard unit, but variable size EECS GO: 1 MWh	Official GO (PDF): not defined EECS GO: unlimited (until redemption)	Official GO (PDF): no earmarking EECS GO: earmark whether financial support has been received or not	
UK	1 kWh	*n.a.*	GO has earmark whether financial support has been received or not	
Norway	1 MWh	unlimited	GO has earmark whether financial support has been received or not	
Switzerland	1 kWh (aggregation to 1 MWh for international use)	unlimited	Earmarking of: - financial support - RECS	
Iceland	n.a.	n.a.	n.a.	n.a.

n.a. = not available

no standard unit, but variable size = size of the GO depends on the amount of electricity generated during a specified period of time (e.g. one month)

Table notes:

Bulgaria: no standard unit, but variable size. A GO certificate will be issued for the whole amount of electricity generated in the period of 3 foregoing months. This means that the GO for one period can represent a different quantity of electricity generated to the GO for another period. The period of 3 months can be extended with the Commission's decision up to one year for hydro power stations, solar PV or wind installations.

Czech Republic: no standard format for the GO has been defined

Denmark: the GO represents the amount of electricity generated during one, three, six or twelve months (period can be chosen by the electricity generator)

Italy: RES-E plants have access to the GO system when the yearly production exceeds 50 MWh

5.2 Use of the guarantee of origin

5.2.1 Use of the GO for disclosure

In principle, the GO can be used to facilitate administration and proof of the renewables part in the disclosure of the fuel mix used for electricity generation. At this moment several Member States have chosen to use the GO as unique proof for the renewables part of the fuel mix, while other Member States have recommended to do so.

An overview of the current use of the GO for disclosure purposes is provided in Table 29 below.

Table 29. Use of the guarantee of origin for disclosure in EU Member States, Norway and Switzerland

	Use of GO for disclosure obligatory (embedded in legislation/regulation)	Use of GO for disclosure recommended (guidelines)	No provisions made	Disclosure not enforced yet
Austria	X			
Belgium, F	X			
Belgium, W*	X			
Belgium, B*	X			
Bulgaria	GO system not operational			
Cyprus	GO system not operational			
Czech Republic			X	
Denmark		X		
Estonia	GO system not operational			
Finland		X		
France*			X	
Germany*		X		
Greece	GO system not operational			
Hungary	GO system not operational			
Ireland				X
Italy				X
Latvia	GO system not operational			
Lithuania			X	
Luxembourg	GO system not operational			
Malta	GO system not operational			
Netherlands	X			
Poland			X	
Portugal	GO system not operational			
Romania	GO system not operational			
Slovakia				X
Slovenia	X			
Spain	GO system not operational			
Sweden*		X		
UK*	X			
Total EU-27	**7**	**4**		
Norway*	X			
Switzerland		X		

Situation of 1 July 2007

Table notes:
Belgium, Wallonia: GO issued for electricity generated during a given year may only be used for disclosure of that year. No other means than GO are allowed for disclosing RES-E and/or CHP.
Belgium, Brussels: GO issued for electricity generated during a given year may only be used for disclosure of that year. No other means than GO are allowed for disclosing RES-E and/or CHP.
France: GO is not used for disclosure. RECS certificates can be used for disclosure purposes on a voluntary basis.
Germany: guidelines issued by VDEW (German association of energy suppliers) recommend the use of GO for disclosure
Sweden: the energy branch organisation has published guidelines for disclosure where it is recommended to use GO for disclosure.
UK: Guidance note of DTI on the use of REGOs states that REGOs can be used for the renewable part of the fuel mix disclosure. From 1 July 2007 onwards the use of REGOs for the renewable part of the fuel mix disclosure is a supply license condition.
Norway: regulations from the Norwegian Water Resources and Energy Directorate (NVE) obliges suppliers to use GO for disclosure.

As from July 2007 onwards six countries, i.e. Austria, Belgium, the Netherlands, Slovenia, the UK and Norway, have regulation in force which states that only GOs can be used to demonstrate the renewable part of the fuel mix disclosure. When the GO is used for disclosure, it must be redeemed, which effectively prevents any double use of the GO. The use of GOs for disclosure is mandatory in the UK from July 2007 onwards.

In five countries guidelines have been issued which recommend the use of GOs for disclosure purposes. These countries are Denmark, Finland, Germany, Sweden and Switzerland.

Overall we can conclude that in approximately half of the countries where a GO system is currently in operation, a legal framework or guidelines have been set up obliging or recommending the use of GOs for disclosure of the renewable part of the fuel mix.

5.2.2 Use of the GO for the voluntary market

In the liberalised electricity markets some suppliers have started to offer special products, especially green products. In a number of countries green electricity is now offered to consumers by suppliers. The green offers are based on several tracking mechanisms for electricity. In general we see three type of tracking mechanisms (1) based on guarantees of origin (or on RECS certificates), (2) TÜV certificates[26] and (3) so-called self declarations (selling of green electricity from specific renewable energy sources that are monitored by local auditors)

To protect the consumers and to avoid double selling, some governments have taken the initiative to regulate the tracking mechanism for the voluntary market. In all cases the governments have chosen the standardised guarantee of origin as the mandatory tracking mechanism for green

[26] TÜV certificates are issued by TÜV (Germany). TÜV is a private company which provides energy certification services.

electricity. This means that suppliers are forbidden by law to sell green electricity based on other tracking mechanisms.

An overview of countries which use the GO for supply of electricity from renewable energy sources on the voluntary market is shown in Table 30.

Table 30. Countries which have introduced a framework to use GO for the supply of green electricity to consumers

Country	Framework	Status
Austria	Obligation (regulation)	In force
Belgium, Flanders	Obligation (regulation)	In force
Belgium, Wallonia	Obligation (regulation)	Planned
Belgium, Brussels Region	Obligation (regulation)	Planned
Netherlands	Obligation (regulation)	In force
UK	Recommendation (guideline)	In force
Switzerland	Obligation (regulation)	Planned

It must be noted that all countries where a regulation is in place have a GO system standardised according to EECS. This facilitates exports and imports for the voluntary market, while effectively preventing double use (double counting, double selling) of one single GO at the same time.

5.2.3 Use of the GO for target counting

Reports of Member States on the progress towards the 2010 targets are based on national production statistics. In the European Commission Communication[27] from March 2004 the Commission indicated that it is acceptable to include imports for target counting on the condition that the exporting country subtracts the export from their target.

Import and export can be monitored by the guarantee of origin. Due to the absence of any official agreement between governments about the correction of exports for target counting so far, imports are not reported by any country. This explains why the guarantee of origin is not used to facilitate target counting so far.

Import and export of renewable electricity does however takes place. So far the standardised guarantee of origin is monitored and statistics for import and export are available. All cross border trade monitored is based on the standardised EECS GO so that double counting does not occur. As we have seen before, until now all cross border trade of GOs is triggered by a small number of countries where a disclosure system based on mandatory use of the standardised guarantee of origin and/or the voluntary market based on the standardised guarantee of origin is in place.

[27] The share of renewable energy in the EU, COM(2004) 366 final

5.2.4 The GO and support systems

The introduction of GO systems leads to the question of how GOs and the system of financial support for electricity generation from renewable energy sources interact in each country. In this respect, it is important to make a distinction between RES-E which is eligible for financial support and RES-E which is not eligible for financial support.

Table 31 gives an overview of countries which have made provisions to clarify the relationship between GOs and financial support. Countries not listed have not made any official clarifications on the relationship between GOs and financial support.

Table 31. Relationship GO and support system

Country	Remarks
Feed-in/premium system	
Austria	GO of eligible RES-E must be included in the national electronic registry. For GOs of non-eligible RES-E inclusion in the national electronic registry is voluntary.
Bulgaria	GO is part of the national RES-E policy. The RES producer sells electricity together with the GO to the responsible authority at a fixed preferential price. The GO cannot be transferred to another holder.
Denmark	GOs are not eligible for financial support. GOs must be earmarked whether financial support has been granted or not.
France	If RES-E is supported financially, the buyer of electricity also gets the right to issue the GO. The GO however is not earmarked.
Germany	In case financial support has been received, the GO is issued but cannot be transferred to another holder
Ireland	Under the REFIT scheme the GO can be used to demonstrate "eligible imported electricity". Under the REFIT scheme *"eligible imported electricity" means electricity produced from new electricity generation plant in another Member State and imported from that Member State and covered by a guarantee of origin if the exporting state has accepted explicitly, and stated in the guarantee of origin or in a document which refers to the guarantee of origin, that it will not, for a period of 15 years, use the electricity from that plant to meet its own renewable energy sourced electricity (RES-E) targets and has thereby also accepted that, for that period of 15 years, that electricity can be counted towards the State's RES-E target* (Article 2.1, REFIT terms and conditions, DCMNR, 2006)

Lithuania	GOs generated by eligible RES-E sources can only be issued electronically and are automatically redeemed when financial support has been received. GOs generated by non-eligible RES-E sources can be issued in paper format instead of electronically.
Luxembourg	Producers of eligible renewable energy sources will be able to submit GOs to the Ministry of Environment to demonstrate the amount of electricity generated which is eligible for the bonus for renewable electricity. GOs which have been submitted to the Ministry of Environment to qualify for the bonus payment, will be redeemed.
Malta	Not defined. However the Malta MS Report to the European Commission states that "it is noted that Grants and net metering will require monitoring (consistent with EU Guarantees of Origin) as long as the support measures are in place to combat scope for abuse."[28]
Netherlands	Administration of financial support (premium) is done based on GO certificates, which are earmarked whether they are eligible for financial support or not
Slovenia	GO has an earmark whether financial support has been received or not. After the financial support has been received, the GO is still tradable.
Spain	Order ITC/1522/2007, which introduces the GO, states that if a GO is exported, the production device that has received premiums or incentives for the generated electricity and requested the GO for export must resign from financial support.
Switzerland	The revised energy law foresees that the administration of financial support will be done based on GO certificates
Quota obligation	
Belgium, Flanders	Certificates are earmarked whether they can be used for GO (y/n) and whether they can be used as a green certificate under the quota obligation (y/n). In case a certificate is exported, it cannot be used anymore as a green certificate under the quota obligation in Flanders.
Belgium, Wallonia	GOs are issued in coordination with support certificates based on unique measurement data and a unique generation plant registry. GO and support certificates are freely tradable independently from each other and from the electricity. A GO may never be used to fulfil quota obligations and a support certificate may never be used for disclosure: they are different instruments serving different purposes, namely a GO is used to inform the consumer of the quality of the electricity it consumes and a support certificate is used for encouraging renewable electricity generation. Exporting electricity has no impact on GO or on support certificates.

[28] Report by Malta to the European Commission on the Implementation of Directive 2001/77/EC on the Promotion of Electricity from Renewable Energy Sources, October 2005

Belgium, Brussels	GO will be issued in coordination with support certificates based on unique measurement data and a unique generation plant registry. GO and support certificates are freely tradable independently from each other and from the electricity. A GO may never be used to fulfil quota obligations and a support certificate may never be used for disclosure: they are different instruments serving different purposes, namely a GO is used to inform the consumer of the quality of the electricity it consumes and a support certificate is used for encouraging renewable electricity generation. Exporting electricity has no impact on GO or on support certificates.
Poland	GO is used to facilitate the administration of the quota obligation. Each company under the obligation has to submit a pre-defined amount of GOs for redemption, which means that when a GO is used for the quota obligation, it cannot be used anymore for other purposes (e.g. export). URE is responsible for the redemption. Imported GOs cannot be used to fulfil the obligation.
Sweden	Sources eligible for El-Cert: GO (in PDF format) may be issued as well. This GO is not included in the EECS GO registry Sources not eligible for El-Cert: electronic and transferable GO in the EECS GO system may be issued
UK	Both REGOs and ROCs are issued for the same unit of electricity generated from renewable energy sources GO has earmark whether financial support has been received or not

GO and support instruments: possible variants

Taking into account the two main support instruments in place in Europe, i.e. the quota obligation with tradable support certificates and the feed-in (premium) tariff, we can distinguish four variants of how the guarantee of origin is currently being used in relation to these support instruments. The variants are illustrated graphically in Figure 56.

I. Quota obligation with tradable support certificates: the fact that an obligation is in place, increases the value of renewable electricity over the value of conventional electricity. The value level of the renewable electricity varies over time and depends on supply and demand of the support certificates which are required to fulfil the obligation. For this support instrument we can distinguish two variants of the GO:
   a. A free tradable guarantee of origin is given to the generator on top of the support certificate issued to fulfil the obligation.
   b. The guarantee of origin is embedded in the support certificate itself (i.e. the guarantee of origin is redeemed after the support certificate to fulfil the obligation has been issued).

II. Feed-in tariff: a fixed subsidy per kWh. One can distinguish a fixed feed-in tariff, which is one single tariff for both the grey and green part of the electricity together, and a premium tariff, which is a fixed premium for only the green part of the electricity. In the latter case the generator sells (the grey part of) the electricity on the regular electricity market. For the feed-in support instrument (both fixed feed-in tariff and premium tariff) we can distinguish two variants of the GO:
   a. A free tradable guarantee of origin is given to the generator on top of the subsidy.
   b. The guarantee of origin issued is embedded in the subsidy (the guarantee of origin is redeemed after the subsidy is paid).

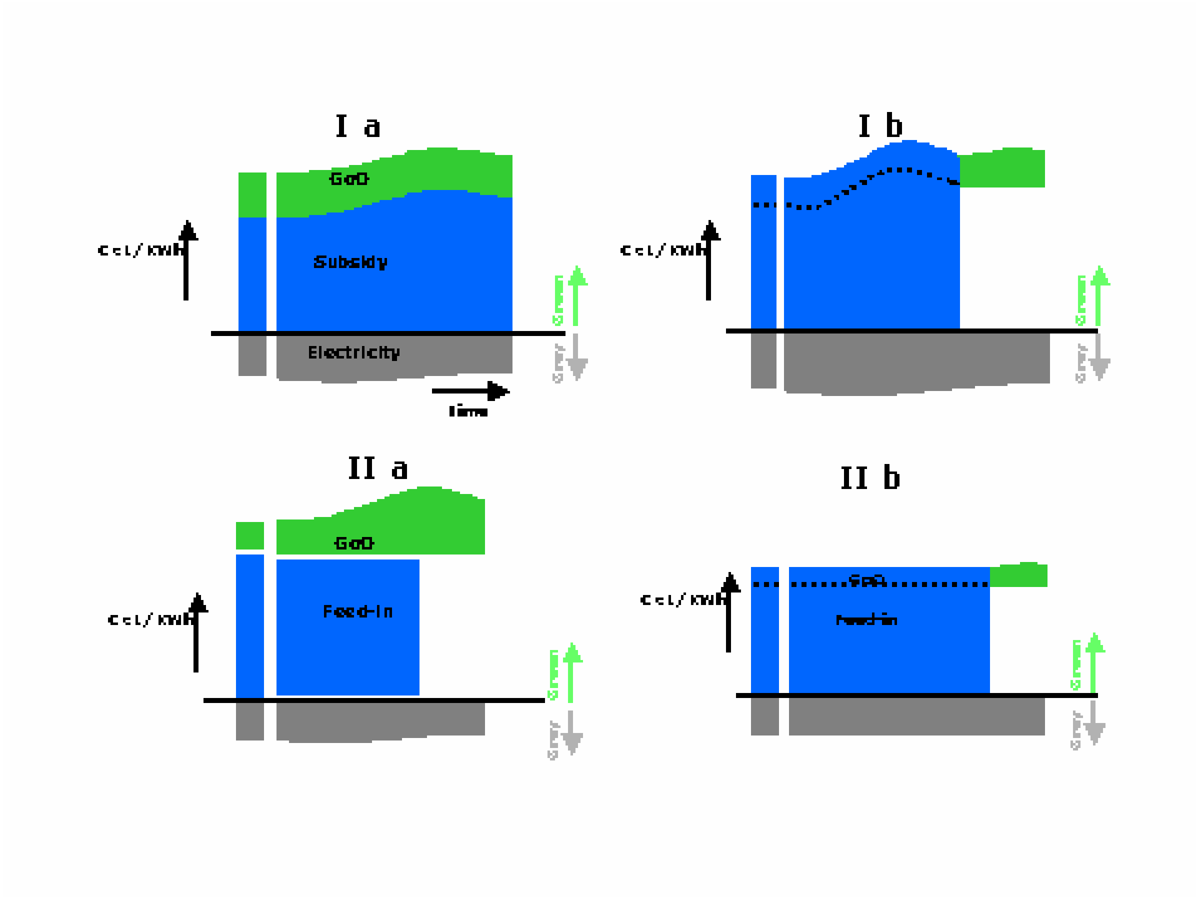

Figure 56. Implementation of GO in quota obligations (I) and feed-in systems (II)[29]

Looking at this overview some remarks must be made:

- The income from selling the physical electricity is not examined. In practice we see some differences between countries as well. In Germany the physical electricity is bought together with the greenness for a fixed price. In most other cases the physical part has to be sold on the electricity market as such.
- In most cases financial support is limited in time. The guarantee of origin and the physical electricity are freely transferable after this period.

[29] The use of the guarantee of origin, RECS International, October 2005

5.3 Trade and statistics of guarantee of origin

The analysis in the previous chapters has made clear that the current picture of the European systems of guarantee of origin is a fragmented one: a wide range of different systems with different designs of GOs has been implemented. In general one can state that most of the earlier GO systems have sought co-operation under the umbrella of the Association of Issuing Bodies. These GO systems have adopted a common standard for issuing, redemption and transfer of the GO: EECS. The majority of GOs currently being issued in Europe, are being issued under EECS. GOs issued outside EECS represent a minority, although accurate statistics on these GO systems are not available.

In this chapter we provide an overview of the volume of certificates under EECS over the past few years.

Volume of certificates in EECS

The AIB monitors the volumes of certificates issued and redeemed within EECS, as well as the certificates exported and imported within the system. Within EECS both GO ('EECS GO') and RECS ('EECS RECS') certificates exist. Unfortunately within the statistics of AIB / RECS International no exact distinction can be made between EECS GO and EECS RECS certificates.

However, virtually all certificates issued within Austria, Belgium (Flanders), Denmark, Finland, the Netherlands, Norway and Sweden are EECS GO certificates. This represents more than 90% of certificates issued under EECS.

Figure 57 provides an overview of the total volume of standardised certificates issued and redeemd in the period 2001 - 2006. One can observe that the number of certificates issued and redeemed has increased strongly throughout this period. In 2006, certificates representing 63 TWh of electricity from renewable energy sources were issued under EECS, with the vast majority (more than 90%) being GO certificates.

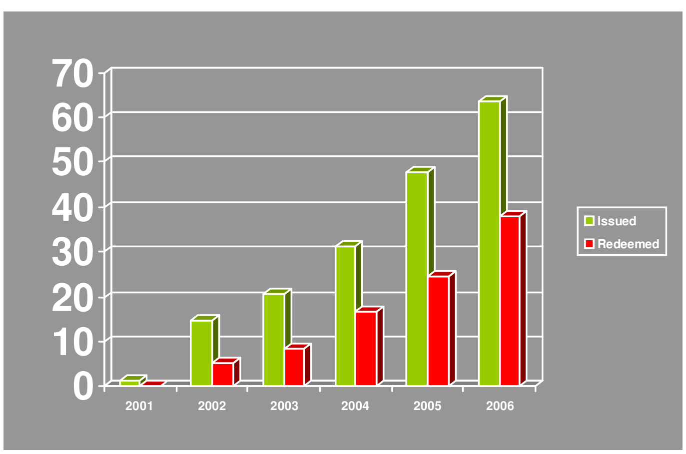

Figure 57. Annual volume of certificates issued and redeemed under EECS (TWh).

Source: RECS International

In 2006, 83% of the volume of certificates (both GO and RECS) issued under EECS represented hydropower, while biomass accounted for 7% and wind for 6% of all certificates issued under EECS.

Figure 58 shows in which countries the certificates were issued. In 2006, most certificates were issued in Sweden, Norway, Finland and the Netherlands. The vast majority of these certificates are GO certificates. It is clear that the Scandinavian countries, especially Sweden and Norway, currently are the largest issuers of EECS certificates. Sweden and Norway represented 71% of all certificates issued under EECS in the year 2006.

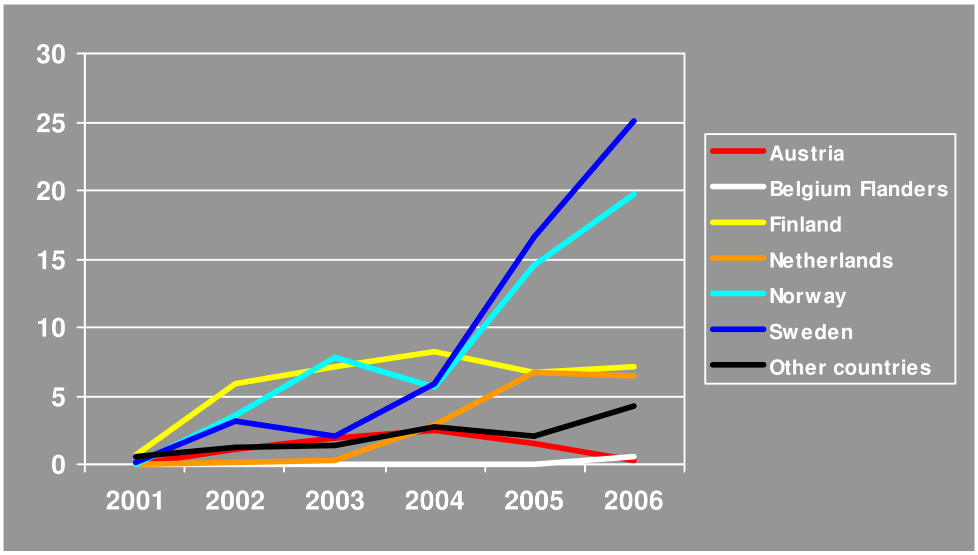

Figure 58. Annual volume of certificates issued under EECS, per country (TWh).

Source: RECS International

Redemption of EECS certificates throughout the period 2001-2006 is depicted in Figure 59. In total 38 TWh of certificates were redeemed under EECS in 2006. The countries contributing most to the redemption of certificates were the Netherlands, Sweden and Austria. The redemption in the Netherlands is to serve the huge voluntary market for green electricity in this country. In the Netherlands it has been stated in the law that suppliers of green electricity offerings need to redeem GO certificates in order to support their claim for green electricity supply to their customers.

In Austria GO certificates serve to demonstrate the renewable part of the fuel mix of electricity supply.

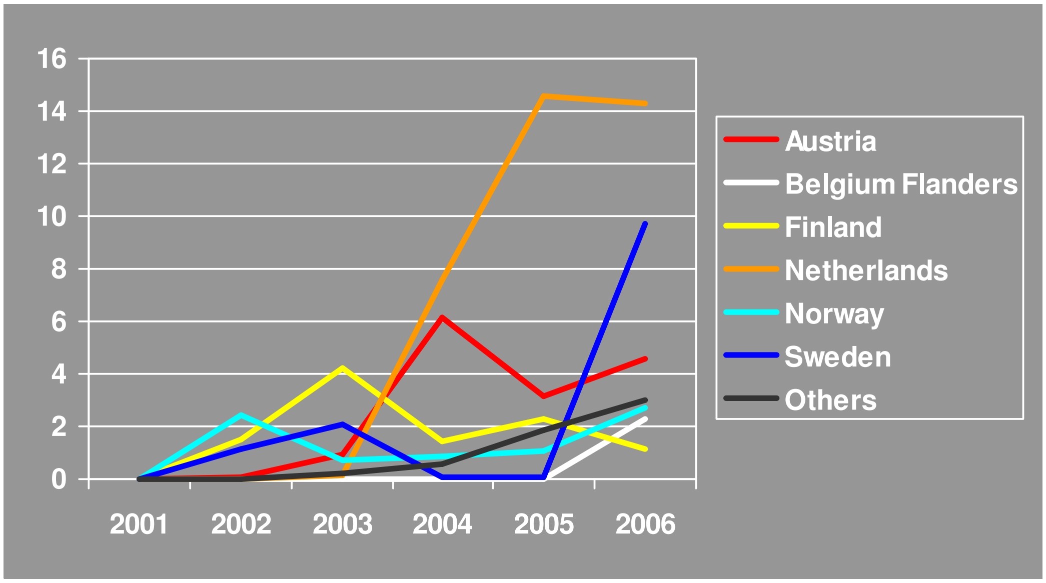

Figure 59. Annual volume of certificates redeemed under EECS, per country (TWh).

Source: RECS International

Figure 59 illustrates clearly that if a specific use of the GO has been assigned and obligatory redemption has been introduced as a core part of this specific use (e.g. fuel mix disclosure, supply of green electricity in the voluntary market), then the volume of certificates redeemed increases significantly. In addition, also current international trade of GO certificates is strongly determined by this. As demonstrated in Figure 60, the international trade of GO certificates really took off in 2004, with the vast majority of international trade being directed towards two countries: Austria and the Netherlands. Again, this can be explained by the fact that in these countries the use of GOs for disclosure has been officially assigned. Since 2006 the use of the GO for disclosure purposes has also been mandatory in Belgium (Flanders), while recent guidelines recommend the use of GO for disclosure in Germany. In 2006, approximately 17 TWh worth of renewable electricity was exported and imported under EECS.

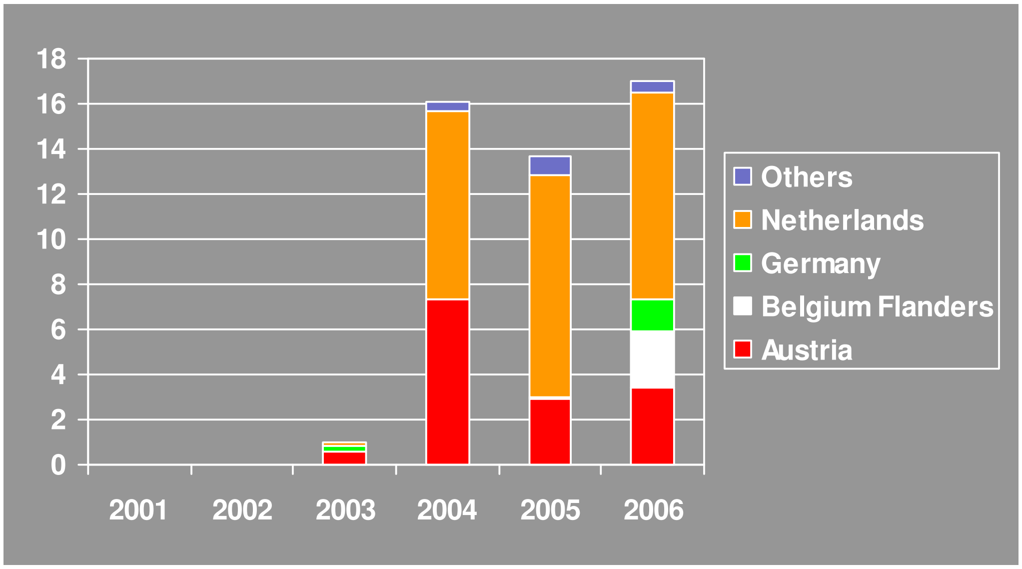

Figure 60. Annual volume of certificates imported under EECS, per country (TWh).

Source: RECS International

The major exporting countries of GO certificates are Finland, Sweden and Norway, as depicted in Figure 61.

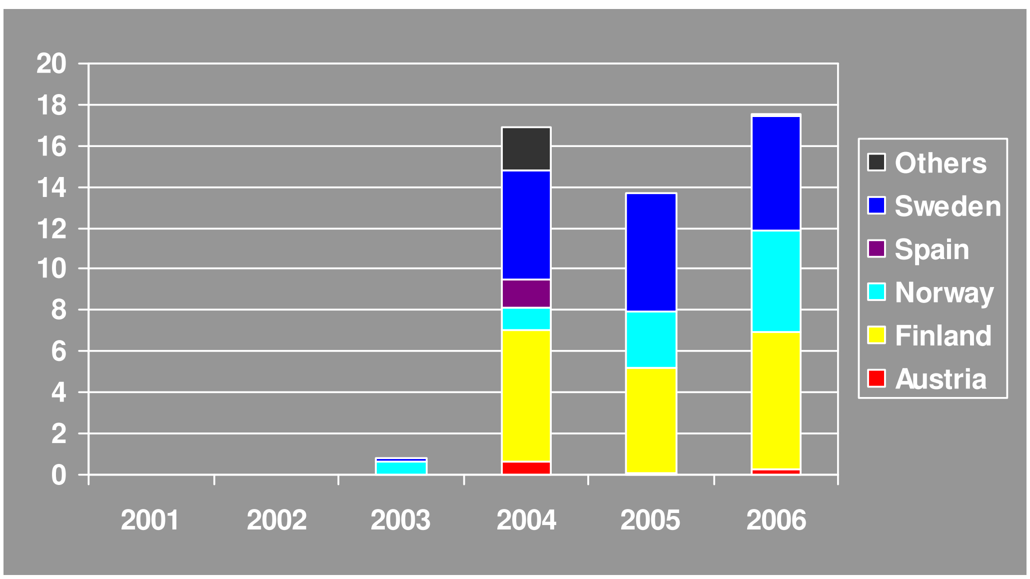

Figure 61. Annual volume of certificates exported under EECS, per country (TWh).

Source: RECS International

International trade of guarantee of origin

At the moment, import and export of GOs is not coordinated between countries and double counting occurs for that reason. It does happen that the importing country takes account of the imported GOs while the exporting country does not take account of the exported GOs for their own disclosure. For example Finland, a big exporting country of GOs, has only recently begun to correct their national residual electricity mix for exported GOs.

In this respect it is worth to mention that in March 2007 Switzerland signed an agreement with Italy regarding the mutual recognition of electricity from renewable sources.

Annex 1: Questionnaire on barriers

1) How many authorities have to be contacted before plant construction of a renewable project can begin?

		Number of authorities							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Comments:

2) Please name the organisations you consider to be main bottlenecks to obtaining the necessary permits to build and operate a RES-E plant? Which technology is affected the most by the organisation indicated?

Please use only one row per organisation!

		Name of bottleneck organisation	
	Country	Organisation	Respective Technology
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

3) Are the procedures for the whole licensing chain clear and well established?

	Country	Procedures clear and well established?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

4a) What is the average lead time for the overall authorization procedure of your projects?

(Time horizon from the beginning of the first planning steps until start of plant construction!)

		Lead time for authorization procedure (months)							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Comments:

4b) What is the average lead time for grid connection authorisation of your projects?

		Lead time for grid connection (months)							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Comments:

5) What is the average rate of permit rejections in your experience?

		Rate of permit rejections (%)							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Main reasons for rejection/Comments:

6) **Do you think it is important to reinforce Community Legislation on the issue of administrative barriers? If so, please comment/specify.**

	Country	Reinforce Community legislation on barriers?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

7) **At which voltage level do you connect your renewables plant to the grid?**

(Please select between >110kV; <110kV or both grid voltage levels!)

		Grid Voltage Level							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Comments:

8) **Please indicate the share of your planned projects where insufficient grid capacity represents a major problem?**

		Share of projects with grid capacity problems (%)							
	Country	Wind on-shore	Wind off-shore	Biogas	Solid biomass	Hydro	Photo-voltaics	Geo-thermal	Tide & Wave
1									
2									
3									
4									
5									

Comments:

9) **Do transmission and distribution system operators provide RES-E producers with an estimation of costs associated with grid connection and is this estimation transparent?**

	Country	Is cost estimate for grid connection transparent?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

10) Are the rules for grid reinforcement and extensions transparent?

	Country	Are rules for grid extensions transparent?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

11) Do transmission and distribution system operators provide RES-E producers with an estimation of costs associated with grid connection and is this estimation discriminatory against RES-E?

	Country	Is cost estimate for grid connection discriminatory?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

12) Are the rules for grid reinforcement and extensions discriminatory against RES-E?

	Country	Are rules for grid extensions discriminatory?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

13) Do the charging fees discriminate against RES-E? If so, please comment?

	Country	Do the charging fees discriminate against RES-E?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐

5		Yes ☐	No ☐

Comments:

14) **Do you think that grid regulation needs to be modified in order to better integrate decentralised RES? If so, please comment?**

	Country	Do the charging fees discriminate against RES-E?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

15) **Do you think it is important to reinforce Community Legislation on points 11-14? If so, please comment/specify.**

	Country	Reinforce Community legislation on grid issues?	
1		Yes ☐	No ☐
2		Yes ☐	No ☐
3		Yes ☐	No ☐
4		Yes ☐	No ☐
5		Yes ☐	No ☐

Comments:

Annex 2: Legal framework on guarantee of origin in EU Member States

Country	Legal framework implementing the guarantee of origin
Austria	Ökostromgesetz (Eco-Electricity Act) – July 2002. This Act came into force in January 2003.
Belgium, FL	"Besluit van de Vlaamse regering van 5 maart 2004 in zake de bevordering van electriciteitsopwekking uit hernieuwbare energiebronnen", March 2004
Belgium, W	Decision on the promotion of green electricity, November 2006
Belgium, BR	Decision on the promotion of green electricity and quality CHP of the Ministry of the Brussels Capital Region, C-2004/31315, May 2004, Belgisch Staatsblad 28 June 2004
Bulgaria	Energy act – September 2006, Regulation for certification of the origin of electricity power generation from RES and/or CHP issuance – June 2007
Cyprus	*Not available*
Czech Republic	Law 180/2005, March 2005 (http://www.eru.cz/pdf/zak_aj_180.pdf) Law 182/2005, July 2005
Denmark	Order No. 1 of 6 January 2004, laid down in Law No. 151, March 2003. In force as of 15 January 2004.
Estonia	Amendment of Electricity Market Act – January 2005 (http://www.eti.gov.ee/en/oigusaktid/electricity_act). Procedure for the issue of GO under development.
Finland	Act on verification and notification of origin of electricity, Electricity Market Act, 28 January 2005
France	Decree 2006-1118 introduces the GO for RES and CHP, September 2006
Germany	Revision of the Renewable Energy Law - EEG, 2 April 2004. Came into force 1 August 2004.
Greece	Law 3468/2006 Generation of Electricity using Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions. Official Gazette A' 129/27.06/2006. Chapter E, Article 15 – 18. http://www.ypan.gr/docs/LAW_3468-2006__RES.doc
Hungary	*Not available*
Ireland	Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations (Northern Ireland) 2003 No. 470. In force November 2003. http://www.opsi.gov.uk/Sr/sr2003/nisr_20030470_en.pdf
Italy	Legislative Decree 29/12/2003 No. 387, article 11.
Latvia	The Law on Electricity Market, approved in May 2005, states that an institution authorised by Cabinet of Ministers shall issue the Guarantees of Origin. The Cabinet of Ministers shall specify procedure for issue of GO. But issuing body is not appointed yet.
Lithuania	Rules on issue of guarantees of origin of electricity produced from renewable energy sources, 2005
Luxembourg	Adopted by Parliament 22 February 2004.

Country	Legal framework implementing the guarantee of origin
Malta	Law nr 186 of 2004; Subsidary Legislation 423.27, article 5, 19-01-2007. http://docs.justice.gov.mt/lom/Legislation/English/SubLeg/423/27.pdf
Netherlands	Regulation Guarantees of origin for renewable electricity. Staatscourant 15 December 2003, no. 242.
Poland	Amendment of the Energy Act (from 1997) on 2 April 2004
Portugal	Decreto-Lei (Decree Law) 33-A/2005 of 16 February 2005.
Romania	2003 Energy Law No. 318 and newly adopted Energy Law No. 13/2007. http://rbd.doingbusiness.ro/nestor_energy_renewable_market_mart2007.htm
Slovakia	Law No.656/2004, Decree of the Government No.124/2005, Decree ÚRSO No.2/2006 of 21. June 2006 – Supplement No.1
Slovenia	Decree on the issuing of guarantees of origin of electricity (OJ RS, No. 121/05)
Spain	Orden ITC/1522/2007 of 24 May 2007, Boletín Oficial del Estado 131, 1 June 2007
Sweden	Electricity Certificate Act, SFS 2003:113. In place since May 2003.
UK	The Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003 SI No. 2562. Regulation came into force on 27 October 2003.