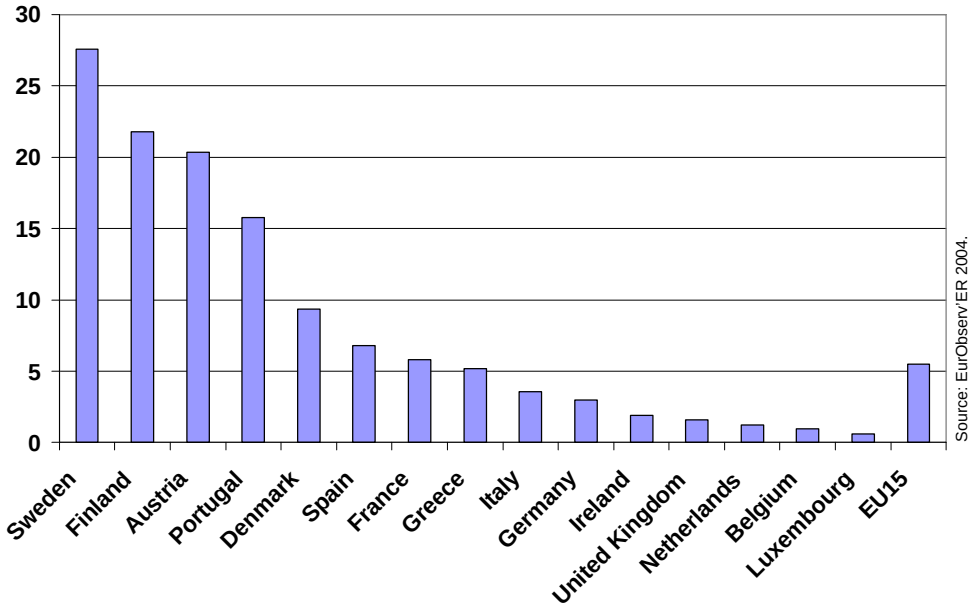
Figure 1. The proportion of renewable energy in relation to total energy supply 2003. The EU target for 2010 is 12 per cent.



Renewable energy in the European Union

Around 20 per cent of our global energy supply comes from renewable sources. In the EU the proportion is six per cent.

From the environmental viewpoint there is no intrinsic value in increasing the supply of renewable energy; the important thing is to phase out the use of fossil energy. It should be stressed that the cleanest, and in many cases cheapest, type of energy is energy that is never used. Efforts to save electricity – or "negawatts" – must therefore go hand in hand with measures to increase our use of renewable energy if we are to reach the goal of an energy system that is sustainable in the long term.

Even at today's costs it is economically beneficial to society to increase the use of renewable energy. The most important benefits are shown in the box on the next page.

The situation today

Although the amount of renewable energy used today is relatively small it has significant potential. It is perfectly possible to meet global energy demand with renewable energy, despite the growing population and rising standard of living. The earth's surface receives an amount of solar energy that is nearly 10,000 times bigger than the world's total primary energy supply.

The use of renewable energy varies widely between the EU member states. Of the fifteen countries that were members before 2004 (EU15), the United Kingdom and Belgium are in bottom place with a renewable share of just a few per cent, while Austria, Finland and Sweden come top with shares of around 20–30 per cent (see figure 1).

The types of energy that account for the lion's share of renewables in the EU are biomass (more than 90 per cent of renewable heating) and hydro (85 per cent of renewable power generation). Windpower and solar heating are nevertheless starting to make substantial contributions.

Political framework

There are three concrete targets for the proportion of renewable energy used in the EU:

1. Double the share of renewable energy in national gross energy consumption from six per cent in 1995 to 12 per cent in 2010. This was set out in the Commission's white paper on renewable energy (COM(97)599 Final), which was presented in 1997. The target has since been confirmed by the Council of Ministers on several occasions.
2. Increase the share of green electricity in total electricity consumption from 14 per cent in 1997 to 22 per cent in 2010 (Di-

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EU on climate change: Targets, strategies and legislation

No. 12, February 2003:
The Kyoto Protocol

No. 11, December 2002:
The Intergovernmental Panel on Climate Change

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rective 2001/77/EC). The directive gives an indicative target for each member country. It also applies to the ten new members, which have indicative national targets in the accession treaty.

3. Raise the share of biofuels in the transport fuel market to 5.75 per cent (Directive 2003/30/EC) in 2010. Exemption from the target may be granted if there is little potential in the country for the production of biofuels, or if the biomass is being used for other purposes.

In a communication presented in 2004 (COM(2004)366 final) the Commission evaluated targets 1 and 2:

OVERALL ENERGY USE: At best, with full application of adopted legislation, a 10-per-cent share can be achieved by 2010. Extra action is needed in the heat sector to reach 12 per cent. The renewable share was 5.2 per cent in 1995 and 6 per cent by 2001. See the situation country by country in figure 1.

ELECTRICITY: With existing national policies and measures the EU15 will achieve a share of 18–19 per cent by 2010. The level in 1997 was 14 per cent. Only four countries – Germany, Denmark, Spain and Finland – are on track to achieve their national targets. Greece and Portugal are not on track and for the remaining countries the outlook is uncertain. See the situation country by country in Table 1.

The directives allow each member country to decide how it will achieve the indicative national targets. If both targets for renewable electricity and biofuels are achieved, it will lead to a 10-per-cent general share of renewable energy in the EU, according to the Commission.

Renewable energy sources

The European Renewable Energy Council defines renewable energy as any energy resource regenerated over a short timescale that is derived directly from the sun (such as thermal, photochemical or photoelectric), indirectly from the sun (such as wind, hydropower and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy).

Biomass

Biomass is generated by plants through the process of photosynthesis, using energy provided by the sun. Exploited in a sustainable manner, biomass is a renewable source of energy. The advantages of bioenergy include the fact that it is often a domestic resource, it is easy to store and it creates jobs, mainly in rural areas. Its disadvantages include the emission of air pollutants, particularly during small-scale combustion in old boilers (modern boilers produce very low emissions). Harvesting too much biomass can also threaten the biodiversity of forests and deplete soil nutrient reserves. The latter can however be compensated for by returning the ash after combustion.

The current trend in the energy sector is to move away from large fossil fuel fired condensing power stations towards smaller combined heat and power plants. This favours bioenergy, although the amount of electricity generated from biomass is still modest. Denmark, Finland and the United Kingdom are the only countries in which there is steady growth.

A lot of bioenergy is used in the heating sector and there is also good potential here – over 40 per cent of the energy in Europe is used for heating buildings, for domestic hot water production and for heating in industrial processes.

At present renewable fuels for cars are produced almost exclusively from agricultural crops. The cultivation of oilseed rape to replace diesel is widespread in Germany and France in particular. Cereals and sugar beet are used to produce ethanol as a substitute for petrol. This is done mainly in France, Spain and Sweden. Imports are also significant. The biofuel share of road vehicle fuels sold in the EU amounted to 0.6 per cent in 2003.

Biomass accounts for just over half of renewable energy in the EU. In percentage terms, Finland, Sweden and Austria are the leading users in Europe. The EU

The benefits of renewable energy

Climate change. The burning of fossil fuels releases carbon dioxide, the most significant of the greenhouse gases that are produced by mankind. The extraction of coal also leads to considerable emissions of methane, another greenhouse gas. Gas extraction also produces methane emissions. Renewable energy sources are climate neutral. The burning of biomass results in CO_2 emissions, but these are bound up again by growing new crops on the site where the biomass was harvested.

Other air pollutants. The burning of coal and oil accounts for most anthropogenic emissions of sulphur and nitrogen oxides and many heavy metals. Acidification, eutrophication, damage from ground-level ozone and damage to health by particulates are some of the resulting effects. The only renewable energy source that can give rise to significant problems in this respect is biomass, which if burned inefficiently in old boilers can produce high emissions of volatile organic compounds (VOCs) and particulates.

Other environmental effects. Extracting coal from open-cast mines involves major disturbance to the land. Oil can cause serious damage to the aquatic environment during transport. Nuclear power gives rise to problems during the extraction of uranium and in the event of accidents. The radioactive waste is harmful for thousands of years and there are no safe storage methods. The negative effects of renewable energy are mainly limited to aesthetic impact on the landscape. However, the expansion of hydropower can cause major harm to the economy of local communities and the biodiversity of waterways. Over-harvesting of biomass can threaten the diversity of forest biotopes and deplete the nutrient reserves of woodland.

External costs. The costs of the various types of energy in terms of damage to the environment and health are called external costs, since they are not normally included in the price. Estimates made under the EU ExternE project (www.externe.info) show that coal and lignite have by far the highest external costs, followed by oil, peat and gas. If the external costs are included in the price the cost of producing electricity from coal is roughly doubled.

Security of supply. The European Commission's green paper on energy security (COM(2002)321 final) highlights both renewable energy and energy efficiency in reducing dependence on imported energy. According to the green paper, in two decades Europe will be importing 70 per cent of its energy – compared to 50 per cent today – if business continues as usual. A higher share of domestic energy not only increases the security of supply, but also improves the balance of trade.

Job opportunities. Using renewable energy technologies creates employment at higher rates than many other energy technologies. The European renewable energy industry currently employs around 200,000 people and has a turnover of 10 billion euro a year.

member states do not all have the same natural potential for bioenergy, however there is considerable unexploited capacity. This is particularly true in some of the new member states: the Baltic States, the Czech Republic, Hungary and Slovakia.

An indicative figure on the biomass availability for energy purposes at EU15 level is 1,700 TWh per year (plus 400 TWh for the ten new member states plus Romania and Bulgaria). This compares with total consumption figures for energy and bioenergy by the EU15 in 2001 of around 17,000 TWh and 650 TWh respectively.

Hydropower

Electricity production from hydropower in the EU15 totalled 380 TWh in 2002, corresponding to about 15 per cent of total electricity production and 84 per cent of all renewable electricity.

Large-scale hydropower has largely been exploited already and the potential for further small-scale hydropower plants (under 10 MW) is also limited. In the new member states, particularly in Hungary, Lithuania and Slovenia, there is still significant potential to increase hydropower generation, however.

Small-scale hydropower contributed 40 TWh of electricity within the EU15 in 2002 and 2–3 TWh in the new member states. The building of new small hydropower plants often meets strong local resistance, because of the damage they cause to waterways.

Windpower

In recent decades there has been a trend towards bigger and bigger windpower turbines. A large, modern wind turbine can produce as much electricity as 200 turbines did in 1980. At the same time the costs have fallen sharply. In good conditions windpower can be produced from around 3.4 eurocents per kWh – half what it cost 20 years ago. The production cost is comparable with new coal power and nuclear power, even without factoring in the health costs and environmental costs of the various types of power.

Almost 80 per cent of all global windpower is produced in the EU15, and around 90 per cent of that produced in the EU15 comes from three countries: Germany, Spain and Denmark. The installed windpower capacity in the EU amounted to 34 GW in 2004 (an increase of around 8 GW over the previous year). In an average wind year this capacity can produce 70 TWh of electricity, approximately 2.4 per cent of EU electricity consumption. The industry estimates that by 2010 the installed capacity will reach 75 GW (of which 10 GW will be offshore), with an annual electricity production of almost 170 TWh.

The potential for windpower in Europe is massive, especially at offshore sites, where it is estimated at 3,000 TWh per year. To arrive at the level of 720 TWh per year in 2020, as suggested in a report from Greenpeace, would require a total capacity of around 240 GW, calling for some 50,000 new large turbines. The area they would take up would not need to be very great, amounting to no more than three per cent of the EU15 countries' seabed.

Variable wind strength means that electricity generation by wind farms varies in a totally different way to that from hydroelectric plants, for instance. This poses problems for electricity grid management, although less serious than many feared. However, the electricity grid will require upgrading in many areas before there can be a major expansion offshore.

Solar thermal heat

Solar thermal energy is now an established technology that is capable of converting 25–50 per cent of incoming solar radiation to useful heat. Thanks to improved technology and mass production the costs have fallen drastically in the last decade, and the quality has improved markedly at the same time. A further halving of the cost is considered realistic over the period 2002 to 2010.

The main disadvantage of solar heating is that availability is often poorest when demand is greatest. Solar thermal energy must therefore generally be supplemented by some other energy source.

Solar heat is difficult to store and requires a water circulation system for distribution. In some locations in Denmark and Sweden there are massive solar thermal collector arrays measuring 10,000–20,000 m^2 connected to district heating systems. Smaller installations are more common, however.

Around 80 per cent of the installed area of solar thermal collectors in the EU is located in three countries: Germany, Greece and Austria. The total area in the EU15 at the end of 2003 was 14 million m^2, plus a further 0.6 million m^2 in Cyprus. The technical potential in the EU15 is estimated at 1,400 million m^2 with an annual energy output of almost 700 TWh.

Solar thermal collectors cover two thirds of the warm water needs of Greek households; in Cyprus up to 90 per cent, and nearly 10 per cent in Austria. In Spain, Portugal and Italy only a marginal 0.5 per cent of warm water needs are covered.

In comparison with windpower and solar electricity the growth of solar heating is moderate, but rising. Europe makes up just 17 per cent of the current global market – two-thirds of which is in China.

Table 1. Share of renewable electricity in relation to targets for 2010 (%).

	1997	2002	2010
Austria	70.0	68.0	78.1
Belgium	1.1	1.4	6.0
Denmark	8.7	20.0	29.0
Finland	24.7	24.7	31.5
France	15.0	14.4	21.0
Germany	4.5	8.1	12.5
Greece	8.6	5.8	20.1
Ireland	3.6	5.1	13.2
Italy	16.0	16.8	25.0
Luxembourg	2.1	2.2	5.7
Netherlands	1.8	3.4	9.0
Portugal	38.5	21.8	39.0
Spain	19.9	12.6	29.4
Sweden	49.1	46.0	60.0
United Kingdom	1.7	2.8	10.0
EU15	13.9	15.2	22.0
Cyprus	0.0	0.0	6.0
Czech Republic	3.7	3.9	8.0
Estonia	0.1	0.2	5.1
Hungary	0.7	0.6	3.8
Latvia	50.1	48.0	49.3
Lithuania	4.0	4.6	7.0
Malta	0.0	0.0	5.0
Poland	1.6	2.0	7.5
Slovenia	31.1	30.4	33.6
Slovakia	15.9	20.2	31.0

Source: Commission staff working paper, SEC(2004) 547.

Solar thermal collectors that operate at higher temperatures are under development. Such systems can also be used for space cooling, which accounts for a growing share of energy consumption in many countries. The use of solar energy for space cooling is seen as very promising, since periods of high demand coincide with high levels of solar radiation.

Solar electricity

Photovoltaic (PV) technology involves the direct generation of electricity from light. The solar cells are made from semiconductor materials – usually silicon – which can be adapted to release charged particles, forming the basis of electricity. The greater the intensity of light, the greater the flow of electricity. The most widely used are cells of crystalline silicon, which are able to convert 13–16 per cent of sunlight into electricity, but more efficient thin-film cells are being developed.

Photovoltaics are already economically competitive for loads up to a few kW in many remote sites away from main electricity grids. Most of the installed capacity in Europe is connected to the grid however as result of extensive support schemes in Germany, where 80 per cent of the total capacity can be found.

The cost of solar cells has fallen by a factor of ten in the last 15 years. If the

market grows by 20 per cent each year it is estimated that the price will drop to one-third of the current level by 2020. In the last few years the annual growth rate has been 30–40 per cent. The cost could be pressed down even further if solar panels are used to replace other materials on the exterior walls of buildings, an application that has become increasingly common in recent years.

The industry's own scenario is an increase to 41 GW of installed capacity within the EU by 2020 (compared with 0.4 GW today), capable of producing 27 TWh of electricity, a development that could create around 450,000 full-time jobs. Solar cells are most profitable where sunlight is strongest, which for the EU means that the greatest potential is in the south.

Geothermal

Heat from the Earth's core can be used for heating and electricity production. Like several other renewable energy sources geothermal energy involves high investment costs and relatively low operating costs.

Electricity generation requires steam at temperatures in excess of 150°C. Within the EU15 the installed capacity is 800 MW, and 98 per cent of this is in Italy. Electricity production in 2003 totalled 5 TWh.

Italy is also the leading country in the EU15 for low-energy applications of geothermal energy (heating) with a capacity of 0.44 GW_{th}, followed by France and Germany. Total production in the EU15 amounted to 3.5 TWh in 2002.

Geothermal energy is also a well-developed energy source in Hungary, where the installed capacity is similar to that of France. The Czech Republic, Slovakia, Slovenia and Poland use geothermal energy mainly in the form of direct heat.

The category of very low energy applications includes heat pumps, the use of which for space heating and cooling has expanded considerably over recent years. Sweden is at the top of the list with a capacity estimated at 1 GW_{th} from 176,000 units in 2002, representing one-third of all the heat pumps installed in Europe. Germany and France come next. Growth in Sweden has continued, with 100,000 new units installed in 2004 alone.

Heat pumps are powered by electricity, with one kWh of electricity yielding three kWh of heat in return. More heat pumps therefore mean greater electricity consumption, which is a problem, especially during peaks in demand.

Wavepower

Technology for generating electricity from the wave motion is still in its infancy. The first commercial installation is located in Portugal. This has an initial output of 2 MW, but if successful there are plans to extend it to 20 MW in the next few years.

According to industrial estimates the potential is very large. For example, there is enough wave energy off Britain's coastline to provide three times its current electricity consumption (350 TWh in 2002). Some five to eight per cent of that is estimated to be economically realized.

The World Energy Council predicts that wavepower can eventually supply 15 per cent of current global energy demand. With existing technology the production cost per kWh would be roughly double that of windpower.

How to increase the renewable share

Although the availability of renewable energy has grown rapidly in the EU in recent decades, the use of finite energy sources has also increased. It is therefore important to continue promoting renewable energy, while at the same time taking strong measures to use energy more efficiently. However, the debate tends to concentrate on energy supply, partly because the energy suppliers are much better organized than consumers.

Renewable energy could be strongly promoted if each country created a level playing field in the energy sector, by including external societal benefits/costs in its energy policy framework.

In many EU countries there are large tax subsidies for the nuclear and coal industries. Subsidies to energy in the EU15 totalled 29 billion euro in 2001, with 73 per cent directed towards the support of fossil fuels. In Germany, where the highest subsidies are now paid, 2.5 billion euro go every year to subsidizing coal production, which is about 70,000 euro per coal worker.

Support schemes are needed in order for renewable energy to establish its place in the market. Experience from those countries where windpower has flourished point to various factors for success, including an attractive long-term financial framework, uniform planning procedures and licensing systems, and non-discriminatory terms for grid connection.

Different means are available in the EU member states, such as feed-in tariffs, green certificates, market-based mechanisms and tax exemptions. Rising costs for carbon dioxide emissions as a result of the EU's trading system for emission rights may also favour renewable energy.

OECD data indicate that only 10 per cent of government energy R&D budgets are related to renewable energy, in contrast with more than 50 per cent for conventional (fossil fuel and nuclear) energy technologies.

Many interest groups want the EU to formulate a new target for renewable energy. A share of 20 per cent by 2020 has been suggested. Such a target would give investors a clear signal of the level of political ambition. However, the Commission wants to wait until 2007 before proposing a target, as it will then have a better picture of progress towards to the 12-per-cent target for 2010.

Further information

The share of renewable energy in the EU. COM(2004)366 final. Progress report, includes a Commission staff working paper with country profiles for all member countries, SEC(2004) 547.

Sea Wind Europe. 2004. Published by Greenpeace, www.greenpeace.org

Vision 2050. The EU states could phase out both nuclear energy and 98 per cent of fossil fuels by 2050, according to a vision presented by the NGO network Inforse Europe, www.inforse.dk.

AGORES, A Global overview of Renewable Energy Sources: www.agores.org

European Renewable Energy Council (EREC): www.erec-renewables.org.

European Commission, DG Energy and Transport: http://europa.eu.int/comm/energy/index_en.html

Global Wind Energy Council: www.gwec.net

International Solar Energy Society: www.ises.org

Johannesburg Renewable Energy Coalition (JREC) database: www.iea.org/textbase/pamsdb/jr.aspx

Renewable Energy in Europe: Building Markets and Capacity

This book, compiled by the European Renewable Energy Council (EREC) and published in 2004, has been the main source for this fact sheet. It presents an overview of the latest technological, financial and economic information on renewable energy technologies. It also explains how renewable energy sources could play a more significant role in the EU's future energy balance.

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