EN29 Renewable Energy

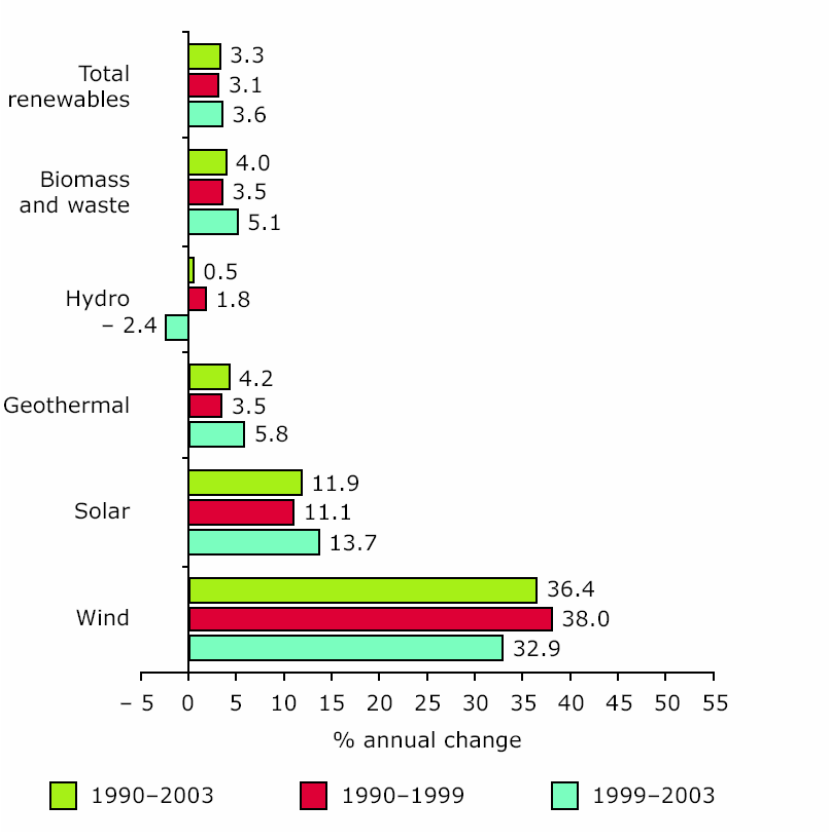
Key message

The share of renewable energy sources in total energy consumption increased slowly between 1990 (4.4 %) and 2003 in the EU-25 to reach 6.0 % in 2003. Significant further growth will be needed to meet the indicative target of a 12 % share by 2010, particularly from biomass. Between 2002 and 2003, energy produced from geothermal, wind and biomass increased substantially, while hydropower production fell as a result of little rainfall.

Rationale

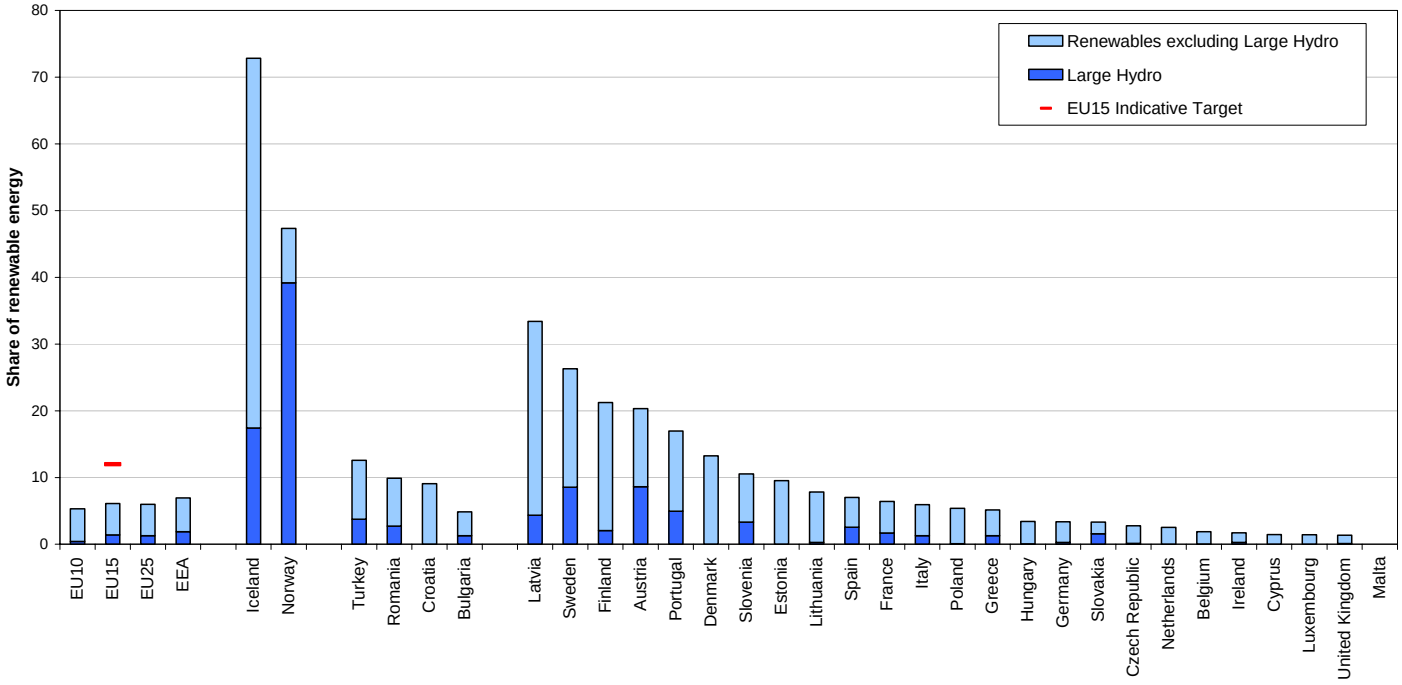
Renewable energies are generally considered more environmentally benign than fossil fuels with regard to levels of greenhouse gas emissions as well as other air pollutants such as SO_2 and NO_x emitted. The share of energy consumption from renewable energy thus provides a broad indication of progress towards reducing the environmental impact of energy consumption, although its overall impact has to be seen within the context of the total fuel mix, potential impacts on biodiversity and the extent to which pollution abatement equipment is fitted.

Fig 1: Annual average growth rates in renewable energy consumption, EU-25



Data source: Eurostat.

Fig. 2: Renewable energy sources contribution to total energy consumption in 2003



Data source: Eurostat, indicative target as defined in European Commission COM(97) 599 final
Note: Large hydropower plants have a declared net capacity of more than 10 MW.

1. Indicator assessment

The contribution of renewable energy sources to total energy consumption increased in the EU-25 from 4.4 % in 1990 to 6.0 % in 2003, up by 0.3 percentage points from the share in 2002. This is still substantially short of the indicative target set in the White Paper on renewable energy (COM(97) 599 final) to derive 12 % of total energy consumption in the EU from renewable sources by 2010 (at present, the 12 % aim applies only to pre-2004 EU-15 Member States). In absolute terms, renewable energy consumption grew by 52.2 % between 1990 and 2003, compared to a 10.9 % increase in total energy consumption (EN26).

Biomass and waste is the largest renewable energy source (66.5 %) and was responsible for the majority of the absolute growth in renewables during the period 1990-2003, where it increased by 66.7 %. Biomass and waste incorporates a diverse range of sources including combustion of wood, wood wastes and other solid wastes; combustion of industrial and municipal wastes; and biogas/biofuels; it can be used to produce biofuels for transport, electricity and heat. It is also seen as one of the main areas for future growth in renewable energy and biomass and waste is projected to be the largest contributor in absolute terms to the future growth of renewable energy sources (COM(2004)366 final). However, increased use must be balanced against potentially increased environmental pressures on biodiversity, soil and water resources (EEA, 2005b). Latvia, Finland and Sweden have particularly high shares of biomass and waste in total energy consumption, about 29 %, 19 % and 17 % respectively. In Latvia this is due to the large availability of low-cost wood and wood-wastes for heating rather than a coherent renewable energy support scheme (EREC, 2004), whereas in Sweden it has been due primarily to taxation favouring non-fossil fuels that was introduced in the early 1990s as well as a grant support for biomass fuelled combined heat and power, and district heating plants (Johansson, 2001).

Consumption of hydropower grew by 6.7 % over the period 1990-2003, to reach 24.1 % of total renewable energy consumption and 1.4 % of total energy consumption in the EU-25 in 2003. Its contribution to renewable energy consumption actually decreased slightly over the period, due both to a decrease in absolute production as a result of low rainfall in recent years and the rapid growth of other renewable sources of energy, such as biomass and waste, wind, geothermal and solar energy. Energy consumption from hydropower is not expected to increase significantly due to environmental concerns and a lack of suitable sites, particularly within the EU-15. For example, the Water Framework Directive (2000/60/EC) places a greater emphasis on the protection of the environment, in particular the river morphology (i.e. shape of the river bed and adjacent zones) as a subject of protection, and due to the obligation to prevent any further deterioration it is likely that the construction of new hydro-power plants will become more difficult. Some of the new Member States such as Slovenia do intend to increase their large hydro output significantly but the affect of this on overall EU-25 hydro capacity is still likely to be small.

Between 1990 and 2003, wind energy in the EU-25 grew by a factor of almost 57. This was largely accounted for by strong growth in Denmark, Germany and Spain, encouraged in these cases by direct price support policies (i.e. feed-in tariffs) for the development of wind power, where a payment is made directly by the utilities to renewable electricity producers for each unit of renewable electricity supplied to the national grid (for example, feed-in tariffs in Germany, Spain, Denmark and the Czech Republic). Wind power is a fast-growing energy source worldwide, and this trend is expected to be reflected throughout the EU-25, as technological development both on- and offshore, combined with national renewable energy promotion policies (most notably the introduction of the feed-in tariffs), leads to the introduction of wind power in all Member States. However, output still accounts for a small (around 0.2 %) proportion of total energy consumption and 3.7 % of renewable energy consumption.

The growth of geothermal heat and electricity was around 70 % over the period 1990-2003. The use of geothermal schemes depends on the quality (temperature and density) of the heat available. Relatively low quality heat is used as an input to district heating schemes and some industrial processes, and higher quality heat can be used to produce steam for electricity production in turbines. Geothermal energy contributed only 5.1 % to total renewable energy consumption (and 0.3 % of total energy consumption) in the EU-25 in 2003, with Italy accounting for over 91 % of this. Electricity from geothermal is not expected to contribute significantly to meeting the EU's indicative target for renewable energy as resources in the EU are in general limited and costs of production high relative to other sources. However, there is still significant potential to exploit geothermal heat, particularly in the form of heat pump technology (IEA, 2004).

Between 1990 and 2003 in the EU-25, solar energy grew by over a factor of four. Solar thermal energy developments in Austria and Germany benefited greatly from proactive government policy coupled with subsidy schemes and communication strategies that emphasised the benefits of solar thermal. In most Member States solar energy comes from solar thermal energy (rather than electricity generated using PV cells). At present PV cells are limited due to relatively high production and installation costs, but represent a medium- to long-term opportunity as costs are beginning to fall (JRC, 2004). The proportion of solar energy in total renewable energy amounted to 0.04 % in 2003.

Despite growing subsidies and programmes, and support for renewables in individual Member States, the observed growth rates in renewable energy consumption are not sufficient if the indicative target of a 12 % share in 2010 is to be met. Baseline projections indicate that the contribution of renewables to total energy consumption is likely to grow at around the same rate to 2010 as it did during the previous decade (EEA, 2005). The contribution of renewables in overall energy consumption is projected to reach only around 8 % in 2010, reflecting the conclusions from the Commission communication on the share of renewable energy in the EU (COM(2004) 366) that given current trends the EU will not meet its indicative 12 % target by 2010. Evaluations from the European Commission recently concluded that European states need to step up efforts to cooperate among themselves and fine-tune their support schemes as well as to remove administrative and grid barriers for green electricity (EC, 2005). The Commission concluded that it is not appropriate to present a harmonised European system at this stage.

The main growth is expected to come from biomass and waste, wind and solar, although the latter is starting from a very low base so its absolute share in consumption remains small. Currently, biomass is lagging behind. The European Commission thus issued a Biomass Action Plan that proposes measures which could lead to an increase of bioenergy use to around 150 Mtoe in 2010 or shortly after (EC, 2005b). After 2010, the rate of expansion of wind power is expected to slow, as many of the most favourable (and cheapest) sites will have been exploited. However, growth is still expected to be strong in those countries that have not yet begun to fully realise their wind energy potential, including Austria, Finland, Greece and Portugal. In addition, the exploitation of the off-shore wind resource may provide additional scope for an increased contribution from wind power in countries such as Denmark, the Netherlands and the United Kingdom, such large-scale exploitation of offshore wind is not included within the baseline projections. This needs to be set in the context of current discussions within the European Institutions, surrounding a further indicative target of 20-25 % by 2020, which are based around the significant remaining potential of some of the renewable resources. Biomass growth is also expected to slow after 2010 due to potential conflicts in land use for agricultural and forestry areas, nature conservation requirements, as well as competition with alternative developments such as housing. Scenarios that assume shares of renewable energies significantly above baseline developments (such as the Low Carbon Energy Pathway and High Renewables scenarios, EEA, 2005) suggest a much faster expansion of biomass and waste, due primarily to a high growth in its use in electricity production in combined heat and power plants, as well as the expanded use of biofuels in transport. However, it should be noted that while increasing the use of biomass for energy purposes, it has to be ensured that no additional pressures on farmland and forest biodiversity, and water and soil resources are created.

2. Indicator rationale

2.1 Environmental context

The share of energy consumption from renewable energy provides a broad indication of progress towards reducing the environmental impact of energy consumption, although its overall impact has to be seen within the context of the total fuel mix, potential impacts on biodiversity and the extent to which pollution abatement equipment is fitted.

Renewable energy sources are generally considered environmentally benign, with very low net emissions of CO_2 per unit of energy produced, even allowing for emissions associated with the construction of the plant. Emissions of other pollutants are also often lower for renewable energy production than for fossil fuel energy production. The exception to this is municipal and solid waste (MSW) incineration which, due to the cost associated with separation, usually involves the combustion of some mixed wastes including materials contaminated with heavy metals. However, emissions from MSW incineration are subject to stringent regulations including tight controls on quantities of cadmium, mercury, and other such substances.

Most renewable (and non-renewable) energy sources have some impact on landscape, noise and ecosystems, although many of these impacts can be minimised through careful site selection. Large hydropower schemes in particular, can have adverse impacts including flooding, disruption of ecosystems and hydrology, and socio-economic impacts if resettlement is required. Some solar photovoltaic schemes require relatively large quantities of heavy metals in their construction and geothermal energy can release pollutant gases carried by its hot fluid if not properly controlled. Some types of biomass and biofuel crops also have considerable land, water and agricultural input requirements such as fertilisers and pesticides.

2.2 Policy context

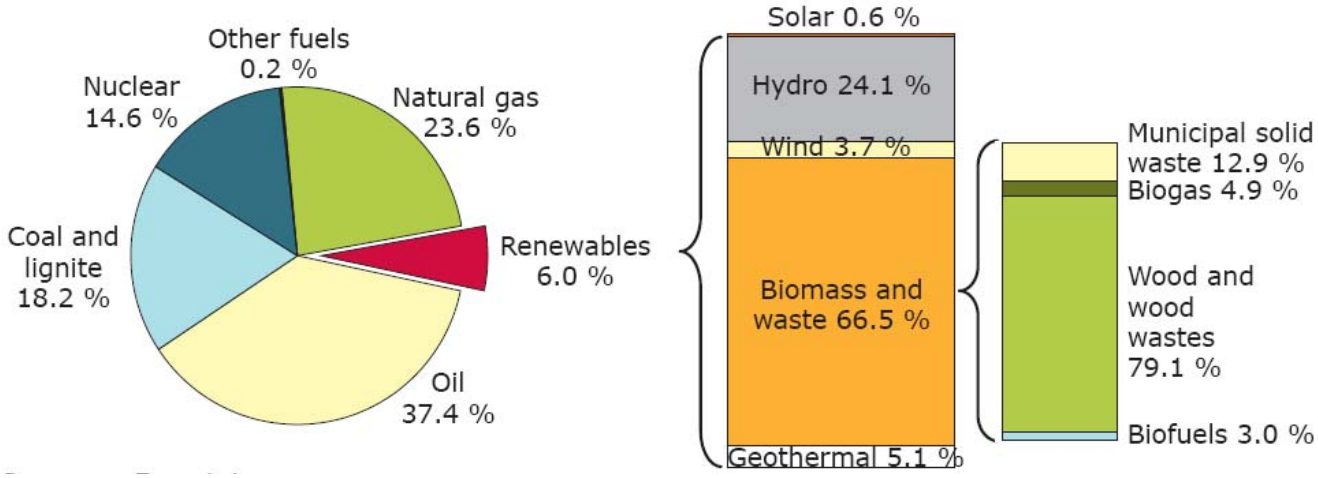
Energy use (both energy production and final consumption) is the biggest contributor to greenhouse gas emissions in the EU-25. The energy-related share of emissions increased from 79 % in 1990 to 82 % in 2003. Increased market penetration of renewable energy can help to reach the EU commitment under the Kyoto Protocol of the United Nations Framework Convention on Climate Change. The overall Kyoto target for the pre-2004 EU-15 Member States requires an 8 % reduction in emissions of greenhouse gases by 2008-2012 from 1990 levels, while most new Member States have individual targets under the Kyoto Protocol.

The main target for the indicator is defined in the White Paper for a Community Strategy and Action Plan (COM(97) 599 final), which provides a framework for Member State action to develop renewable energy and sets an indicative target to increase the share of renewable energy in total energy consumption in the EU-15 to 12 % by 2010. Further targets are actively being discussed within the European institutions. Recently, the European Council called for an Energy Policy for Europe which looks into longer-term targets for the share of renewables of e.g. 15 % by 2015 (European Council, 2006). The European Parliament called for a binding 20 % target for the share of renewables in total energy consumption by 2020, which was initially proposed in 2004. It also noted that a share of 25 % could be provided by renewables in a more integrated approach that simultaneously focused on improving energy efficiency. Some Member States (e.g. Germany) have set individual targets for the share of renewables in the long term.

One of the main policies for promoting the expansion of renewable energy is the EU Directive on the promotion of electricity from renewable energy sources in the internal electricity market (2001/77/EC), which sets an indicative target of 22.1 % of gross electricity consumption from renewable sources in EU-15 by 2010. It requires Member States to set and meet annual national indicative targets consistent with the Directive and national Kyoto Protocol commitments. For the new Member States, national indicative targets are included in the Accession Treaty (the EU-10 calculated theoretical aggregate target would be 11.1 %): the 22.1 % target set initially for EU-15 for 2010 became 21.0 % for the EU-25.

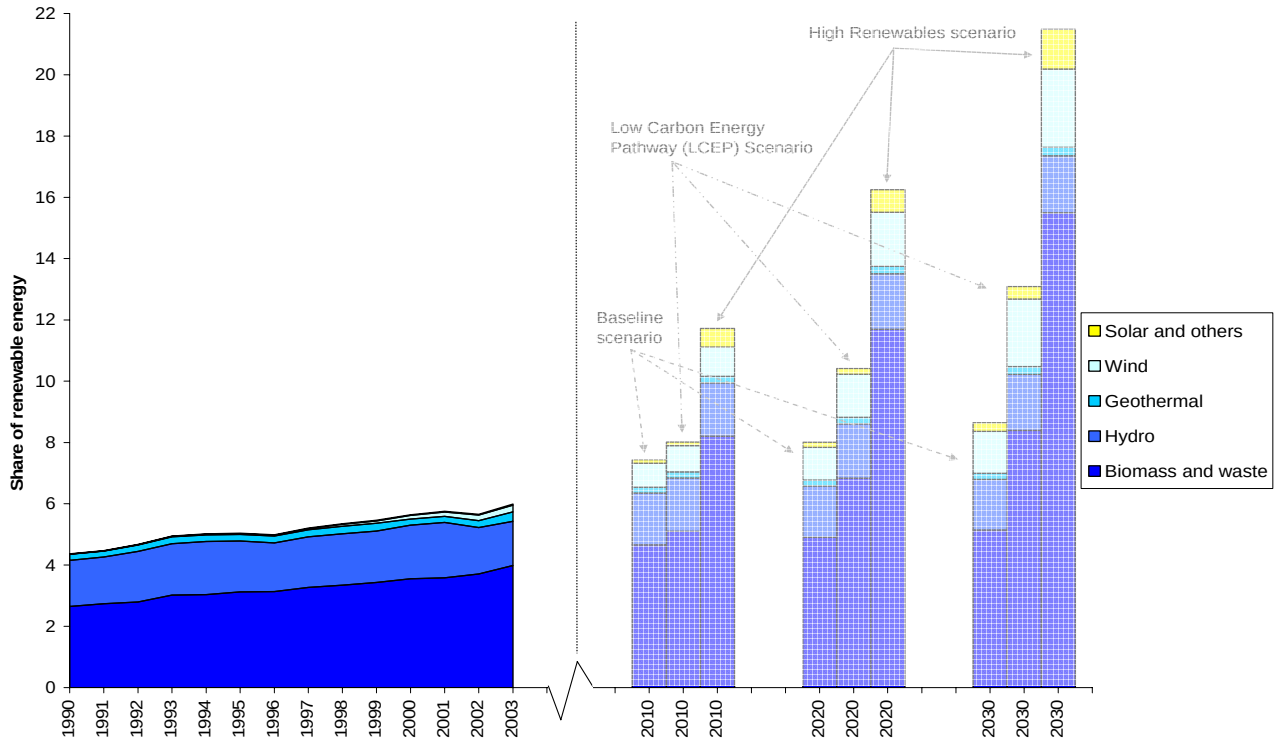
The second main policy is the Directive (2003/30/EC) on the promotion of the use of biofuels or other renewable fuels for transport. It sets national indicative targets with a reference value of 2 % of transport consumption to come from these fuels by 2005 and 5.75 % by 2010.

Fig. 3: Energy consumption by renewable energy source in 2003, EU-25



Data source: Eurostat.

Fig. 4: Contribution of renewable energy sources to total energy consumption, EU-25



Data source: Eurostat (historic data) and EEA (2005) for projections.

Note: EEA baseline projections are consistent with European Commission (2004). The Low-Carbon-Energy Pathway (LCEP) scenario assumes that ambitious future greenhouse gas emission reduction targets will be reached and thus assumes a CO_2 permit price of EUR 30/t CO_2 and EUR 65/t CO_2 in 2020 and 2030, respectively. The renewables expanded variant assumes that the share of renewables in total energy consumption meets the indicative target of 12 % in 2010 and then future targets are set to increase this to 16 % in 2020 and 20 % in 2030, which will be achieved by a renewables premium in the power sector and tax regulations in transport.

Fig. 5: Share of renewable energy in total energy consumption

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
EEA members	5.4	6.1	6.2	6.3	6.5	6.7	6.8	6.8	6.8	6.9
EU-25	4.4	5.0	5.0	5.2	5.4	5.5	5.6	5.8	5.7	6.0
EU-15 pre-2004 members	4.8	5.3	5.2	5.5	5.6	5.6	5.8	5.9	5.8	6.1
EU-10 new members	1.6	3.6	3.4	3.5	3.9	4.2	4.4	4.7	5.0	5.3
Belgium	1.4	1.4	1.3	1.2	1.3	1.3	1.3	1.4	1.6	1.9
Czech Republic	0.3	1.5	1.4	1.6	1.6	2.0	1.6	1.8	2.2	2.8
Denmark	6.7	7.6	7.2	8.3	8.7	9.6	10.7	11.1	12.3	13.3
Germany	1.6	1.9	1.9	2.2	2.4	2.6	2.9	2.8	3.1	3.4
Estonia	4.7	9.1	10.4	10.7	9.7	10.4	11.0	10.6	10.6	9.5
Greece	5.0	5.3	5.4	5.2	4.9	5.4	5.0	4.6	4.7	5.1
Spain	7.0	5.5	7.0	6.4	6.3	5.2	5.8	6.5	5.6	7.0
France	6.9	7.5	7.0	6.8	6.7	6.9	6.8	6.9	6.2	6.4
Ireland	1.6	2.0	1.6	1.6	2.0	1.9	1.8	1.8	1.9	1.7
Italy	4.2	4.8	5.2	5.3	5.4	5.8	5.2	5.5	5.3	5.9
Cyprus	0.3	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.9	1.5
Latvia	21.9	27.4	27.4	31.3	35.0	34.7	34.1	34.3	34.7	33.4
Lithuania	0.2	0.4	0.3	0.3	6.5	7.9	8.9	8.5	8.0	7.8
Luxembourg	1.3	1.4	1.2	1.4	1.6	1.3	1.5	1.3	1.4	1.4
Hungary	0.1	0.1	0.1	0.1	0.1	1.5	1.7	1.6	3.4	3.4
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	1.1	1.2	1.6	1.8	1.9	2.1	2.1	2.1	2.2	2.5
Austria	20.2	22.0	20.6	21.1	20.8	22.4	22.7	21.8	22.3	20.3
Poland	1.6	4.0	3.6	3.7	4.0	4.0	4.2	4.5	4.6	5.4
Portugal	15.9	13.3	16.1	14.7	13.6	11.1	12.9	15.7	14.0	17.0
Slovenia	4.6	8.9	9.4	7.7	8.3	8.8	11.5	11.4	11.0	10.5
Slovakia	1.6	2.9	2.7	2.5	2.6	2.7	2.9	4.1	3.8	3.3
Finland	19.2	21.3	19.8	20.6	21.8	22.1	24.0	22.7	22.2	21.2
Sweden	24.9	26.1	23.6	27.6	28.2	27.8	31.6	28.8	27.1	26.3
United Kingdom	0.5	0.9	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.4
Bulgaria	0.6	1.6	2.0	2.3	3.4	3.5	4.2	3.6	4.4	4.9
Romania	4.2	5.9	12.3	10.7	11.2	11.9	10.9	9.3	10.1	9.9
Turkey	18.5	17.4	16.6	15.8	15.9	15.1	13.1	13.1	13.4	12.6
Iceland	65.8	64.9	65.5	66.8	67.6	71.3	71.4	73.2	72.8	72.8
Norway	53.1	48.9	43.3	43.7	44.0	44.8	51.0	44.1	47.7	47.3

Data source: Eurostat

Note: No data for Liechtenstein or Switzerland is available from Eurostat.

References

COM(97) 599 final - Energy for the future: Renewable sources of energy. White Paper for a Community strategy and action plan.

COM(2004) 366 final - The share of renewable energy in the EU Commission Report in accordance with Article 3 of Directive 2001/77/EC, evaluation of the effect of legislative instruments and other Community policies on the development of the contribution of renewable energy sources in the EU and proposals for concrete actions.

DG TREN Energy sources and demand management legislation http://europa.eu.int/comm/energy/index_en.html.

Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

Directive (2003/30/EC) on the promotion of the use of biofuels or other renewable fuels for transport.

EC (2004) COM(2004) 366 final – The share of renewable energy in the EU, European Commission

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Johansson B (2001) Biomass and Swedish Energy Policy, Environmental and Energy Systems Studies, Lund University, for the Swedish National Energy Administration and Vattenfall AB http://www.miljo.lth.se/svenska/internt/publikationer_internt/pdf-filer/biopolicy.pdf.

Treaty of Accession to the European Union, Annex II, Part 12, page 588, which amends Directive 2001/77/EC in order to set targets for new Member States on the contribution of renewable energy to electricity generation.

Meta data

Technical information

1. Data source:
   Eurostat (historic data), http://europa.eu.int/comm/eurostat/
   European Commission, EEA (2005) (projected data) – baseline projections are consistent with European Commission (2004)
   Renewable energy consumption is one of the European Environment Agency's core-set indicators. More information can be found at http://themes.eea.eu.int/IMS/CSI.

2. Description of data / Indicator definition:
   The share of renewable energy consumption is the ratio between gross inland consumption of energy from renewable sources (TOE) and total gross inland energy consumption (TOE) calculated for a calendar year, expressed as a percentage. Both renewable energy and total energy consumption are measured in thousand tonnes of oil equivalent (ktoe).
   Renewable energy sources are defined as renewable non-fossil sources: wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.
   The PRIMES model was used by the EEA to analyse possible future developments of the European energy sector, including a baseline scenario without a permit price and the low carbon energy pathway (LCEP) scenario. It describes the least-cost response of the EU-25 energy system to the introduction of a carbon permit price that rises to EUR 65/t CO_2-equivalent by 2030. Scenario variants were developed, such as a high share of renewable energies in addition to the permit price. This renewables expanded variant assumes that the share of renewables in total energy consumption meets the indicative target of 12 % in 2010 and then future targets are set to increase this to 16 % in 2020 and 20 % in 2030, which will be achieved by a renewables premium in the power sector and tax regulations in transport.

3. Geographical coverage:
   The Agency had 31 member countries at the time of writing of this fact sheet. These are the 25 European Union Member States and Bulgaria, Romania and Turkey, plus Iceland, Norway and Liechtenstein. On 1 April 2006, Switzerland joined the EEA, bringing its number of member countries to 32.
   No energy data available for Switzerland and Liechtenstein. No projection data are available for Iceland, Liechtenstein.

4. Temporal coverage: 1990-2003, projections to 2030 in 5 year intervals.

5. Methodology and frequency of data collection:
   Data collected annually.
   Eurostat definitions for energy statistics http://forum.europa.eu.int/irc/dsis/coded/info/data/coded/en/Theme9.htm
   Eurostat metadata for energy statistics http://europa.eu.int/estatref/info/sdds/en/sirene/energy_base.htm

6. Methodology of data manipulation:
   Renewable energy consumption is the ratio between the gross inland consumption of energy from renewable sources and the total gross inland energy consumption calculated for a calendar year.
   The coding (used in the Eurostat New Cronos database) and specific components of the indicator are:
   Numerator: solar energy 5530 gross inland consumption 100900 + biomass and waste 5540 gross inland consumption 100900 + geothermal energy 5550 gross inland consumption 100900 + hydropower 5510 gross inland consumption 100900 + wind energy 5520 gross inland consumption 100900.
   Denominator: (total) gross inland consumption (of energy) 100900
   Average annual rate of growth calculated using: [(last year/base year) ^ (1/number of years) –1]*100

Qualitative information

7. Strengths and weaknesses (at data level)
   Data have been traditionally compiled by Eurostat through the annual Joint Questionnaires, shared by Eurostat and the International Energy Agency, following a well established and harmonised methodology. Methodological information on the annual Joint Questionnaires and data compilation can be found in Eurostat's web page for metadata on energy statistics.
   http://europa.eu.int/estatref/info/sdds/en/sirene/energy_sm1.htm

8. Reliability, accuracy, robustness, uncertainty (at data level):
   Biomass and wastes, as defined by Eurostat, cover organic, non-fossil material of biological origin, which may be used for heat production or electricity generation. They comprise wood and wood waste, biogas, municipal solid waste (MSW) and biofuels. MSW comprises biodegradable and non-biodegradable wastes produced by different sectors. Non-biodegradable municipal and solid wastes are not considered to be renewable, but current data availability does not allow the non-biodegradable content of wastes to be identified

separately, except for industry.
The indicator measures the relative consumption of energy from renewable sources in total energy consumption for a particular country. The share of renewable energy could increase even if the actual energy consumption from renewable sources falls. Similarly, the share could fall despite an increase in energy consumption from renewable sources. CO_2 emissions depend not on the share of renewables but on the total amount of energy consumed from fossil sources. Therefore, from an environmental point of view, attaining the 2010 target for the share of renewable energy does not necessarily imply that CO_2 emissions from energy consumption will fall.

Scenario analysis always includes many uncertainties and the results should thus be interpreted with care:
• uncertainties related to future socioeconomic developments (e.g. GDP) and human choices;
• uncertainties in the underlying statistical and empirical data (e.g. on future technology costs and performance);
• uncertainties in the choice of indicators (representativeness);
• uncertainties in the dynamic behaviour of systems and its translation into models;
• uncertainties in future fuel costs and the impact on low carbon technologies.
The LCEP scenario uses relatively optimistic assumptions on economic growth, compared with other scenarios. The same level of carbon prices as in the LCEP scenario would lead to higher CO_2 emission reduction when simulated with other models (e.g. TIMER), which may partly result from the fact, that carbon capture and storage was not included in the PRIMES LCEP scenario.

9. Overall scoring (historical data)
   Relevance: 1
   Accuracy: 2
   Comparability over time: 1
   Comparability over space: 1