

EN30 Renewable Electricity

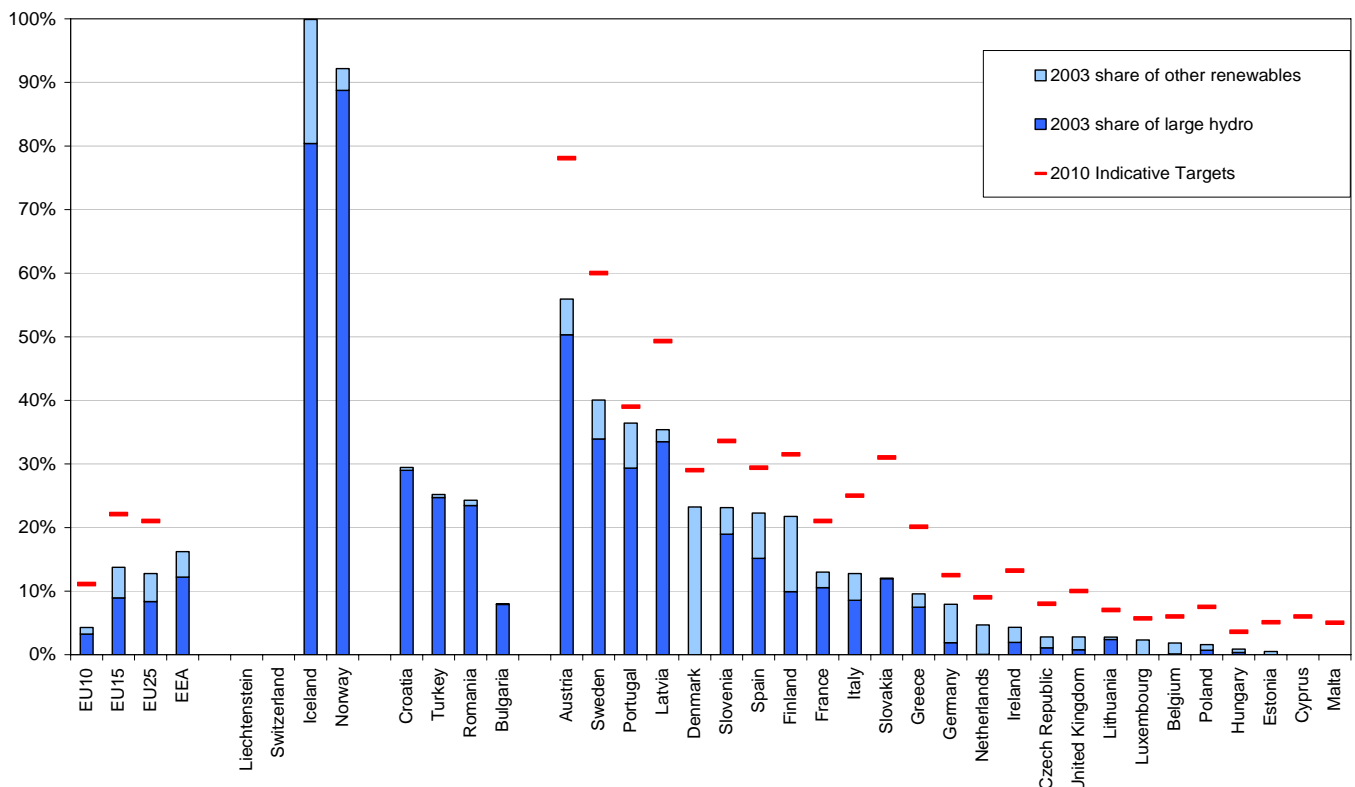
Key message

The share of renewable energy in EU-25 electricity consumption grew slightly over the period 1990-2003 to reach 12.8 %, despite a substantial increase in the total amount of renewable electricity (up by 36 % since 1990). Lower electricity production from hydropower in 2002 and 2003 as a result of little rainfall means that this share has fallen since 2001, but production from both wind and biomass has increased by more than 20 % from 2002 to 2003, helping to partly offset this. Significant further growth will be needed to meet the EU-25 indicative target of a 21 % share by 2010.

Rationale

Electricity produced from renewable energy sources is generally considered environmentally benign with almost no CO₂ emissions. An increased share of renewable electricity will thus help the EU to meet its Kyoto target. The EU has set an indicative target for the EU-25 of 21 % of gross electricity consumption to come from renewable sources by 2010.

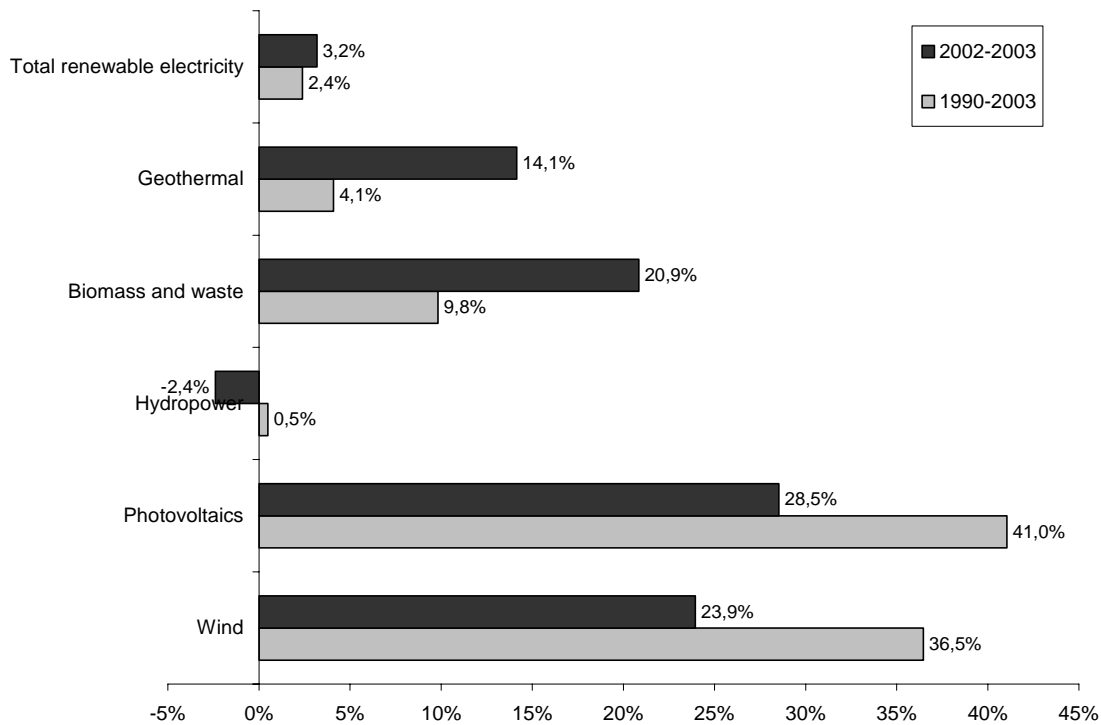
Fig. 1: Renewable electricity as a percentage of gross electricity consumption, 2003



Data source: Eurostat

Note: The electricity directive (2001/77/EC) defines renewable electricity as the share of electricity produced from renewable energy sources in gross electricity consumption. The latter includes imports and exports of electricity. The electricity generated from pumping in hydropower plants is included in gross electricity consumption but it is not input as a renewable source of energy. Large hydropower plants have a declared net capacity of more than 10 MW. No data is available for Liechtenstein or Switzerland from Eurostat.

Fig. 2: Average annual growth rates 1990-2003 and 2002-2003



Data source: Eurostat

1. Indicator assessment

Renewable energy makes an important contribution to meeting electricity consumption, with a share of 12.8 % in 2003. However, this share has only grown slightly since 1990 (12.2 %) despite increasing substantially in absolute terms. Total renewable electricity production grew by 35.9 % over the period 1990 to 2003, but this was only slightly faster than the growth in electricity consumption. In 2002, the share of renewables in gross electricity consumption declined quite substantially, by 1.5 percentage points (compared to 2001) due to lower production from hydropower, as a result of lower rainfall. In 2003 it remained almost unchanged compared to 2002 - a further slight decrease in hydropower was offset by strong growth in output from wind and biomass and waste (by 24 % and 21 % from 2002 to 2003, respectively). However, large hydropower still dominated renewable electricity production in most Member States with approximately a 64 % share across the EU-25 in 2003, compared to around 14.6 % coming from biomass and 11.1 % from wind and the rest from small and medium hydro (8.4 %), geothermal (1.4 %), and solar.

There are significant differences in the share of renewables between the EU-25 Member States. These reflect differences in the availability of natural resources in each country and the policies chosen to support the development of renewable energy. Amongst the EU-25 in 2003, Austria had the greatest share of renewable electricity, including large hydropower, in gross electricity consumption and the seventh highest share excluding large hydropower. Finland and Denmark show the largest shares of renewable electricity when large hydropower is excluded. Finland's high share is mostly due to electricity production from biomass and hydro, while Denmark's renewable electricity is produced by wind power and, to a much lesser extent, biomass and wastes. In both these countries, government policies have been in place to encourage the growth of these technologies. In absolute terms, Germany has the largest absolute production of renewable electricity excluding large hydropower, mainly from wind and biomass, which are both supported by premium feed-in tariffs for renewable electricity. If large hydropower is included France, Spain and Sweden have the largest levels of absolute renewable electricity production.

Within the new Member States, Latvia and Slovenia had the largest share of electricity from renewable energy in 2003, with most of this coming from large hydropower. Excluding large hydro, Slovenia has the highest renewable energy shares in electricity generation, originating mainly from small hydro and biomass and wastes. Only Poland and Latvia have measurable amounts of wind power, with significant growth only having occurred in the last couple of years. All the new Member States have challenging renewable generation targets and will need to make full use of their potential renewable energy resources to achieve these.

Member States use a variety of support schemes for the promotion of renewable electricity production, including: *direct price support*, 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); *market-based mechanisms* such as trading of green or renewable energy certificates issued according to the amount of renewable electricity produced or sold into the grid to ensure that pre-determined quotas are met (for example in the United Kingdom, Sweden, Italy and Belgium); as well as general *subsidies and loans* to support the development and uptake of new technologies (EWEA, 2005). Many Member States have also introduced an energy or carbon tax (see EN32), for which some offer refunds or exemptions if renewable energy or energy efficiency projects are undertaken.

Despite the introduction of policies promoting the development of renewable energy in all EU-25 Member States, substantial additional production will be required to meet the EU-25 renewable electricity indicative target of 21 % by 2010 set in Directive 2001/77/EC, particularly given the expected increase in gross electricity consumption over this period (see EN18). While large hydropower accounts for almost two-thirds of renewable electricity production, it is unlikely to increase substantially in the future due to environmental concerns and a lack of suitable sites, particularly within 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 effect of this on overall EU-25 hydro capacity is still likely to be small. Other renewable energy sources, such as wind, biomass, solar and small-scale hydropower will therefore have to grow substantially if the 2010 target is to be met. In order to increase the use of bioenergy, the Commission recently issued a biomass action plan (EC, 2005b).

The 2004 communication from the European Commission expects the share of renewable electricity for the EU-15 at between 18 and 19 % in 2010 on the basis of currently implemented policies (EC, 2004), still short of the 21 % indicative target. While Denmark, Germany, Spain and Finland are seen as being on track to meet their individual 2010 targets, and Austria, Belgium, Ireland, the Netherlands, Sweden, the United Kingdom, and France are about to be on track, Greece and Portugal are considered not to be on track. 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.

Recent baseline energy projections published by the EEA (EEA, 2005) project a similar development of renewable electricity production in gross electricity generation, to reach around 18 % by 2010 for the EU-25. After 2010, the baseline projection shows the rate of increase in renewable energy production slowing, so that by 2030 the share of renewable electricity in gross electricity consumption would be only marginally higher than in 2010. In a carbon-constrained Europe¹ with a limited growth in electricity consumption, the share of renewable electricity would grow substantially compared to the baseline, but still remain below 30 % (EEA, 2005). If additional policies to support renewable energies were introduced², the share of renewable electricity in total electricity consumption could be expanded rapidly, primarily through greater use of wind, biomass and waste as illustrated in the High Renewables Scenario (EEA, 2005).

Outside of the EU, Norway produces virtually all its renewable electricity from hydropower, with production often exceeding gross electricity consumption, as some hydroelectricity is exported. Iceland also has a very high share of renewables, with almost 100 % of total electricity consumption being provided by large hydro and geothermal sources. Renewable electricity production is also important in Romania and Turkey, mostly through the exploitation of large hydro.

2. Indicator rationale

2.1 Environmental context

The share of electricity consumption from renewable energy sources provides a broad indication of progress towards reducing the environmental impact of electricity consumption as renewable electricity is generally considered environmentally benign, with very low net emissions of CO₂ per unit of electricity produced, even allowing for emissions associated with the construction of the electricity production facilities. Increasing the share of renewables in electricity consumption will thus help the EU reduce the CO₂ emissions from power generation, although its overall impact has to be seen within the context of the total fuel mix, the extent to which pollution abatement equipment is fitted, and potential impacts on biodiversity.

(1) This scenario assumed that carbon permit prices rise from 30 €/t CO₂ in 2020 to 65€ in 2030.

(2) The Low Carbon Energy Pathway Scenario with a high share of renewables assumes a renewables premium of 2.4 ct/kWh in 2020 and 4.5 ct/kWh in 2030 in addition to the carbon permit price

Emissions of other pollutants are also generally lower for renewable electricity production than for electricity produced from fossil fuels. The exception to this is the incineration of Municipal and Solid Waste (MSW), which due to high costs of separation, usually involves the combustion of some mixed wastes including materials contaminated with heavy metals. Emissions to the atmosphere from MSW incineration are subject to stringent regulations including tight controls on emissions of cadmium, mercury, and other such substances.

The exploitation of renewable energy sources usually has some negative impact on landscapes, habitats and ecosystems, although many 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 hot fluids if not properly controlled. Wind turbines can have visual impacts on the areas in which they are sited. Some types of biomass and biofuel crops have considerable land, water and agricultural input requirements such as fertilisers and pesticides.

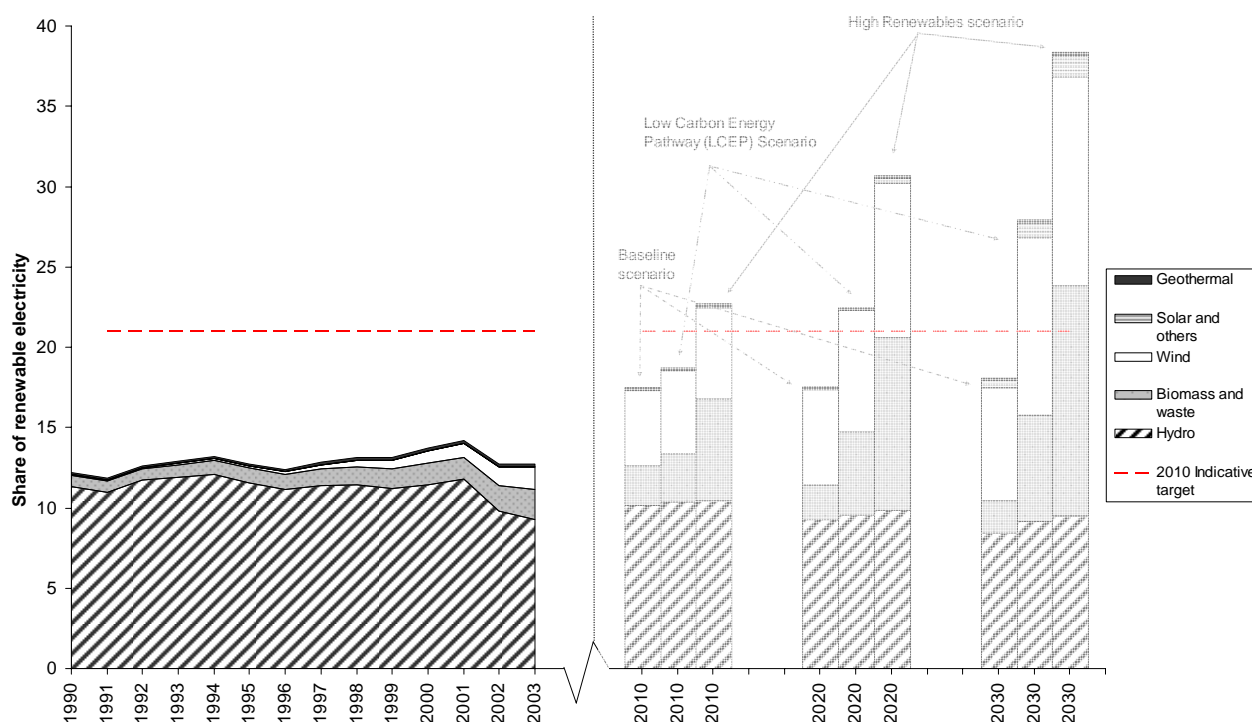
2.2 Policy context

The original EU Directive on the promotion of electricity from renewable energy sources in the internal electricity market (2001/77/EC) sets an indicative target of 22.1 % of gross EU-15 electricity consumption from renewable sources 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.

Discussions on renewable energy targets have already commenced. Recently, the European Council called for an Energy Policy in 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.

The power sector is responsible for a significant share (33 % in 2003) of European greenhouse gas emissions and therefore increased market penetration of renewable electricity would 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.

Fig. 3: Contribution of electricity from renewable sources to total electricity consumption, and projections of the future share of renewable sources in electricity generation, 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 CO₂ permit price of 30 €/t CO₂ and 65 €/t CO₂ in 2020 and 2030, respectively. The high renewables 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, which will be achieved by a renewables premium in the power sector and tax regulations in transport in addition to a carbon permit price. Historic data refer to the share of renewables in gross electricity production, while projection data refer to the share of renewables in electricity production.

Fig. 4 Share of renewable electricity in gross electricity consumption (%) 1990-2003 in EEA member countries and 2010 indicative targets)

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2010 targets
EEA members	17.1	17.5	16.6	17.2	17.7	17.5	18.2	17.8	17.0	16.2	-
EU-25	12.2	12.8	12.4	12.8	13.1	13.1	13.7	14.2	12.7	12.8	21.0
EU-15 pre-2004 members	13.4	13.7	13.4	13.8	14.1	14.0	14.7	15.2	13.5	13.7	22.1
EU-10 new members	4.2	5.4	4.8	5.0	5.7	5.5	5.4	5.6	5.6	4.3	-
Belgium	1.1	1.2	1.1	1.0	1.1	1.4	1.5	1.6	1.8	1.8	6.0
Czech Republic	2.3	3.9	3.5	3.5	3.2	3.8	3.6	4.0	4.6	2.8	8.0
Denmark	2.4	5.8	6.3	8.8	11.7	13.3	16.4	17.4	19.9	23.2	29.0
Germany	4.3	4.7	4.7	4.3	4.9	5.5	6.8	6.5	8.1	7.9	12.5
Estonia	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.5	0.5	5.1
Greece	5.0	8.4	10.0	8.6	7.9	10.0	7.7	5.1	6.0	9.6	20.1
Spain	17.2	14.3	23.5	19.7	19.0	12.8	15.7	20.7	13.8	22.3	29.4
France	14.8	17.8	15.3	15.2	14.4	16.5	15.1	16.3	13.7	13.0	21.0
Ireland	4.8	4.1	4.0	3.8	5.5	5.0	4.9	4.2	5.4	4.3	13.2
Italy	13.9	14.9	16.5	16.0	15.6	16.9	16.0	16.8	14.3	12.8	25.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Latvia	43.9	47.1	29.3	46.7	68.2	45.5	47.7	46.1	39.3	35.4	49.3
Lithuania	2.5	3.3	2.8	2.6	3.6	3.8	3.4	3.0	3.2	2.8	7.0
Luxembourg	2.1	2.2	1.7	2.0	2.5	2.5	2.9	1.5	2.8	2.3	5.7
Hungary	0.5	0.7	0.8	0.8	0.7	1.1	0.7	0.8	0.7	0.9	3.6
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Netherlands	1.4	2.1	2.8	3.5	3.8	3.4	3.9	4.0	3.6	4.7	9.0
Austria	65.4	70.6	63.9	67.2	67.9	71.9	72.0	67.3	66.0	55.9	78.1
Poland	1.4	1.6	1.7	1.8	2.1	1.9	1.7	2.0	2.0	1.6	7.5
Portugal	34.5	27.5	44.3	38.3	36.1	20.5	29.4	34.2	20.8	36.4	39.0
Slovenia	25.8	29.5	33.0	26.9	29.2	31.6	31.4	30.4	25.9	23.1	33.6
Slovakia	6.4	17.9	14.9	14.5	15.5	16.3	16.9	17.4	18.6	12.0	31.0
Finland	24.4	27.6	25.5	25.3	27.4	26.3	28.5	25.7	23.7	21.8	31.5
Sweden	51.4	48.2	36.8	49.1	52.4	50.6	55.4	54.1	46.9	40.0	60.0
United Kingdom	1.7	2.0	1.6	1.9	2.4	2.7	2.7	2.5	2.9	2.8	10.0
Bulgaria	4.1	4.2	6.4	7.0	8.1	7.7	7.4	4.7	6.0	8.0	-
Romania	23.0	28.0	25.3	30.5	35.0	36.7	28.8	28.4	30.8	24.3	-
Turkey	40.9	41.9	43.0	38.1	37.3	29.5	24.3	19.1	25.6	25.2	-
Iceland	99.9	99.8	99.9	99.9	99.9	99.9	99.9	100.0	99.9	99.9	-
Norway	114.6	104.6	91.4	95.3	96.2	100.7	112.2	96.2	107.3	92.2	-

Data source: Eurostat.

Note: The electricity directive (2001/77/EC) defines renewable electricity as the share of electricity produced from renewable energy sources in gross electricity consumption. The latter includes imports and exports of electricity. The electricity generated from pumping in hydropower plants is included in gross electricity consumption but it is not input as a renewable source of energy. Almost all electricity generated in Iceland and Norway comes from renewable energy sources. The renewable electricity share in Norway is above 100 % in some years because a part of the (renewable) electricity generated domestically is exported to other countries. The share of renewable electricity in Germany in 1990 refers to West Germany only. Notes to the directive 2001/77/EC are made by Italy, Luxemburg, Austria, Portugal, Finland and Sweden in relation to their 2010 national indicative targets. Austria and Sweden note that reaching the target is dependent upon climatic factors affecting hydropower production, with Sweden considering 52 % a more realistic figure if long-range models on hydrologic and climatic conditions were applied.

References

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.

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

EC (2005) COM(2005) 627 final - The support of electricity from renewable energy sources, European Commission.

EC (2005b) COM(2005)628 final – Biomass Action Plan, European Commission.

EEA (2005) Climate change and a low-carbon European energy system, European Environment Agency report No 1/2005.

European Commission (2004) European energy and transport – scenarios on key drivers, Directorate General for Transport and Energy

European Council (2006). Presidency Conclusions European Council 23/24 March 2006. Council Document 7775/06.

EWEA (2005) Support schemes for renewable energy: A comparative analysis of payment mechanisms in the EU, European Wind Energy Association

http://www.ewea.org/documents/projects/RE-Xpansion/050620_ewea_report.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 (historical data), <http://europa.eu.int/comm/eurostat/>

European Commission, EEA (2005) (projected data) – baseline projections are consistent with European Commission (2004)

Renewable electricity 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 electricity is the ratio between the electricity produced from renewable energy sources and gross national electricity consumption calculated for a calendar year, expressed as a percentage. It measures the contribution of electricity produced from renewable energy sources to the national gross electricity consumption. As well as being one of the EEA's core set indicators, it is also one of the structural indicators used to underpin the European Commission's analysis in its annual Spring report to the European Council. The methodologies are identical for both indicators.

Renewable energy sources are defined as renewable non-fossil energy sources: wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding that produced as a result of pumping storage systems), wind, solar, geothermal and electricity from biomass/wastes. Electricity from biomass/wastes comprises electricity generated from wood/wood wastes and the burning other of solid wastes of a renewable nature (straw, black liquor), municipal solid waste incineration, biogas (incl. landfill, sewage, farm gas) and liquid biofuels. Gross national electricity consumption comprises total gross national electricity generation from all fuels (including autoproduction), plus electricity imports, minus exports.

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 CO₂-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:

Share of electricity produced from renewable energy sources as a percentage of total national electricity consumption. The coding (used



in the Eurostat New Cronos database) and specific components of the indicator are:

Numerator: hydro 5510 primary production 100100 + wind 5520 primary production 100100 + photovoltaic (PV) 5534 primary production 100100 + 6000 electrical energy 107002 gross electricity generation - geothermal power plants + 6000 electrical energy 107011 gross electricity generation -biomass-fired powerstations.

Denominator: 6000 electrical energy 107000 total gross electricity generation + 6000 electrical energy 100900 gross inland consumption (i.e. net balance of imports minus exports).

Average annual rate of growth calculated using: $[(\text{last year}/\text{base year})^{(1/\text{number of years})} - 1] * 100$

Qualitative information

7. Strengths and weaknesses (at data level)

Data gaps for breakdown of large hydropower. No projection data for Croatia, Iceland and Liechtenstein.

Data have traditionally been 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 on Eurostat's website in the section on metadata on energy statistics:

http://europa.eu.int/estatref/info/sdds/en/sirene/energy_sm1.htm

8. Reliability, accuracy, robustness, uncertainty (at data level):

Indicator uncertainty (historic data)

The renewables electricity directive (2001/77/EC) defines the share of renewable electricity as the percentage of electricity produced from renewable energy sources in gross electricity consumption. The numerator includes all electricity generated from renewable sources, most of which is for domestic use. The denominator contains all electricity consumed in a country, thus including imports and excluding exports of electricity. Therefore, the share of renewable electricity can be higher than 100 % in a country if all electricity is produced from renewable sources and some of the over-generated renewable electricity is exported to a neighbouring country.

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 electricity produced as a result from hydropower storage systems is not classified as a renewable source of energy in terms of electricity production, but is part of the gross electricity consumption in a country.

The share of renewable electricity could increase even if the actual electricity produced from renewable sources falls. Similarly, the share could fall despite an increase in electricity generation from renewable sources. Therefore, from an environmental point of view, attaining the 2010 target for the share of renewable electricity does not necessarily imply that carbon dioxide emissions from electricity generation will fall.

Electricity consumption within the national territory includes imports of electricity from neighbouring countries. It also excludes the electricity produced nationally but exported abroad. In some countries the contribution of electricity trade to total electricity consumption and the changes observed from year to year need to be looked at carefully when analysing trends in renewable electricity. Impacts on the (national) environment are also affected since emissions are accounted where the electricity is produced whereas consumption is accounted where the electricity is consumed.

It should also be noted that electricity consumption in 1990 for Germany refers only to the western part.

Indicator uncertainty (scenarios):

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 CO₂ 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 – historic data (1 = no major problems, 3 = major reservations):

Relevance: 1

Accuracy: 1

Comparability over time: 1

Comparability over space: 1