

2. Background



Photo: Volker Quaschnig

2.1. The importance of renewable energy

Renewable energy is the term used to describe a wide range of naturally occurring, replenishable energy sources — in particular, sun, wind, water and a range of biomass resources. Renewable energy sources can be used to generate heat or electricity, or can be used to produce liquid fuels for transport. For a general description of the various renewable energy sources see Box 1.

Box 1

Sun: The sun's energy can be used to generate power from photovoltaic cells, which convert light directly into electricity. Solar thermal energy is available by transferring energy from the sun via a liquid to heat water or air.

Wind energy is extracted by wind turbines, situated onshore or offshore. These transfer the momentum of passing air to rotor blades, which is then converted into electricity.

Biomass is a general term for material derived from growing plants or from animal manure. Biomass includes waste materials such as straw, or crops specifically grown as biomass fuel. Energy can be recovered through combustion of solid material, or of gases generated from the anaerobic fermentation of liquid material.

Water can be exploited as a renewable resource in a number of ways. Hydroelectric power is generated from the potential energy of inland water resources such as streams, rivers and lakes. Tidal energy is produced by the rotational energies of the earth, moon and sun, and can be used to generate electrical energy. Electricity can also be generated from waves. Waves receive their energy from the wind, which is mainly driven by the effects of solar heating in the atmosphere.

Geothermal: Some definitions include geothermal energy as a renewable energy source. Geothermal energy is the heat energy contained in rocks beneath the earth's surface and can be exploited to produce heat or generate electricity.

Renewable energy plays an important role in the process of integrating the environment into energy policy, through its potential to contribute to the objectives of sustainable development.

At the point of generation, renewable energy sources generally emit no greenhouse gases, with the notable exception of biomass, which is neutral over its life cycle in greenhouse gas terms. They also produce significantly lower levels of environmental air pollutants than fossil sources. Each EU Member State has committed itself to national targets to reduce or limit greenhouse gas emissions in order for the EU as a whole to meet the Kyoto Protocol obligation of reducing greenhouse gas emissions by 8 % from 1990 levels by 2008–12. Individual governments are working towards appropriate measures to achieve their own targets. The energy sector is one of the major emitters of carbon dioxide (CO₂) and other greenhouse gases, so increasing the use of renewable energy in place of fossil fuels can contribute towards achieving these targets.

Negative environmental impacts from renewable energy are, in general, lower than those encountered from fossil or nuclear energy sources and are usually more significant at the local level, near to the plant. Renewable energy installations may cause visual, noise or interference impacts, especially at the local level, although generally these can be minimised if the installation is planned and sited sensitively. The use of biomass necessitates additional transport. Biomass combustion also generates potentially polluting emissions, which need to be carefully regulated. The environmental consequences of growing biomass crops may include an impact from the use of agrochemicals, changes to water use, as well as changes to biodiversity and habitat, and visual alterations to the landscape. Hydro installations, in particular large installations, can have a local impact through construction activities, but will also affect water quality and flow, with consequent potential impact on the aquatic ecosystem. Photovoltaic (PV) systems have few effects when in operation, but the manufacture of PV cells needs to be carefully controlled due to the use of potentially toxic or hazardous materials.

Renewable energy can make an important contribution to security and diversity of energy supply, by providing a secure, indigenous source of energy that is available in a variety of forms to all Member States.

Renewable energy use is also important for reasons of social and economic cohesion. Renewable energy technologies are generally situated in regions with lower levels of investment or employment, such as rural or remote regions. Investment in new renewables plants in such areas can therefore benefit the local and regional economy.

The renewable energy industry is one of Europe's fastest-growing sectors, as Member States develop manufacturing capabilities to meet the growing demand for renewable energy, both domestically in the EU, and increasingly worldwide⁽⁴⁾. Building on a strong domestic market, European renewable energy companies already lead the world in their skills and expertise.

2.2. Targets for renewable energy use in the EU

At the EU level, the European Commission's 1997 White Paper on renewable energy sources (European Commission, 1997a) set out the objective of increasing the share of renewable energies to 12 % of gross inland energy consumption⁽⁵⁾ by 2010.

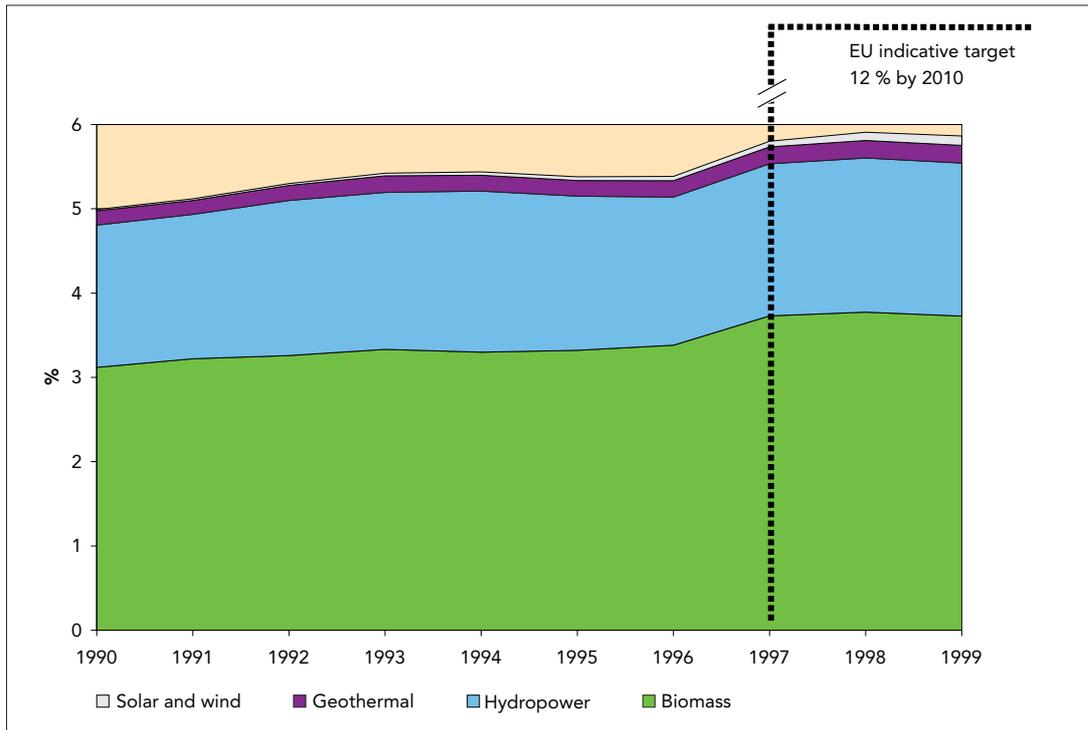
(4) A recent EU study estimated that the renewable energy industry may generate up to 500 000 jobs by 2020 (ECOTEC, 1999).

(5) The gross inland energy consumption is the total amount of energy which is consumed in an economy. See also Glossary.

Figure 1

Renewable energy sources as a contribution to gross inland energy consumption, EU

Source: Eurostat.



Renewable energy's share of gross inland energy consumption was 5.9 % in 1999, well short of the 12 % indicative target. Clearly the target is challenging for the EU. Indeed, even if the high growth rates observed between 1996 and 1999 are extrapolated, the share of renewable energies still falls short of the 2010 indicative target ⁽⁶⁾.

As a follow-up to the 1997 White Paper, in 1999 the Commission launched the Campaign for Take-Off (European Commission, 1999b). The campaign identified three key renewable energy sectors to be promoted during the period 1999–2003: solar energy (photovoltaics and solar thermal), wind and biomass (combined heat and power biomass installation, dwellings heated by biomass, biogas installations and biofuels). These also correspond to those technologies or market sectors where rapid uptake of renewable energy use is more likely to occur over this short timescale (to 2003), since they are already being successfully implemented in a number of Member States.

2.2.1. Renewable energy and liberalisation of the energy markets in the EU

The ongoing process of liberalisation of the electricity and gas markets in Europe has significant implications for renewable energy, particularly the proportion of electricity produced from renewable sources in the EU.

As a result of the 1996 EU directive on the internal market for electricity ⁽⁷⁾, Member States have been obliged to gradually open up an important proportion of their national electricity markets to competition which, combined with some other developments, has led to reduced prices for power from conventional sources.

However, despite many technological advances in the past decade, electricity from renewable sources is still more expensive than equivalent conventional power. This is mainly due to the relatively smaller size of renewable energy plant (which therefore cannot benefit from economies of scale) and the fact that external costs of fossil fuels have often not been fully internalised to level out the playing field between fossil and renewable energy. As the EU market becomes increasingly liberalised, it may become progressively more difficult for

(6) This assumes that gross inland energy consumption will grow at the levels forecast by the Commission in its 1999 Primes baseline scenario (European Commission, 1999a).

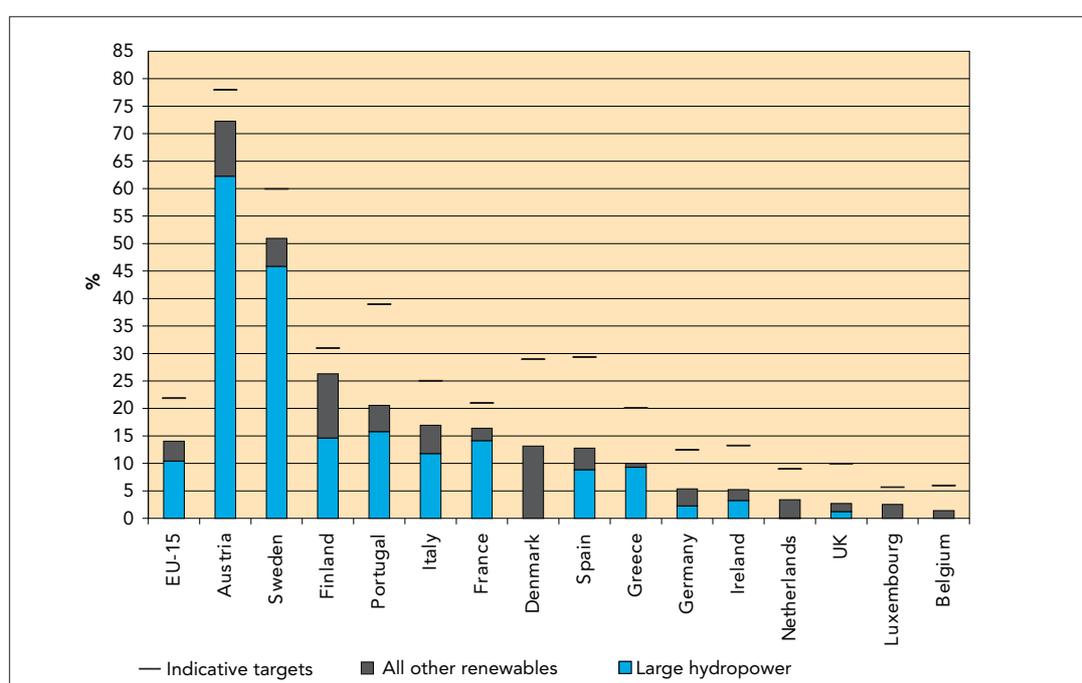
(7) Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity.

renewable energy to compete in these changing markets without some support mechanisms over the medium term.

The recently adopted Directive to promote renewable electricity in the EU ⁽⁸⁾ attempts to address these issues. It aims to create a framework for electricity from renewables which will contribute towards achieving the indicative target of a 12 % renewables share in gross inland energy consumption (i.e. the total amount of energy consumed in an economy, including both heat and electricity) by 2010. The Directive requires Member States to take appropriate steps to encourage greater consumption of electricity produced from renewable energy sources by setting and achieving annual national indicative targets consistent with the Directive and national Kyoto commitments. The national indicative targets should be consistent with an increase in the share of electricity generated from renewable energy sources in the EU from 13.9 % in 1997 to 22.1 % by 2010. Such national indicative targets, as well as the 1999 levels of renewable electricity share in gross electricity consumption ⁽⁹⁾ are shown in Figure 2.

Renewable energy contribution to gross electricity consumption, 1999

Figure 2



Source: Eurostat.

Notes:

1. Industrial and municipal waste has been included in 'All other renewables'. According to the renewable electricity directive (2001/77/EC) only the biodegradable part of industrial and municipal waste is renewable. Data on industrial and municipal waste presented here include all industrial and municipal waste, as there are no data available on the biodegradable part only. The share of renewable electricity in gross electricity consumption is therefore overestimated by an amount equivalent to the electricity from non-renewable industrial and municipal waste.
2. National indicative targets shown here represent reference values that Member States agreed to take into account when setting their indicative targets by October 2002, according to the renewables electricity directive (2001/77/EC).

In 1999 renewable sources contributed 14.2 % of gross electricity consumption: 10.5 % from large hydropower installations (a capacity of 10 MW or more) and 3.7 % from all other renewables.

Due to site limitations, the contribution of electricity from large hydro is expected to remain approximately constant between 1999 and 2010. Between 1996 and 1999 electricity from non-large hydro renewables (i.e. all other renewables except large hydro) grew rapidly. However,

(8) Directive of the European Parliament and of the Council on the promotion of electricity from renewable energy sources in the internal electricity market (2001/77/EC).

(9) See glossary.

non-large hydro renewables will have to grow significantly faster if the 2010 target is to be reached.

2.3. Technologies covered under this study

This study concentrates on the technologies promoted under the Campaign for Take-Off.

For the purposes of the study the following renewable energy sources have been chosen:

- solar photovoltaics
- solar thermal
- wind
- biomass energy (biomass power including combined heat and power, biomass district heating and biofuels).

Table 1 Renewable energy sources/technologies studied

Source: Eurostat.

Renewable energy source/technology	Description	Units of measurement used in this study
Solar photovoltaics	Power generated using photovoltaic cells to convert light directly into electricity.	Power output (Gigawatt hours, GWh)
Solar thermal	Transfer of energy from the sun via a liquid to heat water or air.	Heat output (thousand tonnes of oil equivalent, ktoe)
Wind	Wind turbines extract energy from the wind by transferring the momentum of passing air to rotor blades, which is then converted into electricity.	Power output (GWh)
Biomass	A range of biomass fuels such as forestry and agricultural residues, and energy crops can be used to generate electricity in <i>power stations</i> including in <i>combined heat and power plant</i> , or can be used to produce heat in <i>district heating plant</i> . In addition, biomass can be used to produce transport fuels (<i>liquid biofuels</i>), primarily biodiesel and bioethanol, from processed agricultural crops and other biomass feedstocks.	Power output (GWh) or energy output as heat or fuel (ktoe)

In 1999, the renewable technologies covered under this study together represented approximately 23 % of the non-hydro ⁽¹⁰⁾ renewables gross inland consumption (both heat and electricity) and 64 % of the non-hydro renewables gross electricity consumption. The remaining renewable energy sources not covered in this study are mainly waste combustion, including industrial and municipal waste ⁽¹¹⁾ as well as contributions from other biomass sources and from geothermal energy.

Energy from biogas is included in the Campaign for Take-Off but is not considered in this study. Biogas generation is derived from the safe disposal of animal manure residues. Its exploitation is therefore dependent to a great extent on animal husbandry and waste management legislation. For this reason, the technology has not been studied further here.

Offshore wind energy is at an early stage of implementation, and so far there are only a few offshore plants in operation. This is why the penetration of offshore wind energy has not been included. Nevertheless Annex 4 provides a short analysis of lessons that could be learnt from previous experiences of renewable energy developments onshore, and in particular from the case studies presented here.

(10) Hydro power is either large hydro power (over 10 MW) or small hydro power (less than 10 MW). The vast majority of hydro power in the EU is large hydro power. The contribution of large hydro power is expected to remain approximately constant in the coming decades due to site limitations. Hydro power (both large and small) is a site-specific resource dependent on water availability and thus has a number of different characteristics from those of other resources (such as wind and solar) which can be developed at a variety of sites.

(11) In general, industrial and municipal waste also contains waste from non-renewable sources.