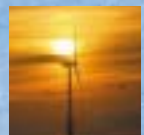
EWEA
WIND IS POWER

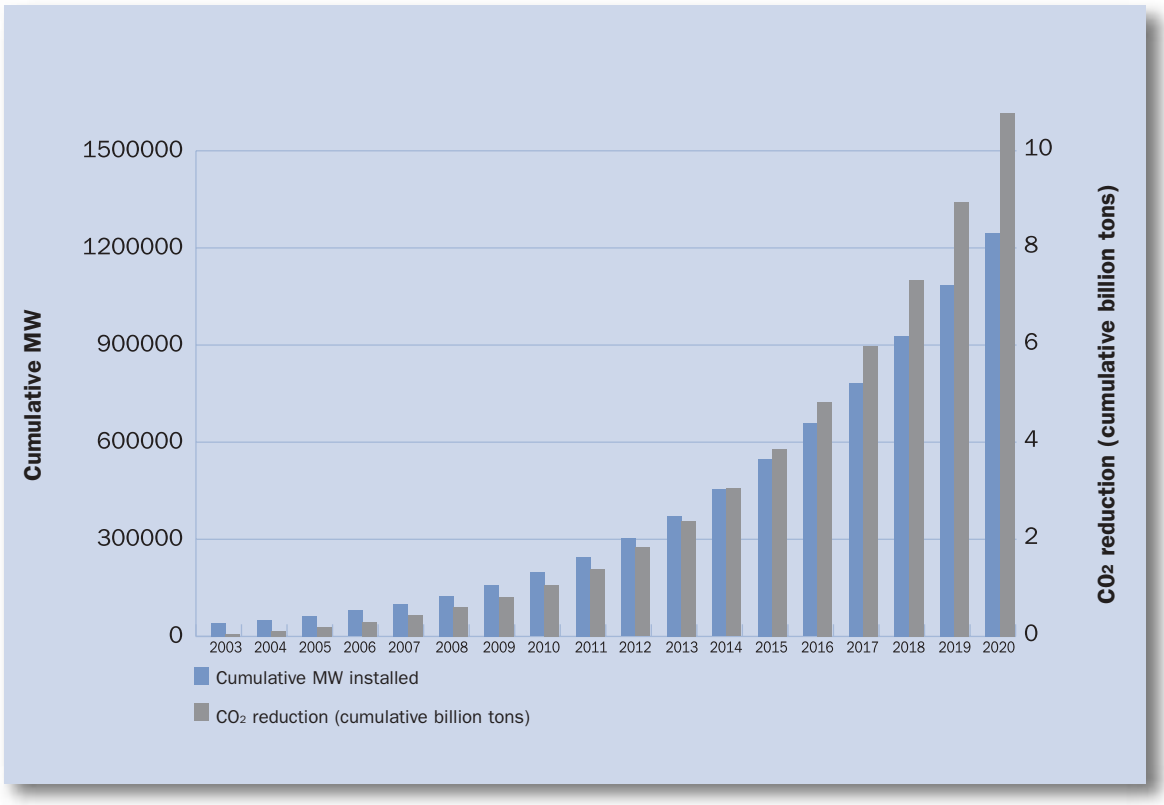
WIND ENERGY AND THE **ENVIRONMENT**



ENVIRONMENTAL BENEFITS, EXTERNAL COSTS, LOCAL IMPACTS, PUBLIC ACCEPTANCE

The large-scale use of renewable energy sources is essential if the necessary reductions in CO_2 and other emissions from electricity generation are to be met and if sustainable development and sustainable growth are to be achieved.

Carbon dioxide savings and market development 2003-2020 (Wind Force 12 scenario)



Wind turbines cause virtually no emissions during their operation and very little during their manufacture, installation, maintenance and removal.

Environmental benefits

Environmental pollution and the emission of CO_2 (carbon dioxide) from the use of fossil fuels constitute a threat to health, the environment and sustainable economic growth. Other major pollutants from conventional electricity, which are avoided through wind power, include SO_2,NO_x and PM10.

The most serious threat comes from accelerating climate change, whose effects are already being seen around the world in rising temperatures, melting ice caps and volatile weather patterns. Climate change is a direct result of the greenhouse effect – the build-up of greenhouse gases in the atmosphere above the earth. Carbon dioxide emissions from power plants, industry and the transport sector is by far the largest contributor. The Intergovernmental Panel on Climate Change has predicted that human-induced greenhouse gas emissions will lead to a substantial increase in global mean temperatures, which will rise between 1.4 and 5.8 degrees over the course of this century.

As most renewable energy sources emit neither greenhouse gases nor other pollutants such as SO_2 (sulphur dioxide) or NOx (nitrogen oxide) they will form the basis of any long-term sustainable energy supply system. The large-scale use of renewable energy sources is essential if the necessary reductions in CO_2 and other emissions from electricity generation are to be met and if sustainable development and sustainable growth are to be achieved.

Wind turbines cause virtually no emissions during their operation and very little during their manufacture, installation, maintenance and removal.

Because the fuel is free, wind generated kilowatts should be used as often as possible in the electricity system to replace intermediate power loads, from coal and gas.

Across Europe in 2003, wind power on average was responsible for the annual reduction of 27 million tonnes of CO_2. Only 4 countries have any meaningful quantities of wind energy installed, and the situation changes quickly as more wind power is built.

By 2020, taking EWEA projections that 180GW of wind energy would be generating 425 TWh per annum, wind power will provide

- annual saving of 215 million tonnes CO_2.
- annual saving of 261,000 tonnes SO_2.
- annual savings of 333,000 tonnes NOx.

"Recent months, in which a series of hurricanes have devastated the Caribbean and the parts of the Eastern United States, show that an international alliance against climate change and for the reduction of gases is even more necessary than when Kyoto was signed in 1997. These kinds of natural disasters, with their appalling loss of life and significant economic costs, are likely to become even more frequent and extreme unless global warming is effectively checked".

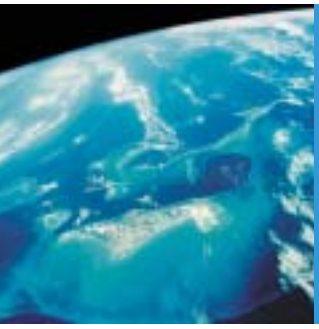
(Klaus Toepfer, Executive Director of the United Nations Environment Programme, Sept 2004)

Effects of Climate Change

The consequences of climate change are already apparent around the world. They include:

- **The proportion of CO_2 in the atmosphere has risen by about one third since industrialisation began.**
- **The number of natural disasters has trebled since the 1960s. According to insurance company Munich Re the resulting economic damage has increased by a factor of nine.**
- **The eight warmest years over the last 130 years were recorded during the past 11 years.**
- **A United Nations' study says that the economic damage of climate change will reach an annual figure of $300 billion by 2050.**
- **Sea levels have risen by 10-20 centimetres in the last 100 years, 9-12 cm of this in the last fifty years.**
- **According to a World Health Organisation study, up to 160,000 people are already dying each year as a result of climate change.**
- **According to a study published in Nature (January 2004), a mid-range level of global warming could result in the extinction of 1,000,000 terrestrial species by the middle of this century.**

Because of the time lapse between emissions and their effects, the full consequences of the climate change to which we are already committed have still to emerge over the coming decades, bringing increased danger to the stability of the world's economy and lifestyle. To effectively stem the greenhouse effect, emissions of CO_2 must be greatly reduced.



By 2020, taking EWEA projections for wind energy to be generating 425 TWh/a, the level of avoided external costs would have risen to an annual €25 billion.

The cost of producing electricity from coal or oil would double and the cost of electricity production from gas would increase by 30 %, if external costs, in the form of damage to the environment and health, were taken into account.

Wind Force 12

This scenario of wind industry growth shows how much CO_2 can be saved if there is increase political support for the technology. See graph on page 2.

External costs

The environmental benefits associated with the generation of electricity from renewable energy, including wind power, can be quantified in economic terms. These benefits are not fully reflected in the market prices paid for wind generated electricity. By giving a value to a range of "external costs" related to energy production, the aim is to show the full cost to society of producing electricity from different fuels. Examples of external costs include effects on human health, damage to the environment, loss of amenity as well as economic effects such as payment of subsidies and employment benefits.

The most detailed analysis of external costs to date has been carried out through the European Commission's ExternE project. This has been conducted over a period of more than ten years and is ongoing. The analysis shows that if the entire fuel cycle is assessed – from fuel extraction through processing to transformation, construction, operation and waste disposal - it becomes clear that the economic damage attributable to conventional fuels towers over that of wind.

The ExternE project values the external costs of wind energy at less than 0.26 €cents/kWh whilst those for coal-fired generation range from 2 to 15 €cents/kWh. Economic savings through the implementation of wind power can then be calculated by comparing its external costs with those of fossil fuel technologies, and relating these costs to the proportion of fossil fuel generation capacity displaced by penetration of wind technology.

The ExternE report estimates that the cost of producing electricity from coal or oil would double and the cost of electricity production from gas would increase by 30 %, if external costs, in the form of damage to the environment and health, were taken into account. The study further estimates that these costs amount to 1-2 % of EU GDP or between €85 billion and €170 billion, not including the cost of global warming and climate change.

In 2000, the total avoided external costs through the use of wind power amounted to nearly €1.8 billion. By 2020, taking EWEA projections for wind energy to be generating 425 TWh/a, the level of avoided external costs would have risen to an annual €25 billion.

At present, the external costs associated with different fuels are rarely internalised. The EU ordinance on subsidies for environmental measures (Official Journal of the European Communities, 2001) states, however, that proven externalities may be compensated by public payments of up to 5 €cents/kWh without being considered as subsidies.

Wind-related avian collision fatalities represent 0.01 - 0.02% of annual avian fatalities in the US.

Environmental impacts of wind energy

Most wind energy projects require an Environmental Impact Assessment (EIA) under national and European Law, which allows the full details of environmental costs and benefits of a project to be scrutinised in the public domain.
Whilst wind energy is a clean technology, it is not free of impacts on the environment. The main issues are:

Visual impact: Wind turbines are a relatively new feature in the European countryside, and have an impact on amenity. Attitudes towards them will depend on aesthetic judgements on beauty and diversity, which are subjective and with general reactions towards the technology. Consultation with, and acceptance by, local communities is essential, especially in rural areas where a particularly high value is placed on landscape amenity. Land use planning rules in some countries recommend avoiding areas with protected designations; in others, specific areas have been earmarked for potential wind farm development. In order to maintain public acceptance, wind farms need to be designed in such a way to minimize various aesthetic and amenity impacts.

Sound emissions: Modern wind turbine designs have improved to the point where mechanical noise is insignificant, so the issue is now aerodynamic noise from the turning blades. At a distance of 300 metres from a 1 MW wind turbine, the expected sound level would be 45 decibels (dBA). The 'subjective' impression at this level is deemed 'quiet'. The noise from turbines is usually masked by other ambient sounds such as the movement of trees when the wind picks up, or near an industrial or urban area.

Birds: Collisions with turbines have been an issue at some older wind farm sites form the 1980s, especially the Altamont Pass in California – a result of poor siting, out-moded turbines and tower technology. Subsequent experiences in Germany and Denmark show that such effects can be avoided by responsible planning practice. Proper siting of turbines is important if adverse impacts are to be avoided.

In the United States, a study in 2001 estimated an average of 2.2 fatalities for each turbine. By comparison, between 100 and 1,000 million birds are estimated to die each year in the US from colliding with vehicles, buildings, power lines and other structures. That is wind-related avian collision fatalities represent 0.01 - 0.02% of annual avian fatalities in the US. In Spain, a study in the province of Navarre showed that 0.13 birds had died per year per turbine.

The impact of birds must be placed in context. 99% of threats to birds are human related, from habitat loss to industrialization, over exploitation of natural resources, hunting, the pet trade, pollution, etc. Habitat loss is the single greatest threat to birds, and 12% of the world's 9,800 bird species face extinction.

Construction: The construction process usually takes no more than a few weeks depending on the size of the project. Once complete, apart from access roads, agricultural activity can resume right up to the turbine bases of an operational wind farm. Between 1-3% of a wind farm area is utilized by turbines, so up to 99% of the land is available for other uses.

Over its 20 year lifetime, an average turbine will provide 63-78 times more energy than used in construction.

Energy balance: A 1997 study of a typical turbine by the Danish Wind Industry Association shows that a modern wind turbine recovers all the energy inputs involved in its manufacture and operating life within three to four months – i.e. that over its 20 year life-time, an average turbine will provide 63-78 times more energy than used to construct, operate and eventually dismantle the turbine. It is fair to assume that the energy balance of wind power has improved considerably since the 1997 study.

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Public acceptance

Surveys of public attitudes both across Europe and in specific countries show consistent, strong support for renewable energy in general and wind power in particular.

The pan-European survey "Energy, Issues, Options and Technologies", commissioned by the EU's Directorate for Research in 2002, interviewed over 16,000 people across the fifteen then member states. One of its main findings was that 88% of respondents saw climate change as a serious issue. Fossil fuels were recognised as one of the main causes of climate change (75%).

When asked to look ahead to how our energy might be supplied in the year 2050, 67% of those questioned thought that renewable energy sources were the best environmental option. On costs, 40% predicted that renewables like wind, solar and biomass would be the least expensive energy sources by then, followed by hydroelectric power (24%) and natural gas (21%).

The EU study concluded that "overall, the perception Europeans have of energy options in 20 and 50 years from now is clearly influenced by their own instinctive preferences for renewable energy sources".

An analysis of public opinion surveys carried out in a number of EU countries, including Spain, the UK, Denmark, Germany and Sweden shows substantial majorities in favour of developing wind energy, especially when compared with other fuel sources. The surveys also show that local approval rises once a wind farm starts operating. In some countries, direct involvement of the general public in wind energy projects has helped to encourage acceptance. In Denmark, about 150,000 families either own wind turbines or have shares in wind turbine co-operatives.

Developing Europe's potential for using renewable energy will contributeto security of energy supply, reduce fuel imports and dependency, reduce greenhouse gas emissions, improve environmental protection, decouple economic growth from resource use, create jobs, and consolidate efforts towards a knowledge-based society

- The share of renewable energy in the EU' Communication from the Commission to the Council and the European Parliament Brussels 26.5.2004

•Spain

A study carried out by opinion research company CIES for wind park developers Energias Eolicas Europeas showed that 79% of respondents considered wind energy to be a benefit, with only 1% considering it to be damaging. The survey also found that 62% of those questioned thought that wind parks made no difference to the landscape.

Alongside acceptability values higher than 70% in all the areas surveyed, 88% saw wind power as a clean energy source and 48% considered that it created wealth and jobs. 69% of those surveyed thought that wind energy was the best energy source to produce electricity. This compares to 17% for hydroelectric power, 2% for thermal power and 1% for nuclear.

A study carried out by CIES for Spanish developer EHN showed that between 1995 and 2001, positive attitudes towards wind turbines in the Navarre region had remained at a level above 80%, alongside a steady increase in the number of projects constructed.

• United Kingdom

Data from 50 surveys carried out in the UK between 1990 and 2004 show that, on average, 77% of the public are in favour of wind energy, with 9% against, a consistently high level of support of wind energy.

• Denmark

Results from a study in 2001 show that 86% of the population supports wind energy, with 68% wanting Denmark to install more wind turbines and 18% agreeing that existing capacity is sufficient. A 2002 poll by Danmarks Windmølleforening, the Danish Wind Turbine Owners Association, showed that 79% supported wind energy as a fuel source compared with 24% for natural gas and 5% for nuclear.

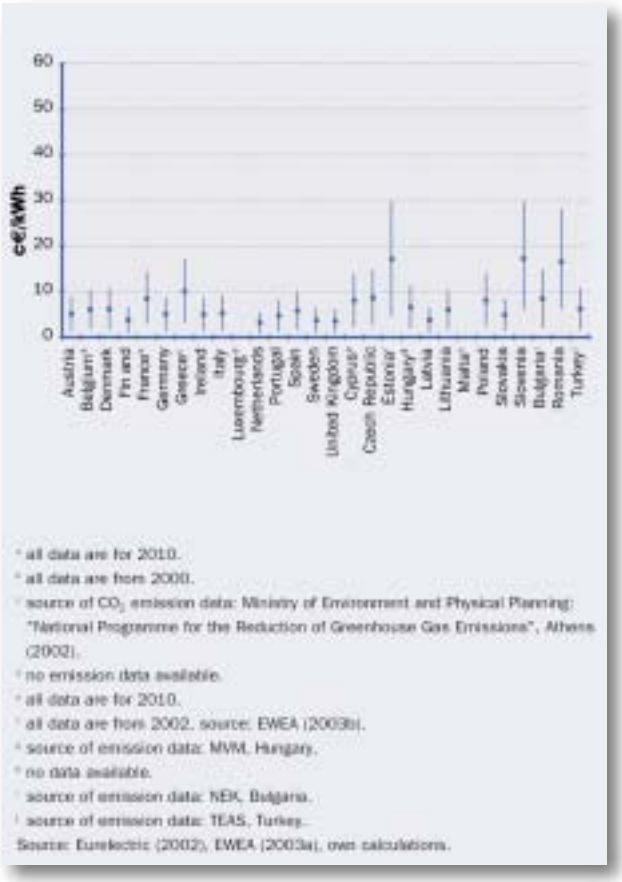
• Germany

A survey by the EMNID Institute in 2003 showed that 66% of respondents supported the construction of more wind parks. The survey in 2002 showed that in Germany 86% were in favour of increasing wind's contribution to the energy mix, with 9.5% saying wind contribution was sufficient.

More installations exploiting wind power can help to plug the growing gap in European electricity supply and at the same time dovetail with the Lisbon Strategy providing the EU with high-tech world-class technology

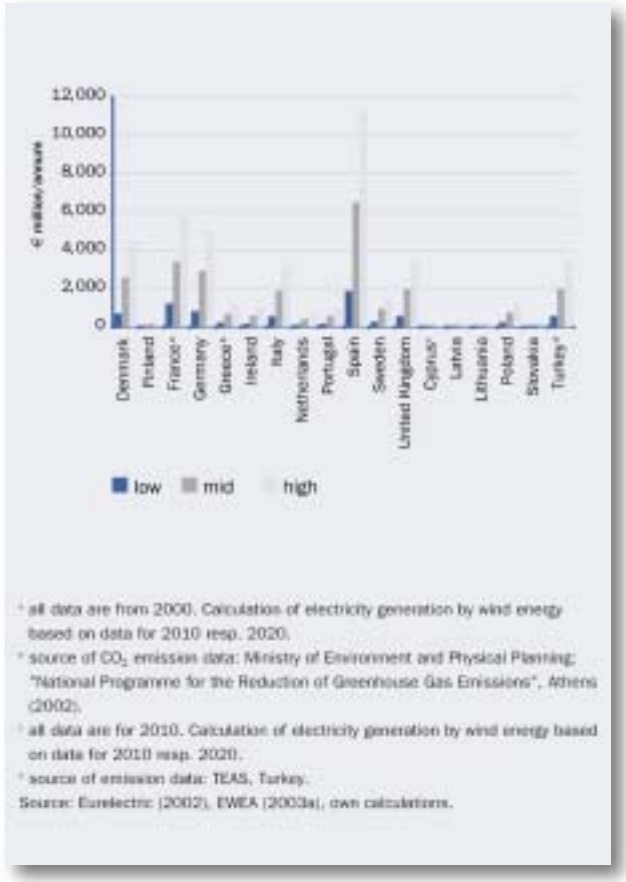
-Introduction to Wind Energy The Facts, DGTREN, European Commission, May 2004

Avoidable External Costs in c€/kWh by the Use of Wind Energy in 2020, EU-25 and other European Countries



¹ all data are for 2010.
² all data are from 2000.
³ source of CO_2 emission data: Ministry of Environment and Physical Planning: "National Programme for the Reduction of Greenhouse Gas Emissions", Athens (2002).
⁴ no emission data available.
⁵ all data are for 2010.
⁶ all data are from 2002, source: EWEA (2003b).
⁷ source of emission data: MVM, Hungary.
⁸ no data available.
⁹ source of emission data: NEK, Bulgaria.
¹⁰ source of emission data: TEAS, Turkey.
Source: Eurelectric (2002), EWEA (2003a), own calculations.

Total Avoidable External Costs in €Million/annum by the Use of Wind Energy in 2020, EU-25 and Turkey



¹ all data are from 2000. Calculation of electricity generation by wind energy based on data for 2010 resp. 2020.
² source of CO_2 emission data: Ministry of Environment and Physical Planning: "National Programme for the Reduction of Greenhouse Gas Emissions", Athens (2002).
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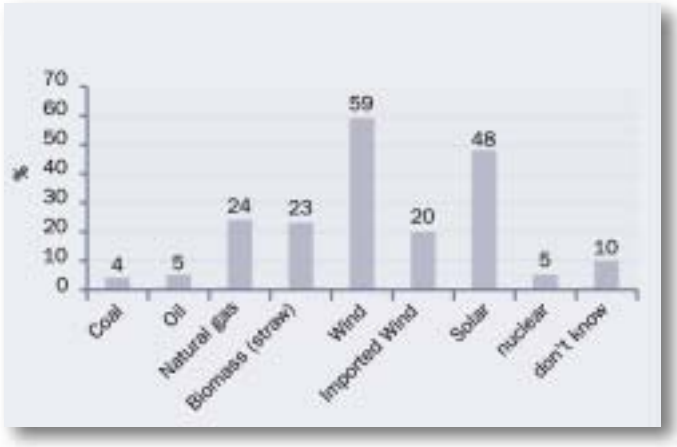
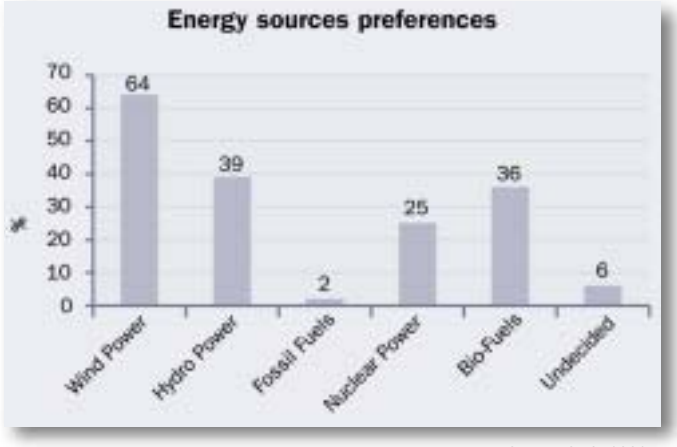
Energy Sources Preferences in Denmark



Source: Danmarks Vindmølleforening (2002).

Energy Sources Preferences Sweden



Source: SIFO (2002).

About EWEA

EWEA is the voice of the wind industry - promoting the best interest of the sector in Europe and worldwide.

EWEA members include manufacturers covering 98% of the global wind power market, as well as component suppliers, research institutes, national wind and renewables associations, developers, electricity providers, finance and insurance companies and consultants. The combined strength of more than 200 members from over 40 countries makes EWEA the world's largest renewable energy association.

Located in Brussels, close to key EU institutions and players, the EWEA Secretariat co-ordinate international policy, communications, research and analysis. The first stop for external enquiries about wind power from around the world, EWEA manages European programmes, hosts events and supports the needs of its members.

For further information and details of membership:
www.ewea.org

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More detailed information than this fact sheet can be found in the full version of Wind Energy the Facts