WIND ENERGY - THE FACTS

VOLUME 5

MARKET DEVELOPMENT

Acknowledgments

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1 MARKET INCENTIVES

1.1 Introduction

As mentioned in the section on externalities, the full costs to society of electricity production are not reflected in electricity prices. Those costs are paid by taxpayers and society as a whole in the form of increased health care and environmental costs such as climate change.

Wind energy is becoming increasingly competitive with conventional sources. However, it is likely that some form of incentive will be required for the foreseeable future, at least until environmental costs are fully internalised or increased economies of scale and technological development makes wind power fully competitive with conventional sources, such as coal and gas, without the need to consider externalities.

There are currently five main systems to support electricity from renewable energy sources in the EU member states: investment subsidies, fixed price systems, fixed premium systems, auctions, and certificates systems. The idea behind the mechanisms is to offset at least some of the competitive disadvantage for renewables as a consequence of electricity markets neglecting the environmental cost of production from conventional technologies. Low electricity prices are of little benefit if they lead to high costs to society as a whole through higher health care costs and environmental costs levied on current and future taxpayers and citizens.

If the environmental costs of power production were reflected in European power prices, wind power and many other renewable energy technologies would not need support, as pointed out in the European Commission's Green Paper on Security of Supply (European Commission, 2002a)

The Green Paper states that wind energy can fully compete with combined cycle gas if externalities are taken into account. Furthermore, both wind energy, biomass, small hydro, photovoltaics (PV) and geothermal are significantly cheaper for society than coal if externalities are included. Coal is almost twice as expensive as wind and biomass (1998 figures) according to the Green Paper.

The European Commission's ExternE project on external costs estimates that the cost of producing electricity from coal or oil in the EU 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 (European Commission, 1999). Currently, average electricity production costs in the EU are 0.04 € per kWh. The study further estimates that the external costs amount to 1-2% of EU GDP or between €85 billion and €170 billion, not including the cost of climate change.

Table 1.1 summarises the incentives for wind power and other renewables available in the EU-15 as of 2003. The table only includes conditions for new installations. Other conditions may apply to existing renewable energy capacity.

Table 1.1: Support Mechanisms

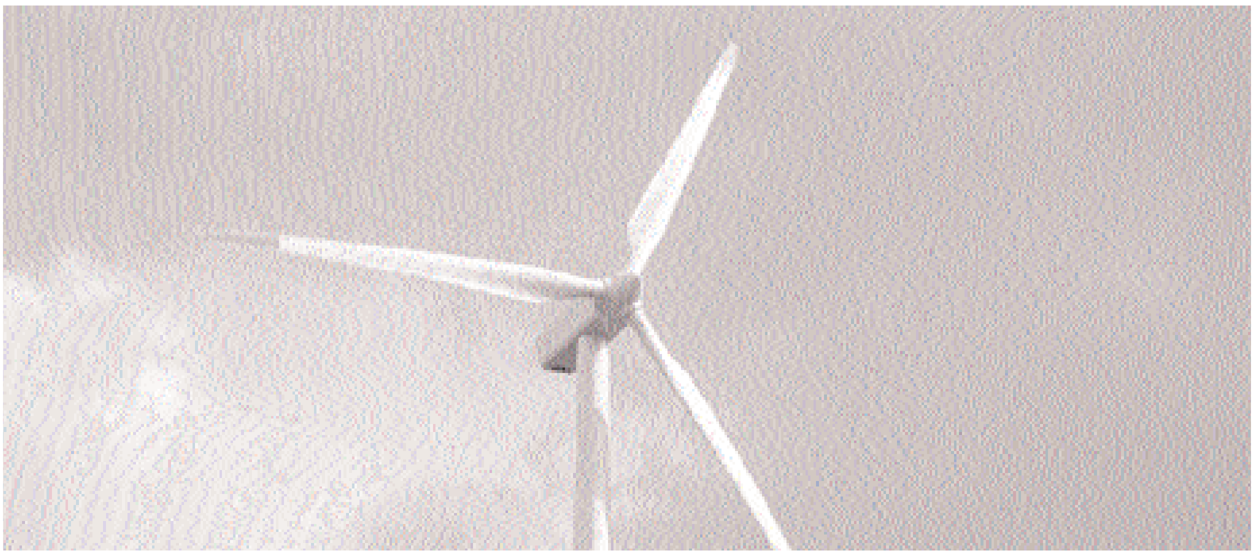
		RES-E TECHNOLOGIES CONSIDERED			
	Major Strategy	**Large Hydro**	**Small Hydro**	**'New' RES (Wind On- & Offshore, PV, Solar Thermal Electricity, Biomass, Biogas, Landfill Gas, Sewage Gas, Geothermal)**	**Municipal Solid Waste**
Austria	FITs	No	Renewable Energy Act 2003. (Ökostromgesetz). FITs guaranteed for 13 years for plants which get all permissions between 1st of January 2003 and 31st of December 2004 and, hence, start operation by the end of 2006. Investment subsidies mainly on regional level.		No
Belgium	TGC + guaranteed electricity purchase	No	Federal: The Royal Decree of 10 July 2002 (operational from 1st of July 2003) sets minimum prices for RES-E. Except for offshore wind it will be implemented by the regional authorities: Wallonia: Quota obligation (based on TGCs) Wallonia: Quota obligation (based on TGCs) on electricity suppliers– increasing from 3% in 2003up to 12% in 2010. Flanders: Quota obligation (based on TGCs) on electricity suppliers– increasing from 3% (no MSW) in 2004 up to 6% in 2010. Brussels region: No support scheme yet implemented.			
Denmark	Partial Tax Exemption + tender	No	Act on Payment for Green Electricity (Act 478): Max combined price for wind power and partial tax exemption of 4.4 c€/kWh. Minimum price of 1.33 c€/kWh. Exemption of CO_2 tax (max 1.33 c€/kWh) depends on electricity market price. Plans for offshore wind tenders.		No
Finland	Tax Exemption	No	Tax refund 0.44 c€/kWh (plant <1MW)	Mix of tax refund and investment subsidies: From January 2003: Tax refund of 0.73 c€/kWh for wind and of 0.44 c€/kWh for other RES-E. Investment subsidies up to 40% for wind and up to 30% for other RES-E.	No
France	FITs	No	FITs for RES-E plant < 12 MW guaranteed for 15 years (20 years PV and hydro). Tenders for plant >12 MW. FITs in more detail[1]: biomass - 4.9 c€/kWh; biogas - 4.6 c€/kWh; geothermal - 7.62 c€/kWh; PV[2] - 15.25-30.50 c€/kWh; landfill gas - 4.50-5.72 c€/kWh; wind[3] - 3.05-8.38 c€/kWh; hydro[4] - 5.49-6.10 c€/kWh. Investment subsidies for PV, biomass and biogas (biomass and biogas PBEDL 2000 - 2006).		No
Germany	FITs	No	German Renewable Energy Act: FITs guaranteed for 20 years[5]. In more detail, FITs for new installations in 2003 are: hydro - 6.65- 7.67 c€/kWh; wind[6] - 6-8.9 c€/kWh; biomass - 5,8-10 c€/kWh; landfill gas, sewage gas and mine biogas - 6.65-7.67 c€/KWh; solar PV and solar thermal electricity - 45.7 c€/kWh; geothermal - 7.16-8.95 c€/kWh.		No
Greece	FITs + investment subsidies	No	FITs guaranteed for 10 years (at a level of 70-90% of the consumer electricity price)[7] and a mix of other instruments: a) Law 2601/98: Up to 40% investment subsidies combined with tax measures; b) CSF III: Up to 50% investment subsidies depending on RES type.		No
Ireland	Tender	No	Tendering scheme – currently AER VI with technology bands and price caps for small wind (<3 MW), large wind (>3 MW), small hydro (<5 MWp), biomass, biomass and biogas. In addition, tax relief for investments in RES-E.		No
Italy	TGC	Quota obligation (based on TGCs) on electricity suppliers: 2% target, increasing annually; TGC issued for all (new) RES-E (inc. large hydro and MSW) – with rolling redemption[8]; unclear penalty enforcement and market distortions[9]. Investment subsidies for PV (Italian Roof Top programme).			
Luxembourg	FITs	No	No	FITs[10] guaranteed for 10 years (PV 20 years) and investment subsidies for wind, PV, biomass and small hydro. FITs for wind, biomass and small hydro - 2.5 c€/kWh; for PV - 50 c€/kWh[11].	No
Portugal	FITs + investment subsidies	No	FITs (Decree law 339-C/2001 and Decree law 168/99) and about 40% investment subsidies small hydro and wave. FITs in 2003 - wind[12] - 4.3c€/kWh - 8.3c€/kWh; wave - 22.5c€/kWh; PV[13] - 22.4c€/kWh - 41c€/kWh; small hydro - 7.2c€/kWh.		
Spain	FITs	Depending on the plant size[14]	FITs (Royal Decree 2818/1998): RES-E producers have the right to opt for a fixed price or for a premium tariff[15]. Both are adjusted annually by the government according to the variation in the average electricity sale price. In more detail (only premium, valid for plant < 50 MW[16]): wind - 2.7 c€/kWh - PV[17] - 18-36 c€/kWh - small hydro - 2.9c€/kWh - biomass - 2.5 - 3.3 c€/kWh. Moreover, soft loans and tax incentives (according to "Plan de Fosento de las Energías Renovables") and investment subsidies on a regional level.		1.7 c€/kWh

FIT: Feed-in Tarifs
TGC: Tradable Green Certificates

RES-E TECHNOLOGIES CONSIDERED					
	Major Strategy	**Large Hydro**	**Small Hydro**	**'New' RES (Wind On- & Offshore, PV, Solar Thermal Electricity, Biomass, Biogas, Landfill Gas, Sewage Gas, Geothermal)**	**Municipal Solid Waste**
Sweden	TGC	No	Quota obligation (based on TGC) on consumers: Increasing from 7.4% in 2003 up to 16.9% in 2010. For Wind Investment subsidies of 15% and additional FITs ("Environmental Bonus"[18]) in size of 1.9 c€/kWh are available.		No
Netherlands	FITs + tax exemption		Mixed strategy: green pricing, tax exemptions and FITs. The tax exemption for green electricity amounts 2.9 c€/kWh and FITs range from 2.9 c€/kWh for mixed biomass and waste streams to 6.8 c€/kWh for wind, PV, tidal, wave and small hydro.		No
United Kingdom	TGC + investment subsidies	No	Quota obligation (based on TGCs) for all RES-E: Increasing from 3% in 2003 up to 10.4% by 2010 – penalty set at 3.51 £/kWh. Optional to the TGC-system, eligible RES-E are exempted from the Climate Change Levy certified by Levy Exemption Certificates (LECs), which cannot be separately traded from physical electricity. The current levy rate is 0.43 £/kWh. Investment grants in the frame of different programmes (e.g. Clear Skies Scheme, DTI's Offshore Wind Capital Grant Scheme, the Energy Crops Scheme, Major PV Demonstration Programme, and the Scottish Community Renewable Initiative).		No

1 Without efficiency premiums.
2 30.5 €/kWh for Corsica and Overseas Departments.
3 Stepped FIT: 8.38 c€/kWh for the first 5 years of operation and then between 3.05 and 8.38 c€/kWh depending on the quality of site.
4 Producers can choose between four different schemes. The figure shows the flat rate option. Within other schemes tariffs vary over time (peak/base etc.).
5 The law includes a dynamic reduction of the FITs (for some RES-E options): For biomass 1% per year, for PV 5% per year, for wind 1.5% per year.
6 Stepped FIT: 8.9 c€/kWh for the first 5 years of operation and then between 6 and 8.9 c€/kWh depending on the quality of site.
7 Depending on location (islands or mainland) and type of producer (independent power producers or utilities)
8 In general only plant put in operation after 1st of April 1999 is allowed to receive TGCs for their produced green electricity. Moreover, this allowance is limited to the first 8 years of operation (rolling redemption).
9 GRTN (Italian Transmission System Operator) influences strongly the certificates market selling its own certificates at a regulated price – namely at a price set by law as the average of the extra prices paid to acquire electricity from RES-E plant under the former FIT-programme (CIP6).
10 Only for plants up to 3 MW except up to 50 kW for PV systems.
11 For plants commissioned in 2004 the FIT will be in the range of 45 c€/kWh
12 Stepped FIT depending on the quality of the site.
13 Depending on the size: <5kW - 42 c€/kWh or >5kW - 22.4 c€/kWh
14 Hydropower plant with a size between 10 and 50 MW receive a premium depending on the farm size according to the formula: Premium (c€/kWh) = 2.9 * (50-'plant size in MW') / 40. For plants >50MW the premium tariff is set to 0.6 c€/kWh.
15 In case of a premium tariff, RES-E generators earn in addition to the (compared to fixed rate lower) premium tariff the revenues from the selling of their electricity on the power market.
16 For Small Hydro the plant size is limited to 10 MW.
17 Depending on the plant size: <5kW: 36c€/kWh or >5kW: 18c€/kWh
18 Decreasing gradually down to zero in 2007

Source: EWEA, Rexpansion Project, forthcoming.



1.2 Environmental Taxes

Energy taxes that reflect the actual environmental impacts of each technology constitute an effective means to internalise external costs. Taxes could make the full production costs of electricity generation transparent, level the playing field in the future internal electricity market and introduce fair competition between renewables and conventional power technologies. This is recognised by the European Commission. In a Communication to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions in February 2001, the Commission states:

> *"Environmental taxes and charges can be an appropriate way of implementing the 'polluter pays' principle by including the environmental costs in the price of goods and services and by this means internalising external costs. The White Paper emphasised that the environmental benefits of renewable energy justify favourable financing conditions, e.g. through tax exemptions in products from RES."*

After six years of negotiations, an EU Directive[1] setting minimum tax rates for energy products came into force on 1st January 2004. As a result of numerous compromises between the member states, the level of the minimum energy tax rates is close to being the lowest common denominator for the Community and is considerably lower than originally proposed by the Commission in 1997, and by the Parliament in 1999. For electricity, the Directive introduces minimum taxes of 0.5 €/MWh for business and 1 €/MWh for non-business. Due to the low minimum tax levels, the many general exemptions and the lack of mandatory exemptions for renewables, the effect of the Directive on wind power will be insignificant in the short term. However, the importance of reaching a final agreement cannot be underestimated, as it emphasises the political will in the EU to contribute to the "polluter pays" principle set out in Article 174 of the Treaty establishing the European Community.

Electricity generators are not financially penalised for the pollution they cause and the associated costs that society has to bear. Environmental costs do not disappear from the face of the earth just because they do not appear on the electricity bill or because they are not included in electricity producers' costs of generating energy. They are being paid for by society as a whole through taxes on households and companies and through environmental degradation such as that caused by climate change.

Meaningful environmental taxes are an effective way to level the playing field in the electricity markets, but are difficult and time consuming to agree upon at EU level. The same is true for removal of state aid to conventional power production technologies. Efforts should be made to remove harmful subsidies to mature electricity technologies based on fossil fuel and nuclear, as suggested by an OECD study on improving the environment through reducing subsidies. The higher the subsidies to polluting technologies, the higher the costs to society of introducing clean technologies.

The OECD argues that *"support is seldom justified and generally deters international trade, and is often given to ailing industries"*. It further argues:

> *"This policy [state aid] is often both costly and ineffective in the long run. Technological change and the development of new product markets will generally lead to an even further loss in the competitiveness of the supported industry. As a result, larger amounts of support will be required in order to maintain the industry... . In many cases, support is used to prop up declining industries, merely postponing their certain demise at the expense of taxpayers and consumers."*

The OECD also argues *"that support may be justified if it lowers the long-term marginal costs to society as a whole. This may be the case with support to 'infant industries', such as producers of renewable energy."*

The problem with subsidies is that, once introduced, they are difficult to remove. The existence of environmentally damaging state aid to mature industries such as coal and nuclear will inevitably lead to higher environmental policy costs.

Removing state aid to fossil fuels, nuclear and other mature and environmentally damaging industries has many attractions. Not only would it contribute towards a more level playing field in the electricity markets and create less biased market conditions, it would also save large amounts of money currently spent on unproductive state aid schemes and, finally, make it considerably cheaper to develop the environmental technologies that are a precondition to securing the EU's indigenous supply of electricity. Removing environmentally harmful subsidies should ideally be supplemented by energy taxes. Taxation can be an effective tool in energy policy if it aims to internalise the costs to society of environmental degradation, and contribute to the polluter pays principle.

Tax Incentives

Several EU countries have introduced specific tax incentives for renewable energy. These are summarised in Table 1.2.

Table 1.2: Tax Incentives

Country	Tax Incentives
Austria	Private investors get tax credits for investments in using renewable energies (personal income tax). The amount is generally limited to 2.929€ per year.
Belgium	13.5–14% of RES-investments deductible from company profits, regressive depreciation of investments. Reduced VAT on building refurbishing if energy efficiency is included (6% instead 21%).
Denmark	The first 3,000 DKK of income from wind energy are tax free.
France	Deduction of 15% investment costs with a maximum of 3,000 € per person. Reduced VAT (5.5%) on renewable equipment (not applicable to installation costs).
Germany	Losses of investments can be deducted from the taxable income. This fact increases return on investments into wind projects.
Greece	Up to 75% of RES-investments can be deducted.
Ireland	Corporate Tax Incentive: Tax relief capped at 50% of all capital expenditure for certain RES-investments.
Portugal	Up to 30% of any type of investments on RES can be deducted with a maximum of 700€ per year. Reduced VAT (12%) on renewable equipment.
Spain	Corporation Tax: 10% (up to 20% in some autonomous regions) tax liability instead of 35% for investments in environment friendly fixed assets.
The Netherlands	EIA scheme: RES-investors (most renewable energy systems) are eligible to reduce their taxable profit with 55% of the invested sum. Lower interest rates from Green Funds: RES- investors (most renewable energy systems) can obtain lower interest rates (up to 1.5%) for their investments. Moreover dividends gained are free of income tax for private investors.

Source: EWEA (2003).

1.3 Payment Mechanisms – the "Second Best" Solution

With environmentally harmful subsidies still in place, and in the absence of environmental taxes that fully reflect the internal costs of energy production, a second best solution to create a level playing field in the electricity markets is for member states (and potentially the EU) to provide frameworks that create adequate incentives to increase renewable electricity's share of the electricity consumption.

Usually, the level of the incentive depends on the production cost of wind power compared to other technologies and the market prices for electricity. As a result of the gradual liberalisation of electricity markets, competition is increasing in the European electricity sector. There is some concern, however, that Europe is moving from a situation of national electricity monopolies to private monopolies or oligopolies, rather than perfect competition. Increased competition, in combination with the present over-capacity in European electricity generation, will probably in the short term make conditions more difficult for wind power and other renewables as wholesale electricity prices decrease. The price reduction will continue until generating companies close down the least competitive part of their generation capacity and electricity demand increases (the European Commission expects electricity consumption in the EU to grow by 1.3% annually up to 2030[2]).

Several mechanisms can be applied to promote the increased deployment of wind power. These can be grouped into three main categories:

- Voluntary systems where the market determines the price and the quantity of renewable energy (green marketing).

- Systems where the government dictates the electricity prices paid to the producer and lets the market determine the quantity (fixed prices).
- Systems where the government dictates the quantity of renewable electricity and leaves it to the market to determine the price (renewables quotas).

Fixed price systems and renewables quotas are both ways of creating a protected market, separate from the open electricity market where electricity from new renewable energy sources would have difficulties competing with existing, already depreciated nuclear and fossil based power plants. They are also ways of offsetting (fully or partly) the competitive disadvantage arising from markets' neglect of the environmental effects of conventional energy production.

It is sometimes argued that systems where the government fixes the quantity of renewable electricity demand (e.g. renewables quotas with green certificate trading) is more "market oriented" than systems where governments fix the price. However, a system where the government fixes quantity and leaves it to the market to determine the price is unlikely to be more "market oriented" than a system where the government fixes the prices and leaves it to the market to determine the quantity.

Few would argue that the oil cartel OPEC is a market oriented mechanism because the members have chosen to control the market through quantities rather than prices. The reason is that quantities are easier to administer. In the WTO, however, quantitative restrictions are generally banned while tariffs are accepted to some degree because quotas are regarded as more market distorting.

The main purpose of the wide range of available economic measures to support wind energy and other renewable energy technologies is to provide incentives for technological improvements and cost reductions of environmental technologies, in this case the production costs of wind turbines (WTs). The aim is to ensure the future availability of cheap, clean technologies as a competitive alternative to conventional power sources. It is less important whether markets are controlled through prices or through quantities. What matters is that control is achieved in a rational and effective manner.

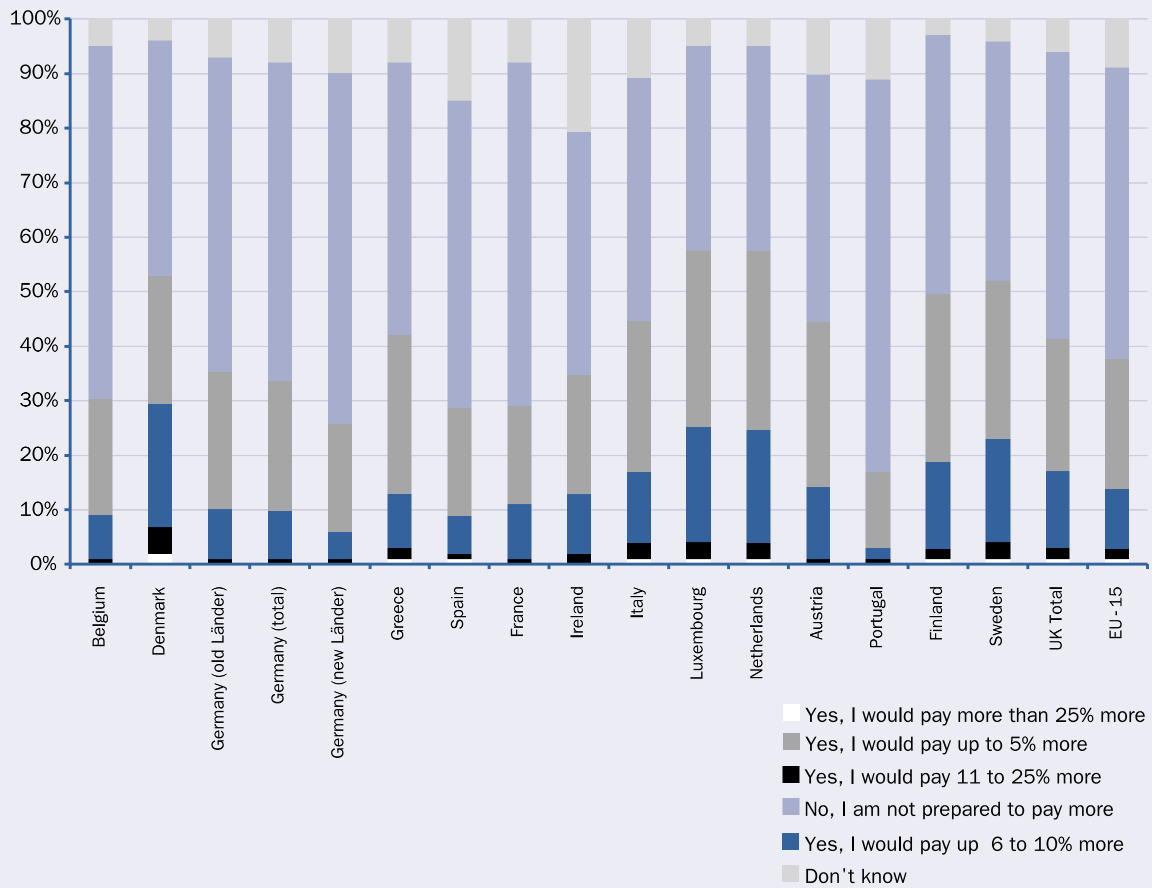
The main difference between quota-based systems and price-based systems is that the former introduces competition between the electricity producers (WT operators). Competition between WT manufacturers, which is crucial in order to bring down production costs, is present regardless of whether government dictates prices or quantities.

1.3.1 VOLUNTARY SYSTEMS AND GREEN MARKETING

In theory, voluntary demand could provide a market for wind power and other renewable energy technologies independently of government policy. However, experience with voluntary systems or "green marketing programmes" to date clearly suggests that voluntary green power schemes purely based on customers' willingness to pay extra for green electricity (ie. without additional measures), have had no noticeable impact on the deployment of wind energy and other renewable energy sources.

A survey by European Opinion Research Group from 2003 shows that some willingness exists among Europeans to pay more for energy produced from renewable energy sources (see Figure 1.1).

Figure 1.1: Results of the Survey Relating Willingness to Pay More for Energy Produced from Renewable Sources



Source: European Opinion Research Group (2003).

However, the number of customers signing up for green marketing programmes cannot be directly translated into support for renewables, as most products contain less than 100% renewables. In Pennsylvania, USA 60,000 out of 80,000 customers signed up for a "green" electricity product that had a renewable energy content of less than 1%.

Much research into voluntary green electricity systems has been conducted in the US where approximately 40% of households have access to a green power product. One study conducted by Lawrence Berkeley National Laboratory at the University of California shows that 0.6% of the residential customers with access to voluntary green electricity products are signed up (2000). In Denmark, only 0.5% of the customers of a Copenhagen-based supply company have decided to buy its green electricity product. For comparison, in a survey by Ramboll, a majority of 58% of Danes answered yes to the question: "Would you consider buying more environmentally friendly electricity, when it becomes possible?"

The Lawrence Berkeley study suggests that the collective impact of green marketing schemes on renewable electricity generation has been very modest. The study concludes that there is a considerable difference in consumers' stated attitudes toward environmental products and the actual demand for them[3].

Schemes referred to as "shareholder programmes", "contribution programmes", "ethical trusts", "green electricity tariffs" or "green electricity labels" are frequently referred to as voluntary schemes, because customers subscribe to a service of their own free will. However, in most cases where voluntary schemes are perceived to be successful (in terms of subscriber numbers), the driving force behind the increase in these so-called “green” customers is the politically determined framework for investments in wind power and other renewables rather than high voluntary demand for clean power.

The Dutch “Voluntary” System

One example of this is the Netherlands. Following the opening of the Dutch retail market for electricity in July 2001, the number of renewable electricity customers increased from 250,000 to 1.4 million in January 2003. However, the main reason behind the rapid increase in customers signing up to green power schemes was not the population’s willingness to buy green. Exemption from a 6 c€/kWh ecotax on electricity in combination with a production incentive (2 c€/kWh in 2002) was the main driver. By surrendering a guarantee of origin (not to be confused with tradable green certificates), supply companies could claim exemption from the ecotax. That made it possible for suppliers to sell green electricity as cheap or cheaper than conventional power.

The Dutch system had obvious flaws, mostly related to the possibility of importing green electricity from abroad. The high level of support for renewables in the Netherlands made it a highly attractive market for foreign renewable electricity producers, which led to high costs in the form of large avoided tax revenues. That would not be so serious a problem had the incentive increased the renewable electricity production abroad. But most imports came from existing plant, e.g. Danish wind power and Swedish hydropower that would have been produced and sold domestically in the absence of the export opportunity to the Netherlands.

In short, Dutch taxpayers were paying for renewable electricity production that would have been produced anyway and, thus, did not increase EU production of renewable electricity by one single kilowatt hour. Furthermore, it was unclear whether the Netherlands or the exporting country could claim the production towards meeting their renewables Directive targets.

Finally, the system was problematic for Dutch wind power developers as they had to compete with cheap production from existing, already depreciated renewables plant abroad, making them reluctant to build domestic capacity. As a consequence of these shortfalls, the Dutch Ministry of Economic Affairs has decided to change the framework.

“Green” Marketing in Denmark

An important issue relating to green marketing is that it can be difficult for the consumer to make informed choices between different suppliers. Determining whether a product is “green” and how to define “green” requires time and effort for electricity customers, suppliers and regulators.

A Danish electricity supplier was marketing a green electricity product, Naturstrom (Natural Power). In 2002 the Danish Energy Regulatory Authority (Energitilsynet) notified the company that it was not allowed to charge its customers a premium price for Naturstrom since the company could not prove that the product had any effect on the environment. Ironically, for the Danish Energy Regulatory Authority it was not a problem that the company actually sold the product (that is up to the ombudsman). The only problem was that it charged a premium price for it. In 2003, the company decided to pay back the surcharges it had collected from its “green” customers.

The case illustrates the challenge facing the electricity consumer who wants to make an informed choice. In the Naturstrom case, Danish customers were paying surcharges for renewable electricity that would have been produced regardless of the green marketing programme. No additional green electricity was produced. Furthermore, Danish customers were paying extra for green electricity that Swedish taxpayers had already paid for once through investment subsidies and feed-in tariffs to wind power.

That the transparency of the green electricity product market leaves much to be desired is underlined by the fact that Naturstrom was endorsed by the Danish Society for the Conservation of Nature and certified by the Swedish Society for Nature Conservation which claims to have “the world's toughest environmental label". However, for renewable electricity supplies it is not a requirement to obtain the Swedish label that more renewable electricity production takes place, says the organisation.

Obviously, not all green marketing schemes are flawed. Following a decision by the Irish government to open the electricity market to suppliers of green power, Irish company Airtricity started supplying green electricity, predominantly from wind. The company builds, owns and operates its own wind farms and sells the electricity output directly to end customers. Due to Ireland's enormously rich wind resource, it is possible for the company to deliver electricity to its customers below or at the same price as the national electricity monopoly ESB. 26,000 Irish businesses have signed up to Airtricity. According to the company, the production from its wind farms saved the release of 502,968 tonnes of CO_2 into the atmosphere in 2003, equivalent to taking 119,754 cars off the road for a year.

1.3.2 FIXED PRICE SYSTEMS

Figure 1.2 shows the level of feed-in tariffs for onshore wind energy in the EU-15 as of mid 2003.

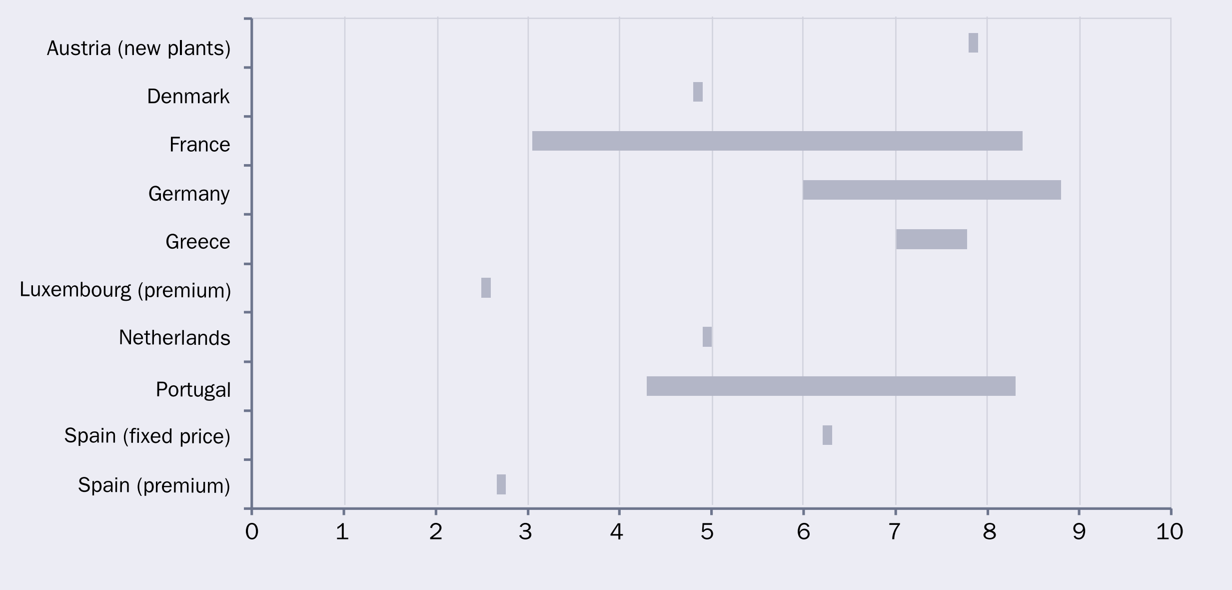
In France, Germany, Greece and Portugal, the tariff is related to the siting of the turbine. In high wind areas, the tariff is lower than in low wind areas. This is to avoid concentrating the development of wind energy in very windy areas of a country. In Spain, WT operators can choose between a fixed tariff per kWh or a premium above a fluctuating electricity price.

1.3.3 INVESTMENT SUBSIDIES

In the early days of wind power development, investment subsidies were often used as an incentive to investors, normally given on the basis of the rated power (in kW) of the generator. It is generally acknowledged that systems that relate the amount of support to the size of the WT rather than the production of the electricity are not ideal because they lead to less efficient turbines. The incentive should be related to efficiency of electricity production rather than to completing the construction phase of a project.

In the 1990s, India gave a subsidy to WT owners based on the rated capacity of the turbines. This proved problematic because the subsidy was given whether or not production was efficient. The scheme resulted in poor sit-

Figure 1.2: Feed in Tariffs for Onshore Wind Plants (c€/kWh)



ing of WTs, and manufacturers followed customer demands to use very large generators, which improved project profitability but reduced production and also attracted highly dubious products. India has since corrected the inherent flaws of its incentive scheme and the market has started to develop properly.

For wind energy, the global trend is to reject investment subsidies as the only means of encouraging investments, because it is considered economically inefficient as illustrated by India's experience.

However, investment subsidies can be effective if combined with other incentives, as is seen in the UK. In order to take account of the higher cost of offshore wind power compared to onshore, the UK government offers investment grants to offshore projects to complement the Renewables Obligation (RO), a renewables quota system. In the absence of such investment grants either onshore development only would be possible or it would be necessary to create two separate RO markets – one for onshore and one for offshore, assuming that both are priorities for the government.

1.3.4 FIXED FEED-IN TARIFFS

Mechanisms based on fixed feed-in tariffs (FITs) have been widely adopted throughout Europe. Operators of wind farms are paid a fixed price for every kWh of electricity they feed into the grid. The cost of the system - defined by the difference between the level of the tariff and the market price of electricity - is borne by the taxpayers or the electricity consumers.

The structure of the mechanism makes it impossible to predict the level of support per kWh. If the level of the tariff remains constant, the level of support will change as a result of changing electricity prices. The level of support per kWh could become negative if electricity prices were to rise above the level of the tariff. Such a situation has occurred in Scandinavia recently. In 2002/2003, electricity prices on the Nordic power exchange Nord-Pool has periodically increased dramatically as a result of low levels of water (low electricity supply) in the Norwegian and Swedish hydropower reservoirs combined with increasing power demand. At times, this has led to the somewhat paradoxical situation that owners of coal power plants receive higher prices for the electricity they supply than owners of WTs.

In Germany, as a rule of thumb, the additional cost of the FIT adds approximately 1 € to the average household electricity bill per month but, as indicated above, the level is difficult to establish when power prices fluctuate. Large German electricity users receive a discount on the tariff contribution.

FIT systems have been highly effective at attracting wind power investments in Denmark, Spain and Germany. Other countries with FITs in place are Austria, France, Greece, Luxembourg, the Netherlands and Portugal.

The main determinant of whether a FIT model is successful at attracting investments is the level of the tariff. Of course, the payment mechanism has to be supplemented by adequate grid connection conditions and a well functioning planning framework. Good planning and grid connection frameworks are a precondition for any mechanism to be successful.

The relatively high level of the FITs in Denmark, Spain and Germany is the reason for their success. In contrast, Belgium, Norway and Sweden have all been running FIT systems that did not contribute much to wind power or other renewable energy development. Profitability, rather than the system itself, is what determines success, together with effective planning and grid connection regulation.

The main benefit of a FIT is that it is simple and often encourages better planning. A FIT is not associated with a formal power purchase agreement (PPA) and has no definite term of existence. In principle, therefore, the level of the tariff can be changed at any time or removed by repealing the law. The main disadvantage of a FIT is the political risk inherent in the system.

The political risk of the FIT in Spain, seen from an investor's point of view, is perceived to be somewhat lowered, since the government has established some degree of assurance that changes in the tariffs will not bankrupt existing projects built under previous conditions. However, the risk of political change is not eliminated in Spain, and investors can only guess how long the tariff will continue and at what level. Investors therefore have to include a risk premium when planning the financial soundness of projects.

Germany has been able to reduce much of the political risk by guaranteeing payments for 14 to 20 years. If the tariff is believed to be reduced it will have a negative effect on the market for new wind power capacity in Germany, as was seen in 2003. But those who have already invested will not be affected – that is unless the government decides otherwise. Some political risk is therefore still inherent in the German system as investors generally consider it less risky to enter into long-term PPAs enforceable under civil law rather than rely on the good will of a government or parliament.

Greece is a good example that a sufficiently high FIT does not guarantee development of wind energy. The FIT of 90% of the consumer price or approximately 5.75 c€/kWh (around 7 c€/kWh if there is no grid access) is supplemented by up to 40% capital grants. That level would be sufficient to develop wind energy taking into account Greece's wind resources. However, wind power development was not taking off in Greece. The main barrier was in the planning system rather than the level of the tariff.

France is faced with a similar problem to Greece. The financial incentives in the form of FITS for projects smaller than 12 MW and auctions for larger projects seem adequate, but little wind development is taking place. The main problem in the past has been grid and, especially, planning barriers. However, the French government seems determined to overcome these following a national energy debate in 2003.

The political risk of FITs is usually understood as the risk that a government will progressively lower the tariff to reflect the fact that wind power becomes cheaper as the technology develops. But there is also the potential risk that a government will take no action when a FIT is no longer sufficient to attract investments under the overall economic climate.

Fixed payments for wind power supplied to the grid in Denmark and Germany, combined with technology improvements, falling interest rates and low inflation have undoubtedly added to the profitability of investing in wind turbines (WT) over the past decade. On the other hand, higher profitability has been somewhat offset by the increasing use of sites with lower wind speeds.

But what if interest rates had gone up instead of down? Under a fixed price system, turbine owners would not receive any compensation for the higher cost of finance - and the outcome would have been lower profitability - unless the fixed price had been adjusted upwards. WTs are capital-intensive investments with low operating costs, so the cost of finance can have profound impact on project profitability. Had inflation added further to the decline in profits, a situation could occur where technology improvements and economies of scale in WT manufacturing would not be sufficient to offset the higher costs of finance and lower inflation-adjusted income.

Such a situation has not occurred, so there is no evidence of politicians' willingness to increase tariffs to reflect higher wind power production costs. However, it is probably fair to assume that it would be more difficult to convince governments to raise the tariffs – at least in established markets – than to lower them. That test of political will has yet to be seen. The main point is that a fixed price system is rather rigid when it comes to adjusting tariffs – whether up or down – to reflect changes in the production costs of wind power. It should be mentioned that inflation risk can be avoided by including an automatic inflation adjustment to the mechanism, as is done in the US production tax credit (see section 1.3.6).

1.3.5 FIXED PREMIUM SYSTEMS

A "fixed premium" or "environmental bonus" mechanism is another variant of the fixed price system. Rather than fixing the price, the government fixes a premium to be added

to the electricity price. The cost per kWh of the system is, contrary to the fixed FIT, predictable, although the total costs to society depends on the level of development.
From the perspective of a WT owner, the total price received per kWh (electricity price plus the premium) is less predictable than under a FIT because it depends on a changing electricity price.

In theory, a mechanism that is based on a fixed premium/environmental bonus that reflects the external costs of conventional power generation could establish fair trade, fair competition and level the playing field in the internal electricity market between renewable energy sources and conventional power sources. Together with taxing conventional power sources in accordance with their environmental impact (see volume 4), fixed premium systems are, theoretically, the most effective way of internalising external costs.

From a market development perspective, the advantage of a price premium is that it allows renewables to penetrate the market very quickly if their costs drop below the electricity price plus premium. If the premium is set at the "right" level (theoretically at a level equal to the external costs of conventional power), it allows renewables to compete with conventional sources, without the need for politicians to set quotas.

In practice, however, basing the mechanism on the environmental benefits of renewables is challenging. Very ambitious American and European studies (such as the European Commission's ExternE project) on the external costs of power generation have illustrated that establishing the exact costs is very complex. How do we account for lost homes on Pacific islands if the icecap melts, or put a price on deteriorating health? In reality, fixed premiums for wind power and other renewable energy technologies, such as the Spanish model, are based on estimated production costs and comparisons with the electricity price rather than the environmental benefits of renewable energy.

1.3.6 TAX CREDITS

A tax credit is another variant of the fixed price system. Whether an incentive is given in the form of a tax credit or a cash payment does not make a big difference from a socio-economic or investor perspective. Politically, however, it can make a difference whether an incentive is paid by the electricity consumer or by the taxpayer.

The largest wind power market to make use of a tax credit is the US. Canada is also considering introducing a tax driven system. The US market is driven by the federal production tax credit (PTC), which is worth approximately 1.8 c/kWh. It is adjusted annually to take inflation into account.

In recent years, there have been three separate phases of the PTC. The first phase ended on 30th June 1999 and was not renewed until 1st January 2000. The second PTC expired on 31st December 2001. Again, there was a gap before its extension was announced in March 2002, with the third PTC continuing until December 2003. As at December 2003, the tax credit has not been extended, as it is included in a controversial energy Bill on which Congress has not yet reached.

As a result of the relatively short lifetime of each individual PTC, the market has been very volatile and characterised by "boom and bust" cycles. Activity usually picks up dramatically prior to the end of a PTC. There was an enormous amount of activity in late 1998 and early 1999, almost no activity in 2000, and a great deal of activity again in 2001. Activity was picking up again prior to the December 2003 deadline. For both investors and manufacturers, these boom-bust cycles are highly problematic because it makes planning very difficult. Most European WT manufacturers have plans to start up local production in the US, but are reluctant to execute them until long-term stability is secured.

1.4 Fixed Quantity Systems

In fixed quantity or "renewable quota" systems ("renewable portfolio standards" in the US), the government sets a quota for the level of renewable energy that should be produced. It is then up to market forces to determine the price. Two types of renewable quota systems have been employed in national wind power markets: "tendering systems" and "green certificate systems".

1.4.1 TENDERING SYSTEMS

Tendering systems or competitive bidding has been or is being used to promote wind power in Ireland, France (for wind farms larger than 12 MW) and the UK. Scotland and Northern Ireland have also made use of the mechanism. Developers of wind farm projects are invited to bid for a limited wind energy capacity in a given period. The companies that bid to supply electricity at the lowest cost win the contracts. Usually, 15-year PPAs are entered into. The difference in price between these contracts and the price of conventional power represents the additional costs of producing green electricity.

One of the major drawbacks of the tenders made so far is that they have encouraged gaming of the system. Wind energy is a technology that gets cheaper with time. Therefore, a contract holder will wait as long as possible before building a project. Partly because of this inherent flaw, the UK's non-fossil fuel obligation (NFFO) tender system did not result in many projects being built. Another flaw of the NFFO model was that it did not penalise developers if they failed to install the capacity for which they had secured a power purchase contract. In principle, anyone was free to make an unrealistic low and unprofitable bid, win the contract and not develop the project. The ineffectiveness of the UK NFFO system led the government to abandon the model and introduce a new system based on tradable green certificates (see below).

The NFFO was heavily criticised for its failure to deliver, and the UK experience has discredited tendering systems substantially. Although the NFFO had obvious flaws, as described above, that does not mean that tendering systems cannot function. They need to be better designed. The problem with falling production costs over time could have been overcome by introducing deadlines. Furthermore, the model should be combined with a performance bond and meaningful penalties for failing to meet the contract. Finally, poor planning procedures in the UK must also take their share of the blame for the disappointing performance of the NFFO.

If designed correctly, tendering systems can work. One of the main attractions of the model is that the 15-year power purchasing contracts that bidders compete for are enforced under civil law. From an investor risk perspective, a long contract is very attractive since it minimises risk. A second attraction of a well-designed tendering system is that the government (as well as electricity users and taxpayers) does not have to make best guesses about the cost of producing wind power. Through the bidding process, the market sends a clear signal to the government about the cost of wind power production. The political risk of tendering systems is therefore lower than that of fixed price systems. However, investors are faced with another risk element under tendering. All developers that enter a bid risk losing the planning costs if the bid is not accepted or if planning permission is not given on the location in question.

Following the NFFO experience, most countries have disregarded tendering procedures. At present, only Ireland continues its competitive bidding procedure through the AER (see table 1.3), although it is considering changing its system. The overall objective of the AER is to secure 500 MW of new renewable energy capacity in the period 2000 to 2005. The winners of the tender are awarded PPAs for 15 years.

Table 1.3: Status of AER Contracts

AER No.	Launched	Technology	Supported Capacity Amount (MW)	Cap Price/KWH
AER I	1994			
		Wind	73,1	IR £0,04
		Hydro	4,3	IR £0,04
		Biomass	11,8	IR £0,04
		CHP	22,6	IR £0,04
AER II	1995			
		Biomass/waste	30	IR £0.036
AER III	1997			
		Wind	137,3	≤IR£0,039
		Hydro	4,4	≤IR£0,039
		Biomass/waste	17	≤IR£0,039
AER IV	1997			
		CHP	49,6	≤IR£0,03
AER V	2001	Large scale		
		wind (>3MW)	318,3 MW	c€ ≤4,812
		Small scale		
		wind (<3MW)	35,795	c€ ≤5,297
		Biomass	8 MW	c€ ≤5,916
		Hydro	0,949	c€ ≤6,475
AER VI	2003			
		Large scale		
		Wind (<3MW)	259,82	c€ ≤ 5,216
		Small scale		
		wind >	19,6	c€ ≤5,742
		Offshore Wind	50	c€ ≤8,4
		Hydro	5,483	≤
		Landfill gas	1,309	c€ ≤7
		Biomass		
		(anaerobic		
		digestion)	2,022	c€ ≤6,412
		Biomass CHP	26,83	c€ ≤ 7,018

Source: Ener-lure Project Phase III (2002), Sustainable Energy Ireland (2003).

Denmark is planning to introduce a tendering procedure for its future offshore wind power development. The country, which gets some 20% of its electricity from wind power in 2004, is following a strategy that future development of wind power should be offshore combined with repowering of onshore wind energy. The tender conditions were expected to be published in December 2003 but had not been published at the time of writing. However, at a meeting arranged by the Danish Wind Turbine Owners' Association on 27th November 2003, a leading civil servant from the Danish Energy Authority revealed a few details of the forthcoming tender. The information currently available indicates that the competitive bidding will be combined with a price cap of 4.8 c€/kWh. Both the Danish Wind Industry Association, which represents Danish WT manufacturers, and the Danish Wind Turbine Owners' Association have already expressed some concerns about the price cap.

The main criticism is that the cap will make the tender meaningless as bids will not be made. Potential developers are asked to take the risk of low electricity prices on the power exchange, but will not get any benefit if electricity prices increase above the cap. The Danish organisations suggest that the tender is conducted as an auction over the lowest "environmental bonus", defined as the premium above the market price that is required to build the power plants. The cap should be removed in order to create competition and attract a sufficient number of bids. Only then will the price signal about the cost of offshore wind power be effective and able to secure the lowest cost to the consumers. Furthermore, the organisations argue, it is neither market compatible nor in accordance with the polluter pays principle that wind power developers, as the only electricity producers in Denmark, are asked to bear the downside risk of low market prices and at the same time face income restrictions if market prices go up. Although the final proposal had not been published at the time of writing, the debate is already taking place and is illuminating some of the issues that are relevant to the design of tendering mechanisms.

If designed correctly, tendering systems could probably function adequately, as have offshore oil and gas leases. However, it still remains to be proved that the system can be effectively applied to wind power investments.

The sunk planning cost risk described above will also have an effect on the ownership structure of the wind energy market. As projects increase in size the sector is witnessing a shift in ownership away from individuals towards larger developers. The popular element of the early days of wind power cooperatives and individual ownership will probably vanish unless new collective risk-sharing project development institutions are developed. Another effect of the tendering system would be to concentrate development in the windiest areas. That is desirable from an economic efficiency perspective, but may have implications for planning and public opinion.

Finally, the model is probably better suited to large offshore wind farms than onshore projects. But the planning issues must be dealt with, deadlines must be in place and there should be meaningful penalties for not building. Imposing price caps appears incompatible with the basic idea of tenders – to get the market to provide price signals for the production of wind power.

1.4.2 TRADABLE GREEN CERTIFICATE SYSTEMS

Tradable green certificate (TGC) systems are similar to tendering. The main difference is that the price for the power and certificate is settled daily on the electricity market and there is a separate market for tradable certificates (tendering systems are typically based on 15-20 year PPAs). With daily setting of prices, the TGC model is more risky for the investor unless an effective market for long-term certificates contracts (probably in the form of financial futures or options) is developed.

If a TGC market works effectively, the price of a certificate will reflect the difference between the market price of electricity and the generation costs of new renewable generating capacity. The value of a certificate thus represents the additional cost of producing renewable electricity compared to conventional sources. That value will only by coincidence be equal to the environmental benefits of wind power and other renewables.

In theory (we have not yet seen a well functioning TGC market for wind power), the mechanism should work as follows: the government sets a specific and gradually increasing quantity – or minimum limit – for the amount of renewable electricity in the supply portfolio. An obligation is placed on either the electricity suppliers or end users of the electricity (it is of little importance who has the obligation). The generators (producers), wholesalers, retailers or consumers (depending who is obliged in the electricity supply chain) are obliged to supply/consume a certain percentage of electricity from renewable energy sources. At the settlement date, they have to submit the required number of certificates to demonstrate compliance. Obligated parties obtain certificates in three ways:

- they can own and operate renewable energy plant;
- they can purchase certificates from another renewable energy generator; or
- they can purchase certificates from a generator or broker by purchasing certificates that have been traded independently of the power itself.

The (gradually increasing) obligation creates a demand for TGCs. It is left to the market to deliver the supply of and establish a price for certificates. TGCs are issued to producers of renewable electricity in proportion to the volume of green electricity they generate. A TGC serves as evidence that a specific amount of green power has been produced and fed into the grid. If demand for certificates exceeds supply - the amount of renewable electricity produced is lower than the government quota - then the price of certificates will rise. It will continue to do so until the price satisfies investors' requirements for return, whereas new capacity will be installed to meet the quota.

Currently, the introduction of tradable renewable certificate systems has been proposed or is being implemented in Denmark, UK, Belgium Sweden and Italy (see Table 1.4).

Table 1.4: Overview of Various Certificates Models

	Denmark	UK	Belgium (Flanders)	Belgium (Wallonia)	Italy	Sweden
Period	start 2002	start 2002	start 2002	start 2002	start 2002	start 2003
Obligation	20% by end 2003 (proposal abandoned)	3% in 2002; 4.3% in 2003; 10.4 % in 2010; 15% in 2015	1.2% (2003), 2% (2004) increasing up to 6% in 2010	3% in 2003 increasing up to 12% in 2010 From September 2010 onward, the quota will be multiplied by a factor of 1.01	2% in 2002 and will be increased annually by 0.35% between 2004 and 2008	7.4% in 2003, 16.9% in 2010
Obligation on	end user	supplier	supplier	supplier	producers and importers	end user
Technology bands (baskets) within overall quota	no	no	no	no	no	no
Involved technologies	small hydro, wind, bio-mass, solar, geothermal energy, no waste	small hydro, wind, biomass, solar, geothermal energy, no waste	all renewables, no solid municipal waste	all renewables and high quality CHP	all renewables (incl. large hydro), facilities not older than eight years	small hydro (<1.5 MW), large hydro (only in some cases), wind, biomass, geothermal, wave energy
International trade allowed	no	no	no	no	yes, but only in exchange for physical electricity	no
Price restrictions (min/max price)	min= € 0.014/kWh max= € 0.037/kWh	not planned, max price according to penalty	max price according to penalty, min at federal level. From 1.7.03 onward the grid operator has the obligation to buy TGCs issued anywhere in Belgium for the minimum prices per TGC of: € 90 (offshore wind); € 50 (onshore wind) € 50 (hydro); € 150 (solar); € 20 biomass	max price defined by penalty. Min - producers of RES-E may exchange their TGC for a subsidy at a fixed price of € 65. At federal level, from 1.7.03 onward the grid operator has the obligation to buy TGCs issued anywhere in Belgium for the minimum prices per TGC of: € 50 (onshore wind); € 50 (hydro); € 150(solar); € 20 biomass	n.a.	min prices in the introductory phase: in 2003 € 6 in 2004 € 5.5 in 2005 € 4.4 in 2006 € 3.3 in 2007 € 2.2 in 2008 € 0. max price according to penalty
Penalty	€ 0.037/kWh	The buy- out price is £30.51/kWh (for 2003/2004) (~€ 45/kWh)	€ 75 per certificate (1,000 kWh) in 2003, € 100 in 2004 and € 125 in 2005	from 1.4.03 onward: € 100 per TGC (1,000 kWh)	n.a.	150% of the market price, but with a maximum of a SEK 175 for certificates that should have been surrendered during 2004, and SEK 240 for 2005
Trading scheme	n.a.	stock exchange	stock exchange	open trading and direct support	free or in the power pool	open

Comments: **Denmark**: the proposed TGC was abandoned. **UK**: recent developments have shown that the certificate price is higher than the buy-out price. This development is due to a shortage of certificates due to limited RES-E construction and the fact that the buy-out revenues for non-compliances are recycled to the suppliers in proportion to the certificates they have used for complying with the obligation. **Belgium**: the green certificate system is run by regional regulators. Only certificates for offshore wind energy (non-existent as yet, but expected) will be issued by the federal government. **Italy**: GRTN (Italian Transmission System Operator) strongly influences the certificates' market by selling its own certificates from old CIP6 plants at a regulated price, namely that set by law as the average of the extra prices paid to acquire electricity in the CIP6 programme that year. The Italian system has little to do with TGC systems because both the price and the quantity of certificates issued are fixed.

The Dutch system (see section 1.3.1) is also sometimes erroneously promoted as a TGC system, due to some confusion about the difference between TGCs and guaranties of origin (GoO). A GoO can be compared to content descriptions in the supermarket. They are not tradable in themselves unless the products are homogenous in nature and a financial market is established. The existence of GoOs in the Netherlands does not therefore make it a TGC system.

Complex Design

The TGC mechanism is more complex in nature than other payment mechanisms. WT operators will have to be active in two interrelated financial markets: one for TGCs and one for power. One of the problems is that there seems to be an asymmetry between the demand and the supply side in the markets. WT owners would prefer to have as long a contract as possible to minimise risk, while the electricity companies on the demand side seem to prefer short contracts. It is essential that the certificate market is able to attract financial arbitragers and speculators that can allocate risk.

Ideally, there should be no floor or cap on the price of certificates. However, there will need to be a penalty for not complying. As with any other penalty, this should be set at a level so high that it will never be enforced. A high penalty is one reason for the success of the US SO_2 trading market. If the penalty is set too low (too close to the expected market price of the certificates) it will act as a price controlling factor, which will distort the market.

In the ideal market, the price of the certificate and the expected price of electricity will always add up to what economists refer to as the “marginal cost” of producing wind power; that is, the costs of adding one more unit - a WT - to the generating base. In reality, any change in costs associated with wind power production will be compensated for by an equal change in the combined income from selling the electricity and its accompanying certificate. If, for example, interest rates rise, so will the combined payment. If sites with poorer wind resource are used the combined payment will also rise. And if technology improves it will fall.

In theory, under a Renewables Portfolio Standard (RPS) all changes - or rather, all expected changes - in the cost determinants of wind power investment will be immediately reflected in the combined price of electricity and the price of renewable energy certificates. Likewise, a fall in electricity prices will be accompanied by an equal rise in the price of the certificate.

As with tendering mechanisms, the rationale behind the TGC system is to reduce the costs of expanding renewable capacity by introducing competition between producers of renewable energy. Price competition will be transferred further down the system and renewable energy producers will seek to bargain with turbine manufacturers and land owners for lower prices to a larger extent than under the fixed price system.

The role of the TGC market, as any other market, is to establish a price according to the laws of supply and demand. But determining a price is problematic when supply and demand are fixed in the short term (the problem of vertical demand and supply curves). A price cannot be determined if a situation where demand equals supply is an exception. The effect will be that the price will tend to be banging either against the price cap created by the penalty or the price floor (if there is one), rather than floating in the mid-range.

In other words, if there is one certificate more in circulation than is needed to comply with the obligation, nobody will want to buy it and it has no value. This is a problem arising from fixed demand and fixed short-term supply - it causes the price to become very volatile, fluctuating between zero or infinity (or zero and the level of the fine for not complying with the obligation).

In order to eliminate price fluctuations caused by the fixed demand and to secure flexibility in payment, a system of “banking” must be available. Certificates will be issued at the time of production of renewable energy and will be destroyed, in accordance with the requirements of the obligation, on delivery to an independent authority. But there will most likely be an imbalance between actual production of wind kilowatt hours and the quota obligation for any given period. The market must be structured to cope with the imbalance. A banking system could be a solution. Such a system gives consumers the option of buying future production - and WT owners the option of selling future production by trading borrowed certificates. This stabilises fluctuating prices by creating a basis for long-term certificate purchase contracts. The system thus allows participants in the market the option of hoarding certificates in the expectation of future price changes, and WT owners the option of borrowing certificates in case their turbines do not produce enough electricity to meet their long-term delivery contracts.

Because of the expected imbalances between actual production and the renewables quota, and the problems of volatile certificate prices, consumers or electricity suppliers (who bear the weight of the obligation to buy renewables) must be able to hand in contracts on future delivery by sending a larger number of certificates to destruction. This can be viewed as the “interest” on a certificate. With no interest element, the obligation will be met at the latest possible juncture, causing disturbance in the market.

For owners of WTs (and their sources of finance) it is of paramount importance that any payment system allows a fair amount of certainty to be attached to cash flow projections. In support systems based on fixed price this tends to be less of a problem. But when selling power and certificates on spot markets with fluctuating prices it could become a problem. It increases the risk and thereby the cost of producing wind power.

Financial long-term contracts could limit this problem through the establishment of a futures or options market. By selling electricity and certificates on long-term futures or options contracts, the risk (and the price) can be reduced. Futures and options contracts make it possible to sell or buy certificates for delivery some time in the future at a price that is agreed upon today. Such a market would need an institution to facilitate trade and guarantee delivery if a WT owner is unable to deliver.

Another aspect to consider is whether all renewables technologies defined in the EU Directive on promotion of electricity from renewable energy sources should be included in a single “umbrella certificate” or whether a certificate for each technology is the answer. One certificate, however, only ensures development of the cheapest renewable technology, while several certificates will result in a market with dangerously low liquidity, at least in the beginning of development.

One way to deal with the problem is to accept, say, that PV is 10 times more expensive than wind power and issue 10 times the number of PV certificates. But such a solution brings us back to the fixed price problem - there is no easy way of estimating the true production costs of the various technologies, which makes it difficult to determine the proportional relationship between the costs of wind and solar. What if the cost of solar drops 10% from its current level, and the certificate proportion is not changed politically to reflect the drop? Investment in solar would soar and nobody would invest in other renewables options, even though they may be several times cheaper in real terms - hardly a cost effective way of meeting renewable energy targets. Offshore wind, being more expensive than the onshore variety, gives rise to the same problem; a way needs to be found of stimulating its development if politically desirable.

Furthermore, issuing certificates in proportion to estimated production costs requires constant evaluation of the costs of technologies as well as political intervention in the form of changed certificate proportions. The political risk in such a market would be substantial. One certificate for all technologies would also make it impossible to determine the price of pollution abatement in relation to the individual technology and determine when a technology will no longer need support: an “umbrella certificate” will still have a positive value when the least costly technology becomes competitive. The risk is that support will be given to technologies that no longer need it.

On the other hand, the liquidity problem of having several certificates cannot be ignored. Low liquidity is a problem for efficiency in any market. There are compromise solutions, however. Certificates could be issued to different technologies in exactly the same proportions, with the less competitive technologies receiving separate subsidies. Or instead of granting direct capital investment subsidies, auctions could be held for subsidised contracts, to encourage competitive bids and provide an incentive to reduce costs, much along the lines of the UK NFFO.

Voluntary Demand and TGCs

In the meantime, there is "green marketing" (see section 1.3.1) to consider. There is potential for the introduction of a green pricing market where like-minded citizens and companies can opt to pay a premium to receive their electricity from a renewable source.

Consumers who want to buy renewable energy in excess of the obligation must have the opportunity of doing so without being cheated. So far there is no European structure in place to allow for this.

Discussions to date among electricity sellers have centred on offsetting electricity bought by consumers in excess of the obligation against the quota requirement. Should this be allowed, consumers would be fools to buy excess certificates. Such purchases would not lead to more renewable energy being produced and these green consumers would be paying for those who declined to meet their obligation. A clean environment is considered a public good. If a neighbour buys it, they cannot prevent you from benefiting from their purchase for free.

Legislation is necessary if the market is to work properly. Just as it is on stock and bond markets. Legislation and rules create a framework within which the market can work. Once the framework has been established, intervention from law-makers should be kept at an absolute minimum. Otherwise prices on the market will reflect expectations of political action rather than fundamental economic relationships.

Economic theory, however, does not reflect the real world. When politicians get into the game of creating free markets, so do numerous opposing views and compromises. WT owners want one thing, electricity companies another and consumers (voters) a third. Senseless compromises can very well create disturbances to the market mechanism and, in the worst case, render it useless.

The UK Renewables Obligation

The most ambitious attempt to promote green electricity through tradable green certificates is the UK's RO. This came into force in April 2002, replacing the much maligned NFFO tendering procedure. Suppliers have to demonstrate compliance with the RO through the presentation of renewables obligations certificates (ROCs) which are issued in proportion to green electricity production. Each ROC represents 1 MWh of renewable electricity from eligible generators. Ofgem, the regulator, is responsible for the administration of the RO and for the compliance. For the period of 2003/2004 suppliers have to meet 3.4% of total electricity consumption through renewables. The obligation runs yearly, rising to 10.4% in 2010 and to 15% in 2015. It is due to finish in 2027. To meet the RO suppliers have three options:

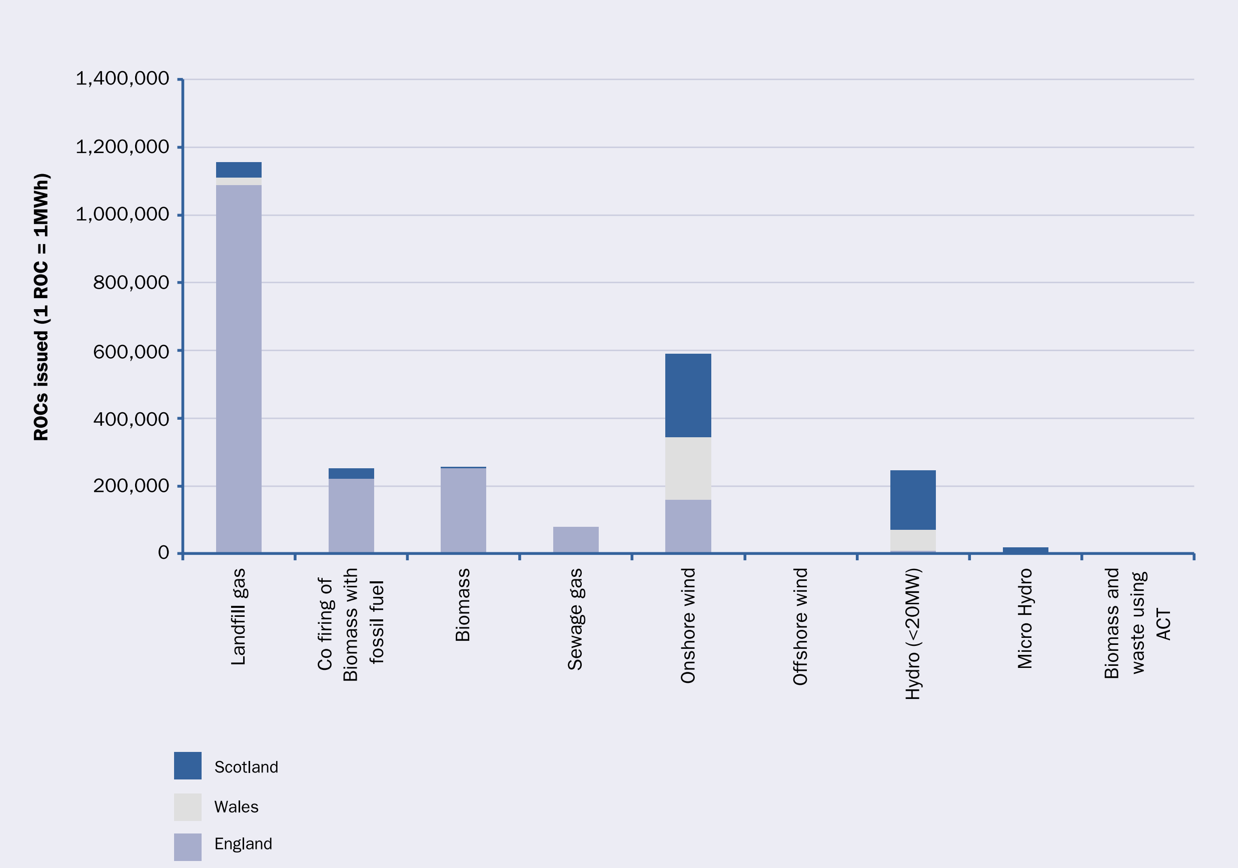
- purchase ROCs through the supply of renewable energy purchased from eligible generators;
- buy ROCs from other suppliers or from the NFPA which periodically auctions the ROCs it has acquired under the existing NFFO contracts; or
- pay the penalty or buy-out price set by Ofgem for not meeting the quota.

The buy-out price is currently set at £30.51 per MWh. All payments proceeding from the buy-out price made by suppliers for each MWh of shortfall between the amount of their obligation and the number of ROCs presented are placed in a central fund. This money is redistributed to suppliers which have met the obligation in proportion to the number of ROCs presented. Therefore, the real costs for a supplier who is not complying with the obligation is higher than the buy-out price. That explains why ROCs are trading at higher prices than the penalty. ROCs are traded at approximately £40 to £50 while the buy-out price is £30. Figures released by Ofgem in 2003 show that electricity companies missed the target for renewable electricity by 40% in the first year of the RO. 5.5 TWh of renewable electricity was produced, while the obligation was around 9 TWh. The RO does not differentiate between different renewable technologies so only the cheapest technologies will be developed unless additional measures are introduced or other markets are developed. For offshore wind power, the government supplements the RO with capital grants to reflect the fact that offshore wind power is currently more expensive than onshore.

The UK ROC system is providing valuable experiences with the complicated task of developing TGC systems. So far, the mechanism has not proved effective in adding renewable capacity and the cost of the system (on a cost per kWh basis) is high. However, it is still early days in the ROC market and the UK government seems determined to make the necessary adjustments and prove sceptics wrong.

Figure 1.3 shows the number of ROCs issued in the UK between October 2002 and February 2003 by technology and country.

Figure 1.3: ROCs Issued Between October 2002 and February 2003 by Technology and Country in the UK



Source: Ofgem Newsletter (2003).

1.5 Renewables in the New Member States

From 1 May 2004, 10 new EU member states will have to comply with the EU renewables Directive. Electricity from renewable energy sources met 5.6% of the new member states' electricity supply in 2000. To meet the indicative targets, that share will need to rise to 11% by 2010 (see Table 1.5).

Some of the new member states already have payment mechanisms in place. Hungary, Latvia and Estonia have introduced renewable tariffs. But development of wind power faces bigger barriers than simply the payment mechanism. There is a need to develop more accurate resource assessments, wind maps, reliable grid reinforcements and grid connection frameworks. In many countries, distribution and transmission grids are not robust enough to support large penetration of wind power. In Poland, up to 1,000 MW of wind power is planned in the north of the country on the Baltic coast. Infrastructure reinforcements will be needed to transport the electricity generated to the main population areas further south. Both the Polish and Czech Republic governments are currently in the process of debating new frameworks for investing in wind power and other renewables. Fixed FITs are currently in place in both countries, but it is difficult to obtain long-term PPAs.

Appendix K provides an overview of wind power development in various new member states.

1.6 The EU Legal and Political Framework

The Treaty establishing the European Community calls for: a *"balanced and sustainable development of economic activities"* and *"a high level of protection and improvement of the quality of the environment"* (Article 2); *"the integration of environmental protection requirements in the implementation of Community policies with a view to promote sustainable development"* (Article 6); and bases its Community policy on the environment on the principles that preventive action should be taken: *"that environmental damage should, as a priority, be rectified at source and that the polluter should pay"* (Article 174).

Table 1.5: Renewables in the New Member States

	1999/2000			2010		
	Renewable Gross Consumption (TWh)	**Total Gross Consumption (TWh)**	**Proportion Renewable Electricity (%)**	**Renewable Gross Consumption (TWh)**	**Total Gross Consumption (TWh)**	**Proportion Renewable Electricity (%)**
Cyprus	0.00	3.00	0.05	0.26	4.27	6
Czech Republic	2.34	61.70	3.8	5.66	70.7	8
Estonia	0.01	6.75	0.2	0.37	7.3	5.1
Hungary	0.22	28.30	0.7	1.71	47.4	3.6
Latvia	2.76	6.50	42.4	4.09	8.3	49.3
Lithuania	0.33	9.95	3.3	0.80	11.4	7
Malta	0.00	1.80	0	0.10	2	5
Poland	2.35	140.00	1.6	10.50	140	7.5
Slovak Republic	5.09	28.30	17.9	9.24	29.8	31
Slovenia	3.66	12.20	29.9	4.91	14.6	33.6
Total EU 10	16.8	298.5	5.6	37.62	335.77	**11.21**
Total EU 15	338.41	2435.00	13.9	646.6	3000.26	**21.6**
Total EU 25	355.2	2733.5	13.03	684.22	3336.03	**20.5**

Source: Directorate-General for Transport and Energy (2003).

The Lisbon strategy aims to make the European economy "*the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion*".

According to the Commission's Green Paper on security of energy supply, in two decades Europe will be importing 70% of its energy (up from 50% today) unless it changes direction. Wind power can plug the gap in the European energy supply and, at the same time, contribute greatly to the goals set out at Lisbon: economic growth, high quality jobs, technology development, global competitiveness, and European industrial and research leadership. Furthermore, wind power and other renewable energy technologies will have a large impact in meeting the EU's Kyoto commitments and contributing to sustainable development. The Green Paper recognises that:

> *"Renewable sources of energy have a considerable potential for increasing security of supply in Europe. Developing their use, however, will depend on extremely substantial political and economic efforts... In the medium term, renewables are the only source of energy in which the European Union has a certain amount of room for manoeuvre aimed at increasing supply in the current circumstances. We cannot afford to neglect this form of energy."*

> *"Effectively, the only way of influencing [European energy] supply is to make serious efforts with renewable sources."*

1.6.1 THE ELECTRICITY DIRECTIVE

In December 1996, joint rules for an internal electricity market in the EU were adopted. The overall goal is to increase the economic efficiency of the electricity supply in the EU by introducing competition. EU countries are therefore in the process of gradually liberalising their electricity markets and full liberalisation should be achieved by 2007. So far, renewables have avoided being included in the liberalisation process because their contribution to total electricity supply is small and therefore causes little distortions.

But as the contribution of renewable energy sources to the EU supply mix grows, so too will the distorting effects of the many different payment mechanisms currently in place in the EU. That is not compatible with free trade, according to the European Commission, and they could eventually be subject to internal market conditions.

On 26th June 2003 the European Parliament and the Council adopted a new Directive concerning common rules for the internal market in electricity. The new Directive seeks to achieve the complete opening of the EU electricity market by July 2007. It aims to reduce the risk of market dominance and predatory behaviour and ensure non-discriminatory transmission and distribution tariffs and network access. Furthermore, it establishes provisions for the unbundling of transmission and distribution operators and establishes labelling requirements for electricity suppliers regarding CO_2 emissions and radioactive waste from electricity production as well as the contribution of each energy source in the supplier's fuel mix.

The EU recognises that wind power and other renewables remain at a competitive disadvantage to fossil and nuclear sources. The support and payment mechanisms currently in place in the member states can be regarded as a substitute for a pollution tax on energy. Renewable electricity technologies do not benefit from decades of financial support and would be required to compete with existing nuclear and fossil fuel power stations producing at marginal costs, because interest and depreciation of power plants have already been paid for by electricity consumers and taxpayers. The medium term solution could be to create an internal market for renewables and the European Commission may, if it deems necessary, propose a harmonised framework for renewable electricity in 2005.

1.6.2 THE RENEWABLES DIRECTIVE

Directive 2001/77/EC on the promotion of electricity from renewable energy sources aims to double the amount of electricity produced by renewable energy by 2010. Indicative targets for shares of electricity have been set for each member state (see Appendix M). The

Commission is assessing member states' progress towards meeting the targets. The Directive States:

(1)" The potential for the exploitation of renewable energy sources is underused in the Community at present. The Community recognises the need to promote renewable energy sources as a priority measure given that their exploitation contributes to environmental protection and sustainable development. In addition this can also create local employment, have a positive impact on social cohesion, contribute to security of supply and make it possible to reach Kyoto targets more quickly. It is therefore necessary to ensure that this potential is better exploited within the framework of the internal electricity market."

(2)" The promotion of electricity produced from renewable energy sources is a high Community priority as outlined in the White Paper in renewable energy sources for reasons of security and diversification of energy supply, of environmental protection and economic cohesion."

Article 9 stipulates that member states shall bring into force the laws, regulations and administrative provisions necessary to comply with the Directive not later than October 2003.

The purpose of the Directive is:

"To promote an increase in the contribution of renewable energy sources to electricity production in the internal market for electricity and to create a basis for a future Community framework thereof." (Article 1).

The Directive recognises that:

"It is too early to decide on a Community-wide framework regarding support schemes, in view of the limited experience with national schemes and the current relatively low share of price supported electricity produced from renewable energy sources in the Community."

However, the Directive states that mechanisms should eventually be adapted to include renewable energy sources in the internal electricity market:

"It is, however, necessary to adapt, after a sufficient transitional period, support schemes to the developing internal electricity market."

Furthermore, it is emphasised that the intention is to use market forces to make renewable energy sources competitive.

"It is important to utilise the strength of the market forces and the internal market and make electricity produced from renewable energy sources competitive and attractive to European citizens."

The Directive on electricity from renewable energy provides the wind power and other renewables industries with crucial assurance that the EU is determined to further progress the development and integration of renewable energy technologies. It sends a powerful signal to the industry of long-term political commitment at European level which, in return, should reduce investment risks and thereby the cost to society of developing and integrating renewable energy sources.

The liberalisation process will not create a perfect market or a level playing field overnight and the RES-E Directive ensures that short-term distortions of the European electricity markets do not undermine the possibility of developing those renewable energy technologies that will facilitate a future European energy supply that is cheap, clean and independent of fluctuating oil and gas prices.

For many years, the European Wind Energy Association (EWEA) has called for a level playing field in the electricity sector, including the internalisation of external costs in electricity prices and the removal of state subsidies to conventional energy sources. The Commission has actively pursued the same agenda, e.g. by proposing common energy taxes and reductions in the level of state aid to conventional energy technologies. However, these have still to materialise. In the meantime, the renewables Directive serves as a good substitute. It will allow the industry to develop the renewable energy technologies that will secure the availability of cheap, clean energy and a future European indigenous energy supply.

No later than October 2005 the Commission shall present (Article 4):

> *A well-documented report on experience gained with the application and coexistence of the different [payment] mechanisms. The report shall assess the success, including cost-effectiveness, of the support systems referred to in paragraph 1 in promoting the consumption of electricity produced from renewable energy sources in conformity with the national indicative targets referred to in Article 3(2). This report shall, if necessary, be accompanied by a proposal for a Community framework with regard to support schemes for electricity produced from renewable energy sources.*

Any proposal for a framework should:

(a) contribute to the achievement of the national indicative targets;

(b) be compatible with the principles of the internal electricity market;

(c) take into account the characteristics of different sources of renewable energy, together with the different technologies, and geographical differences;

(d) promote the use of renewable energy sources in an effective way, be simple and, at the same time, as efficient as possible, particularly in terms of cost; and

(e) include sufficient transitional periods for national support systems of at least seven years and maintain investor confidence."

Presidency Conclusions -
Brussels, 20 and 21 March 2003

At its meeting in March 2003, the Council urged member states to accelerate progress towards meeting the indicative renewable electricity targets (section 1). *Ensuring delivery on the environmental dimension of sustainable development,* subsection *Reversing unsustainable trends:*

> *"53. Economic and social development will not be sustainable in the long run without taking action to curb environmental pressures and preserve natural resources within the framework of the comprehensive sustainable development strategy launched at Göteborg. This must include action aimed at decoupling environmental degradation and resource use from economic growth. Despite some progress, the worrying trends observed when the Strategy was launched have not been reversed, and a new impetus must therefore be given."*

> *"54. Against this background, the European Council:*
> *- invites Member States to accelerate progress towards meeting the Kyoto Protocol targets, including the reduction of greenhouse gas emissions, the increase in the share of renewable energy, setting an EU-wide indicative target for renewable energy of 12% of primary energy needs and of 22% of electricity needs by 2010 and encouraging national targets; increased energy efficiency, inviting the Environment Council to examine setting indicative targets in a cost-efficient manner and with minimum distortionary effects; and achieving a final agreement on the emissions trading Directive;"*

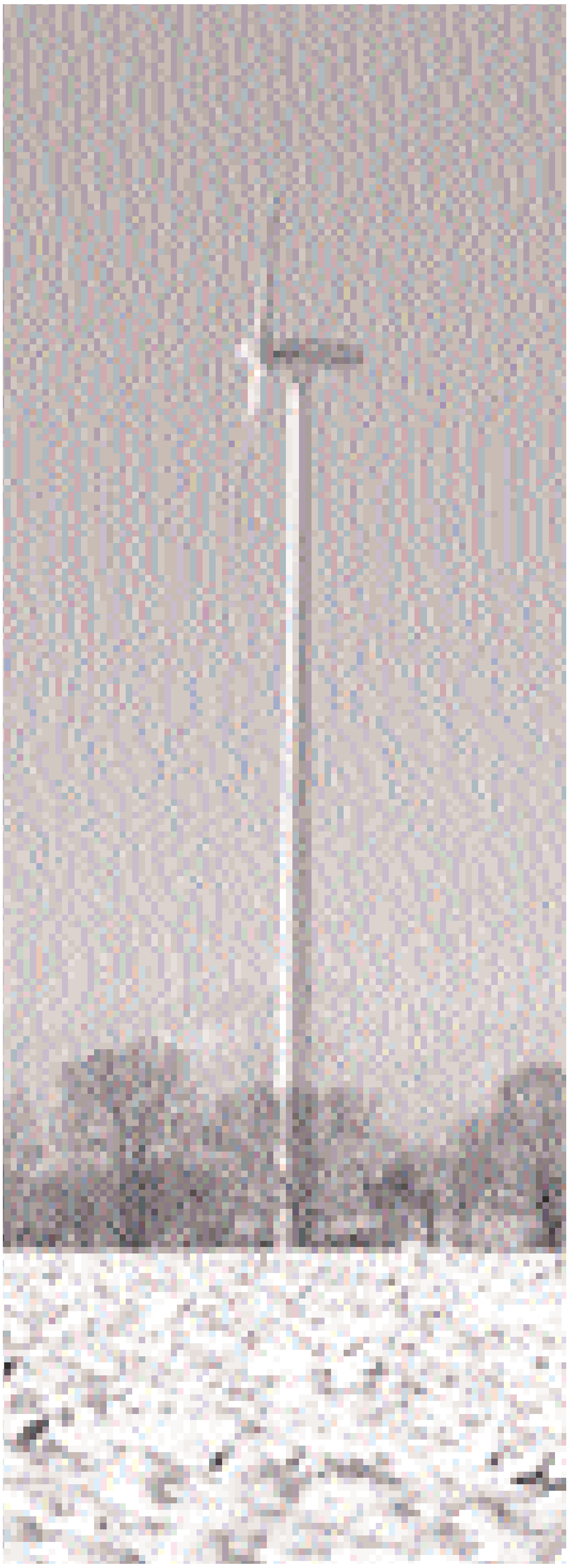
1.7 Concluding Remarks

The analysis in this section has focused specifically on national mechanisms. National experiences are obviously useful when analysing the effectiveness of various mechanisms, but the analysis cannot be directly translated into a Community-wide system. Introducing cross-border trade in the economic analysis of payment mechanisms raises a myriad of additional questions related to the functioning of the support mechanisms. It is beyond the scope of this report to analyse the effects of international trade on renewable energy sources. The two year RE-Xpansion project funded by the European Commission is currently looking into the European-wide dimension of payment mechanisms.

One issue is crucial, however, regardless of which mechanism is considered at a EU-wide level. A precondition for a well-functioning internal market in renewable energy is that rules and regulations relating to WT investments are harmonised. It therefore makes sense to continue the practice followed by the Community ever since the signing of the Single European Act in 1986. Without harmonisation of rules and regulations, e.g. in relation to grid access conditions, tax treatment, safety standards, etc., the market will be distorted.

It is clear from the industry's experience of various mechanisms that, although the price paid for electricity is vital, of equal importance, particularly if project finance is needed, is consistency of the market, the creditworthiness of the offtaker and hence the ability to make a long-term plan. Finally, planning procedures and fair grid access at reasonable cost is of equal importance to the development of wind power and other renewable energy technologies.

Successful countries are characterised by substantial inward investment by suppliers who see a future market in that country, and who see the benefits of local supply. The most successful in this respect have been Spain, Denmark and Germany, which now have not only a substantial installed wind capacity, but also a substantial wind energy industry.



2 FUTURE MARKETS

2.1 Introduction

This chapter presents two market scenarios; a conventional and an advanced scenario to the years 2007 and 2012. The advanced scenario is, taken from *Wind Force 12* - a scenario for a greatly increased market due to higher political and policy support than is envisaged today. For the status of European Markets see volume 3, chapter 1.

Future market assessments are essentially scenarios that are shaped by the assumptions and data used, by historical trends and their extrapolation, and by individual perspectives, all interacting with a wide range of external factors. The assumptions behind any future estimates of what is a rapidly evolving and changing market are key to determining the status and scope of that prediction.

Specific factors that define future wind market prospects include:

- Future demand for electricity generating capacity.
- Future power plant decommissioning.
- Government political priorities and policies on energy, electricity, environment and climate change.
- Continuous and increasing acknowledgement of the environmental benefits of renewable energy production as well as the external costs to society of conventional energy production.
- Prospects for emerging new markets to follow the current "big three" (Germany, Spain, Denmark).
- The economics of wind power itself and its competitiveness with other electricity generating technologies.
- Prospects for the large amount of wind power capacity currently awaiting final completion and construction.
- Evolving status of the leading commercial wind actors, the industry structure, and new entrants and stakeholders.
- Effectiveness and improvements of wind power technology through R&D and scale.
- Detailed understanding of wind resources and their exploitation.

Some of the trends and data on the industry's development are described earlier in this report. The nature of the major commercial players is changing, and it is predicted that the trend towards larger companies will continue.
Some commentators predict the market will continue to grow, with more established conventional energy companies joining the sector in larger numbers, as wind power emerges as a major energy source, not just an environmental "add-on".

2.2 Conventional Scenario

Specific market assessments for the short to medium term future wind energy markets are made by a number of players within the sector: wind companies and developers; consultancies; members of the financial services community, and by external institutions such as the IEA and the EU. Market analyses that are not published are undertaken by a number of consultancies, investors and institutions. This assessment by EWEA for the conventional scenario utilises inputs from Garrad Hassan and compares them to other leading market opinions of DEWI and BTM Consult.

The conventional scenario takes the following core assumptions which, to some degree, could be classified as a "favourable business-as-usual scenario". In this, EWEA estimates that the current strong development of the wind power market to date will continue as long as commitment to the sector by a number of governments continues to strengthen, and that such support is converted into actual deployment. But there is no potent policy intervention on the scale of that envisaged in the advanced scenario in Wind Force 12, which assumes, for example, that the Production Tax Credit in the USA (a tax incentive for investing in renewables) will be renewed. A market assessment of around five years is generally regarded as being a more accurate forecast. Beyond that, the predictive ability is greatly reduced because the defining factors are difficult to foresee with any real accuracy.

What is apparent is that future markets are going to be rather different from historical ones. The annual level of growth of approximately 35% observed over the last four to five years can only be sustained for a limited period, as such a growth level is only possible from a low starting point. Eventually, two obstacles will appear: an inability to produce additional manufacturing resource at the required rate; and the inroads which such rapid development make on the general level of demand for new generating capacity, conventional or renewable.

2.2.1 CONVENTIONAL SCENARIO RESULTS

Table 2.1: Market Projection by Region - Annually Installed MW

	2002	2003	2004	2005	2006	2007
Europe	5,983	6,050	6,300	6,550	6,750	7,000
(Of which EU-15)	(5,871)	(5,900)	(6,100)	(6,300)	(6,450)	(6,600)
North America	450	1,600	1,200	1,500	2,000	2,000
Central & South America	10	100	200	300	500	600
Asia	411	600	700	800	850	850
Africa	11	25	50	100	150	150
Australia & New Zealand	119	150	250	250	300	300
Others	17	75	100	100	100	100
Total	**7,001**	**8,600**	**8,800**	**9,600**	**10,650**	**11,000**

Table 2.2: Market Projection by Region - Cumulative Installed MW

	2002	2003	2004	2005	2006	2007
Europe	23,291	29,341	35,641	42,191	48,941	55,941
(Of which EU-15)	(23,056)	(28,956)	(35,056)	(41,356)	(47,806)	(54,406)
North America	4,923	6,523	7,723	9,223	11,223	13,223
Central & South America	144	244	444	744	1,244	1,844
Asia	2,610	3,210	3,910	4,710	5,560	6,410
Africa	148	173	223	323	473	623
Australia & New Zealand	225	375	625	875	1,175	1,475
Others	59	134	234	334	434	534
Total	**31,400**	**40,000**	**48,800**	**58,400**	**69,050**	**80,050**

Table 2.3: Market Projection for the World - Cumulative Installed MW[1]

	2008	2009	2010	2011	2012
World	**92,000**	**105,800**	**121,670**	**139,920**	**160,900**

[1] Assuming 15% average annual growth in cumulative capacity between 2007 and 2012.

The average annual growth rate in cumulative capacity between 2002 and 2007 is 20.6%.

The European data corresponds to those outlined in the targets in Chapter 3. Europe continues to dominate, with increased interest in France and the UK predicted, together with a gentle decline in German onshore activity followed by an uptake of the offshore segment. Spanish activity remains dominant but fairly flat. In Europe, the leading markets will remain Germany and Spain, although important markets in France, the UK, the Netherlands, Italy and Sweden will emerge.

The market forecast indicates a slight slowing down of the onshore European market, but an increase in activity in countries which have not played a major role to date. There will be a time gap before the offshore market takes off to replace it. In the meantime, there will be significant growth in the US. New markets are starting to develop in Australia, Japan and South America. There is relatively little installed capacity in these countries and, hence, the potential for future growth is large.

Other countries that are considering serious investment include Canada, Brazil, Tunisia, China, Egypt, Morocco, the Philippines, Turkey and Vietnam.

2.3 Other Forecasts

BTM Consult in its World Market Update of 2002, forecasts a global market of **83,000 MW** by the end of **2007**, and **177,000 MW** by the end of **2012**.

DEWI's WindEnergy-Studie 2002, an annual survey of several hundred wind companies, estimates that the market will be **80,000 MW** installed worldwide by the end of **2007**, and **120,000 MW** by the end of **2010**.

Hamburgische Landesbank's study in July 2002, *Wind Power: Evaluating International Markets for Wind Power and Wind Power Generator Manufacturers*, estimates **80,800 MW** installed worldwide by the end of **2006** and **144,000 MW** by the end of **2011**.

Dresdner Kleinwert Wasserstein's 2001 report Power Generation to the 21st Century predicted the global market by the end of **2006** to be **67,000 MW**.

The EU and other international institutions have also made future market assessments (see box).

Europe in 2010	
European Commission	
White Paper (1997)	40,000 MW
EU *Energy Outlook for 2020* (1999)	22,600 MW
EU *Energy Trends to 2030* (2003)	69,900 MW
World in 2010	
IEA World *Energy Outlook reference scenario* (2002)	55,000 MW
IEA forecast (2003) *Renewables for Power Generation, Status and Prospects*	120,000 MW

2.4 Wind Force 12 – The Advanced Scenario

EWEA has published advanced scenarios for the wind power sector since 1999 - *Wind Force 12* (May 2003) is in its fourth edition. It is the main long-term scenario analysis for the wind power sector worldwide and can be accessed in full at www.ewea.org.

2.4.1 METHODOLOGY

The aim of the Wind Force 12 study is to assess the technical, economic and resource implications for a penetration of wind power into the global electricity system equal to 12% of total future demand in 2020. The intention has been to work out whether a 12% penetration is possible within that timescale in terms of technical feasibility, industrial ability and resource availability.

The methodology used explores the following questions:

- Are the world's wind resources large enough and appropriately distributed geographically to achieve a level of 12% penetration?
- What level of electricity output will be required and can this be accommodated in the existing grid system?
- Is wind power technology sufficiently developed to meet this challenge? What is its technical and cost profile?
- With the current status of the wind power industry, is it feasible to satisfy a substantially enlarged demand and what growth rates will be required?

The first *Wind Force* study was carried out by BTM Consult for the Danish Forum for Energy and Development (FED) in 1998. This served as the model for a more detailed analysis released in 1999 by FED, Greenpeace and EWEA, entitled *Wind Force 10*. An update, *Wind Force 12*, was published in 2003 by EWEA and Greenpeace.

The 1998 study examined the potential for 10% wind penetration by working with two different scenarios for world electricity demand. In the more detailed *Wind Force 10* report (1999) only one parameter of future electricity demand was used - the IEA's 1998 "World Energy Outlook", a projection which assumes "business as usual" and in which electricity consumption is predicted to double by 2020.

2.4.2 REGIONAL UPDATE OF WIND FORCE 12 ADVANCED SCENARIO

Table 2.4 provides an update from the *Wind Force 12* scenario, split into regions. In this assessment, a breakdown by region for the years 2007 and 2012 has been carried out - taking into account the initial status (2002 figures). It shows that a few regions, namely Europe and the US, are on track to achieving their potential, while others have not yet left the starting blocks. To calculate the cumulative figures for each continent, a certain average annual growth rate of annual installation is chosen and later turned into a growth rate for cumulative installation. Typically, this results in a high value for new and emerging regions and a more modest value for regions already on track, i.e. OECD Europe.

Table 2.5: Summary of Conventional and Advanced Market Scenarios (Cumulative Installed MW)

Year	2007	2012
ADVANCED scenario - Europe	59,000	112,000
Average annual growth rate	20%	14%
ADVANCED scenario - world	106,000	311,000
Average annual growth rate	27%	24%
CONVENTIONAL scenario - Europe	55,941	-
CONVENTIONAL scenario - world	80,050	160,900
Average annual growth rate	20.6%	15%

The average annual growth rates are for the periods 2003 - 2007, and 2008 - 2012.

Table 2.4: Wind Force 12 Scenario Update - Breakdown by Region in 2007 and 2012

Region	2002[1] Installed Capacity	Average Growth of Cumulative Installation 2003 - 07	New Annual Capacity In 2007	Cumulative Capacity in 2007	Average Growth of Cumulative Installation 2008-12	New Annual Capacity 2012	Cumulative Capacity in 2012	Distribution of the Total World's Wind Power Capacity By 2012
	MW	%	MW/yr	MW	%	MW/yr	MW	%
OECD Europe	23,832*	20%	7,900	59,000	14%	10,750	112,000	36.0 %
US & Canada	4,944	29%	5,200	17,500	30%	14,090	65,000	20.9 %
Latin America	143	74%	1,420	2,300	51%	4,560	18,000	5.8 %
OECD Pacific	730	45%	1,615	4,700	24%	4,630	13,500	4.3 %
East Asia	0	-	410	1,200	38%	2,225	6,000	1.9 %
South Asia	1,714	39%	1,470	9,000	23%	4,560	25,000	8.0 %
China	473	76%	2,270	8,000	37%	7,600	38,000	12.2 %
Middle East	32	90%	270	800	30%	960	3,000	1.0 %
Transition Economies	22	257%	1,185	2,500	59%	6,490	25,500	8.2 %
Africa	148	47%	305	1,000	38%	1,315	5,000	1.6 %
Total World Capacity WF12 Scenario (figures rounded)	32,038	27%	22,000	106,000	24%	57,000	311,000	100 %

* Source: EWEA (2003c).
[1] 2002 Figures sourced from BTM Consult (2003).

2.5 Overview of Non European Markets

2.5.1 NORTH AMERICA

Canada

Late 2001 and early 2002 saw a major change in the Canadian market. Hitherto, apart from one isolated development of a 100 MW project in Quebec, the Canadian market has been dormant. The Canadian Wind Energy Association has announced a very ambitious plan to achieve 10 GW of installed wind power capacity by the year 2010. Commentators consider that this is highly unlikely under the current legal framework, yet a concrete proposal for a tax credit, rather similar in nature to that in the US, has resulted in a high level of interest in several states. It has also reawakened interest in the wind energy business by many Canadian utilities.

Space is clearly not a limitation in the Canadian market, but the availability of grid connection for large-scale projects is likely to pose challenges. Wind maps have been produced, or are under production, for several of the Canadian provinces, and the authorities in Newfoundland, Saskatchewan, British Columbia and Quebec have expressed interest during the 2003. Little development took place in Canada during 2002, but there are signs that activity will accelerate. Expressions of interest have been sent to NRCan for 1,220 MW for commissioning in 2003; 1,500 MW for 2004; and 600 MW for 2005. A substantial failure rate and delay must be expected, but these are nevertheless sizeable numbers.

2.5.2 CENTRAL AND SOUTH AMERICA

Argentina

Argentina has long been considered a promising market for wind energy, since it has a prodigious resource in terms of both wind speed and space. Particular interest is often expressed in the large, open expanses of Patagonia. Several European companies have articulated detailed plans to exploit this resource, and some modest level of installation has taken place. However, the recent economic difficulties in Argentina suggest that any short to medium term large-scale exploitation is unlikely. Market commentators do not, therefore, see a lot of commercial activity in Argentina in the near future. In the longer term, Argentina does seem to be a good candidate for substantial investment, however.

Mexico

Mexico has continued to surprise the wind energy industry by its lack of development. A large-scale wind energy resource investigation has been conducted, and there is a need for new generating capacity. There have been several calls for tender for significant development, but none have yet been realised. No new capacity was installed in Mexico in 2002. However, 2003 has seen a significant change in mood, and it is expected that there will be Mexican development in the short term, and future development will be significant thereafter. Mexico has some areas of wind energy resource which are exceptional, and these are likely to be the first to be exploited. It now seems that there is interest of sufficient substance and local influence to allow developments to take place.

Brazil

In 2001, Brazil suffered a severe water shortage and, since its electricity industry is dominated by hydroelectric power, this translated directly into a shortage of electricity. As a result, a Ministry of Crisis was created; part of its responsibilities was to investigate new methods of procuring additional electrical capacity on a short time-scale. A new law to encourage renewable energy, and wind power in particular, was enacted: the Pro Eolica Law called for the immediate construction of 1,050 MW of wind energy in Brazil. Substantial interest was shown, with some 3,000 MW proposed. Ironically, since the level of interest was more substantial than the Brazilian government had been expecting, and consequently there was no mechanism in place to differentiate between the different proposals, the over-subscription resulted in delay. At the same time, the level of hydro resources returned to a more normal level. Neither of these events bodes well for the immediate development of large-scale wind energy in Brazil.

The financial arrangements for payment under the Pro Eolica Law are not yet clear, and it is possible that some new bidding mechanism or other form of competition may be invoked in order to determine where the contracts will be placed. The Brazilian electricity industry has recently been privatised, and many of the large ex-utilities have been purchased by European companies. As a result, it is possible, even in the absence of a resolution of the Pro Eolica difficulties discussed above, that some private, but nevertheless large, wind farm developments will proceed. This is possible by virtue of the use of direct Purchasing Power Agreements (PPAs) between wind farm developers and utilities who have some common ownership. Very recent changes again appear to suggest that large-scale development may be about to start. It is necessary, however, to view these possibilities with a cynical eye since there have been many false starts for wind energy in Brazil.

Costa Rica

Costa Rica already has a high level of wind power penetration into its relatively limited electrical grid. Nevertheless, the Costa Rican state utility has further plans for additional implementation of wind energy projects. Continued growth is expected in wind energy installation in this country.

Panama

Panama has recently completed the development of a wind resource map and, whilst specific plans to develop projects are not yet available, it seems reasonable to assume that some level of modest development will take place in the future.

Chile, Columbia, Peru, Venezuela

These countries have all expressed interest in wind energy projects, and plans and proposals in various forms have been discussed. To date, there has been little activity, but it is expected that, as developments take place in the countries surrounding them in the region, some modest activities will appear.

Development of a 24 MW wind farm by the Colombian utility EPM was planned for 2003.

2.5.3 AUSTRALIA AND NEW ZEALAND

Australia

The recent review of Mandatory Renewable Energy Target (MRET) which places a legal obligation on wholesale purchasers of electricity to contribute towards the generation of an additional 9,500 GWh of renewable electricity annually by 2010 has caused some uncertainty but also a sudden and quite substantial increase in activity in Australia. To date, the level of installation is modest, but the planned activity is significant – of several thousand MW. At the time of writing, the obligation was set at 2% of 1999’s total electricity production to come from renewables or specified waste-product energy sources by 2010. Australia’s electricity consumption has risen quite substantially during the last few years and, hence, this level now equates more closely to 0.5% of total electricity production. The current target is estimated to result in the construction of 900 MW by 2010.

A MRET review report was released in January 2004 and will pass through the political process during 2004. Currently, the dominant players are the incumbent generators, but many private developers are also present in the market, and it is particularly interesting to note that some European developers who are expecting a downturn in the onshore German market, have chosen to make investments.

The biggest hindrance to development in Australia is the lack of substantial grid connections. The electricity grid follows the centre of populations along the coastal areas of the South East, with separate grids in the different states. Western Australia and the Northern Territory are completely disconnected from the south. There is no clear mechanism for resolving this issue at present.

Local benefits, in terms of indigenous manufacturing, are going to be a key consideration, and several states are in the late stages of negotiation with wind turbine manufacturers. In order to gain a permit for the construction of a wind farm in Australia, it will be necessary to demonstrate local benefit. “Local”, meaning the state rather than the country.

Some commentators see Australia as “the new Spain”. One market commentator considers that the Australian market is going to be substantial within the next few years. It has wind, it has space, it has an excellent industrial infrastructure and a clear code of business ethics. It does, however, require some amendments to its electricity and renewable energy legislation.

New Zealand

There has been little activity in New Zealand in recent years. Nevertheless, there are some projects at the planning stage, and there is significant resource assessment activity in progress. The early promise of New Zealand as a new market, indicated by the construction of the 40 MW Tararua project, has not been realised, due largely to the continued weakening of the New Zealand dollar, the further reorganisation of the electricity industry, and a continued drop in the electricity price. The New Zealand market is expected to continue to be flat for some years.

2.5.4 ASIA

India

In the mid- to late-1990s there was a great deal of activity in India, driven by a combination of energy shortages and tax credits. Unfortunately, the market mechanisms gave particular benefit to the installation of wind farms, rather than to their efficient operation. The result was a series of irresponsible developments, with poor engineering and inadequate resource assessments in advance of construction. That spate of activity was followed by several years of minimal activity as a result of the general economic crisis in Asia but, recently, the Indian market has restarted in a much more controlled fashion. Market commentators expect this approach to continue and, hence, growth in the Indian market to continue at this level. It is considered beneficial to analyse the way in which the Indian market has changed and to consider the new mechanisms which have been put in place. It may be sensible for other countries which suffer from power shortages and financially weak utilities to use India as a model e.g. some of the micro-financing models in place could serve as good inspiration for developing countries.

A notable characteristic of the previous Indian development was the fact that, by the end of the Indian “wind rush” in the late 1990s, some 70% of the turbines installed were manufactured in India. This high level of indigenisation is an important characteristic of the wind industry as a whole, and should be given due weight when considering new export markets. Most of the turbines manufactured in this way were made under licence from European or American vendors. A significant result of this approach has been the emergence of Suzlon Energy as a manufacturer in its own right. Suzlon purchased the German company Sudwind, and is now developing its own turbine technology and has a research centre in Germany and a blade factory in the Netherlands. It is presently operating its prototype 1 MW turbine in California and is developing a 2 MW successor. Suzlon turbines are now being offered for sale outside India and Suzlon itself is operating as a developer in other countries. This step is significant, not only for India, but for the industry as a whole: a continuation of the relatively modest growth over the last two years with a slight increase over time is likely.

Japan

Historically, the Japanese market has not been active, despite the fact that Japan boasts not only a major manufacturer in the form of MHI, but also several of the leading wind farm developers - Tomen Power Corporation (Eurus), Marubeni and Nichimen. This imbalance has been redressed in the last two years as a result of some attractive incentives, both in terms of kWh price and capital grants. The Purchasing Power Agreements (PPAs) have a long-term lifespan of 17 years which creates investor confidence. The wind speeds are relatively low, and the cost of construction in Japan seems high by world standards. Therefore, some caution must be exercised in considering tariffs in a more general context. Japan is relatively densely populated in areas where construction is feasible. It is considered that some of the Japanese terrain will complicate large-scale developments. It is, therefore, noted that the Japanese are also considering the possibility of offshore development, but there are some limitations because of water depth and the occurence of typhoons. Commentators expect the level of installation in Japan to increase from that experienced over the last few years, but not to rise dramatically due to space limitations and a reluctance on the part of the Japanese utilities to accept wind energy projects under current conditions.

China

The development of the Chinese market has been somewhat disappointing. Several years ago there was a lot of activity aimed at developing both a domestic Chinese manufacturing industry, and various aid-assisted projects which were intended to lead to a substantial uptake of wind energy in various of the Chinese states. Many of the aid-assisted projects now appear to have foundered and, hence, the rate of uptake expected is rather slower than was previously anticipated. The construction of conventional power stations in China, using predominantly brown coal, has slowed slightly. This is also likely to have the effect of reducing the uptake of wind. It is considered that the level of introduction of wind energy in China will depend very strongly on the level of licence agreements or indigenous manufacture which can be achieved. Several Chinese companies are developing indigenous technology, to date with limited success.

2.5.5 AFRICA

North Africa

All of the countries along the southern coast of the Mediterranean, with the exception of Algeria, are expressing a keen interest in wind energy. Plans have developed in Morocco, Tunisia, Libya and Egypt. There has been much discussion in Morocco over the last two to three years of developments of the order of 100 MW. The tendering process has been very protracted, however, and is still not resolved. It is, nevertheless, acknowledged that there is a very substantial resource available, with exceptional wind speeds at some sites. However, the incumbent utility's lack of willingness to develop these projects is a major cause for delay.

In Tunisia, matters are progressing slowly but steadily and, although there is little activity to date, it is likely that the future will see significant installation in Tunisia within the next two years. The geographical proximity of Italy may, in itself, have an effect, and the presence of the Vestas manufacturing plant in Taranto will be useful.

Libya has recently called for assessments to be made of its wind resource and for the establishment of a technology centre for the development of wind energy. No concrete plans are known to date but it is thought that some will appear in a foreseeable future. The political situation, however, makes Libya a difficult market, at least in the short to medium term.

Egypt has benefited for a long period from various overseas aid-related projects from different European countries and, hence, does have a base of installed capacity. Together with the World Bank, these aid agencies are continuing to show an interest in Egypt. The wind resource along the Nile is substantial and is now reasonably well documented, but there is still no sign of any real commercial development of this market.

Mild growth is expected in this block of countries over the next five years.

The Rest of Africa

The vast majority of the African continent does not have sufficient wind to merit any serious investigation for large-scale installations. The situation may be rather different for local, small-scale generation. There should, nevertheless, be a promising market in South Africa, since it is well away from the equatorial belt, where winds are limited. Interest has been shown in South Africa but, until the South African utility, ESKOM, becomes convinced of wind power's efficacy, and a political decision is taken to develop it, it seems unlikely that there will be substantial development there. Wind maps have been produced and detailed discussions have taken place, but there is still little real sign of activity at a larger scale. Notwithstanding the comments made above, recent expressions of interest have been shown from Kenya and, perhaps in the longer term, this country may see some modest developments.

2.5.6 THE EAST

Turkey

Turkey is considered to be a very substantial long-term market. It has a major shortage of energy, substantial space, a reasonably good electrical infrastructure and a very good wind resource. Turkish industrial companies with substantial financial muscle have invested in a large-scale resource assessment, and some 2,000 MW of potential development exists. A major hurdle has been the country risk, in particular political and currency instability. During 2001, this resulted in the virtual cessation of Turkish wind development activities. However, new legislation is being considered and, it is expected that projects will eventually be completed and, hence, a market is anticipated, although not for several years.

The Middle East

Syria, Jordan and Iran have all shown interest in wind energy. The promise of some of the early development, particularly in Iran, has not been followed through with further projects and, given the political situation in these countries, a substantial long-term market is not envisaged at present.

The Far East

Interest in wind energy is beginning to emerge in Malaysia, Indonesia, the Philippines, Vietnam and South Korea. There are some concrete projects being planned in all these countries, with some modest activity expected. Many of these countries suffer from a combination of relatively low mean wind speeds and very high extreme wind speeds which, therefore, require a major capital investment for a relatively limited return in energy. Consequently, these countries are not expected to have a substantial market in the near future, although Korea, for example, has repeatedly expressed an interest in establishing an indigenous industry and this appears to be under way.

3 NEW TARGETS

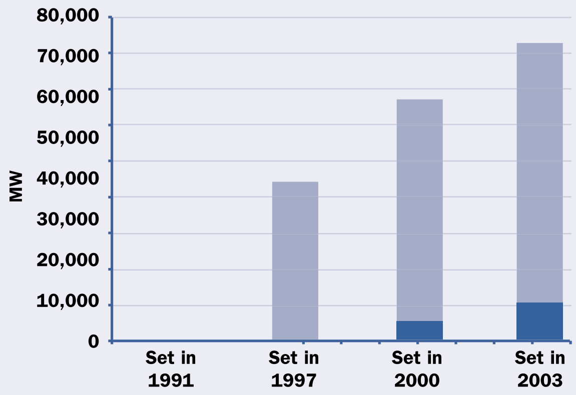
3.1 EWEA Targets - Onshore and Offshore

EWEA targets for wind energy installed capacity in the EU-15 are as follows:

- In 2010 - 65,000 MW onshore, and 10,000 MW offshore: 75,000 MW in total
- In 2020 - 110,000 MW onshore, and 70,000 MW offshore: 180,000 MW in total

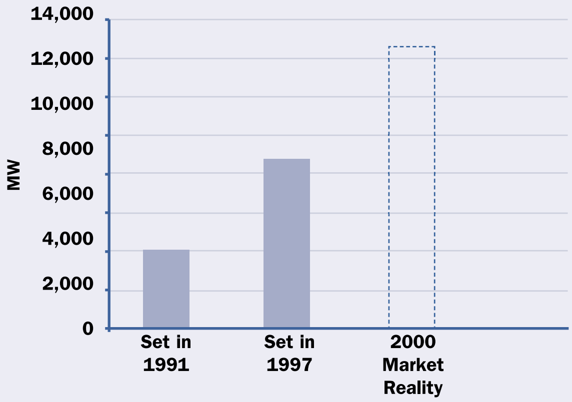
In 1997, EWEA adopted the target set out in the European Commission's White Paper on Renewable Sources of Energy of 40,000 MW by 2010 (Figure 3.2). Three years later, EWEA revised its target to 60,000 MW by 2010 including 5,000 MW offshore; and 150,000 MW by 2020 including 50,000 MW offshore (see figures 3.2 and 3.3). These figures were then revised to the above in 2003.

Figure 3.2: EWEA Targets for 2010 (MW Installed in EU)



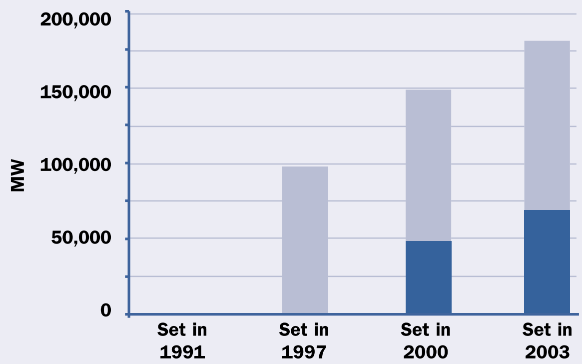
MW Onshore	-	40,000	55,000	65,000
MW Offshore	-	-	5,000	10,000

Figure 3.1: EWEA Targets for 2000 (MW Installed in EU)



MW Onshore	4,000	8,000	12,887	-
MW Offshore	-	-	-	-

Figure 3.3: EWEA Targets for 2020 (MW Installed in EU)



MW Onshore	-	100,000	100,000	110,000
MW Offshore	-	-	50,000	70,000

In 2003, EWEA published *Wind Force 12*, which demonstrates that wind power is capable of supplying 12% of the world's electricity within two decades, even if the overall electricity demand increases by two-thirds in that period, given increased political will. The study is not a long-term forecast or a prediction, but rather a feasibility study for future scenarios taking into account the physical limitations for large-scale development of wind power. It assesses and compares actual industrial growth patterns seen in the wind power sector so far with hydro and nuclear power development.

In this 12% global scenario, Europe (defined more broadly as OECD Europe, under IEA classifications) will install 100 GW by 2010 and 230 GW by 2020, producing 564 TWh/year and saving 338 million tonnes of CO_2 emissions per year. Equally important, it is envisaged that around 1,000 GW of wind power will be installed in non-European countries during the same period.

BTM Consult (2003) in its recent *World Market Update 2002* predicts that the cumulative capacity in Europe will reach 58 GW by the end of 2007 and 108 GW by 2012.

3.1.1 EUROPEAN COMMISSION - HISTORICAL TARGETS

In 1997, the European Commission's White Paper on Renewable Sources of Energy set the goal of doubling the share of renewable energy in the EU from 6% to 12% by 2010. One of the White Paper targets was to increase EU renewable electricity production from 337 TWh in 1995 to 675 TWh in 2010. Within this target, the goal for wind power was for 40,000 MW (40 GW) of installed capacity in 2010, which could produce 80 TWh of electricity.

The subsequent Directive (2001/77/EC) on the promotion of electricity from renewable energy sources sets national indicative targets for the contribution of electricity from renewable energy sources as a percentage of gross electricity consumption. The overall Community goal is to increase renewables' share of electricity from 14% in 1997 to 22% in 2010.

3.1.2 EUROPEAN COMMISSION – NEW TARGETS

The European Commission has dramatically increased its projections for wind power installed by 2010. In its recently published report *European Energy and Transport*, the Commission stretched its previous forecast by more than 200%.

Its earlier prediction (based on the energy model PRIMES) for installed wind power capacity in the EU-15 was 22.6 GW by 2010, a level already reached in 2002. The Commission now predicts a total of 69.9 GW of wind power capacity to be installed in the EU by 2010. Thus, the new Commission estimate is more in line with the EWEA target of 75 GW by 2010.

However, the Commission's energy model is exceptionally pessimistic regarding the long-term forecast for wind power beyond 2010. For the two decades from 2010 to 2030 PRIMES predicts a combined net increase in capacity that will be less than the net increase in the current decade (see Table 3.1).

Table 3.1: Primes - Installed Generation Capacity by Plant Type in EU (GW)

	1995	2000	2010	2020	2030
Nuclear	126.2	131	121.9	100.1	105
Large Hydro	85.1	87.7	88.9	88.9	89.2
Small Hydro	2	2.1	8.1	12.2	14.5
Wind	2.5	12.8	69.9	94.8	120.2
Other RES	0	0.2	0.5	0.6	14
Thermal Plant	322.9	344.8	399.5	516.1	608.1
Total	539	579	689	813	951

One of the shortcomings of the model is that it does not consider technological change. The new Commission estimates for wind power in 2010 have been dramatically revised to better reflect current reality and future industry projections. However, the projections for the period 2010 to 2030 remain unrealistically low. As wind power becomes cheaper, electricity demand is likely to increase by some 1.5% per year in the coming decades, and many conventional power plants will be decommissioned in the coming 25 years. Furthermore, wind power will become increasingly competitive.

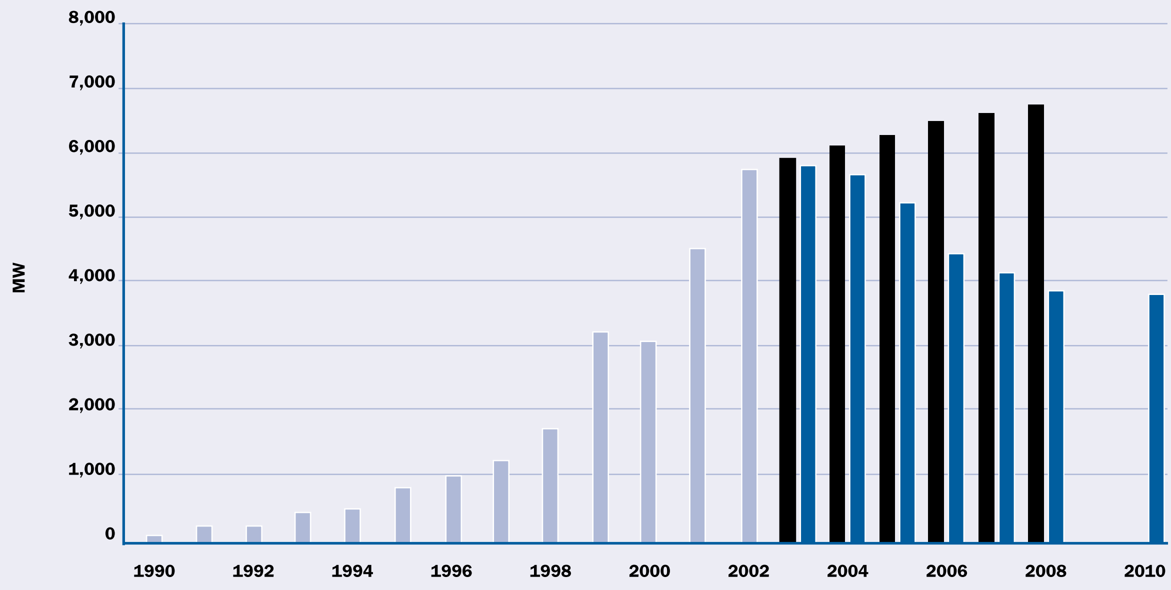
3.2 Increasing Wind Power Targets for Europe

Figures 3.4 and 3.5 detail the new industry targets which show that wind installation will continue to increase, but at a lower rate. The high growth of the last few years has been based mainly on the German and Spanish markets. Market forecasts for coming years indicate that annual installations will stabilise in Spain and will decrease in Germany. A 3.5% increase in annual installations is assumed for the year 2003, decreasing gradually to 1.4% in 2010. This corresponds to a 25.7% increase in total installed capacity in 2003 gradually decreasing to 10.3% in the year 2010.

In order to estimate the electricity production from wind power, and the corresponding CO_2 emission reductions, during the period 2001 - 2010, a yearly projection development has been performed. The average capacity factor (see glossary) of WTs is assumed to increase from 0.25 in 2001 to 0.28 in 2010. Over the past two decades, capacity factors have improved as a result of both better initial design and better siting.

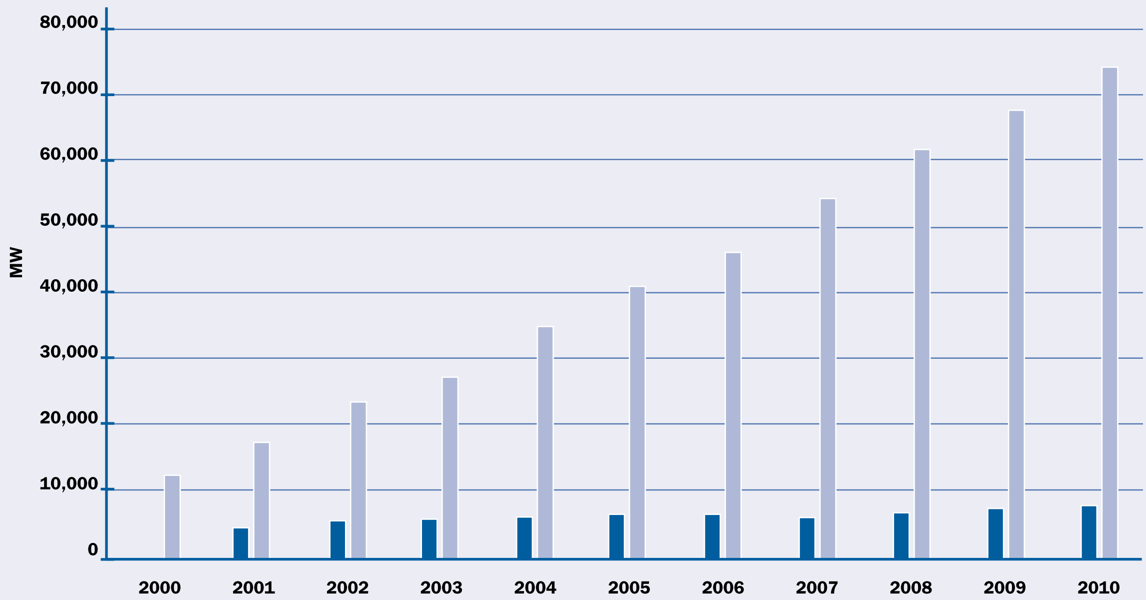
The major contributions to improved capacity factors have been the increased hub height above ground level of the larger turbines and technological improvements from R&D activities. It is worth noting that, for a technology that utilises a free resource, a high capacity factor is not a goal in itself. Improving the capacity factor of WTs presents no technical problems, but it does affect grid integration, modelling and generation costs.

Figure 3.4: Projections of Annual Installations (2003 – 2010) in the EU-15



New Capacity - target 75 GW													5,900	6,100	6,300	6,450	6,600	6,750	6,900	7,000
New Capacity - target 60 GW													5,744	5,650	5,200	4,550	4,150	3,900	3,900	3,850
Actual Market	190	215	367	472	814	979	1,277	1,700	3,225	3,209	4,428	5,871								

Figure 3.5: Wind Power Target Projections up to 2010 (MW) in the EU-15



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Capacity (MW)		4,500	5,700	5,900	6,100	6,300	6,450	6,600	6,750	6,900	7,000
Cumultative Capacity	12,800	17,300	23,000	28,900	35,000	41,300	47,750	54,350	61,100	68,000	75,000
Annual Growth of New Capacity			26.7%	3.5%	3.4%	3.3%	2.4%	2.3%	2.3%	2.2%	1.4%
Annual Growth of Cumulative Capacity		35.2%	32.9%	25.7%	21.1%	18%	15.6%	13.8%	12.4%	11.3%	10.3%

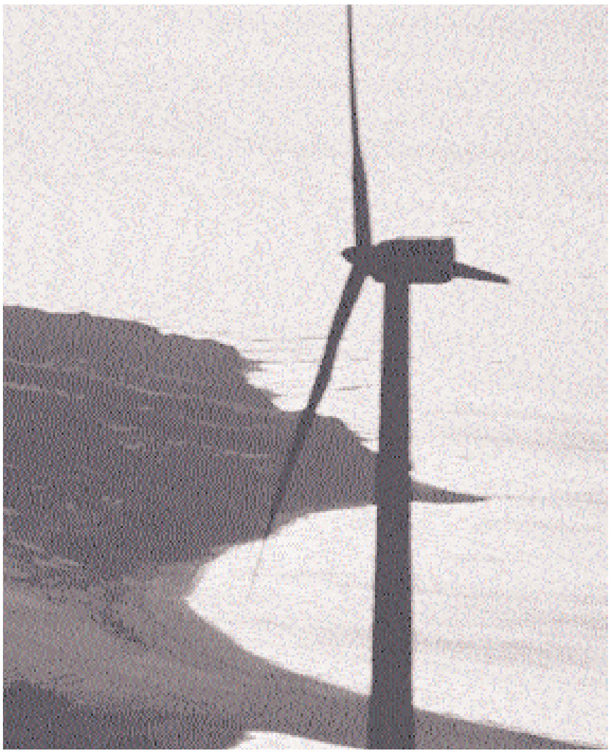
3.3 Targets for the EU-15 in 2010

Table 3.2: Installed Wind Power Capacities by Member State (MW)

	1996	1997	1998	1999	2000	2001	2002	2010
Austria	10	20	30	34	77	94	140	500
Belgium	4	4	6	6	13	31	35	250
Denmark	842	1,129	1,443	1,771	2,417	2,489	2,889	5,000
Finland	7	12	17	39	39	39	43	500
France	6	10	19	25	66	78	148	6,000
Germany	1,552	2,081	2,875	4,442	6,113	8,754	11,994	28,000
Greece	29	29	39	112	189	272	297	2,000
Ireland	11	53	73	74	118	125	137	1,500
Italy	70	103	180	277	427	697	788	3,700
Luxembourg	2	2	9	10	10	15	17	50
Netherlands	299	319	361	433	446	493	693	2,500
Portugal	19	38	60	61	100	125	195	1,500
Spain	249	512	834	1,812	2,235	3,337	4,825	15,000
Sweden	103	122	174	220	231	290	345	2,500
United Kingdom	273	319	333	362	406	474	552	6,000
European Union	**3,476**	**4,753**	**6,453**	**9,688**	**12,886**	**17,313**	**23,098**	**75,000**

Given the current distribution of wind power in EU-15 countries, historical rates of growth, the wind potential of each country, and the current status of the wind-related policies and targets of each, a possible distribution of the total installed capacity for each member state in 2010 is shown in Table 3.2.

In this table, the projected capacities in 2010 are shown, together with the installed capacities of the last seven years for each EU member state. Over the period 2001 - 2010, Germany, Spain, France and the UK comprise 74% of the expected total capacity installed. The increase for a certain number of countries, like the Netherlands, Denmark and the UK is based on the foreseen rapid development of offshore wind during the second half of the decade. Some, like the UK, France, Ireland and Greece have the potential to increase their projected installed capacity substantially if the framework conditions become more favourable for renewables and if several existing barriers are removed.



3.3.1 HOW MUCH ELECTRICITY WILL THIS PROVIDE?

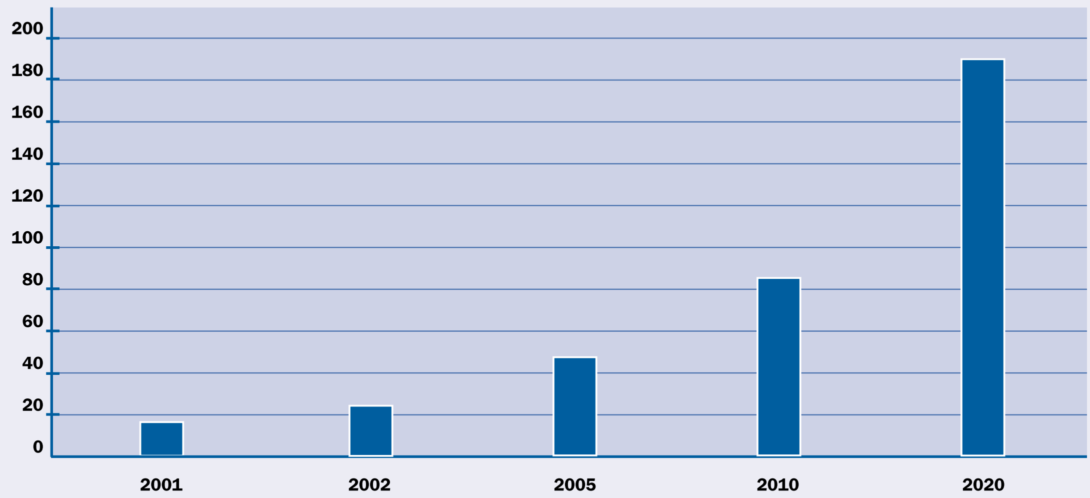
The electricity output from the EWEA targets can be expressed in terms of the equivalent amount of household electricity consumed by the average individual or household in Europe, as in Table 3.3. The calculations are based on data and forecasts from Eurostat and Eurelectric, and the European Commission's *Energy Outlook to 2020* report. These forecasts assume that whilst population and number of households will increase by only a small amount, average household electricity consumption will increase by 16% by 2010 and by 30% by 2020.

The number of people per household will decline by 2020. Therefore, the total amount of households or individuals whose average electricity use is provided by the wind power targets will become progressively less as some of the additional wind power targets output is used for the additional consumption patterns. In 2020, for example, wind power will generate 425 TWh; this is 50% of the forecast EU household electricity consumption in 2020, but 66% of that consumed in 2001.

Table 3.3: Household Electricity Consumption and Supply Forecast

Country	Unit	2001	2005	2010	2020
Austria	TWh	15.00	16.10	17.50	18.70
Belgium	TWh	17.10	18.10	19.50	21.90
Denmark	TWh	9.60	9.50	9.90	10.40
Finland	TWh	19.40	21.50	22.50	23.70
France	TWh	129.74	143.42	157.10	178.20
Germany	TWh	131.00	132.00	132.00	132.00
Greece	TWh	14.50	17.10	20.80	28.40
Ireland	TWh	7.40	8.40	10.00	12.60
Italy	TWh	61.60	65.80	74.20	87.70
Luxembourg	TWh	0.80	0.80	0.90	1.00
Netherlands	TWh	22.90	25.30	28.90	34.50
Portugal	TWh	10.60	11.70	13.60	16.90
Spain	TWh	50.60	60.10	72.60	94.90
Sweden	TWh	43.10	42.40	43.70	44.20
United Kingdom	TWh	115.30	122.50	127.20	136.80
Total EU-15 Consumption	TWh	648	694	750	841
Total EU-15 Consumption	Million KWh	648,640	694,720	750,400	841,900
Total EU-15 Population	Million	378	381	384	386
Average Household Size		2.50	2.50	2.50	2.30
EU-15 Number of Households	Million	151	152	153	167
Average Household Electricity Consumption	KWh	4,284	4,558	4,885	5,016
Average household Electricity Consumption per person	KWh	1,713	1,823	1,954	2,181
Wind Power Production	TWh	32.40	86.50	167.40	425.00
Households Supplied by Wind Power	Million	7.56	18.98	34.27	84.72
People Supplied by Wind Power	Million	18.91	47.44	85.66	194.86
Households/People Supplied by Wind Power	%	5.00	12.45	22.31	50.48

Figure 3.6: Equivalent Electricity Needs Met by Wind Power 2001 - 2020 (Million People)



	2001	2002	2005	2010	2020
European People (millions)	18.91	25.72	47.44	85.66	194.86
Wind Power Production (Twh)	32.4	44.8	86.5	167.4	425

3.3.2 WHAT PROPORTION OF TOTAL EU ELECTRICITY FROM WIND?

According to the IEA's *World Energy Investment Outlook 2002*, consumption of electricity is expected to increase by 1.6% per year over the period 2001 - 2020 (International Energy Agency, 2003). With this assumption, total electricity demand in the EU will increase from 2,572 TWh in 2000 to 3,064 TWh in 2010 and to 3,511 TWh in 2020.

The total share of the EU's electricity consumption that is generated by wind power will be 5.5% in 2010 and 12.1% in 2020.

The IEA study estimates that the installed power capacity requirements are expected to increase by some 210 GW during this period and, additionally, that approximately 235 GW of new capacity will be required to replace decommissioned plants. Thus, the EU is projected to build approximately 445 GW of new plants over the 2001 - 2020 period. Wind power can cover a substantial part of this new capacity. As mentioned above, the contribution of wind power is underestimated in the IEA scenario. If we assume that the wind industry targets will be met, wind will then substitute other conventional energies foreseen in the IEA scenario.

Assuming that wind power is substituting intermediate loads covered by fossil fuels (gas, oil and coal) with the average efficiency foreseen by the IEA study, the total installed generation capacity of 445 GW will be increased by 63.7 GW in the period 2001 - 2020 due to the lower capacity factor of wind.

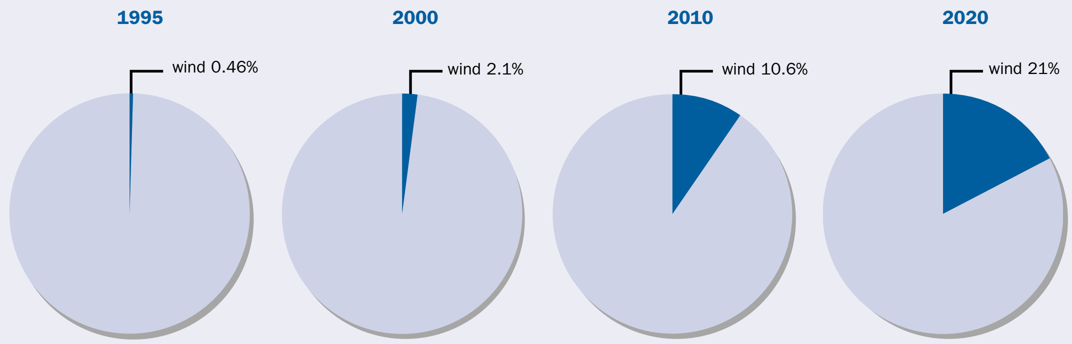
In 2000, wind power represented 2.1% of the total EU generating capacity. This share will increase to 10.6% in 2010 and 21% in 2020.

3.3.3 WHAT SHARE WILL WIND HAVE OF TOTAL NEW CAPACITY INSTALLED?

The leading role that wind power will play in the power generating system of the EU in the coming two decades is even more evident when considering its share of new generating capacity expected to be installed in Europe in the first two decades of this century.

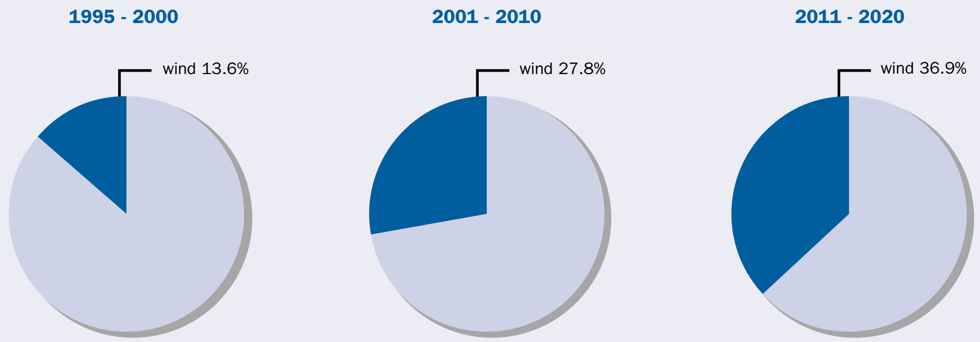
In the period 1995 - 2000, wind power accounted for 23.4% of net increase in generating capacity across the EU. During the period 2001 - 2010, wind power will account for 50% of net increase installed generating capacity and 70.3% for the period 2011 - 2020 (Figure 3.8).

Figure 3.7: Contribution of Wind Power (GW) to EU Electricity Generation Capacity 1995 – 2020 (%)



	1995	2000	2010	2020
Total Generation Capacity (GW)	538.8	580.7	706	855.4
Total Wind Generation Capacity (GW)	2.5	12.3	75	180
Share of Wind (%)	0.46%	2.1%	10.6%	21%

Figure 3.8: Contribution of Wind Power to New EU Generation Capacity (GW)



	1995 - 2000	2001 - 2010	2011 - 2020
Additional Generation Capacity (GW)	41.9	125.3	149.4
New Wind Capacity (GW)	9.8	62.7	105
Share of Wind (%)	23.4%	50%	70.3%
Capacity Retirement (GW)	30	100	135
Total New Capacity Construction (GW)	71.9	225.3	284
Share of Wind (%)	13.6%	27.8%	36.9%

Of total new construction of electricity generating capacity, including capacity replacement of decommissioned plants, wind power will represent 27.8% during the period 2001 - 2010 and 36.9% for the period 2011 - 2020.

3.4 International Energy Agency Scenarios

The IEA estimations in the "reference scenario" presented in the recent *World Energy Investment Outlook 2003* report, are very conservative and do not reflect current trends in the market: 33 GW in 2010, 57 GW in 2020 and 71 GW in 2030. Given the current rate of installation in the EU (almost 6 GW in 2002) and the actual growth rates during the previous years, the IEA's reference scenario estimations would mean a complete reversal of this trend in the next few years resulting in continuously decreasing rates of installation. Even the predictions in the "alternative policy scenario" are very conservative (see below).

In *World Energy Investment Outlook 2003* the IEA visualises an increase in electricity demand of around 50% up to 2030. This would require an additional 650 GW of capacity, and the replacement of about 330 GW of existing capacity. The agency projects that more than half of the new capacity installation will take the form of gas fired plant, and 20% in the form of renewable energy technologies, excluding hydro, with the emphasis on wind and biomass. Renewables, according to the reference scenario of the study, will capture approximately one-third of investment in new power plants in OECD countries.

Table 3.4: Reference Scenario for EU-15

	Generating Capacity (GW)			
	2000	**2010**	**2020**	**2030**
Coal	146	134	122	136
Oil	78	77	55	33
Gas	98	176	310	372
Hydrogen fuel cell	0	0	1	30
Nuclear	124	118	88	76
Hydro	118	124	129	134
Other RES (inc. wind)	19	50	87	120
Total	584	679	792	901

Source: IEA (2003).

3.4.1 OECD ALTERNATIVE POLICY SCENARIO

It is important to point out that the alternative IEA scenario includes increased policy support for renewables. The need for such is voiced in the EWEA feasibility study Wind Force 12, which states that the wind industry is sufficiently advanced to be able to supply 12% of the world's electricity by 2020, but increased political will and policy support will be required if it is to do so.

While the reference scenario only includes policies already in place by mid 2002, the IEA's alternative policy scenario visualises electricity consumption and use under the influence of more aggressive policy measures, principally aimed at CO_2 abatement through increased use of renewables, among other measures. Under the alternative policy scenario, emissions of CO_2 would fall to 2000 levels by 2030.

The policy measures in the alternative scenario directly related to renewables include the EU's renewable energy Directive, the renewable portfolio standard in the US and Canada, and renewable energy targets in Japan, Australia and New Zealand. Under the influence of these supportive measures, renewable energy technologies feature much more prominently.

The policies under consideration in the alternative scenario are projected to achieve a 25% share across the OECD of renewable generation by 2030 compared to 17% under the reference scenario above.

The support mechanisms in use in this scenario do not constitute an exhaustive list of the measures available to policy-makers: for more information, please consult chapter 1 in this volume, on policy support mechanisms.

Endnotes

[1] Directive 2003/96/EC of 27 October 2003.
[2] Source: European Commission, European Energy & Transport Trends to 2030.
[3] Wiser, Bolinger and Holt, Customer Choice and Green Power Marketing: A Critical Review and Analysis of Experience to Date (University of California: Lawrence Berkeley National Laboratory).