WIND ENERGY - THE FACTS

PART IV

INDUSTRY AND MARKETS

Acknowledgements

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PART IV INTRODUCTION

Europe is steadily moving away from conventional power sources and towards renewable energy technologies, a trend driven by the world's most significant piece of renewable energy legislation to date: the 2001 EU Renewable Electricity Directive. The move towards renewables has been further underpinned by the European Council's 2007 decision to establish a binding target of 20 per cent of EU energy from renewable sources by 2020.

Thermal power generation now stands at about 430 GW and, combined with large hydro and nuclear, has traditionally served as the backbone of Europe's power production. In recent years, however, renewable energy, and specifically wind energy, have become mainstream sources of power. Between 2000 and 2007, wind energy capacity in Europe more than quadrupled, from 13 GW to 57 GW. The 2007 total of 57 GW represents over 5 per cent of all power generation capacity in Europe and 30 per cent of all new power capacity installed since 2000. The bulk of European wind energy capacity has been concentrated in three countries, Germany, Spain and Denmark, which are now home to 72 per cent of all capacity in Europe.

Wind's spectacular European growth has attracted a broad range of players across the value chain, from local engineering firms to global vertically integrated utilities. There is strong competition, with about a dozen key suppliers vying for market share. However, the leading suppliers consolidated their dominant position in 2003–2004. Recent supply chain pressure has been a key competitive driver in wind turbine supply, and the relationships between turbine manufacturers and their component suppliers have become increasingly crucial. As more and more players look to develop, own or operate wind farms, wind power markets now include dozens of multinational players, illustrating the industry's increase in size and its geographic expansion. Between 2005 and 2006, the industry also saw more participation by utilities.

If wind energy investment has been tremendous in the past, there is no sign that the speed of development will decrease. Europe's top 15 wind utilities and independent power producers (IPPs) have announced that pipelines of over 18 GW will be installed between 2007 and 2010, translating into well over €25 billion worth of investments in wind plants. Overall, the European wind market is expected to grow at a rate of over 7–9 GW every year until 2010.

The growth of the European wind energy sector has also recently been mirrored in other continents, most notably in China, India and the US. In 2007, over 11 GW of new wind capacity was installed outside Europe, bringing the global total up to 94 GW. In terms of economic value, the global wind market was worth about €25 billion in 2007 in terms of new generating equipment.

Both in Europe and further afield, however, wind energy expansion is facing a number of barriers, both administrative and in terms of grid access. These barriers are created when administrative or financial procedures are opaque or inconsistent. They can also occur in relation to grid connections, and often pose serious obstacles to investment in wind energy, as well as preventing it from achieving competitiveness with other power-generating technologies.

IV.1 WIND IN THE EUROPEAN POWER MARKET

Renewable Energy Policies in Europe

Europe's electricity market is made up of rigid structures that do not take the environmental advantages of wind energy into account. New entrants face a number of barriers: they have to compete with conventional plants that were built decades ago and which are operated and maintained by government funds through former state-owned utilities in a monopoly market. In addition, incumbent electricity players tend to be powerful vertically integrated companies. New technologies experience obstacles when entering the market and often struggle to gain grid access and obtain fair and transparent connection costs.

The EU has acknowledged these problems, and set up a specific legal framework for renewable energies, including wind, which seeks to overcome such barriers.

The first step in this direction was the European Commission's (EC) 1997 White Paper on renewable sources of energy, which set a target for 40,000 MW of wind power to be installed in the EU by 2010. In the event, this target was reached in 2005, five years ahead of schedule. Part of the White Paper target was to increase electricity production from renewable energy sources by 338 TWh between 1995 and 2010.

In 2001, the EU passed what was until recently the world's most significant piece of legislation for electricity produced by renewable energies, including wind: EC Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. This directive has been tremendously successful in promoting renewables, particularly wind energy, and it is the key factor explaining the success of renewables worldwide. Its purpose was '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'.

Thanks to this directive, Europe has become the world leader in renewable energy technology.

The strong development of wind power can continue in the coming years, as long as the clear commitment of the European Union and its Member States to wind power development continues to strengthen, backed up by effective policies.

Therefore, the adoption of the Renewable Energy Directive in December 2008 represents an historical moment for the further development of wind power in Europe. The directive is a breakthrough piece of legislation that will enable wind power and other renewables to push past barriers and confirms Europe as the leader of the energy revolution the world needs. Under the terms of the directive, for the first time each Member State has a legally binding renewables target for 2020 and by June 2010 each Member State will have drawn up a National Action Plan (NAP) detailing plans to meet their 2020 targets.

Key aspects of the directive are:

1. **Legally binding national targets and indicative trajectory**: the 20% overall EU renewables target is broken down into differentiated, legally binding national targets. The Member States are given an 'indicative trajectory' to follow in the run-up to 2020. By 2011–12, they should be 20 per cent of the way towards the target; by 2013–14, 30 per cent; by 2015–16, 45 per cent and by 2017–18, 65 per cent – all compared to 2005. In terms of electricity consumption, renewables should provide about 35 per cent of the EU's power by 2020. By 2020, wind energy is set to contribute the most – nearly 35 per cent of all the power coming from renewables.
2. **National Action Plans (NAPs)**: the directive legally obliges each EU Member State to ensure that its 2020 target is met and to outline the 'appropriate measures' it will take do so, by drafting a National Renewable Energy Action Plan (NAP) to be submitted by 30 June 2010 to the European Commission. The NAPs will set out how each EU country is to meet its overall national target, including elements such as sectoral targets for shares of renewable energy for transport, electricity and heating/

cooling and how they will tackle administrative and grid barriers. The NAPs will have to follow a binding template to be provided by the European Commission in June 2009; if the Commission considers an NAP to be inadequate, it will consider initiating infringement proceedings against that particular Member State. If they fall significantly short of their interim trajectory over any two-year period, Member States will have to submit an amended NAP stating how they will make up for the shortfall.

3. **Priority access to the electricity grid**: the directive requires that EU countries take 'the appropriate steps to develop transmission and distribution grid infrastructure, intelligent networks, storage facilities and the electricity system … to accommodate the further development' of renewable electricity, as well as 'appropriate steps' to accelerate authorisation procedures for grid infrastructure and to coordinate approval of grid infrastructure with administrative and planning procedures.

Assuming that the reliability and safety of the grid is maintained, EU countries must ensure that transmission system operators and distribution system operators guarantee the transmission and distribution of renewable electricity and provide for either priority access or guaranteed access to the grid system. According to the agreement, 'priority access' to the grid provides an assurance given to connected generators of renewable electricity that they will be able to sell and transmit their electricity in accordance with connection rules at all times, whenever the source is available.

When the renewable electricity is integrated into the spot market, 'guaranteed access' ensures that all electricity sold and supported gets access to the grid, allowing the use of a maximum of renewable electricity from installations connected to the grid.

Furthermore, priority during dispatch (which was also the case in the 2001 directive) is a requirement for renewables, and EU countries must now also ensure that appropriate grid and market related operational measures are taken in order to minimise the curtailment of renewable electricity.

Europe can go a long way towards an energy mix that is superior to the business-as-usual scenario, offering greater energy independence, lower energy costs, reduced fuel price risk, improved competitiveness and more technology exports. Over the coming years, wind energy will play a major role in reaching this superior energy mix.

The EU Energy Mix

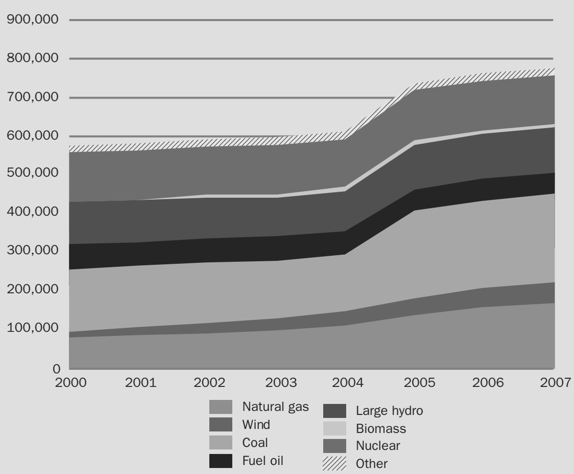
While thermal generation totalling over 430 GW, combined with large hydro and nuclear, has long served as the backbone of Europe's power production, Europe is steadily making the transition away from conventional power sources and towards renewable energy technologies. Between 2000 and 2007, the total EU power capacity increased by 200 GW to reach 775 GW by the end of 2007. The most notable change in the capacity is the near doubling of gas capacity to 164 GW, but wind energy also more than quadrupled, from 13 GW to 57 GW.

The addition of ten new Member States in May 2004 put another 112 GW into the EU generation mix, including 80 GW of coal, 12 GW of large hydro, 12 GW of natural gas, 6.5 GW of nuclear and 186 MW of wind power (see Figure IV.1.1).

Changes in net installed capacity for the various electricity generating technologies are shown in Figure IV.6.2. The figures include the EU-10 (ten new Member States) from 2005 and EU-12 (the EU-10 plus Romania and Bulgaria) from 2007. The growth of natural gas and wind power has taken place at the expense of fuel oil, coal and nuclear power. In 2007, 21.2 GW of new capacity was installed in the EU-27, of which 10.7 GW was gas (50 per cent) and 8.6 GW was wind power (40 per cent).

Gas and wind power also lead in terms of new capacity if decommissioning of old capacity is taken into account. Net installation of power capacity in the EU totalled 98 GW between 2000 and 2007. Gas and wind power accounted for 77 GW and 47 GW respectively

Figure IV.1.1: Installed power capacity, EU, 2000–2007 (in MW)



Source: EWEA and Platts (2008)

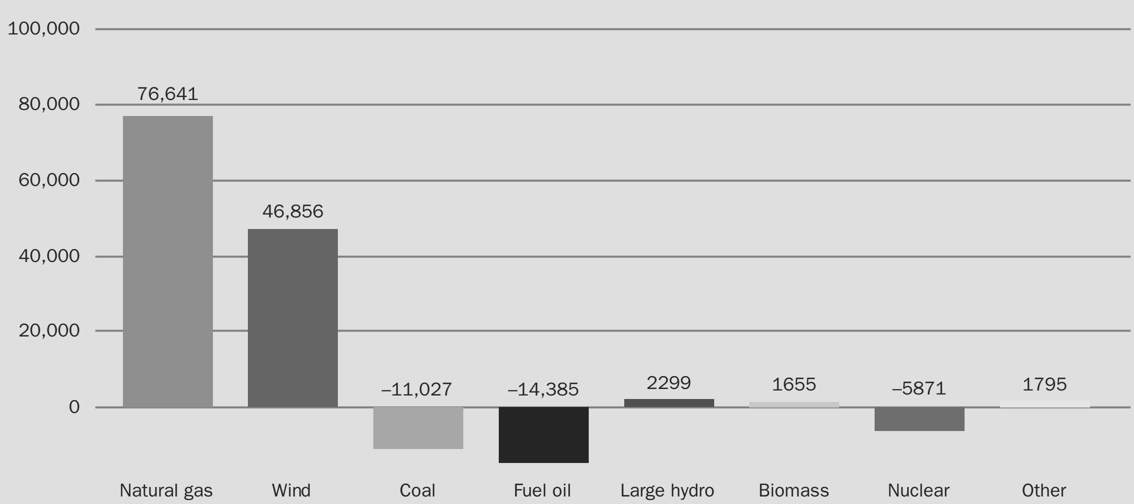
while more oil (–14 GW net), coal (–11 GW net) and nuclear (–6 GW net) have been removed than installed since 2000.

The share of EU capacity covered by natural gas has more than doubled since 1995 to reach 21 per cent. Coal's share is unchanged, while oil, large hydro and nuclear have all decreased in their share. Wind energy's share has increased from 0 per cent in 1995 to 7 per cent in 2007 (Figure IV.1.3).

The obstacles hindering more combined cycle gas turbine plant installations, including the rising costs of gas and volatile supply security from Russia and the Middle East, are most acutely felt in highly import-dependent countries such as Italy, The Netherlands and Portugal.

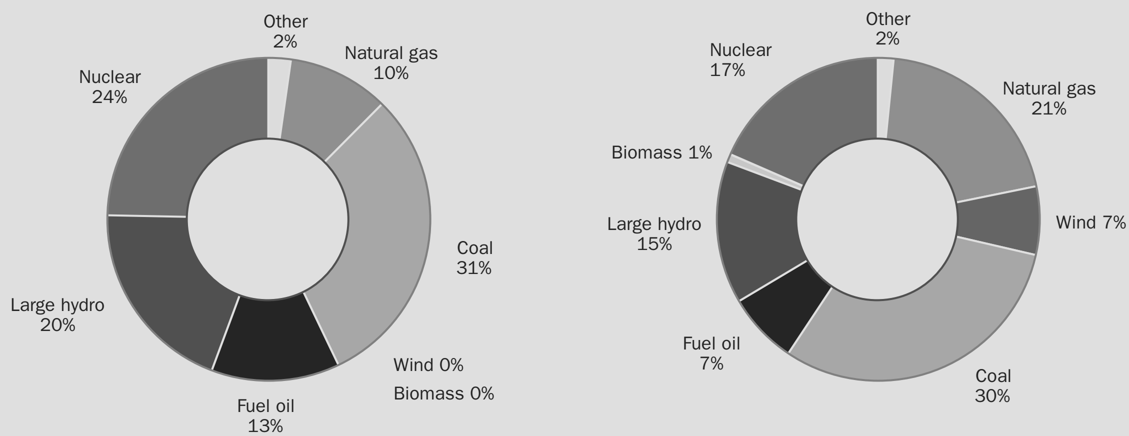
Nuclear accounts for around 17 per cent of the total installed capacity in Europe. While nuclear power emits only low amounts of carbon, safety concerns and costs remain key obstacles. Most of Europe stopped adding nuclear generation capacity in the 1980s, and several countries face major decommissioning programmes over the next ten years and looming capacity gaps to fill. In Germany alone, over

Figure IV.1.2: Net increase/decrease in power capacity, EU, 2000–2007 (in MW)



Source: EWEA and Platts (2008)

Figure IV.1.3: Evolution of EU energy mix, 1995 versus 2007



Source: EWEA and Platts (2008)

20 GW of nuclear capacity stands to be decommissioned by 2020, while France's 63 GW installed base will also require modernisation. At present, there is just one nuclear reactor currently under construction in the EU, in Finland, and this will add less than 5 GW to the country's capacity in the medium term.

Against this backdrop of rising costs and emissions for heavily thermal-dependant Europe, with its significant resistance to new nuclear construction, renewable energy technologies have been able to flourish in the past ten years. Europe's renewables targets, and the need to fill the generation gap, have resulted in a mix of support mechanisms for key technologies, including wind energy, biomass, solar, small hydro, ocean energy and geothermal. These generation options have resulted in a race to position these technologies as cost-competitive options for national energy mixes, with wind clearly in the lead.

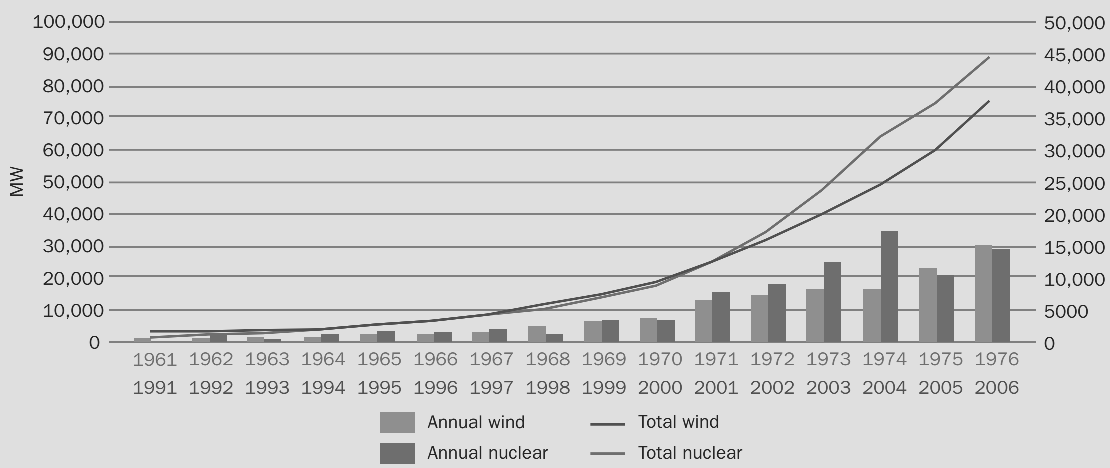
The European Commission expects a 76 per cent decline in EU oil production between 2000 and 2030. Gas production will fall by 59 per cent and coal by 41 per cent. By 2030, the EU will be importing 95 per cent of its oil, 84 per cent of its gas and 63 per cent of its coal.

Wind in the EU's Energy Mix

With an impressive compound annual growth rate of over 20 per cent in MW installed between 2000 and 2007, and now accounting for over 5 per cent of total generation, wind energy has clearly established itself as a relevant power source. In 2007, 40 per cent of all new generating capacity installed in the EU was wind power. Shifting trends in generation mix planning, brought on by the challenges of supply security, climate change and cost competitiveness, are increasing support for wind as a mainstream generation technology able to meet a substantial share of Europe's electricity demand. Based on their existing generation mix, European countries will move at different speeds to incorporate wind into their energy portfolios; however, the changing political will and the improving performance of wind power underline its increasing competitiveness.

Of the main RES technologies, wind is the most rapidly deployable, clean and affordable, which explains why Europe is choosing this technology to help reach its 20 per cent renewable energy target by 2020. Wind

Figure IV.1.4: Sixteen years of global wind energy development, 1991–2006, compared to the first 16 years of nuclear development

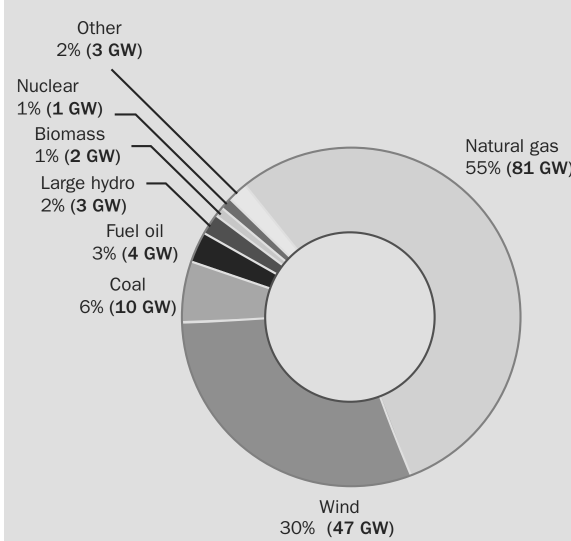


Source: IAEA and EWEA

has already made solid steps forward, penetrating national transmission systems by as much as 10 per cent in several markets and as much as 21 per cent in Denmark. Key features of wind's role in the national energy mix of European countries include its increasing weight relative to competing technologies, the level of penetration it has reached in specific markets and the speed at which it has been deployed. Wind's production variability will have an impact on a grid control area's generation mix, though transmission operators are increasingly capable of managing higher penetration levels as long as they maintain a flexible balance in the portfolio with dispatchable generation plant.

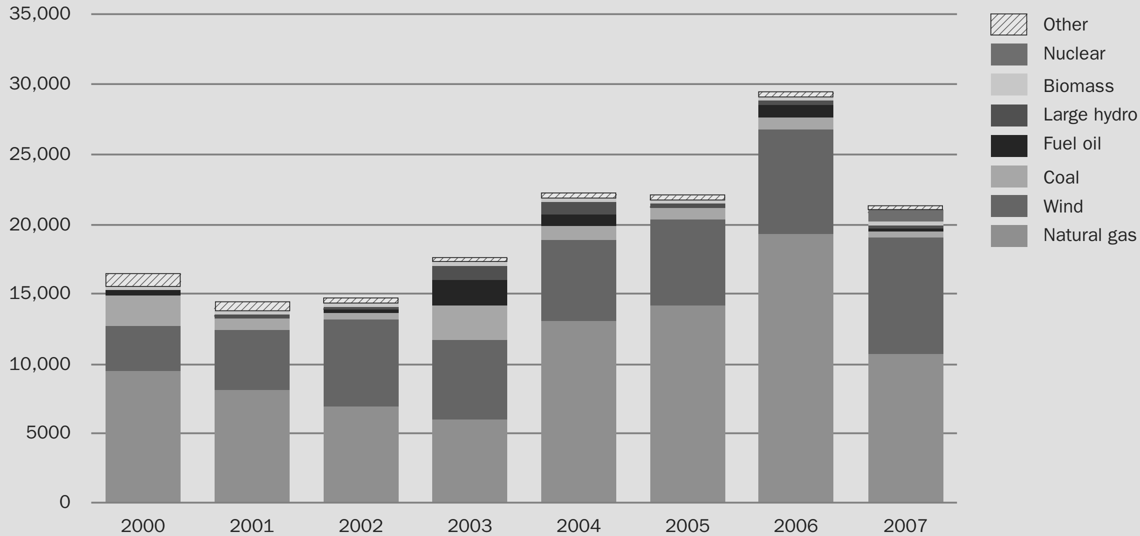
Wind power has experienced dramatic growth over recent years, and now represents over 10 per cent of the total installed power capacity, and more than 5 per cent of national electricity demand, in five European markets, Germany, Spain, Denmark, Portugal and Ireland, surpassing 10 per cent of the electricity

Figure IV.1.5: New power capacity, EU, 2000–2007



Source: EWEA and Platts (2008)

Figure IV.1.6: New power capacity, EU, 2000–2007 (in MW)



Source: EWEA and Platts (2008)

demand in both Spain and Denmark. As the industry continues to work with grid planners, utilities and developers to accommodate the variable nature of wind power generation, it is expected that the threshold for wind power penetration in several markets will increase. This will be particularly crucial for tapping offshore potential, as new transmission lines will be required for wind to see a greater surge in large-scale capacity additions.

Wind power has developed similarly to other power sources. Figure IV.1.4 shows the global development of wind energy (1991–2006) compared with nuclear power (1961–1976).

Wind energy increased its share of total capacity in the EU to 7 per cent in 2007, and its impact on new generation capacity has been noticeable. Thirty per cent of all power capacity installed between 2000 and 2007 was wind power, making it the second largest contributor to new EU capacity over the last eight years after natural gas (55 per cent). In 2007, no other electricity generating technology increased more than wind power in the EU. Six per cent of all new capacity over the eight-year period was coal, 3 per cent fuel oil and 2 per cent large hydro, with nuclear and biomass coming in at 1 per cent each (Figures IV.1.5 and IV.1.6).

IV.2 EUROPEAN MARKET OVERVIEW

The Current Status of the EU Wind Energy Market

Wind has become an integral part of the generation mix of markets like Germany, Spain and Denmark, alongside conventional power sources. Nonetheless, it continues to face the double challenge of competing against other technologies while proving itself as a sound energy choice for large power producers seeking to enlarge and diversify their portfolios.

By the end of 2007, there was 56,535 MW of wind power capacity installed in the EU-27, of which 55,860 MW was in the EU-15. In EWEA's previous scenario, drawn up in October 2003, we expected 54,350 MW to be installed in the EU-15 by the end of 2007. Thus the total capacity was underestimated by 1510 MW over the five-year period. In 2003, EWEA expected total annual installations in 2007 to be 6600 MW, whereas the actual market was significantly higher, at 8291 MW in the EU-15 (8554 MW in the EU-27).

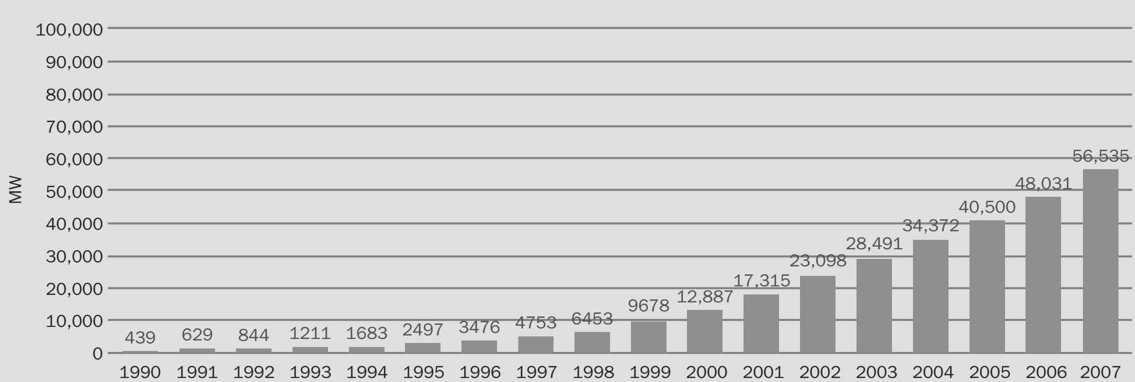
In the EU, installed wind power capacity has increased by an average of 25 per cent annually over the past 11 years, from 4753 MW in 1997 to 56,535 MW in 2007. In terms of annual installations, the EU market for wind turbines has grown by 19 per cent annually, from 1277 MW in 1997 to 8554 MW in 2007.

In 2007, Spain (3522 MW) was by far the largest market for wind turbines, followed by Germany (1667 MW), France (888 MW) and Italy (603 MW). Eight countries – Germany, Spain, Denmark, Italy, France, the UK, Portugal and The Netherlands – now have more than 1000 MW installed. Germany, Spain and Denmark – the three pioneering countries of wind power – are home to 72 per cent of installed wind power capacity. That share is expected to decrease to 62 per cent of installed capacity in 2010.

Germany and Spain continue to attract the majority of investments. In 2007, these two countries represented 61 per cent of the EU market. However, there is a healthy trend towards less reliance on Germany and Spain, although this trend was broken in 2007 due to unprecedented Spanish growth. In 2000, 468 MW of European wind power capacity was installed outside Germany, Spain and Denmark; in 2007, the figure was 3362 MW.

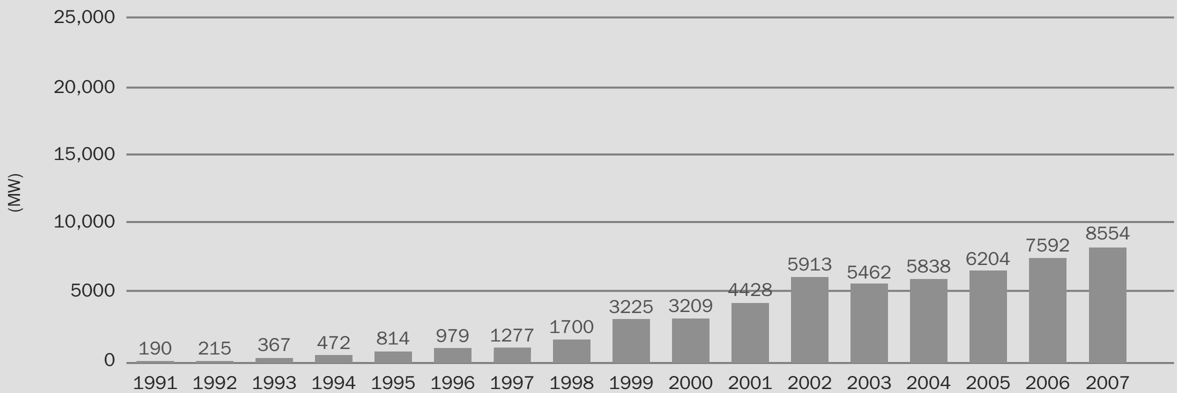
Excluding Germany, Spain and Denmark, there has been an almost fivefold increase in the annual market in the past five years, confirming that a second wave of European countries are investing in wind power,

Figure IV.2.1: European cumulative wind power capacity, 1990–2007 (in MW)



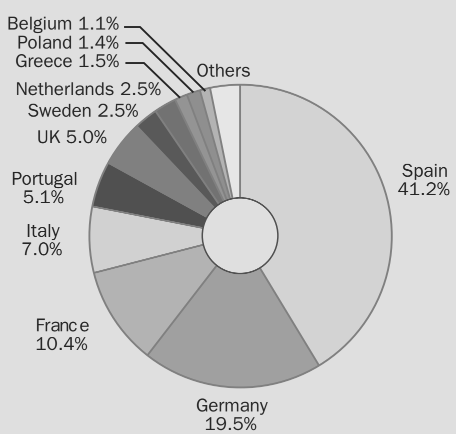
Source: GWEC/EWEA (2008)

Figure IV.2.2: European annual wind power capacity, 1991–2007 (in MW)



Source: GWEC/EWEA (2008)

Figure IV.2.3: 2007 Member State market shares of new capacity

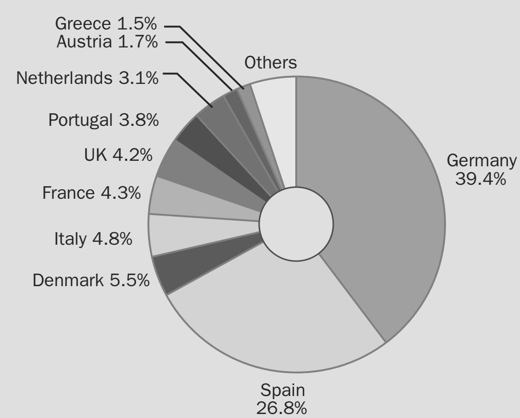


Others

Czech Republic	0.7%	Cyprus	0.0%
Ireland	0.7%	Denmark	0.0%
Estonia	0.3%	Hungary	0.0%
Finland	0.3%	Latvia	0.0%
Bulgaria	0.4%	Luxembourg	0.0%
Austria	0.2%	Malta	0.0%
Lithuania	0.1%	Slovakia	0.0%
Romania	0.1%	Slovenia	0.0%

Source: EWEA (2008a)

Figure IV.2.4: End 2007 Member State market shares of total capacity



Others

Ireland	1.4%	Lithuania	0.1%
Sweden	1.4%	Luxembourg	0.1%
Belgium	0.5%	Latvia	0.0%
Poland	0.5%	Romania	0.0%
Czech Republic	0.2%	Slovakia	0.0%
Finland	0.2%	Cyprus	0.0%
Bulgaria	0.1%	Malta	0.0%
Hungary	0.1%	Slovenia	0.0%
Estonia	0.1%		

Source: EWEA (2008a)

Table IV.2.1: Cumulative installations of wind power in the EU and predictions for 2010 (in MW)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2010
Austria	77	94	140	415	606	819	965	982	1200
Belgium	13	32	35	68	96	167	194	287	800
Bulgaria					10	10	36	70	200
Cyprus			0	0	0	0	0	0	0
Czech Republic			3	9	17	28	54	116	250
Denmark	2417	2489	2889	3116	3118	3128	3136	3125	4150
Estonia			2	2	6	32	32	58	150
Finland	39	39	43	52	82	82	86	110	220
France	66	93	148	257	390	757	1567	2454	5300
Germany	6113	8754	11,994	14,609	16,629	18,415	20,622	22,247	25,624
Greece	189	272	297	383	473	573	746	871	1500
Hungary			3	3	3	17	61	65	150
Ireland	118	124	137	190	339	496	746	805	1326
Italy	427	682	788	905	1266	1718	2123	2726	4500
Latvia			24	27	27	27	27	27	100
Lithuania			0	0	6	6	48	50	100
Luxembourg	10	15	17	22	35	35	35	35	50
Malta			0	0	0	0	0	0	0
Netherlands	446	486	693	910	1079	1219	1558	1746	3000
Poland			27	63	63	83	153	276	1000
Portugal	100	131	195	296	522	1022	1716	2150	3500
Romania			1	1	1	2	3	8	50
Slovakia			0	3	5	5	5	5	25
Slovenia			0	0	0	0	0	0	25
Spain	2235	3337	4825	6203	8264	10,028	11,623	15,145	20,000
Sweden	231	293	345	399	442	510	571	788	1665
UK	406	474	552	667	904	1332	1962	2389	5115
EU	**12,887**	**17,315**	**23,098**	**28,491**	**34,372**	**40,500**	**48,031**	**56,535**	**80,000**

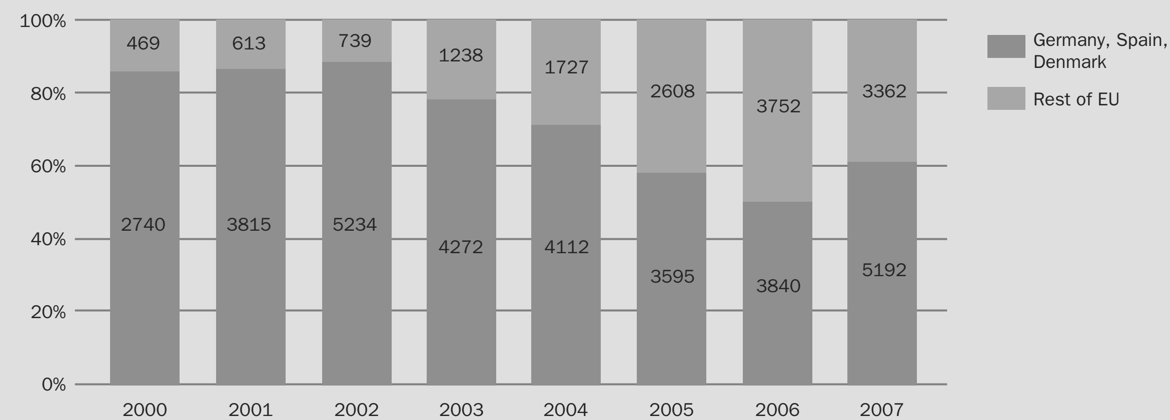
Source: EWEA (2008a)

partly as a result of the EU Renewable Electricity Directive of 2001.

The total wind power capacity installed at the end of 2007 will produce 3.7 per cent of the EU-27 electricity demand in a normal wind year. Wind power in Denmark covers more than 20 per cent of its total electricity consumption, by far the largest share of any country in the world. Five EU countries – Denmark, Spain, Portugal, Ireland and Germany – have more than 5 per cent of their electricity demand met by wind energy (Figure IV.2.6).[1]

By the end of 2007, 116 kW of wind energy capacity was installed for every 1000 people in the EU (Figure IV.2.7). Denmark tops the list, with 579 kW/1000

Figure IV.2.5: Germany, Spain and Denmark's share of the EU market, 2000–2007 (in MW)



Source: EWEA

people, followed by Spain (367 kW) and Germany (270 kW). If all EU countries had installed the same amount of wind power capacity per population as Spain, the total installed capacity in the EU would be 180,000 MW, equal to EWEA's 2020 target. If all EU countries had the same amount of capacity per capita as Denmark, total EU installations would be 282,000 MW, slightly less than the EWEA 2030 target.

There is 12.2 MW of wind power capacity installed per 1000 km^2 of land area in the EU. Not surprisingly, being a small country, wind power density is highest in Denmark, but Germany comes a close second. It is interesting that Spain's wind power density is less than half that of Germany, indicating a large remaining potential, at least from a visual perspective. The Netherlands, Portugal and Luxembourg are also above the EU average.

Many geographically large Member States, such as France, Sweden, Finland, Poland and Italy, still have very low density compared with the first-mover countries. If Sweden had the same wind power density as Germany, there would be more than 28 GW of wind power capacity installed there (0.8 GW was operating by the end of 2007) and France would have more than 34 GW of wind power capacity (compared to 2.5 GW in December 2007).

Tiered Growth Led by Germany, Spain, the UK, Italy and France

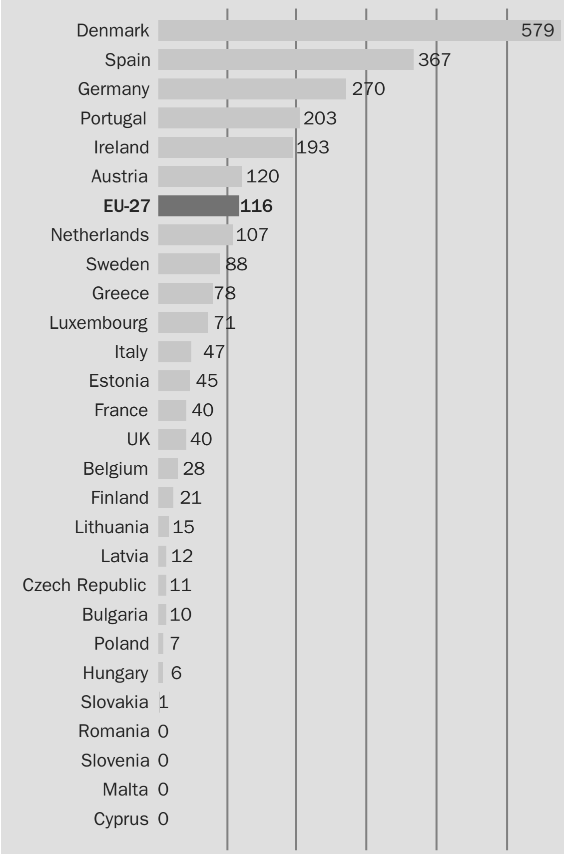
Europe's onshore wind power sector can be divided into three main market types – consolidating, scaling and growth markets – reflecting each market's maturity as a development environment and the intensity of competition within the country:

- **Growth markets** include those with a nascent wind energy sector, where the gradual creation and implementation of a stable regulatory framework is expected to facilitate sporadic project activation. The total wind power installed in growth markets remains under 1100 MW, accounting for less than 3 per cent of the region's total installed power capacity.
- **Scaling markets** are characterised by strong remaining resources coupled with stable regulatory frameworks that will facilitate project development. As such, these markets will experience high project volume in the near term, and are expected to be Europe's main driver of growth, accounting for an

Figure IV.2.6: Wind power's share of national electricity demand

Source: EWEA

Figure IV.2.7: Installed wind capacity, kW/1000 inhabitants



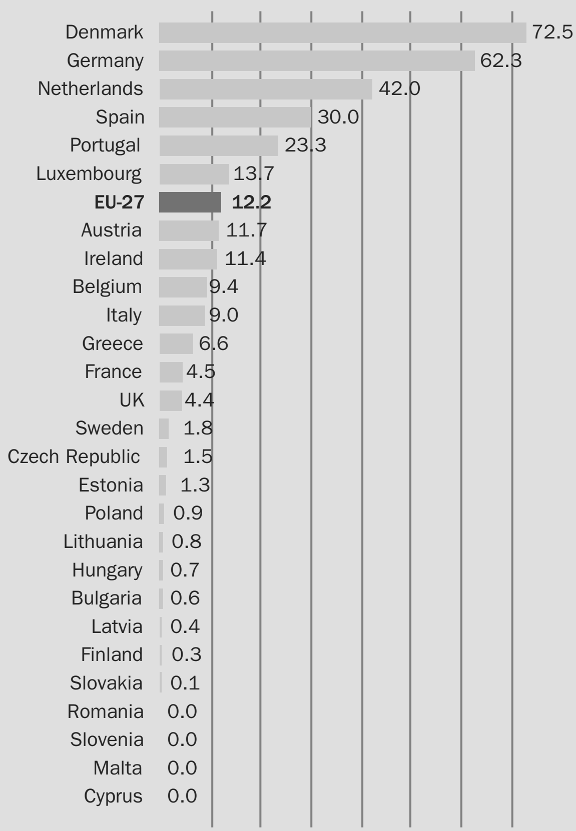
Source: EWEA

increasing share of the region's total installed energy capacity. With large wind resources and market environments propitious to investments in wind, scaling markets are now experiencing an influx of foreign players that is leading to heightened competition for projects.

- **Consolidating markets** have reached a good level of maturity, have high penetration levels (>10 per cent of national installed generation capacity) and have limited greenfield opportunities available. Denmark and Germany are the archetypal consolidating markets, where wind has become a mainstream source of energy and the best sites have already been tapped out. As such, the majority of projects coming online in the next few years have already been fully permitted or are now in the final permitting stages.

At national level, these market groupings have several implications in terms of the expected amount of MW needed to tap remaining potential, as well as the intensity of the competition among players to tap undeveloped sites. Consolidating markets are most likely to turn in relatively flat or declining MW additions in the short term until the markets begin going

Figure IV.2.8: Wind installation, MW/1000 km²



Source: EWEA

offshore or facilitating widespread repowering (replacing older turbines). Germany is gearing up for its first offshore project, while Denmark and The Netherlands have already launched theirs.

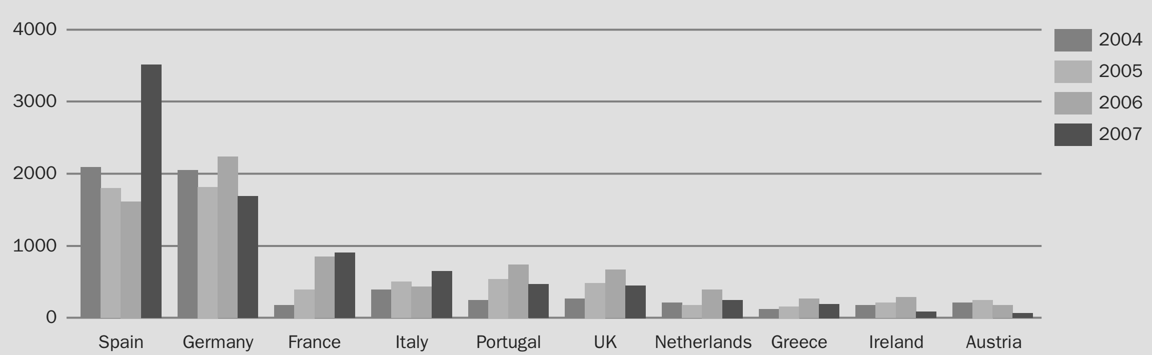
Scaling markets, led by Spain, the UK, Italy, France and Portugal, will probably host the bulk of Europe's onshore growth in the near term. These countries' wind potential, relatively untapped pool of sites and supportive renewables policies will create the most competitive markets for project permits and asset ownership. These markets will be followed by smaller growing markets in Eastern Europe that still have to develop a steady flow of projects to support the industry.

Growth Potential in Emerging Markets

Entry barriers to emerging markets remain high due to unstable regulatory regimes, siting issues and/or grid-related barriers such as the lack of infrastructure at windy sites.

After Poland, Hungary is likely to be one of the most active Eastern European wind markets. However, although the combination of a high incentive scheme with a relatively straightforward permitting process facilitates project development, grid capacity constraints will cap market growth at 330 MW by 2010.

Figure IV.2.9: Top ten annual markets in the EU (MW)



Source: EWEA

Box IV.2.1: Summary of the wind energy market in the EU-27 in 2007

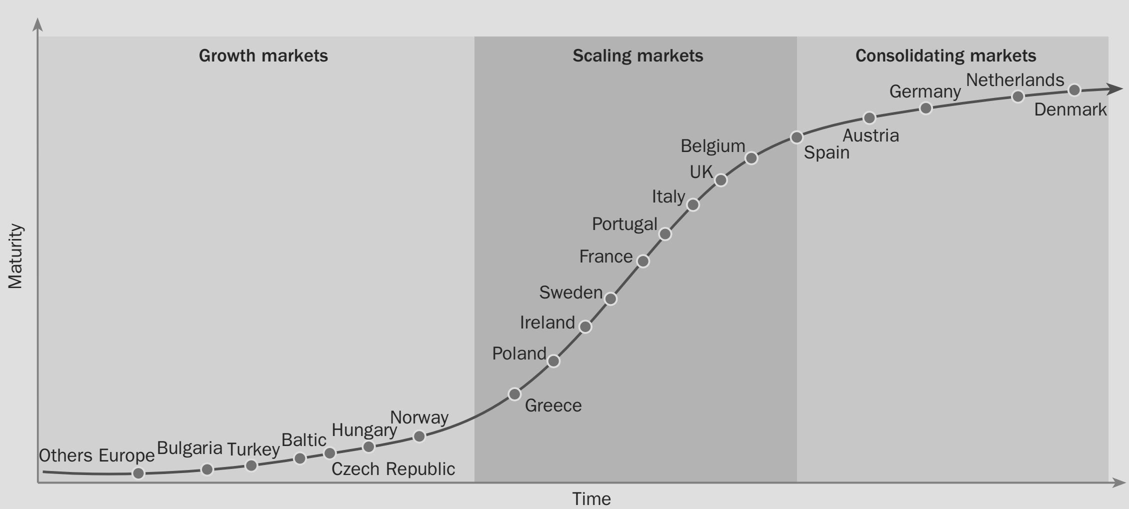
- 56 GW installed capacity, including 1.08 GW offshore
- Annual installations of 8.5 GW, including 0.2 GW offshore
- Electricity production of 119 TWh, including 4 TWh offshore
- Meeting 3.7% of total EU electricity demand.
- 40.3% of the annual new electricity generating capacity
- 55% of annual net increase in installed electricity generating capacity
- 7.3% of total installed electricity generating capacity
- Providing power equivalent to the needs of 30 million average EU households (15% of EU households)
- Annual avoided fuel costs of €3.9 billion
- Annual investments in wind turbines of €11.3 billion
- Total lifetime avoided fuel costs of wind power capacity installed in 2007 of €16 billion (assuming fuel prices equivalent to $90/barrel of oil)
- Total lifetime avoided CO_2 cost of wind power capacity installed in 2007 of €6.6 billion (assuming CO_2 price of €25/t)
- European manufacturers have a 75% share of the global market for wind turbines (2006)[2]

Turkey, as the largest emerging market in terms of both size and population, is driven by large local industrial groups, with the number of projects installed per year as well as the average project size expected to increase over time. Although the country's incentive scheme recently became more stable, thereby lowering investment risks, the authorisation process is rather congested due to growing site speculation and remains difficult to navigate. As such, it is likely that Turkish independent power producers (IPPs) will continue to dominate the wind market.

In both Estonia and the Czech Republic, there are interesting opportunities for growth, given that wind investment risks are moderate despite the existing regulatory frameworks, site approval processes and competitive environments. However, project size in these markets will remain constrained by space and resource availability.

Bulgaria, Lithuania and Romania lead this group, because each has recently adopted a support system, with Lithuania and Bulgaria offering feed-in tariffs and

Figure IV.2.10: Wind power onshore market maturity



Source: Emerging energy research

Romania a green certificate scheme. At the moment, the authorisation processes in these markets are relatively expedient, although delays and congestion are anticipated as project queues get longer, taxing inexperienced permitting authorities.

The European Offshore Market

With a total of 1080 MW by the end of 2007, offshore accounted for 1.9 per cent of installed EU capacity and 3.5 per cent of the electricity production from wind power in the EU (Figure IV.2.11). The market is still below its 2003 level and development has been slower than previously anticipated.

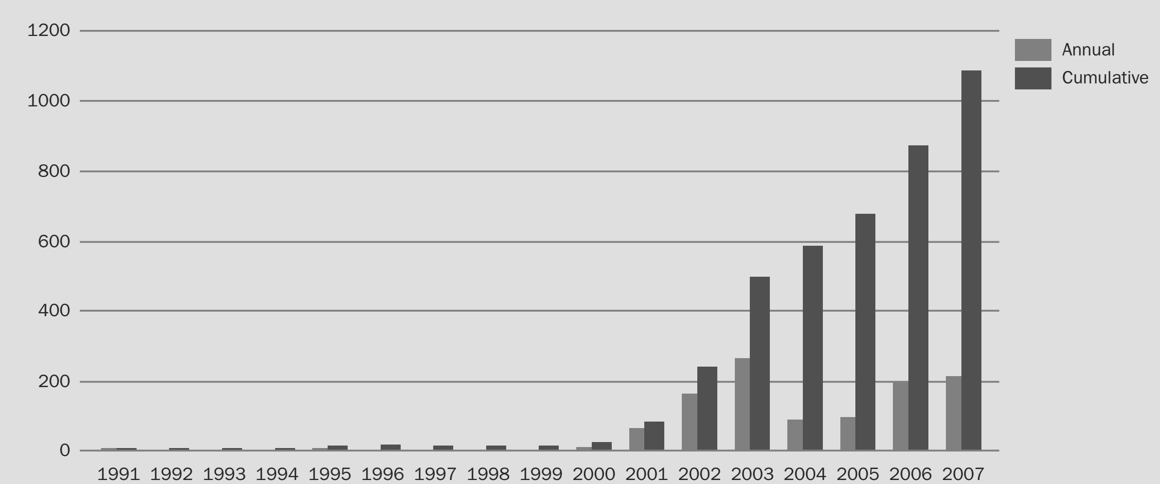
Since 2003, the only country to consistently activate at least one offshore project per year has been the UK, when the 60 MW North Hoyle wind farm was commissioned. Denmark, Europe's earliest offshore pioneer, has not added any new projects since the 17 MW Ronland wind plant was commissioned in 2004, while Germany's first offshore wind turbine, a N90/2500, was installed in March 2006 in Rostock international port. The Netherlands, Sweden and Ireland are the only other European markets with operational offshore projects.

With 409 MW, Denmark now has the most offshore wind capacity, but the UK (404 MW) is a very close second, having installed 100 MW in 2007. Sweden installed 110 MW in 2007. The Netherlands and Ireland also have operating offshore wind farms.

The main barriers to European offshore wind project development include:

- lengthy permitting processes that need to consider key issues such as defence, shipping, fishing and tourism;
- technical issues relating to the construction of the wind farms, including transport of turbines, turbine supports depending on the type of seabed, meteorological restrictions on building wind farms (often limited to a few months of the year in northern Europe) and connecting the wind farm to the mainland;
- incentive schemes that are not in line with the existing risks and/or costs associated with offshore investments, making it difficult to finance projects;

Figure IV.2.11: Offshore wind in the EU (MW)



Source: EWEA

Table IV.2.2: European offshore capacity, end 2007

Country	Total installed by end 2007 (MW)	Installed in 2007 (MW)
Denmark	409.15	0
UK	404	100
Sweden	133.25	110
Netherlands	108	0
Ireland	25.2	0
TOTAL	**1079.6**	**210**

Source: EWEA

- high costs associated with every stage of the project development, from development to construction, and turbine size;
- lack of turbine availability;
- lack of experience in offshore development;
- lack of smarter foundation types for deeper waters (>20 m); and
- an urgent need for more research and development (R&D) and demonstration projects.

Despite these issues, firms are moving offshore in some European markets, driven by high resources, limited onshore potential or even government pressure. As a result, it is estimated that the market will draw near to 10 per cent of total installed wind power within the next decade.

For the most part, utilities will be the main drivers of growth, as these firms can finance projects on their balance sheets, although some IPPs are looking at offshore installations in order to secure their position in the European wind energy market. In addition, more offshore opportunities will arise as developers tend to outsource these activities to firms with the technical know-how required for offshore project construction. In terms of turbine suppliers, Siemens and Vestas are currently the main two, although a handful of other firms are looking to challenge this duopoly with machines of 2.5 MW and 5 MW, and there are even larger models in the design phase.

Although Germany, the UK and Sweden are positioned to become the largest European offshore markets, other markets are now also ready to move offshore, exploiting existing resources. France's first offshore projects are due to be commissioned in 2008–2010, while in Spain several initiatives have been launched by key IPPs and utilities for large-scale projects, mainly in the Sea of Trafalgar and off the coast of Valencia. In Italy, Enel claims that it will develop a 150–200 MW wind farm in the Mediterranean.

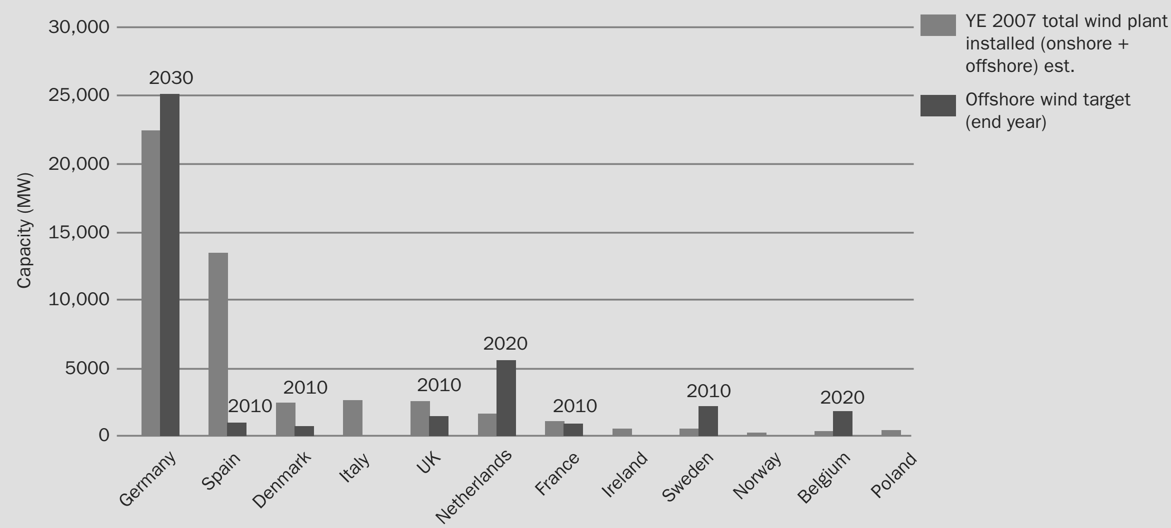
Key Elements for Wind Energy Markets in Europe

Within the context of the Kyoto Protocol, Western European countries and a growing number of Eastern European markets have laid out renewables policies that are dependent on each market's energy balance, political will and level of liberalisation. Security of supply is also a key issue, as Europe works towards reducing its dependence on high-risk fossil fuel providers. An integral part of this policy is the regulatory mechanism that supports renewables, because it determines the economic model of renewables projects in most markets.

In addition to support mechanisms, renewable energy markets depend on resources, site approval, grid issues and the competitive environment. For the wind industry, these issues have been critical in defining both the market opportunity and its rules for participation. Economically viable tariffs and efficient and flexible permitting, combined with available grid capacity, are the key elements of a sound market.

With a policy and support mechanism in place, wind energy markets then depend on the resources available. Europe's highest wind speeds are seen offshore, where it is more expensive to install turbines, and on the coasts of countries in the northwest of the area. While significant untapped potential exists offshore, two onshore markets – Germany and The Netherlands – have begun to exhibit a degree of saturation as turbine procurement moves toward IEC Class III models with

Figure IV.2.12: Europe offshore market installed and targets by country



Sources: Governments, emerging energy research

Figure IV.2.13: European wind market environment and trends

	Wind resources	Regulatory mechanisms	Site approval	Utility/ grid issues	Competition
Key elements	• Mapped potential onshore • % utilised • Quality and location of remaining resources	• National energy policy • Production incentives • Other incentives • Incentive duration	• Clear process for registration • Environmental requirements • Planning and construction consents • Regional variations	• Quality, capacity and access to grid • Willingness to expand • Reserve requirements • Grid connection requirements	• Concentration of the market and size of players • Barriers to entry • Level of competition for sites, permits, grid connection • Tender processes
European trends	• Saturating sites in leading Central European markets • Move to Class II, III sites in the West • Offshore sites offer major potential to be exploited	• Mixed policies of feed-in tariffs, certificate schemes, other incentives • Incentives specifically targeting offshore, repowering segments • General continuation of existing mechanisms in leading markets • Transposition of EU 2020 goal to further stimulate political will	• Mature markets offering relatively streamlined permitting, main bottlenecks in environmental impact assessment • Eastern, less mature markets gradually adopting more unified permitting processes • Repowering permitting still not fully clarified in most markets	• Generally the key bottleneck to additional build out, due to both technical and internal political issues at TSOs • Transmission queues reaching critical levels in key markets such as UK, Spain with grid extension, reinforcement plans underway	• Highly concentrated development, ownership in southern European markets • More liquidity, fragmentation in central, northern European markets • Eastern Europe the next frontier for competitive battles between developers, IPPs, utilities to capture quality sites

Source: Emerging energy research

larger rotors. Southern Europe, however, offers higher wind speeds.

The issue of grid access to the local distribution or transmission network has generally obstructed the development of wind power. Part of this challenge has stemmed from project permits greatly exceeding infrastructure capabilities, as is the case in Spain, the UK and other parts of Europe. At the same time, TSOs are in the process of understanding the technical requirements needed to integrate greater amounts of wind power. The application of new grid codes, improved fault ride-through and more accurate production forecasting are all contributing to resolving transmission challenges across Europe, although problems in connecting wind farm projects to the grid are likely to persist at the local level (this is even truer offshore, where new lines must be built to absorb GW-size offshore power stations).

Given sufficient transmission capacity, another key way of increasing installed wind power capacity is to facilitate the authorisation process for projects. Authorisation processes must not only be streamlined, but they must enable plans to be successfully realised, bolstered by flexibility and an infrastructure that allows new wind plants to be connected to the grid. Initiatives to unify overly bureaucratic permitting processes have been seen in the UK, Italy and Greece; though they have shown mixed results, these are key to shortening project execution time. Germany's reputation for efficiency in turning around applications in well under a year, and regional designations of wind development zones in markets such as Spain, have proven important ways of facilitating new projects.

IV.3 INDUSTRY ACTORS AND INVESTMENT TRENDS

Wind Turbine Manufacturing Trends

The global wind turbine market remains regionally segmented due to the wide variations in demand. With markets developing at different speeds and because there are different resource characteristics everywhere, market share for turbine supply has been characterised by national industrial champions, highly focused technology innovators and new start-ups licensing proven technology from other regions.

The industry is becoming ever more globalised. Europe's manufacturing pioneers have begun to penetrate North America and Asia. Wind turbine sales and supply chain strategies will take on a more international dimension as volumes increase.

As the region responsible for pioneering widespread, larger-scale uptake of wind power, Europe hosts the strongest competition for market share, with roughly a dozen suppliers. The European market has seen highly stable market share distribution with few major shifts since a round of consolidation among leading suppliers in 2003–2004. Between 2004 and 2007, three players held an average of over 15 per cent of the annual market share, followed by four players with a 5–10 per cent share each. During the same period, a handful of other players with a less than 5 per cent market share vied to establish themselves in the market for longer-term positioning. In Europe, manufacturers are primarily focusing on Class II machines of 2 MW and larger. There are several key players in this competitive region:

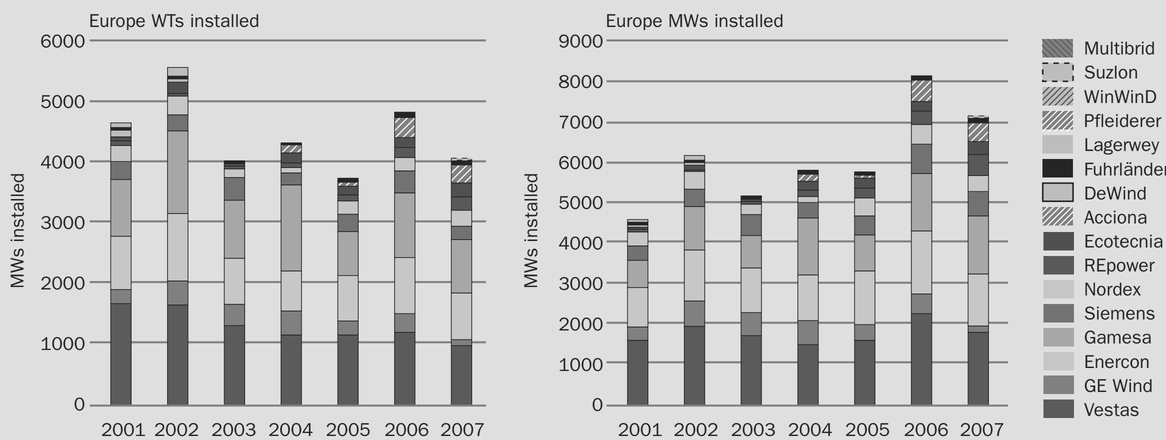
- Global leader **Vestas** averaged 30 per cent of annual MW added in Europe between 2001 and 2007 and is competing for offshore dominance with its 3 MW V90 turbine.
- **Enercon**, Vestas's chief European rival, has held steady at 20 per cent of MW supplied since 2001 with its bestselling 2 MW E-80 turbine.
- **Gamesa** has settled at 18–19 per cent of European MW added annually since 2005, based on steady sales of its 2 MW G80 turbine.
- **Siemens** has maintained 7–10 per cent of annual installations since acquiring Bonus in 2004, leveraging the success of the 2.3 MW turbine and 3.6 MW turbine offshore.
- **GE** has shifted much of its sales focus from Europe to its home US market with its 1.5 MW platform, and has seen its market share drop from 11 per cent in 2003 to 2 per cent in 2007, though it is seeking to regain its position with its 2.5 MW turbine.
- **Nordex** averaged 6 per cent of annual MW installed in Europe between 2001 and 2007, mainly due to steady sales in France and its home market Germany, followed by Portugal and other markets, where it mainly deploys its 2.3–2.5 MW N90 series.
- **Other suppliers** looking for market positioning include **Acciona Windpower**, **Alstom Ecotécnia** and **REpower**, with 5 per cent or less of the market.
- At the same time, **Pfleiderer** licensees **WinWinD** and **Multibrid** are continuing to scale up their pilot turbines, while **Fuhrländer** continued its lower volume deliveries in Germany.

PRODUCT PORTFOLIOS FIRMLY POSITIONED FOR MULTI-MEGAWATT SALES

Manufacturers are shifting their product strategies in order to address larger-scale project implementations, higher capacity turbines and lower wind speeds. Individual site characteristics will always determine which turbines enable buyers to hit their cost of energy targets; however, several trends can be seen in terms of the types of products suppliers are introducing to the market and what is in the development pipeline.

Manufacturers have taken significantly different approaches in terms of generator size and rotor size, based on the varying demands of their target markets. Most suppliers have at least one model available in three segments – 500 kW to 1 MW, 1 MW to 2 MW, and above 2 MW – with varying rotor sizes at 2 MW and above to meet Class II or I wind site conditions. However, some suppliers have created platforms using

Figure IV.3.1: European wind turbine market share, 2001–2007



Sources: Suppliers and emerging energy research

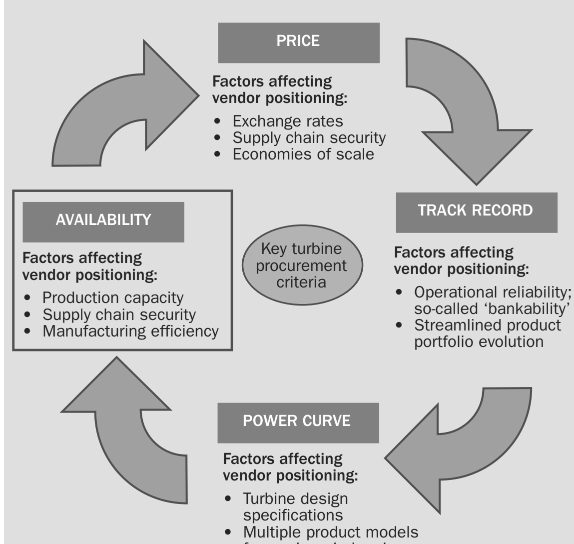
one generator size with varying rotors (Vestas, GE, Gamesa and Enercon), while others have kept a tighter focus on rotor and generator size, with fewer variations on existing models (Nordex, Suzlon and Mitsubishi).

MANUFACTURERS TAILOR SALES STRATEGIES TO KEY CUSTOMERS

Soaring demand for wind turbines has led to bursting order books and a global shortage of key components. Demand has also driven manufacturers to redefine and sharpen their sales strategies over the past two years. Customer profiles have rapidly increased from 20 MW to 50 MW orders in selected countries and 1000 MW agreements spanning multiple regions. In turn, turbine suppliers have had to alter their sales approaches to maximise profitability, while positioning themselves for long-term market share.

Prior to 2005, turbine buyers could generally base their procurement decisions purely on site characteristics and price; however, the recent turbine shortage has made availability a key element in choosing suppliers. Buyers must now carefully balance their development plans with turbine availability and increasing turbine cost in what is clearly a seller's market. This has led to multiple procurement strategies based on a developer's site portfolio, including multinational bulk orders, individual project contracts and a mix of

Figure IV.3.2: Interlinked factors determining turbine procurement



Source: Emerging energy research

both, with varying payment schedules based on the type of customer and of their position in the order book.

SUPPLY CHAIN KEY TO DELIVERY

Supply chain management is key to wind turbine supply. The relationships between manufacturers and their component suppliers have become increasingly crucial, and have come under increasing stress in the past three years as soaring demand has required faster ramp-up times, larger investments and greater agility to capture value in a rapidly growing sector. Supply chain issues have dictated delivery capabilities, product strategies and pricing for every turbine supplier. Manufacturers have sought to strike the most sustainable, competitive balance between a vertical integration of component supply and full component outsourcing to fit their turbine designs.

These procurement trends have given rise to unique market structures for each component segment, underlining the complexity of wind turbine design and manufacturing. Figure IV.3.3 illustrates the fact that the market for multiple segments, including blades, bearings and gearboxes, is highly concentrated and produces pinch points in the supply chain. These segments have high entry barriers based on size of investment and manufacturing ramp-up time. At the same time, controls, generators, castings and tower segments have lower entry barriers, with a larger number of players.

It is evident that with such uneven market structures across the supply chain, turbine manufacturers will see an opportunity to vertically integrate in order to reduce risk. In addition, this supply chain structure makes turbine shortages likely, as pinch points ripple through the market due to disparities in the availabilities of the different components. This means that in

Figure IV.3.3: Turbine component supply chain overview

Key pinch point	Rotor blade	Bearings	Gearbox	Controls	Generator	Castings	Towers
Market concentration	Highly concentrated. One independent supplier of 2000 MW or greater, half of OEMs supply internally	Highly concentrated, just three players supplying all segments, few multi-MW providers	Somewhat concentrated, three leading multi-MW players, 12 other competitors	Highly concentrated among independent suppliers, nearly half source in-house	Highly fragmented – dozens of sub 1-MW suppliers, at least a dozen supplying 1 MW and larger	Highly fragmented – several metal works firms involved, localised sourcing	Highly fragmented – several metal works firms involved, localised sourcing
Market leaders	• LM Glasfiber • Euros • NOI • Abeking & Rasmussen	• SKF • NTN • Timken • Kaydon	• Winergy • Hansen • Moventas	• Mita Teknik • KK Electronic • Ingeteam	• ABB • Winergy • Elin • GE	• Sakana • Felguera Melt • Siempelkamp • Metso Foundries	• Coiper • DMI • Trinity • TowerTech
Typical customer sourcing approach	In-house supply strategic models, outsource older models and non-core markets	Maximise quality-vetted supply partners to avoid shortages	Heavy reliance on 1–2 major players for larger models, open to new reliable suppliers	Single supplier sourcing, highly sensitive to turbine design	3–4 qualified external suppliers, usually 1–2 suppliers for larger turbines	Multiple suppliers selected by region	Multiple suppliers selected by region
	Highly concentrated, split in-house/ outsource	*Highly concentrated, outsource*	*Concentrated, outsource*	*Highly concentrated, split in-house/ outsource*	*Fragmented, outsource*	*Fragmented, outsource*	*Fragmented, outsource*

Entry barriers: High, Medium, Low

Note: Market leaders refers to regional markets; pinch points reported from turbine component buyers.

Source: Emerging energy research

today's seller's market, turbine assembly volume is dictated by the number of units that slip through the tightest pinch point. Generally, a proliferation in suppliers is anticipated throughout the supply chain, due to strong growth in the wind industry.

Value Chain Trends

Wind's spectacular growth as a vehicle for new generation capacity investment has attracted a broad range of players from across the industry value chain. From local, site-focused engineering firms to global, vertically integrated utilities, all have formed part of wind's European growth story. Since Europe's surge in 2005 to an annual market of over 6.5 GW of new capacity, the industry's value chain has become increasingly competitive, as a multitude of firms seek the most profitable balance between vertical integration and specialisation. The overall scaling up of the sector has meant that large-scale utilities have started to build sizeable project pipelines with long-term investment plans that indicate their commitment to adding wind to their generation portfolio, while at the same time a market remains for independent players able to contribute development skills, capital and asset management experience.

Europe's wind energy value chain is seeing dynamic shifts, as asset ownership is redistributed, growth is sought in maturing markets and players seek to maximise scale on an increasingly pan-European stage. While utilities build up GW-size portfolios, through their own strategy initiatives or government prompting, IPPs seek to compete for asset ownership in booming Western European markets, while development activity continues to shift towards new regions in the east. The proliferation of players looking to develop, own or operate wind farms has pushed competition to a new level, underlining the key elements of local market knowledge, technical expertise and financial capacity as crucial to positioning on the value chain.

UTILITIES MOVING INTO PROMINENT ROLE AS DRIVING FORCE FOR INDUSTRY SCALING UP

Most of Europe's utilities have now taken position on the wind energy value chain as they comply with national renewables targets, while some have also taken the initiative of seeking international expansion with this newer generation technology. To maximise profitability, utilities have steadily migrated from risk-averse turnkey project acquisition to greater vertical integration, with in-house teams for development and operations and maintenance (O&M). Strategies devised by these players for meeting their objectives have largely depended on their experience in the sector as well as on their desire to expand geographically.

Utilities adopting a 'green' strategy are among the few European wind players that combine in-house experience and sufficient balance sheet to ramp up capacity at the pan-European level, whilst risking project development in less mature markets to sustain growth in the portfolio. These utilities have generally originated from countries with more pro-active renewables policies, including Spain and Denmark.

Another set of utilities have taken a more gradual approach to adding wind into their generation portfolios. These players, from Portugal, Italy and Germany, have moved into neighbouring markets and looked to build wind alongside thermal plants; they have made major acquisitions to support growth while following green utility strategies of building up internal teams for more vertical integration.

A third set of utilities, mostly working with conventional energies, has remained more domestically focused. Whether due to lower resource conditions, or a lack of scale to pursue larger opportunities, these players tend to focus on complying with national targets.

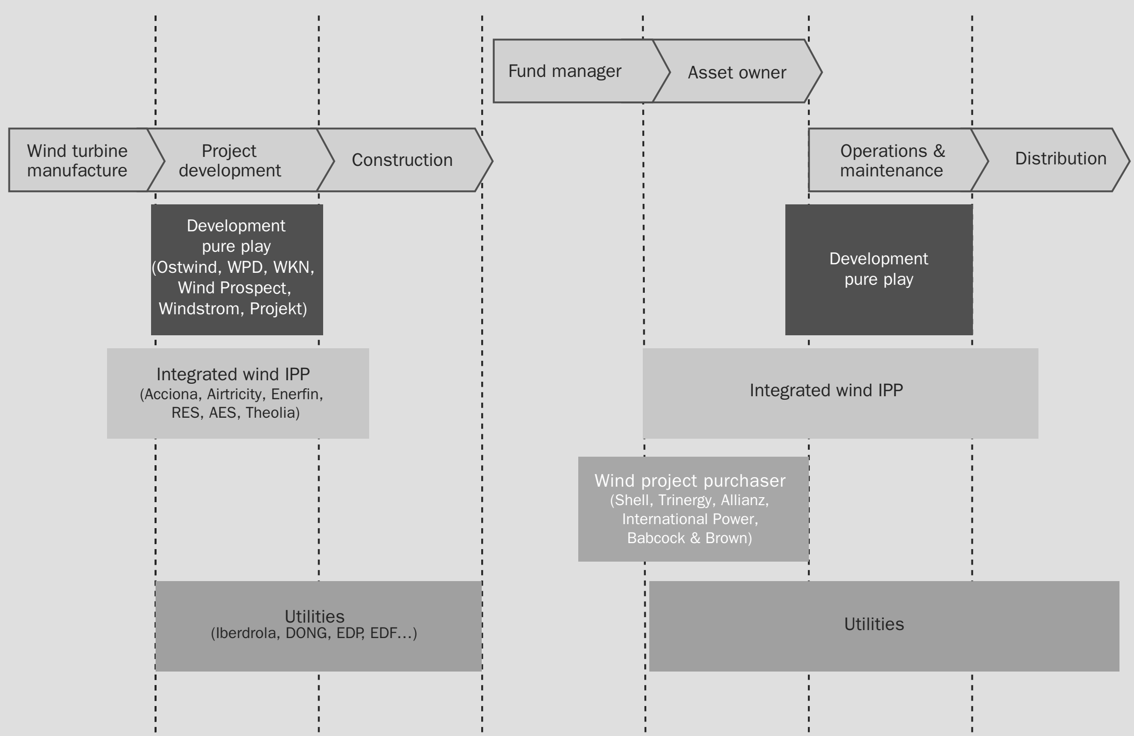
IPPs SEEK POSITIONS IN AN INCREASINGLY COMPETITIVE MARKET

Even before utilities began adopting wind energy, Europe's vertically integrated IPPs started aggressively exploiting wind turbine technology to improve their positioning. Led primarily by Spanish firms that were connected to large construction and industrial companies, the IPP model has evolved in various forms to represent a significant group of players in the value chain.

There are two main types of independent power producer in Europe: integrated ones, which have capabilities across the project development value chain and exploit these for maximum control and returns on their project portfolio, and wind project buyers, which tend not to play a direct role in the development of wind plants in their portfolio, as these firms are often financial investors, rather than energy players. The number of these players that are active has continuously increased over the past three years, as utilities have sought acquisitions among this field of asset and pipeline-holding competitors, though those that are already a significant size may be positioned for long-term growth.

In terms of development, integrated IPPs are continuing to expand internationally, through greenfield project development and acquisitions, in order to compete with utilities. Players with strongholds in Spain,

Figure IV.3.4: Europe wind value chain positioning overview



Source: Emerging energy research

France or Germany consistently look for growth in Eastern Europe, while some are also taking the plunge offshore. More risk-averse IPPs are seeing the number of quality projects available for acquisition in mature markets continue to dwindle.

As wind power owners, IPPs are facing stiffer competition from utilities as several project portfolios have been acquired in markets such as Spain, Germany, France and the UK. IPPs generally have higher capital costs than utilities, and those that can create assets organically through development on their own are generally better positioned to enlarge their portfolio.

As asset managers on the value chain, integrated wind IPPs and project purchasers are distinctly different, with integrated players increasingly focusing on O&M to maximise asset values. The boom in MW additions in the last three years means many turbines are coming out of their warranty periods, requiring IPPs to make key strategic decisions on how to manage their installations.

DEVELOPERS ADJUST STRATEGIES TO THE CHANGING ENVIRONMENT

European developers follow two distinct growth strategies: a develop-and-sell approach or a develop-and-own approach. With greenfield opportunities across consolidating and even scaling markets drying up, some pure play developers have transitioned into IPPs as a means of ensuring a steady revenue flow, often operating as pure plays in some markets and IPPs in others. However, a large number of traditional develop-and-sell players remain, and these are now focusing on capitalising on remaining opportunities in Europe's markets exhibiting wide levels of maturity

- While developers in high-growth markets such as the Balkans are focused on grabbing the best sites, in scaling markets like France, developers are looking to sell their projects. Greenfield project buyers tend to be wind operators with development capabilities, like IPPs and utilities, while new market and/or industry entrants, such as financial investors, tend to buy turnkey.
- In consolidating markets such as Germany and Denmark, existing developers are mostly focused on realising and selling off the projects in their pipelines, while moving to offshore or new markets to ensure a steady revenue flow.
- In three to four years, developers will most likely see new opportunities emerge onshore as markets launch repowering schemes, which require operating wind parks to re-enter the permitting process to increase site output.

Key Player Positioning

Europe's shifting distribution of wind power asset ownership clearly illustrates the industry's scaling up and geographic expansion. From an industry concentrated in Denmark and Germany with single, farmer-owned turbines at the end of the 1990s, wind power ownership now includes dozens of multinational players that own several GWs of installed capacity. The European market is made up of five main ownership types:

1. **Utilities**: This group is made up of over 20 utilities, including pan-European, regional and local players that hold incumbent positions in electricity distribution and generation, and often transmission.
2. **Top IPPs**: Members of this group own over 300 MW each, mainly including vertically integrated players primarily working in Spain, Germany, France, the UK and Italy.
3. **Other Spanish IPPs** are all independent power producers with a presence in Spain, except for the top 20 IPPs with a presence in this market. Spain's heavy weighting in the European wind market, at 25 per cent of total installed capacity, represents a major ownership block for these players.
4. **German investors**: This block is composed of IPPs as well as institutional and private investors that own significant shares of Germany's total installed

capacity of over 22 GW, or 40 per cent of the European market.

5. **Other European investors/IPPs**: This group includes private and institutional investors and IPPs with a wind presence in European countries other than Spain and Germany and which are not among Europe's largest wind power operators.

Over the past five years, the most salient trend has been the increased participation of utilities in the industry. Utilities' share of the total wind power installed increased from 17 per cent in 2002 to 25 per cent in 2007. The biggest jump took place between 2005 and 2006, when the region's top wind utilities saw annual additions of well over 500 MW.

With consolidation in Europe's mature and scaling markets, it is anticipated that utilities and IPPs will have a bigger role in the future. Utility growth will be largely driven by pan-regional players realising their near-term projects, which currently range from 1000 to 4000 MW.

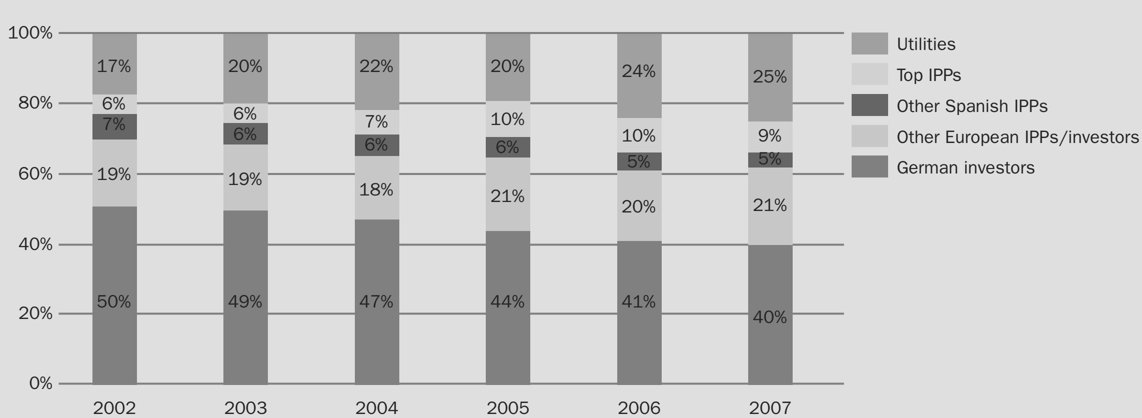
IPPs will also continue to increase their participation in wind, led by experienced vertically integrated players and larger investors able to develop internally or buy turnkey and leverage their strong financial capacity. At the same time, several of these firms may fall prey to expanding utilities, as seen in the past year, in which these firms' share fell to 9 per cent.

While German investors will continue to be the largest wind power ownership block in the next few years, their participation will diminish over time, as Germany's contribution to Europe's total wind power market decreases. On the other hand, Spanish IPPs are expected to decline in the near term despite the Spanish market's continued growth, as these smaller IPPs are either acquired by larger players or struggle to realise their modest pipelines amidst an increasingly competitive development environment.

Planned Future Investment

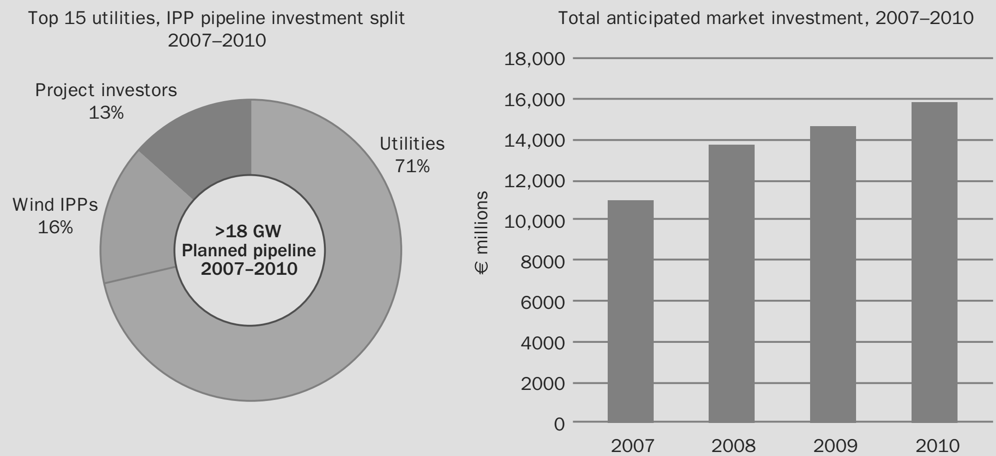
Capital-intensive construction of large wind capacity pipelines requires major investments by the utilities and IPPs planning to own assets. Sources of equity have taken a turn towards larger-scale, longer-term capital expenditure plans, with bond issues, IPOs and debt facilities proliferating among the top players. IPOs of utility renewable units have been consistently

Figure IV.3.5: European ownership shifts to utilities and IPPs



Source: Emerging energy research

Figure IV.3.6: European pipelines: investments surging past €10 billion annually



Note: *Pipeline includes bottom-up announced, approved projects 2007–2008, plus estimates for meeting strategic goals through 2009–2010.

Sources: Utilities, IPPs, emerging energy research

oversubscribed in equity markets, while the overall volume of funds earmarked for wind capacity is reaching new heights.

For the 2007 to 2010 time period, Europe's top 15 utilities and IPPs (in terms of MW owned) declared project pipelines totalling over 18 GW, which translates into well over €25 billion in wind plant investments based on current cost estimates per MW installed. Overall, the European wind market is expected to grow at a rate of over 8–9 GW of annual installations up to 2010, which translates into yearly investments of between €10 billion and €16 billion. There will be several key investment trends in this period:

- Utilities are expecting to move into pole position as the clear leaders in wind capacity construction through three to five year CAPEX investment plans. For some players, these plans are worth over €6 billion and include offshore projects and expansion into Eastern Europe, combined with consolidation of their domestic market positions.
- The financial capacity of vertically integrated IPPs will be tested as they go head to head with utilities. These players will reach deeper into the pockets of their parent companies to carry on accumulating assets in their target markets.
- Project buyers, or non-integrated IPPs, are likely to pick off individual turnkey opportunities with smaller investments plans of under €1 billion.

Industry Scales by Project and Turbine Size

The average size of wind projects is steadily increasing as wind becomes more integrated into the generation portfolios of leading utilities and IPPs that are looking to realise economies of scale. At the same time, project installation sizes are highly sensitive to local market and site restrictions, leading to wide discrepancies in average project sizes in the various European markets. There are several key trends for the different project segments:

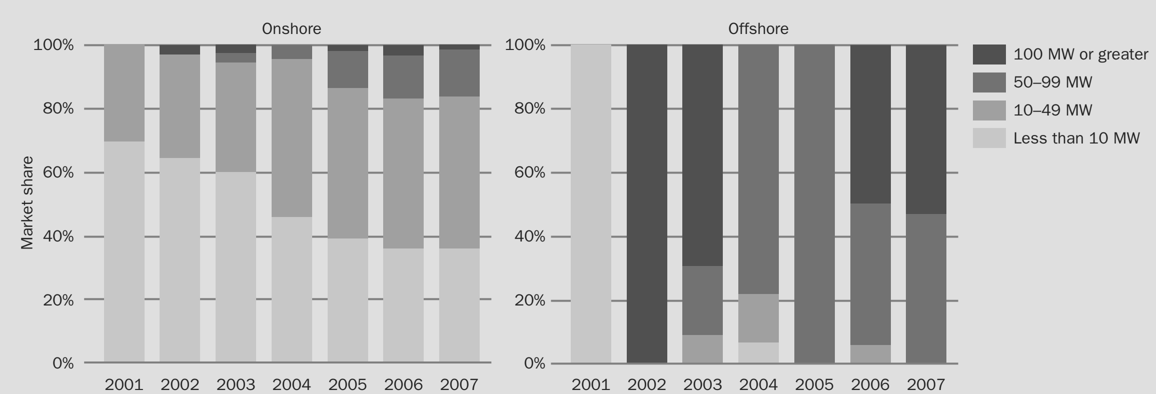
- Projects of under 20 MW were the mainstay of European wind development, particularly in Germany, until 2004, when larger-scale markets like Spain, Portugal and the UK began growing in volume. These projects now represent less than 40 per cent of annual added capacity; however, this size of project remains important in tapping remaining market potential.

- Europe is seeing increasing saturation onshore in terms of mid-sized projects in the 20–50 MW range. While projects this size will maintain Europe's share of the global market, several coastal markets, led by the UK and Germany, are moving offshore for 100 MW and larger projects. Europe's steady growth onshore with average project sizes of 20–30 MW is likely to continue in the near term.
- At the same time, 50–99 MW projects have gradually increased their market share, reaching nearly 20 per cent of the market by 2007. Projects of this size often obtain the necessary permits more quickly from national governments.
- Based on installations in 2007, offshore projects look to be evolving towards the 60–200 MW range. 50–99 MW projects represent an intermediate phase of market development between pilot and large-scale developments, as observed in the UK, and will serve as a means for initiating larger installations in several markets.

As the global pioneer in wind turbine technology, Europe has seen a rapid increase in average turbine size, reaching multi-megawatt capacities. European markets have served as a base in establishing a track record for larger turbine deployment. However, suppliers look to continue maximising investments in workhorse product platforms of under 2 MW where possible. Key trends include:

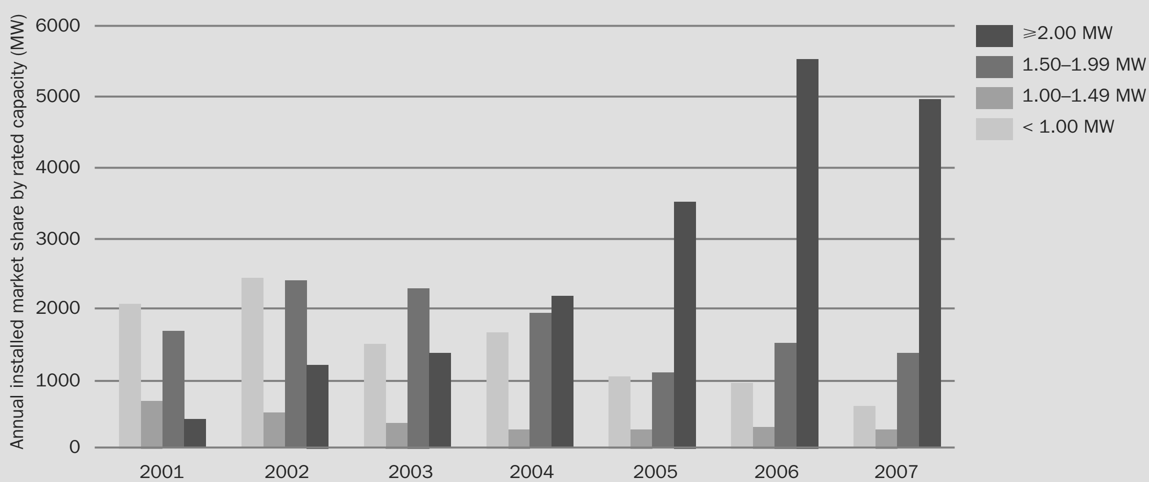
- **Turbines of under 1 MW** are the most proven models of the majority of turbine suppliers, and installations peaked in 2004 with major deliveries in southern Europe. Since then, the introduction of more advanced systems with larger rotors has moved the industry towards higher-capacity machines. However, bigger is not always better, as O&M track records and performance are generally better understood with machines in the lower capacity segment.
- **1 to 1.49 MW** turbines carved out a niche in Europe with a few suppliers, for 3 per cent of annual

Figure IV.3.7: Europe onshore/offshore project size overview



Source: Emerging energy research

Figure IV.3.8: Europe MW installed by turbine size, 2001–2007



Source: Emerging energy research

European MW installations. However, the industry's trend towards multi-megawatt machines has reduced demand, as greater output at the same sites can be captured with 1.5 MW and larger models. The segment has now dropped to under 500 MW of annual installations, as suppliers seek to push their larger platforms.

- **1.50 to 1.99 MW** turbine installations peaked in 2002 and have generally levelled off at around 1500 MW of capacity installed in the past three years. This segment saw a major drop in demand, from over 30 per cent to less than 20 per cent of installations, between 2004 and 2005, as leading suppliers and new entrants have pushed 2 MW and larger models into serial production.
- **2 MW and larger** turbines have become virtually standard in Europe since 2005, when this size machine jumped to over half of total installations in terms of megawatts. This surge continued in 2006, as the amount of MW installed in turbines this size pushed well past 5 GW. While 2007 saw the segment hit more severely by component shortages, Europe continues to rely on these larger turbines for the bulk of its installations.

IV.4 GLOBAL WIND ENERGY MARKETS

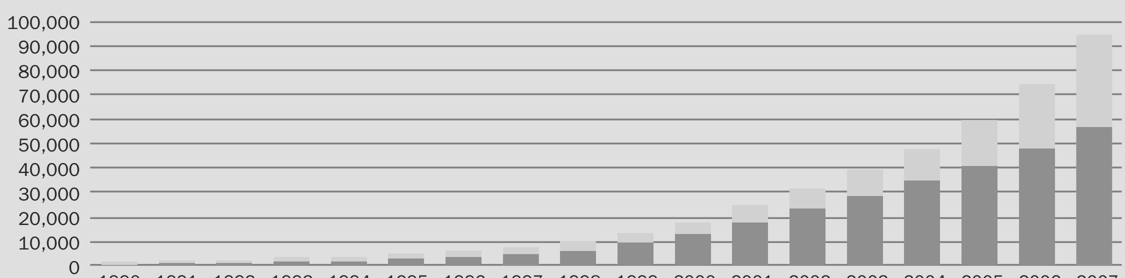
The Status of the Global Wind Energy Markets

In 2007, its best year yet, the wind industry installed close to 20,000 MW worldwide. This development was led by the US, China and Spain, and it brought global installed capacity to 93,864 MW. This is an increase of 31 per cent compared with the 2006 market, and represents an overall increase in global installed capacity of about 27 per cent.

The top five countries in terms of installed capacity are Germany (22.3 GW), the US (16.8 GW), Spain (15.1 GW), India (7.8 GW) and China (5.9 GW). In terms of economic value, the global wind market in 2007 was worth about €25 billion (US$37 billion) in new generating equipment, and attracted €34 billion (US$50.2 billion) in total investment.

Europe remains the leading market for wind energy, and new installations there represented 43 per cent of the global total in 2007.

Figure IV.4.1: Global cumulative installed capacity, 1990–2007



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Rest of the world	1304	1354	1477	1590	1848	2324	2628	2883	3700	3916	4470	7133	8150	10,940	13,248	18,591	23,102	37,587
EU	438	629	844	1211	1683	2497	3476	4753	6453	9578	12,887	17,311	18,098	28,491	34,372	40,500	48,031	56,535

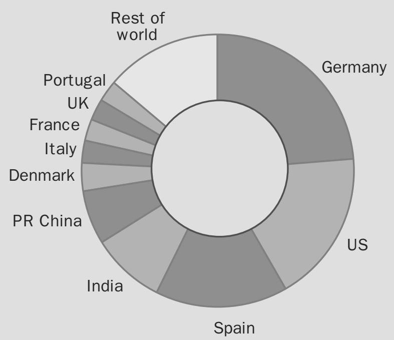
Source: GWEC/EWEA

Figure IV.4.2: Global annual installed capacity, 1991–2007

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Rest of the world	50	123	113	258	476	304	255	817	216	554	2663	1357	2671	2369	5327	7715	11,519
EU	190	215	367	472	814	979	1277	1700	3225	3209	4428	5913	5462	5838	6204	7592	8554

Source: GWEC/EWEA

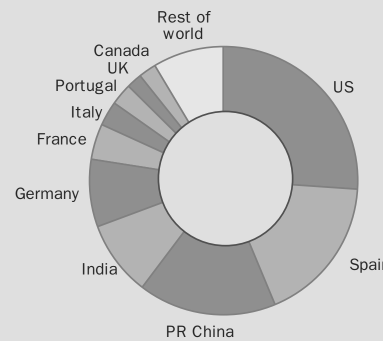
Figure IV.4.3: Top ten installed capacity (end 2007)



	MW	%
Germany	22,247	23.7
US	16,818	17.9
Spain	15,145	16.1
India	7845	8.4
PR China	5906	6.3
Denmark	3125	3.3
Italy	2726	2.9
France	2454	2.6
UK	2389	2.5
Portugal	2150	2.3
Rest of world	13,060	13.9
Total top ten	**80,805**	**86.1**
Total	**93,864**	**100.0**

Source: GWEC

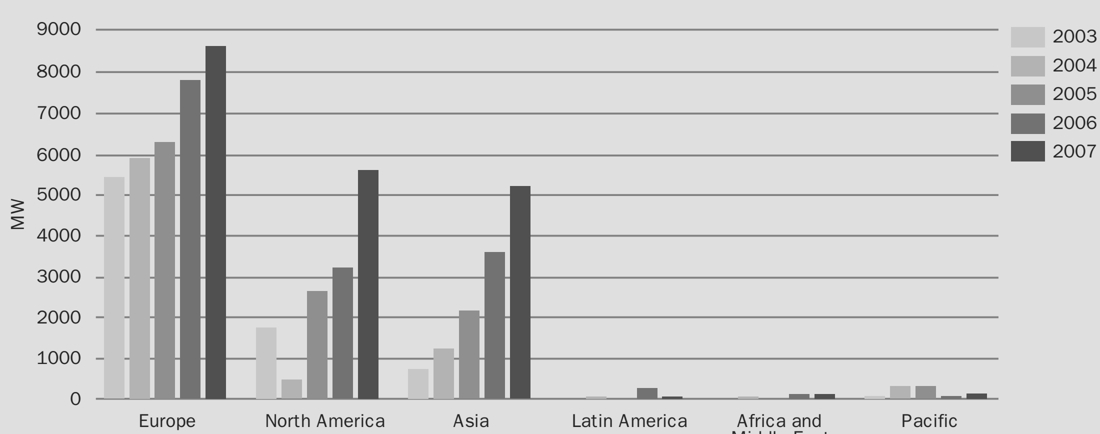
Figure IV.4.4: Top ten new capacity (end 2007)



	MW	%
US	5244	26.4
Spain	3522	17.7
PR China	3304	16.6
India	1575	7.9
Germany	1667	8.4
France	888	4.5
Italy	603	3.0
Portugal	434	2.2
UK	427	2.1
Canada	386	1.9
Rest of world	1815	9.1
Total top ten	**18,050**	**90.9**
Total	**19,865**	**100.0**

Source: GWEC

Figure IV.4.5: Annual installed capacity by region, 2003–2007



Source: GWEC

Global Markets Outside of Europe in 2007

NORTH AMERICA

The US

The US reported a record 5244 MW installed in 2007, more than double the 2006 figure, accounting for about 30 per cent of the country's new power-producing capacity. Overall, US wind power generating capacity grew by 45 per cent in 2007, with total installed capacity now standing at 16.8 GW.

Wind farms installed in the US by the end of 2007 will generate an estimated 48,000 GWh in 2008, just over 1 per cent of the country's electricity supply. The current US electricity mix consists of about 50 per cent coal, 20 per cent nuclear, 20 per cent natural gas, 6 per cent hydropower, with the rest generated from oil and non-hydro renewables, according to the US Energy Information Administration.

Most interesting, perhaps, is how quickly wind's share of current investment is growing: new wind projects account for about 30 per cent of the entire new power-producing capacity added in the US in 2007, establishing wind power as a mainstream option for new electricity generation.

In 2007, wind power production was extended to 34 US states, with Texas consolidating its lead and the Midwest and Northwest also setting a fast pace. The states with the most cumulative wind power capacity installed are Texas (4356 MW), California (2439 MW), Minnesota (1299 MW), Iowa (1273 MW) and Washington (1163 MW) (see Table IV.4.1).

Historically, the political framework conditions for wind power in the US have been very unstable. This sustained growth in wind power is the direct result of availability of the federal Production Tax Credit (PTC) over the past three years. The PTC is the only existing federal incentive in the US for wind power. It provides a 1.9 cent-per-kWh tax credit for electricity generated with wind turbines over the first ten years of a project's operations, and is a critical factor in financing new wind farms. In order to qualify, a wind farm must be completed and start generating power while the credit is in place. The energy sector is one of the most heavily subsidised in the US economy, and this incentive is needed to help level the playing field for wind and other renewable energy sources.

The PTC was set to expire in October 2008 but was extended for one more year, until the end of 2009. The tax credit is set at $2.1/kW at present value (January 2009). Previously when the credit was not extended, well before its expiry date installation growth rates fell

Table IV.4.1: Top ten states by megawatts of wind power generating capacity, as of 31 December 2007

State	Existing (MW)	Under construction (MW)	Share of total installations (existing) (%)	Rank (existing)
Texas	4356.35	1238.28	25.9	1
California	2438.83	45	14.5	2
Minnesota	1299.75	46.4	7.7	3
Iowa	1273.08	116.7	7.6	4
Washington	1163.18	126.2	6.9	5
Colorado	1066.75	0	6.3	6
Oregon	885.39	15	5.3	7
Illinois	699.36	108.3	4.2	8
Oklahoma	689	0	4.1	9
New Mexico	495.98	0	2.9	10

Source: AWEA

by 93 per cent (2000), 73 per cent (2002) and 77 per cent (2004).

The American Wind Energy Association's initial estimates indicate that another 5 GW of new wind capacity will be installed in 2008. However, the pace of growth in 2008 and beyond will largely depend not on turbine availability, but on the timing and duration of the potential extension of the PTC.

Canada

Canada's wind energy market experienced its second best year ever in 2007. A total of 386 MW of new wind energy capacity was installed in 2007, increasing Canada's total by 26 per cent. In 2007, Canada had 1856 MW of installed wind energy capacity.

Ten wind energy projects were commissioned in 2007 in five different Canadian provinces:

- Alberta led all provinces in 2007, installing three new projects totalling 139 MW. Alberta is now Canada's leading province for wind energy, with 524 MW.
- The largest wind energy project commissioned in Canada in 2007 was the 100.5 MW Anse-a-Valleau project in Quebec, the second project to be commissioned from Hydro-Quebec's earlier 1000 MW request for proposals.
- Two new projects, totalling 77.6 MW, were commissioned in Ontario. These two projects brought Ontario's total installed capacity to 491 MW.
- Three smaller projects, totalling 59 MW, were installed in Canada's smallest province, Prince Edward Island (P.E.I.). The installation of these facilities means that P.E.I. has now met its target to produce wind energy equivalent to 15 per cent of its total electricity demand three years ahead of schedule.
- One new 10 MW project was commissioned in Nova Scotia.

Turbines for these projects were provided by three manufacturers: Enercon (169 MW), Vestas (116.4 MW) and GE (100.5 MW).

Canada began 2008 with contracts signed ready for the installation of an additional 2800 MW of wind energy, most of which is to be installed by no later than 2010.

In addition, several new calls for tender for wind energy projects were launched in 2007 in Manitoba, Quebec, New Brunswick and Nova Scotia, and contracts have now been signed for 4700 MW of projects to be constructed in the period 2009–2016.

In addition, three tendering processes were issued in Quebec, Ontario and British Columbia in 2008, and contracts will be awarded in late 2008 or early 2009.

The Canadian Wind Energy Association forecasts that Canada will have 2600 MW of installed capacity by the end of 2008, an increase of around 800 MW on the previous year. Provincial government targets and objectives in Canada, if met, will give a minimum of 12,000 MW of installed wind energy in Canada by 2016.

ASIA

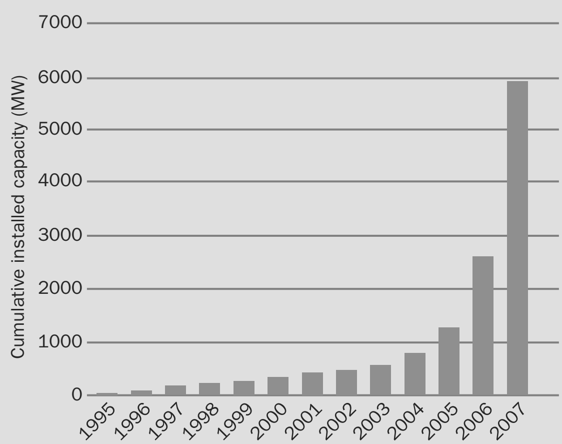
China

China added 3304 MW of wind energy capacity during 2007, representing market growth of 145 per cent over 2006, and now ranks fifth in total installed wind energy capacity worldwide, with 5906 MW at the end of 2007. However, experts estimate that this is just the beginning, and that the real growth in China is yet to come. Based on current growth rates, the Global Wind Energy Council (GWEC) forecasts a capacity of around 200 GW by 2020. The official government target of 30 GW by 2020 is likely to be met as early as 2012 or 2013.

The regions with the best wind regimes are located mainly along the southeast coast and in Inner Mongolia, Xinjiang, Gansu Province's Hexi Corridor, and some parts of Northeast China, Northwest China, Northern China and the Qinghai-Tibetan Plateau.

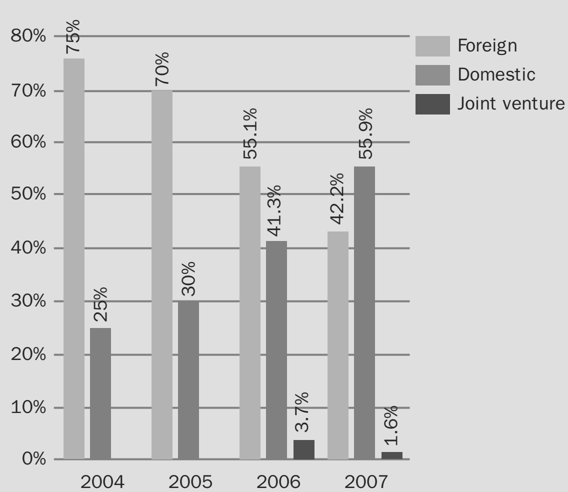
Satisfying rocketing electricity demand and reducing air pollution are the main driving forces behind the

Figure IV.4.6: Growth of the Chinese market, 1995–2007



Source: GWEC and Greenpeace (2008)

Figure IV.4.7: Foreign and domestic players in the Chinese market (annual installed capacity)



Source: Junfeng and Hu (2007)

development of wind energy in China. However, given the country's substantial coal resources and the still relatively low cost of coal-fired generation, reducing the cost of wind power is a crucial issue; this is being addressed through the development of large-scale projects and boosting local manufacturing of wind turbines.

The Chinese Government estimates that the localisation of wind turbine manufacturing brings benefits to the local economy and helps keep costs down. Moreover, since most good wind sites are located in remote and poorer rural areas, wind farm construction benefits the local economy through the annual income tax paid to county governments, which represents a significant proportion of their budget. Other benefits include grid extension for rural electrification, and employment in wind farm construction and maintenance.

The wind manufacturing industry in China is booming. While in the past, imported wind turbines dominated the Chinese market, this is changing rapidly as the growing wind power market and the clear policy direction have encouraged domestic production, and most European manufacturers now produce in China.

The total manufacturing capacity is now about 5000 MW and is expected to reach 10–12 GW by 2010.

India

Wind energy is continuing to grow strongly in India, with over 1500 MW of new installed capacity in 2007, hitting 7845 MW in total. This represents year-on-year growth of 25 per cent.

The development of Indian wind power has so far been concentrated in a few regions, especially the southern state of Tamil Nadu, which accounts for more than half of all installations. This is beginning to change, with other states, including Maharashtra, Gujarat, Rajasthan and Karnataka, West Bengal, Madhya Pradesh and Andhra Pradesh starting to catch up. As a result, wind farms can be seen under construction right across the country, from the coastal plains to the hilly hinterland and sandy deserts.

The Indian Government envisages annual capacity addition of up to 2000 MW in the coming years. Official government estimations set the total wind energy potential in India at around 45 GW.

While there is no countrywide support for renewable energies, the Indian Ministry of New and Renewable Energy (MNRE) has issued guidelines to all state governments to create an attractive environment for the export, purchase and banking of electricity generated by wind power projects. State Electricity Regulatory Commissions (SERCs) were set up in most of the states in the country, with the mandate of promoting renewables, including wind energy, through preferential tariffs and a minimum obligation on distribution companies to source a certain share of electricity from renewable energy. Ten out of India's 29 states have set up renewable purchase obligations, requiring utilities to source up to 10 per cent of their power from renewable sources.

There are also a number of fiscal incentives for the wind energy sector established at national level, including:

- direct taxes – 80 per cent depreciation in the first year of installation of a project;
- a ten-year tax holiday;
- no income tax to be paid on power sales to utilities; and
- foreign direct investments are cleared very fast.

The Indian Government is considering accelerating depreciation and replacing the ten-year tax holiday with tradable tax credits or other instruments. While this would be an issue for established companies, new investors are less reliant on the tax holiday, since they often have little or no tax liability.

India has a solid domestic manufacturing base, including global player Suzlon, which accounts for over half of the market, and Vestas RRB. In addition, other international companies have set up production facilities in India, including Enercon, Vestas, REpower, Siemens and LM Glasfiber.

LATIN AMERICA

Brazil

Between 1999 and 2005, wind energy capacity in Brazil increased only by very small amounts, but in 2006, 208 MW were installed in one year, bringing the total to 237 MW. In 2007, only one wind farm came online: Eólica Millennium, a 10.2 MW project acquired by Pacific Hydro from local company Bioenergy. This brought the total to 247 MW.

The main obstacles to Brazilian wind power are significant import duties and taxes, which make projects less profitable unless complete local production and sourcing are established. Also, the country has prioritised the development of its biomass potential in the past few years. Wind power, however, is expected to grow substantially in the near future.

In 2002, the Brazilian Government passed a programme called the Programme of Incentives for Alternative Electricity Sources (PROINFA) to stimulate the development of biomass, wind and small hydro power generation. This law was revised in November 2003.

In the first stage (up to 2008, although the deadline has been extended until the end of 2008, and will possibly be extended into 2009), the programme guaranteed power sale contracts of projects with a total capacity of 3300 MW using these technologies, originally divided into three equal parts of 1100 MW per technology. Wind's share was later increased to 1400 MW. The Brazilian state-controlled electricity utility, Eletrobrás, will buy power produced by RES under power purchase agreements (PPAs) of 20 years at predetermined preferential prices.

Originally, a second stage of PROINFA was planned for when the 3300 MW objective had been met, with the aim of increasing the share of the three renewable sources to 10 per cent of annual electricity consumption within 20 years. Renewable energy generators would then have been required to issue a number of renewable energy certificates in proportion to the amount of clean energy produced.

However, despite the high expectations raised by the PROINFA programme, the scheme has to date failed to deliver the great number of wind projects the government had aimed for. As a result, the current government is showing little interest in taking PROINFA to its second stage, and is considering replacing it with an auction system. The Brazilian Wind Power Association (ABEEolica) is lobbying to proceed with PROINFA II while at the same time introducing an auction process.

The outlook for 2008 is quite optimistic: there are 14 wind energy plants financed by the PROINFA programme under construction, amounting to 107.3 MW of installed capacity. In addition, experts estimate that another 27 wind farms, representing 901.29 MW, could be added to the grid in 2009, provided that PROINFA is extended until the first semester of 2009.

Mexico

Despite the country's tremendous potential, the uptake of wind energy in Mexico has been slow, mainly due to the lack of government incentives for the use of renewable energy and the lack of a clear regulatory framework that would allow for private-sector participation in the development of wind facilities. At present, Mexico has a total installed capacity of 85 MW.

In 1984, the Confederation for Electricity (CFE – Comisión Federal de Electricidad) built the demonstration project La Venta I, with seven wind turbines and a total capacity of 1.6 MW, located south of the Isthmus of Tehuantepec, 30 km Northeast of Juchitán in the state of Oaxaca.

Another individual 600 kW plant was put into operation by CFE at the end of 1998, near Guerrero Negro in the federal state of Baja California Sur, operating in an isolated urban grid.

In October 2006, a bid for an 83.3 MW wind facility, La Venta II, and a demonstration project was granted to the Spanish consortium Iberdrola-Gamesa, for 98 turbines of 850 kW each. The Global Environment Facility (GEF) launched a programme to subsidise the cost per kWh of electricity produced at La Venta II in order to allow CFE to comply with its legal obligation to purchase power at the lowest cost. This programme is being implemented by the World Bank.

In terms of private-sector involvement, a number of companies have participated in wind energy development in Mexico, including major players such as Cisa-Gamesa, Demex, EDF-EN, Eoliatec, Fuerza Eólica, Iberdrola, Preneal and Unión Fenosa. The combined development portfolio in private wind energy facilities could reach 2600 MW in Oaxaca and 1000 MW in Baja California for the period from 2008 to 2010.

The monopoly of the state suppliers is the main obstacle to a more widespread use of renewable energy in Mexico. In addition, larger projects have failed to materialise due to the lack of favourable building and planning legislation, as well as the lack of experienced developers and officials. Moreover, strong pressure to provide electricity at very low prices has failed to make wind energy installations economically viable.

THE MIDDLE EAST AND AFRICA

Egypt

Egypt enjoys an excellent wind regime, particularly in the Suez Gulf, where average wind speeds reach over 10 m/s.

The Egyptian wind energy market increased from just 5 MW in 2001 to 310 MW at the end of 2007, with 80 MW of new capacity being added in 2007 to the Zafarana wind farm. Over 3000 MW are earmarked for wind power developments in the near future on the Gulf of Suez coast.

In April 2007, Egypt's Supreme Council of Energy announced an ambitious plan to generate 20 per cent of the country's electricity from renewable sources by 2020, including a 12 per cent contribution from wind energy, translating into 7200 MW of grid-connected wind farms. This plan will provide investor security and stimulate private investment in wind energy.

Moreover, a new draft energy act has recently been submitted to the Egyptian Parliament to encourage renewable energy deployment and private-sector involvement. In addition to guaranteeing third party access, power generation from renewable energy would enjoy priority grid access under this law.

With the Zafarana project, Egypt has moved on from limited experimental projects to large-scale grid-connected wind farms. Overall, 305 MW has been installed in different stages: 63 MW in 2001, 77 MW in 2003/2004, 85 MW in July 2006 and 80 MW in December 2007. The electricity production from the Zafarana farm is over 1000 GWh per year at an average capacity factor of 40.6 per cent. A further 240 MW extension of the wind farm is currently being put into place.

In addition to this, an area of 656 km^2 has been earmarked to host a 3000 MW wind farm at Gulf of El-Zayt on the Gulf of Suez coast. Studies are being conducted to assess the site potential to host large-scale grid-connected wind farms of 200 MW capacity (in cooperation with Germany), 220 MW (in cooperation with Japan) and 400 MW (a private-sector project).

Morocco

In April 2007, Morocco's new Amogdoul wind farm, situated on Cap Sim, 15 km south of Essaouira, started operations, thereby bringing the country's total installed capacity up to 124 MW. Other wind farms in Morocco include a 50 MW project in El Koudia El Baida (Tlat Taghramt, Province of Tetouan) installed in 2000, followed by a 3.5 MW project at the same site in 2001.

The annual electricity production from wind energy now stands at 450 GWh, accounting for around 2 per cent of Morocco's power consumption.

The Moroccan National Programme for Development of Renewable Energies and Energy Efficiency (PNDEREE) is to raise the contribution of renewable energies to 20 per cent of national electricity consumption and 10 per cent of primary energy by 2012 (the figures are currently 7.9 per cent and 3.4 per cent respectively, including large hydropower installations).

With 3000 km of coastline and high average wind speeds (7.5–9.5 m/s in the south and 9.5–11 m/s in the north), wind power is one of the most promising sectors for renewable energy generation in Morocco. Taking into account this vast potential, the Moroccan Government decided to raise the wind energy capacity from the current 124 MW to 1000 MW by 2012. Between 2008 and 2010, the Moroccan Government is planning to add 600 MW of installed wind energy capacity near the towns of Tetouan, Tarfaya and Taza.

THE PACIFIC REGION

Australia

With some of the world's best wind resources, Australia is a prime market for wind energy. The growing industry can take advantage of a stable, growing economy, good access to grid infrastructure, and well-organised financial and legal services.

While Australia had an exceptionally weak year in 2007, with only 7 MW of new installations, the change in government at the end of the year encourages hope for a brighter future for wind energy. Within hours of being sworn in to office, the new Labour Prime Minister, Kevin Rudd, signed the ratification of the Kyoto Protocol, thereby dramatically changing Australia's commitment to reducing greenhouse gas emissions. This is likely to have positive long-term impacts for wind energy development in the country.

The total operating wind capacity at the end of 2007 was 824 MW. While there were only three new project commitments during 2007 – amounting to €440 million of investment – the 2008 outlook is rosier as a result of the growing political and public support. Significant amounts of wind capacity are moving through the project planning stages, with over 400 MW of projects receiving planning approval during 2007.

Nine projects (over 860 MW in total) were commissioned, although not yet operational, by December 2007, including three new projects totalling 290 MW of capacity.

The new government expanded Australia's national target of 2 per cent of electricity from renewable energy by 2020 to 20 per cent. To meet this target, around 10,000 MW of new renewable energy projects will be built over the next decade. The wind industry is poised to play a major role in meeting this demand.

New Zealand

New Zealand's wind energy industry is small, but it is growing steadily. Wind energy capacity almost doubled in 2007, increasing from 170.8 MW to 321.8 MW. New Zealand's exceptional wind resource means there is a high capacity factor by international standards. In 2006 the average capacity factor for New Zealand's wind farms was 41 per cent. The estimate for 2007 is 45 per cent, with turbines in some wind farms achieving up to 70 per cent capacity in the windier months.

New Zealand's wind industry does not receive direct financial support or subsidies from the government. Nonetheless, the development of a new wind farm near Wellington, West Wind, and ongoing investigations at other sites shows that with the right conditions, wind energy is competitive with other forms of electricity generation.

In 2007 the government announced its target for New Zealand to generate 90 per cent of its electricity from renewable sources by 2025. New Zealand currently generates about 65 per cent of its electricity from renewable sources, primarily from hydro. To reach 90 per cent, renewable energy capacity needs to grow by about 200 MW each year.

Wind provides about 1.5 per cent of New Zealand's current electricity needs. With limited opportunities for the expansion of hydro and geothermal generation, the renewable energy target gives added impetus to New Zealand's wind industry. Wind energy's contribution is set to grow over the coming years, and developers are currently seeking consent to build projects with a combined capacity of more than 1800 MW.

IV.5 ADMINISTRATIVE AND GRID ACCESS BARRIERS: AN ANALYSIS OF EXISTING EU STUDIES IN THE FIELD

Barriers and EU Action

There are many barriers preventing electricity from renewable energy sources being integrated into the European electricity market. This chapter is written from a developer's point of view, and describes these barriers, taking four EU Member States as case studies. Barriers are related to issues such as obtaining building permits, spatial planning licences and grid access. There are often unclear, or unnecessarily complex, administrative and financial procedures.

Such problems are to be found in every Member State, but their impact on the deployment of renewable energy differs depending on the country. There are also grid connection obstacles, which can discourage investment in wind energy, as well as preventing it from achieving competitiveness with other power-generating technologies.

The European Commission has recognised the importance of the issue, and addresses administrative barriers in Article 6 of Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. It has also raised the issue more recently in its proposed Directive 2008/0016 (COD): energy and climate change: promotion of the use of energy from renewable sources (RES-E), and in its Communications 2004/366 and 2005/627.

In order to develop effective policy and regulatory improvements, EU studies in the form of research and innovation activities address and evaluate these obstacles. Under the Framework Programmes for Research and Technological Development (FP7), 60 projects have been carried out so far. The Intelligent Energy-Europe (IEE) programme accounts for 13 projects in which EU officials work together with experts from the renewable energy industry. The following brief account of barriers is based on two comprehensive studies conducted by the Intelligent Energy-Europe programme: a) the Assessment and Optimisation of Renewable Support Schemes in the European Electricity Market – OPTRES[3] (2005–2006), is an analysis of the main barriers for the development of RES-E in the EU-25 and b) the Promotion and Growth of Renewable Energy Sources and Systems – PROGRESS[4] (2006–2008) focuses on authorisation and grid barriers.

ADMINISTRATIVE BARRIERS

Before building a wind power plant, the project developer needs to obtain permits from the local authorities and has to carry out an impact assessment of his project. This process is riddled with obstacles:

- there are a large number of authorities involved;
- a bad or total lack of coordination between authorities can result in project delays;
- lengthy waiting periods to obtain permits can result in rejection of the project;
- renewable energy sources are insufficiently taken into account in spatial planning;
- there are highly complex and non-transparent procedures for the whole licensing chain; and
- there is a low awareness of benefits of renewable energy sources within local and regional authorities.

GRID-RELATED BARRIERS

One of the most important elements for the success of wind energy projects is access and connection to the grids. Based on stakeholder consultation, OPTRES[5] and PROGRESS[6] identified several obstacles and other grid-related problems faced by project developers in the EU (see Part II on grid integration for more details):

- insufficient grid capacity available;
- grid connection procedure not fully transparent;
- objectiveness in the evaluation of applications not fully guaranteed;

- excessive grid connection costs in some cases;
- long lead times for grid connection authorisation; and
- grid extension problems

SOCIAL AND FINANCIAL BARRIERS

The OPTRES stakeholder consultation showed that social barriers fall into three categories:

1. opposition from local public (NIMBY);
2. lack of awareness of the benefits of renewable energy; and
3. invisibility of the full costs of electricity from non-renewable energy sources.

Financial barriers can be caused by the existing national frameworks and vary depending on the Member State's electricity system. The RESPOND (Renewable Electricity Supply interactions with conventional Power generations, Networks and Demand) project (2006–2009) claims that the growing amount of RES-E affects the electricity system and can only be efficiently integrated if it leads to economically efficient, market-based responses from different stakeholders. In practice, however, current electricity market regulation does not always give sufficient incentives to market participants for an optimal support of integration of RES-E.

The financial barriers that were identified during the OPTRES stakeholder consultation can be divided into two main categories:

1. lack of certainty among banks or investors; and
2. capital subsidies and cash flows that are hard to predict

Case Studies

POLAND

Poland is a relatively new market for wind energy. The installed capacity in 2005 was 73 MW; it reached 152 MW in 2006 and 276 MW in 2007.

The Polish Wind Energy Association (PWEA) identifies the main administrative barriers as:

- There is a lack of transparency in the decision-making process for authorising grid connection.
- Requirements for the environmental impact assessment, spatial planning permission and grid-connection processes are badly defined and vary throughout the country.
- The Natura 2000 certification process slows down the realisation of wind farm projects. Candidate areas for Natura 2000 status are added permanently to a list which is subject to unexpected changes. In these areas, development is generally not allowed and can thus lead to the failure of a project.

One of the main administrative barriers that developers are confronted with is the fact that neither the timeframe nor the costs involved in the building permit application process can be accurately estimated. This is due to the fact that the application process is structured heterogeneously and varies from project to project. The number of authorities involved in the building permit application at community and local level does not depend only on the capacity of the individual project but also on the possible impact it may have on the environment and whether it endangers any species protected within the Natura 2000 network. According to the PWEA, developers are not given specific guidelines for environmental impact assessments and are often required to submit additional, time-consuming information at a later stage, which often results in the general application procedure being delayed. In the worst-case scenario, this time delay and the opposition from environmental organisations or local residents can lead to the failure of a project. Depending on whether the project is perceived as having a large, small or non-existent impact, the developer contacts the local and/or community authority. The bigger the anticipated impact, the higher the number of authorities and organisations for nature conservation involved in the environmental study. In the case of a low expected impact, the developer may or may not be required to provide additional input.

Moreover, the procedures to be followed to obtain all the necessary permits in Poland are felt by stakeholders to be highly unclear and ill-adapted to the requirements of wind turbines. The investor is obliged to contact the bodies responsible for grid connection, spatial planning and environmental concerns individually, which may lead to confusion and delays as these bodies do not cooperate effectively with each other. Nevertheless, the lead time for the authorisation procedure is around two years, which is relatively short in comparison to other countries assessed in this chapter.

In terms of obtaining grid connection, the PWEA identifies four crucial barriers for wind energy projects in Poland:

1. the reserving of connection capacity, or 'the queue for the connection point';
2. the initial charge made by the system operator on the developer when obtaining connection offers;
3. the process's lack of transparency and the lack of published data; and
4. the limited validity of offers, which often expire between their being made and the start of the construction of the wind farm.

When applying for grid connection, the Polish distribution companies (DSOs) do not provide the developer with a specific deadline by which they will be granted grid access. This makes it uncertain as to when the wind plant will become operational. Moreover, the Polish grid has a limited capacity. Since developers do not receive information in terms of grid capacity available, and are unaware of their interconnection acquisition, many apply in advance for more capacity than actually needed in order to anticipate potential land gains for the project. This leads to the so-called 'queue for the connection point', in which the DSO treats all applications in the same way, without verifying the feasibility of MW applied for, resulting in long time delays. Moreover, transmission and distribution operators can curtail production from wind, arguing that wind generation poses a threat to the security of the smooth functioning of the grid. The PROGRESS report confirms that, in Poland, more than 50 per cent of the planned projects encounter serious problems due to the constraints of the existing grid capacity. The same is valid regarding priority grid access. The PWEA claims that, despite the Polish law granting priority grid access to renewable energy, neither the transmission system operators (TSOs) nor the distributors commit to this piece of legislation. This is because the legislation is not well defined, which creates a loophole in the system: due to the numerous exceptions to the law, the TSO has the power to decide that including electricity from wind energy in the grid is not imperative. Furthermore, the situation in terms of transparency for connection costs seems rather controversial. The PWEA confirms that these costs differ widely between investors. In this context, in order to deploy wind energy successfully in Poland, it is necessary to establish effective central and local grid systems.

FRANCE

Over the last decades, France has invested massively in nuclear power and designed its grids for this purpose. Nevertheless, it is a strong emerging wind energy market. The installed capacity in 2005 was 757 MW and reached 1.6 GW in 2006, representing an annual increase of 112 per cent. By the end of 2007, the installed capacity reached an impressive 2,454 MW.

The main administrative barriers in France, according to the French Wind Energy Association (FEE), are:

- the frequent addition of new constraints to the environmental impact assessment studies; and
- the regular changes in legislation.

France has the second largest wind potential in Europe. Despite this strongly developing market, the deployment of the technology is often slowed down or even stopped.[7] In general, the highest barriers in France are seen to be administrative and legislative ones. According to OPTRES, this is because RES-E policies are not fully clear or consistent, and a large number of authorities are involved in granting the building permit.[8] In their assessment of administrative procedures in France, the Boston Consulting Group observes a 'vicious cycle' faced by the project developers, as failing to obtain one permit can result in the refusal of additional permits, which might lead to the failure of the planned project. The procedure takes place in three rounds, and involves 25 different offices, according to the French electricity board. Small-scale and large-scale project developers have to comply with different procedures: projects with a hub height below 50 m and those below 4.5 MW face a slightly simplified application process. In France, the time needed to get a building permit for a wind park is usually between one and two years, although the official length of time is given as five months. Project developers cannot undertake any actions against administrations which do not fulfil the legal terms. Although the procedures for the licensing chain are transparent in France, they tend to be lengthy and complex. Lead times for the authorisation procedure can also be lengthy.

On an environmental level, before being able to install a wind plant, the location has to be determined and approved after a thorough impact assessment. France has established local committees which give advice on the siting of every project that might affect the landscape, including wind farms. These committees work in cooperation with the army, civil aviation and the meteorology services. This impact assessment process, despite its lack of transparency and legal value, is often used by local authorities to reject projects without taking their benefits into account.

A discrepancy between the attitudes of national authorities and local/regional authorities towards RES-E projects can be observed in many Member States. OPTRES observes that environmental impact assessments currently only take into account the negative impacts of RES-E projects, without highlighting the positive points. Furthermore, OPTRES and the Boston Consulting Group have observed significant misinformation about legislative rules and how to apply them, as well as a lack of knowledge about the environmental, social and economic benefits of wind energy, especially at local authority level. In this context, wind energy project development is severely hindered, as the results are not only delays in the granting of building permits, but also significant and unnecessary increases in administration costs for the developers. The European Commission therefore urges the development of guidelines on the relationship with European environmental law.

In terms of priority grid access for wind energy, the grid operators' mistaken belief that wind energy is a potential threat to grid security has changed over the last few years. Nevertheless, many grid operators and power producers do not want to reduce the capacity of existing power plants in favour of energy produced by wind power plants, as it could pose a financial risk to the producer. In France, permits are granted based on grid studies, which last 6 to 12 months. In particular, the lack of connection capacity in large areas like the North, Picardie or on the Massif Central creates barriers. In these areas, the connection is in need of grid infrastructure development and better connection to the transmission grid. In this case, the grid studies requested by the grid operators are very complex and expensive, and the high initial costs can make projects less profitable, thus discouraging project developers and investors from installing new capacities.

The attribution of the costs of grid reinforcements is controversial. Since new financial rules were introduced, only a part of the connection cost (60 per cent) has to be covered by the project developer. The impossibility of dividing the cost of reinforcements between several producers is a real problem in all areas with a lack of capacity. Where small distribution networks are concerned, grid connection procedure is not fully transparent, meaning that the grid owner is sometimes reluctant to disclose information on available connection capacities and points.

SPAIN

In Spain, the installed capacity in 2005 was 10 GW and reached 11.6 GW in 2006, representing an annual increase of 16 per cent. This impressive total had reached 15,950 GW in July 2008. The main barriers are related to grid connections:

- Authorisation procedures are slow and sometimes non-transparent.
- Lack of coordination between the different levels of government involved and the lack of heterogeneity of the procedure to be followed (which mostly differs in each region). This can lead to conflicts over which level is responsible for what.
- Delays by the authorities can have a significant impact on the finance of the project.

Despite these barriers, wind energy deployment is successful in Spain.

In Spain, 25 different permits are needed from regional and national authorities, each of which requires a different set of documentation. According to the experiences of the Spanish stakeholders and OPTRES, the permitting process for small-scale projects is just as complex as for large-scale projects. Furthermore, there is no real difference between the processes for different RES-E technologies. In Spain the various administrative bodies are sometimes not well coordinated, thus causing authorisation application deadlines to be missed.

Regarding administrative licences in Spain, the administration often requests that project developers process the administrative licences for the wind farm and the connecting line together. This can be a single dossier or more, depending on whether the line is to be used by a single producer or by several. Negotiations with the owners of the land necessary to build a wind farm are usually quick, while negotiations with the owners of the land necessary to build a connecting line are more difficult. When no agreement can be reached with the landowners, it is possible to expropriate the land as long as the installations are declared to be 'useful to the public' by the authorities.

The authorisation procedures regarding connection to the grid and the environmental impact assessment of RES-E plants often overlap, causing confusion. In the past, conflicts between investors and environmental organisations in some regions, for example Cataluña, have impeded the development of the wind power sector. Moreover, the environmental assessment of the projects is a part of the administrative licensing process and is necessary in order to get the administrative licence necessary to build the installations. The administrative licence can be processed at the same time as the access and connection licences. In practice, the environmental assessment process takes about six or seven months.

The electricity grid needs reinforcement and investment, as it is of limited scope and cannot accommodate all approved RES-E projects. According to a project developer in Spain, the bottleneck in the development of wind power projects has changed. In the past, the bottleneck was the administrative licensing issue, while nowadays the bottleneck is the connection issue. According to the Spanish Wind Energy Association (AEE), if a solution is not found, the Spanish wind energy market could stop growing. As for France and Poland, OPTRES has found that it is often impossible for Spanish renewable energy project developers to know the available grid capacity; hence they cannot verify technical and cost data of the grid connection presented to them by the grid operator. In the different regions, there have been different ways of allocating the connection capacity to the different project developers, such as calls for tender. According to the wind power sector in Spain, the target of 20,155 MW installed wind power capacity is likely to be met. However, it is more uncertain whether this capacity is going to be built by 2010, as stated in the political target in the Plan de Energías Renovables (Renewable Energy Plan) published by the Spanish Institute for Energy Diversification and Saving in 2005. The reason behind a possible delay is not the lack of investment but the possible lack of capacity in the grid to transport the produced electric power. The construction of the required infrastructure takes a long time to complete.

In terms of priority grid access, the AEE confirms that all forms of renewable power generation are granted priority grid access under Spanish law. Furthermore, Spanish energy distributors are obliged to buy the energy surplus, which amounts to 20 per cent of the demand coverage. In practice, almost all wind generation, amounting to 95 per cent of the total production, disposes of priority access as long as wind producers offer power at zero price in the electricity market. In this way, guaranteed transmission and distribution of electricity produced from renewable energy sources are highly important, as they secure the purchase of the excess power production once connected to the grid.

Looking at grid connection costs, OPTRES observes that the Spanish system is significantly less strict against electricity generators selling the energy to distributors for a fixed price, so it applies lower penalties. During the OPTRES stakeholder consultation, some respondents questioned whether it is fair that the investor has to pay for all hardware and renewal costs, while ownership of the installations goes to the grid operator. In Spain, the RES-E developers can get an estimate of connection costs from the grid owners, as this is required by Spanish legislation. However, the estimate is often not detailed and comprehensive enough, and sometimes the costs are exaggerated. In many countries it is unclear how the connection costs should be shared between the grid operator and the RES-E developers. There is a high need for a legal framework with clear, objective and non-discriminatory rules for cost-sharing.

OFFSHORE: UK

Installed offshore capacity in Europe accounted for 886 MW by the end of 2006. The technology is developing fast – 1.08 GW were installed in the EU-27 in December 2007. However, offshore development is being slowed by the high level of financial and technical risk associated with the projects.

Offshore wind is a significant potential contributor to the 20 per cent target, but certain obstacles hamper its development:

- In most countries, the maritime policy framework is not adapted to electricity production at sea.
- There is often an absence of transparency in permitting and subsidising processes.
- There is a lack of strategic planning for offshore wind sites.
- There is a lack of coordination regarding offshore grid extension.
- A high level of environmental scrutiny and application of the precautionary principle do not take into account the environmental benefits of wind energy.

Moreover, the integration of offshore wind energy into the grid is strongly affected by the possibilities for trans-European power exchange. The main barriers concerning the connection of offshore wind farms to the national power systems are:

- transmission bottlenecks;
- offshore transmission infrastructure and grid access; and
- balancing.

The following case study of the UK illustrates on the one hand the barriers confronted by developers wishing to build an operational offshore wind farm, and on the other hand how successful offshore wind energy can be once administrative and grid barriers have been overcome.

In the UK, offshore wind is growing fast. In 2007, 404 MW of offshore wind capacity was in operation, and a further 460 MW was under construction. In addition, permits have been granted for over 2700 MW of new offshore capacity. Current programmes for offshore wind make a total over 8 GW of future installed capacity. Work is currently underway to build a new programme, which will aim to deliver up to a further 25 GW of installed capacity by 2020.

Recognising the huge potential for offshore wind electricity generation, the UK regulates the offshore energy installations through the Energy Act of 2004. This Act establishes renewable energy zones (REZs) adjacent to the UK's territorial waters – taking into consideration the rights accorded in the United Nations Convention on the Law of the Sea (1982) – and creating a comprehensive legal framework for offshore energy projects. The 2004 Energy Act facilitates the streamlining of the consent process within the REZs and inshore waters.

Barriers

Administrative Barriers

In the UK, six authorities are involved in the authorisation procedures for onshore and offshore renewable energy projects, depending on local circumstances. In addition to this, the offshore project developers can decide whether to submit the applications separately to the different authorities or to manage the process through the Offshore Renewables Consents Unit (ORCU) of the Department for Trade and Industry (DTI). The ORCU has established a so-called 'one stop shop', which provides developers with a single liaison point for questions regarding the administration of applications, clarifies issues and provides updates on the progress of all consent applications.

Legislation is currently being reviewed on marine consenting, and a new Infrastructure Planning Commission will become responsible for offshore wind consents. Marine planning and strategy frameworks are also being developed. A new system of offshore transmission regulation is currently being developed, where all connections of over 132 kV will require a transmission operator to be established via competitive tendering. The operator will be required to design, build and maintain the transmission system in return for a stream of revenue.

Key barriers identified in the UK are the rather slow approval rate of building applications and limited transmission capacity in parts of the country, in particular between the very windy Scottish locations and the southern part of the UK. At present, nearly 8 GW of capacity are held up in the onshore planning system, equivalent to nearly 6 per cent of potential UK electricity supply. A further 9 GW from offshore projects are awaiting decision or due to be submitted for consent. In 2006 it took local authorities an average of 16 months to decide on wind farm applications, even though the statutory time period for decisions is 16 weeks.

Grid Capacity

The grid connection application for offshore wind farms is given by the UK's National Grid:

- Grid reinforcements are necessary in order to facilitate the grid connection of offshore wind farms in the future; however, they require very long lead times.
- In wind transmission grid codes there is a trend towards active control of large wind farms within the boundaries of the legal frameworks. This contributes to grid stability, although some contractual issues are still unclear. The capabilities required from large wind farms should be harmonised with TSO-specific set points.
- Common offshore cables bundling several wind farms would be beneficial. Moreover, they can become initial nodes of an international offshore grid. Up to now no bundling has taken place.
- Grid access, energy pricing and balancing are inter-related. To increase the value of wind energy,

measures such as adapted demand control, backup generation and storage are needed. Furthermore, good short-term forecasting will increase the value of wind energy on the energy markets.
- In order to take advantage of the geographical aggregation of wind speed, the transmission of wind power must be possible over distances comparable to the extensions of meteorological systems. Strong trans-European networks are essential for this.

In conclusion, many things need to be done on a technical level in order to integrate large amounts of offshore wind power into the UK power system. The feasibility of integrating large amounts of offshore wind power is mainly a question of finance, and hence closely related to political decisions and the creation of a favourable framework.

Renewables Obligation Certificates

In the past, only a few offshore wind farms were installed, as they had to deal with low Renewables Obligation Certificate (ROC) prices and technical difficulties. As a result, the building of offshore wind farms in the rather harsh offshore environment around the UK was very difficult and came almost to a standstill two years ago. With increasing ROC prices and more suitable wind turbine technology, the interest in offshore wind power has now picked up again; however, due to the high worldwide demand for wind turbines, both onshore and offshore, it is rather difficult to find wind turbine suppliers that are interested in delivering wind turbines for large offshore wind projects in the UK.

It is expected that in 2009, 1.5 ROCs per MWh will be established for offshore wind. This increase will be beneficial; however, the increasing steel, aluminium and copper prices will also have an impact on wind turbine costs.

Conclusion

Offshore wind is expected to make a large impact on the UK's 2020 renewable energy targets, and a major expansion is planned. The transmission system will be crucial for the success of this expansion, and efficient and appropriate connections and access will be required.

Part IV Notes

1 Source: Eurelectric and EWEA. The national wind power shares are calculated by taking the electricity that the capacity installed by the end of 2007 will produce in a normal wind year and dividing it by the actual 2006 electricity demand. The statistical methodology used differs from the methodology otherwise used throughout this chapter, which explains the difference of 0.1 per cent for the total EU share. The figures may differ from the shares reported by national wind energy associations, due to difference in methodology.

2 See www.btm.dk/documents/pressrelease.pdf.

3 The OPTRES full report is available at www.optres.fhg.de/.

4 The PROGRESS full report is available at www.res-progress.eu/.

5 see Coenraads et al. (2006).

6 see Held (2008), p9.

7 'Administrative and grid barriers', EWEA internal paper, July 2007.

8 Coenraads et al. (2006).