EWEA
THE EUROPEAN WIND ENERGY ASSOCIATION

Pure Power

Wind energy targets for 2020 and 2030

A report by the European Wind Energy Association - 2009 update

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Foreword

I am delighted to introduce this latest edition of *Pure Power*, the most up-to-date scenarios on the future of wind energy in Europe, produced by the European Wind Energy Association (EWEA).

Wind power has experienced dramatic growth over recent years with more new installations than any other electricity-generating technology, including coal, gas and nuclear, in 2008. We at the European Commission are keen to see an expansion of renewable energies as a way to fight climate change, enhance Europe's energy security, and improve our competitiveness, which is why we support this publication of wind industry growth scenarios. I personally find it hugely encouraging seeing more ambitious growth targets for the sector than previously predicted by EWEA.

In the European Union we have established the target of achieving a 20% share of renewable energies in the overall energy mix by 2020. To reach this we estimate that 34% of Europe's electricity needs must be met by renewable technologies, with wind power meeting much of the increase.

Further benefits will arise from the switch to green energy including significant employment opportunities. Creating energy from sources indigenous to Europe is also central to reducing our energy dependence on fossil fuel exporting nations in less stable regions of the world.

The European Commission is convinced that there is a huge potential for wind energy in Europe, including offshore wind. However we are also aware of the significant obstacles the industry faces in meeting its targets. Europe needs a Europe-wide electricity grid and interconnectors between Member States, and properly functioning electricity markets, to cope with larger amounts of wind power. Planning processes for wind farms also need to be streamlined.

Reading this publication, a clear and concise analysis of the future projections for wind energy in Europe, has persuaded me that wind energy is heading in the right direction, and one that is essential for the sustainability of our future generations.

Christopher Jones
European Commission
Director, New and Renewable Sources of Energy,
Energy Efficiency and Innovation
DG TREN

Contents

Picturing Europe's Energy Future – Pure Power

Europe's current electricity supply structure still bears the characteristics of the time in which it was developed. It is national in nature, the technologies applied are ageing and the markets supporting it are underdeveloped. Given the international nature of the energy challenges that the EU is facing, it is astounding that, 22 years after the Single European Act was signed, we still do not have a well-functioning internal market for electricity in Europe.

Europe is faced with the global challenges of climate change, depleting indigenous energy resources, increasing fuel costs and the threat of supply disruptions. Over the next 12 years, 332 GW of new electricity capacity – 42% of current EU capacity - needs to be built to replace ageing power plants and meet the expected increase in demand. Over the next 12 years, Europe must use the opportunity created by the large turnover in capacity to construct a new, modern renewable energy power supply and grid system capable of meeting the energy and climate challenges of the 21st century, while enhancing Europe's competitiveness and creating hundreds of thousands of manufacturing and related jobs. The new power system must be supported by a well functioning internal market in electricity in which investors, rather than consumers, are exposed to carbon and fuel price risk.

The 2009 EU Renewable Energy Directive aims to increase the share of renewable energy in the EU from 8.6% in 2005 to 20% in 2020. In 2007, the share of renewable energy had already reached 9.9%. At that pace – an increase of 0.65%-points per year – the EU will reach 18.35% renewables in 2020. The European Commission took on an ambitious political project when it proposed a binding 20% target for renewables and succeeded. However, from a technology point of view, the 20% target is not ambitious. We can almost reach it just by continuing doing what we did in the period 2005 to 2007, when no binding Directive was in place.

Supported by national frameworks and the adoption of the 2001 EU Directive on the Promotion of Electricity from Renewable Energy Sources, wind energy technology has developed to a point where, in 2008, more new wind power capacity was installed in the EU than any other power generating technology, including coal, gas and nuclear power. From 2002 to 2007 the wind energy sector created more than 60,000 new direct jobs in the EU, equal to 33 new jobs every day of the year. In 2008, European manufacturers had a 60% share of the €36 billion global market for wind turbines.

As the cheapest of the renewable electricity technologies, onshore wind will be the largest contributor to meeting the 34% share of renewable electricity needed by 2020 in the EU, as envisaged by the 2009 Directive. As a consequence of the adoption of the Directive, the European Wind Energy Association (EWEA), in March 2009, increased its 2020 target from 180 GW to 230 GW, including 40 GW of offshore wind power. With this report, EWEA is now increasing its 2030 target from 300 GW to 400 GW.

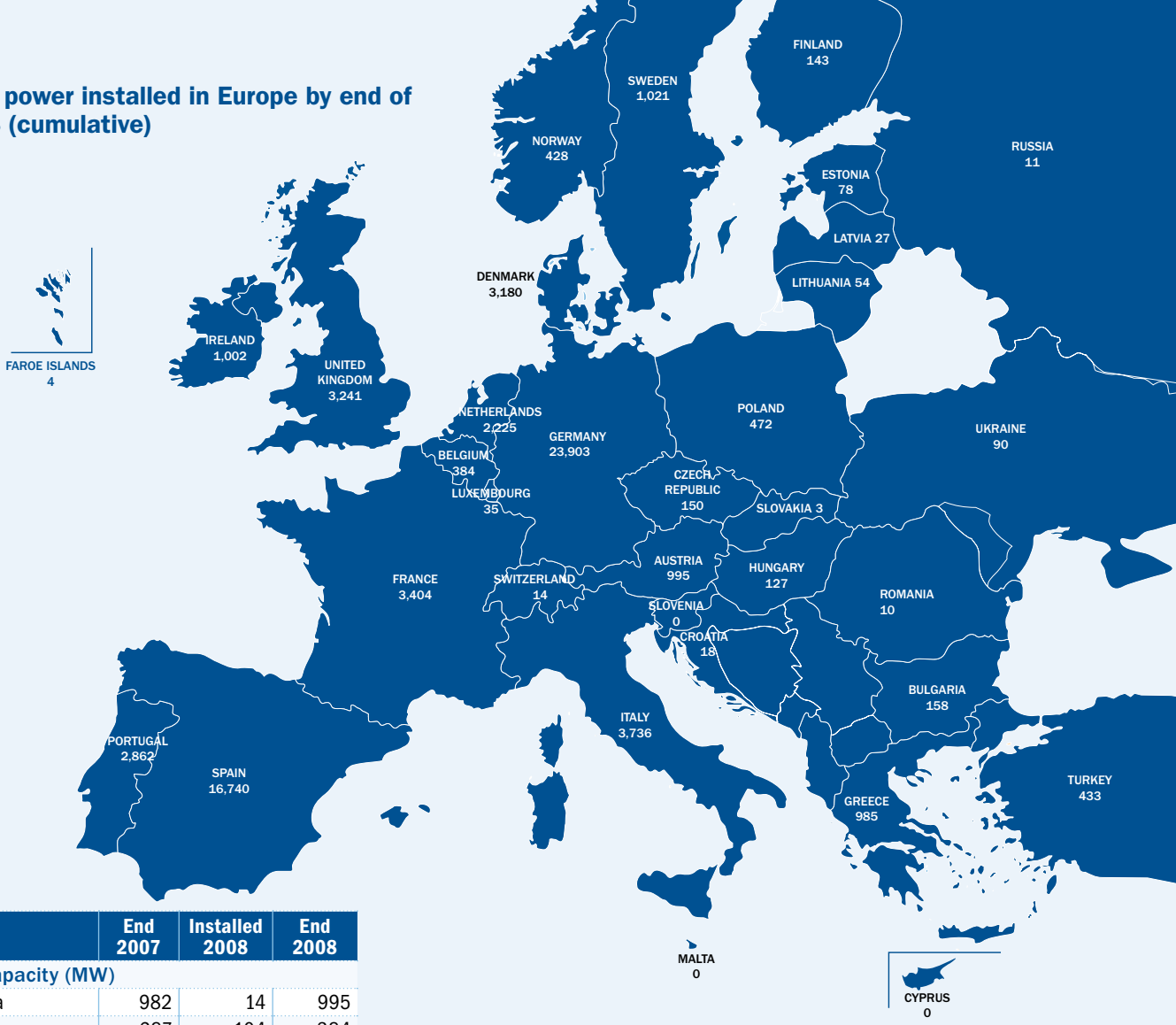
By 2020, most of the EU's renewable electricity will be produced by onshore wind farms. Europe must, however, use the coming decade to prepare for the large-scale exploitation of its largest indigenous resource, offshore wind power. We must stop thinking of electrical grids as national infrastructure and start developing them - onshore and offshore - to become European corridors of electricity trade. And we must start developing them now. The faster they are developed, the faster we will have a domestic substitute if future fuel import supplies are disrupted or the cost of fuel becomes prohibitively expensive, as the world experienced during 2008.

With wind energy, Europe is in prime position to turn the looming energy and climate crisis into an opportunity for our companies, a benefit to the environment and a source of increased welfare to our citizens.

Arthouros Zervos
EWEA President

Christian Kjær
EWEA Chief Executive Officer

Wind power installed in Europe by end of 2008 (cumulative)



	End 2007	Installed 2008	End 2008
EU Capacity (MW)			
Austria	982	14	995
Belgium	287	104	384
Bulgaria	57	101	158
Cyprus	0	0	0
Czech Republic	116	34	150
Denmark	3,125	77	3,180
Estonia	59	20	78
Finland	110	33	143
France	2,454	950	3,404
Germany	22,247	1,665	23,903
Greece	871	114	985
Hungary	65	62	127
Ireland	795	208	1,002
Italy	2,726	1,010	3,736
Latvia	27	0	27
Lithuania	51	3	54
Luxembourg	35	0	35
Malta	0	0	0
Netherlands	1,747	500	2,225
Poland	276	196	472
Portugal	2,150	712	2,862
Romania	8	2	10
Slovakia	5	0	3
Slovenia	0	0	0
Spain	15,131	1,609	16,740
Sweden	788	236	1,021
United Kingdom	2,406	836	3,241
Total EU-15	**55,854**	**8,067**	**63,857**
Total EU-12	**663**	**417**	**1,078**
Total EU-27	**56,517**	**8,484**	**64,935**
Of which offshore and near shore	1,114	357	1,471

European Union: 64,935 MW
Candidate Countries: 452 MW
EFTA: 442 MW
Total Europe: 65,933 MW

	End 2007	Installed 2008	End 2008
Candidate Countries (MW)			
Croatia	17	1	18
FYROM*	0	0	0
Turkey	147	286	433
Total	**164**	**287**	**452**
EFTA (MW)			
Iceland	0	0	0
Liechtenstein	0	0	0
Norway	326	102	428
Switzerland	12	2	14
Total	**338**	**104**	**442**
Other (MW)			
Faroe Islands	4	0	4
Ukraine	89	1	90
Russia	13	0	11
Total	**106**	**1**	**105**
Total Europe	**57,125**	**8,877**	**65,933**

*FYROM = Former Yugoslav Republic of Macedonia
Note: Due to previous-year adjustments, project decommissioning of 70 MW, re-powering and rounding figures up and down, the total for the 2008 end-of-year cumulative capacity is not exactly equivalent to the sum of the 2007 end-of-year total plus the 2008 additions.

1. National Wind Energy Scenarios for 2020

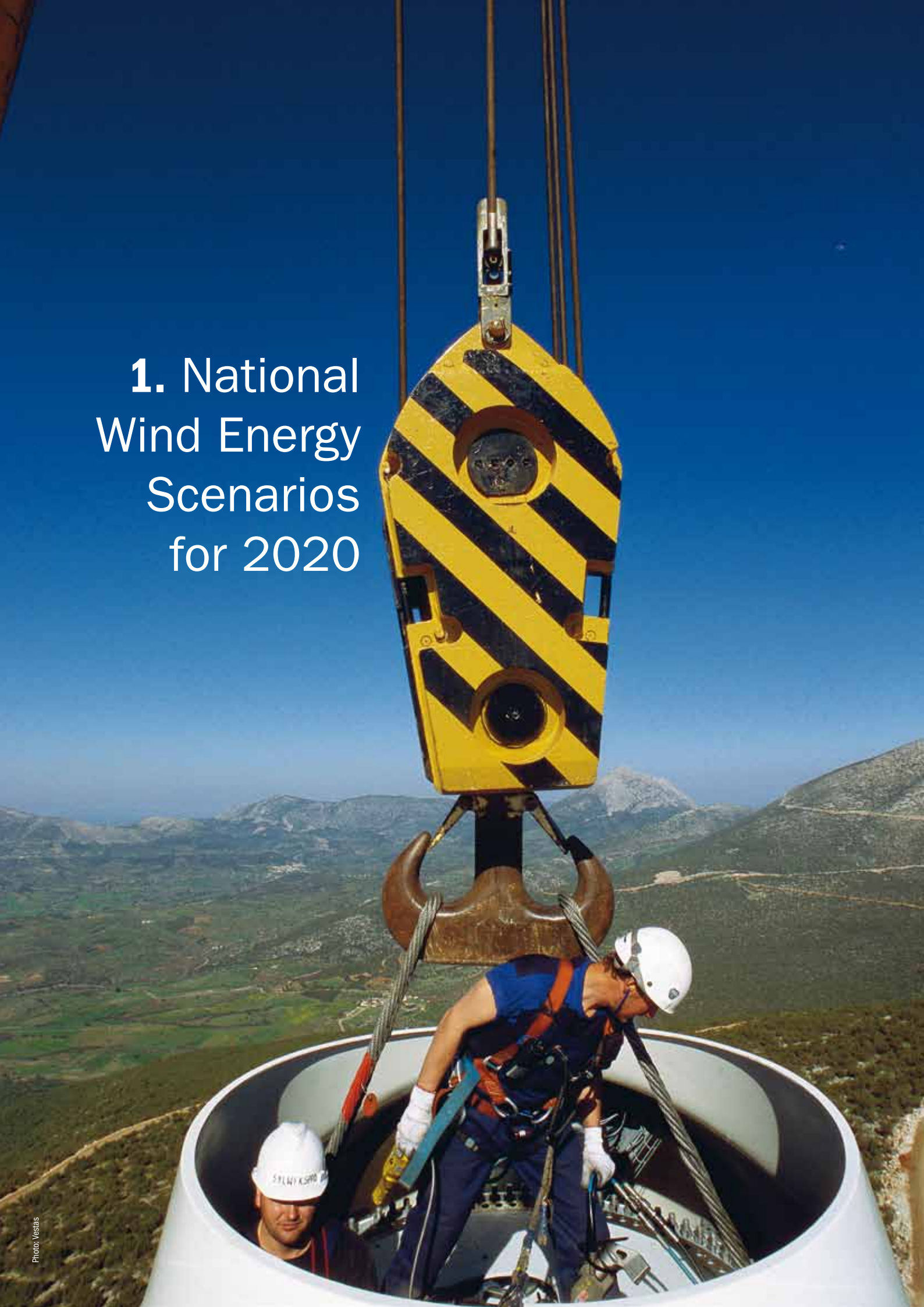


Photo: Vestas

The 2009 EU Renewable Energy Directive[1] requires Member States to submit National Renewable Energy Action Plans[2] (NREAPs) to the European Commission by 30 June 2010.

All 27 EU Member States must provide estimates of their gross final energy consumption of all types of energy (both renewable and non-renewable), for each year between 2010 and 2020. They must provide expected contributions for three different sectors: heating/cooling, electricity, and transport. They also need to provide a target for each renewable energy technology, including both onshore and offshore wind energy, and they must specify both installed capacity (MW) and electricity production (GWh).

In consultation with its corporate members and national wind energy associations, EWEA has analysed the wind energy markets in the 27 EU Member States. This chapter provides the results of this analysis in the form of two 2020 scenarios for each national market: a "low" scenario and a "high" scenario. The "low" scenario is based on EWEA's traditionally conservative approach to setting future targets for wind energy (see Chapter 4). It assumes a total installed capacity of wind energy in the EU by 2020 of 230 GW, producing 580 TWh of electricity.

The "high" scenario acknowledges that wind power – as the most affordable of the renewable electricity technologies – is likely to meet a much higher share of the EU's Renewable Energy Directive target than the 12% of electricity demand by 2020 indicated by the European Commission[3]. For many of the countries, the "high" scenario also takes into account wind power targets already announced by national governments. In the "high" scenario, total installed wind power capacity will reach 265 GW by 2020, producing 681 TWh of electricity.

The aim of this chapter is to provide national governments with some guidance on wind power's contribution to meeting their binding national targets.

For more details, including a breakdown of the national scenarios on onshore and offshore wind, see Table 1.1.

[1] Source: EU, 2009a.
[2] Source: EC, 2009a.
[3] Source: EC, 2007a.

AUSTRIA

MW
2008: **995 MW**
2020 (L/H): **3,500/4,000 MW**
Avg annual 2009-2020 (L/H): **209/250**

TWh
2008 TWh (%): **2.0 TWh (2.9%)**
2020 TWh (L/H): **7.5/8.6 TWh (9.5/10.9%)**

BELGIUM

MW
2008: **384 MW**
2020 (L/H): **3,900/4,500 MW**
Avg annual 2009-2020 (L/H): **293/343**

TWh
2008 TWh (%): **0.8 TWh (0.9%)**
2020 TWh (L/H): **11.3/13.0 TWh (10.4/11.9%)**

BULGARIA

MW
2008: **158 MW**
2020 (L/H): **3,000/3,500 MW**
Avg annual 2009-2020 (L/H): **237/279**

TWh
2008 TWh (%): **0.3 TWh (0.9%)**
2020 TWh (L/H): **7.1/8.3 TWh (12.6/14.7%)**

CYPRUS

MW
2008: **0 MW**
2020 (L/H): **300/500 MW**
Avg annual 2009-2020 (L/H): **25/42**

TWh
2008 TWh (%): **0 TWh (0.0%)**
2020 TWh (L/H): **0.6/1.0 TWh (8.9/14.8%)**

CZECH REPUBLIC

MW
2008: **150 MW**
2020 (L/H): **1,600/1,800 MW**
Avg annual 2009-2020 (L/H): **121/138**

TWh
2008 TWh (%): **0.3 TWh (0.4%)**
2020 TWh (L/H): **3.5/3.9 TWh (3.4/3.8%)**

DENMARK

MW
2008: **3,180 MW**
2020 (L/H): **6,000/6,500 MW**
Avg annual 2009-2020 (L/H): **235/277**

TWh
2008 TWh (%): **7.7 TWh (20.3%)**
2020 TWh (L/H): **17.0/18.5 TWh (42.5/46.2%)**

ESTONIA

MW
2008: **78 MW**
2020 (L/H): **500/600 MW**
Avg annual 2009-2020 (L/H): **35/44**

TWh
2008 TWh (%): **0.2 TWh (1.8%)**
2020 TWh (L/H): **1.2/1.6 TWh (8.4/10.9%)**

FINLAND

MW
2008: **143 MW**
2020 (L/H): **1,900/3,000 MW**
Avg annual 2009-2020 (L/H): **146/238**

TWh
2008 TWh (%): **0.4 TWh (0.4%)**
2020 TWh (L/H): **5.1/8.6 TWh (5.0/8.4%)**

FRANCE

MW
2008: **3,404 MW**
2020 (L/H): **23,000/26,000 MW**
Avg annual 2009-2020 (L/H): **1,633/1,883**

TWh
2008 TWh (%): **8.1 TWh (1.6%)**
2020 TWh (L/H): **62.4/72.3 TWh (9.9/11.4%)**

GERMANY

MW
2008: **23,903 MW**
2020 (L/H): **49,000/52,000 MW**
Avg annual 2009-2020 (L/H): **2,091/2,341**

TWh
2008 TWh (%): **42.9 TWh (6.9%)**
2020 TWh (L/H): **106.8/116.2 TWh (15.8/17.2%)**

GREECE

MW
2008: **985 MW**
2020 (L/H): **6,500/8,500 MW**
Avg annual 2009-2020 (L/H): **460/626**

TWh
2008 TWh (%): **2.5 TWh (3.7%)**
2020 TWh (L/H): **17.5/23.1 TWh (21.8/28.8%)**

HUNGARY

MW
2008: **127 MW**
2020 (L/H): **900/1,200 MW**
Avg annual 2009-2020 (L/H): **64/89**

TWh
2008 TWh (%): **0.3 TWh (0.6%)**
2020 TWh (L/H): **2.1/2.8 TWh (4.0/5.3%)**

IRELAND

MW
2008: **1,002 MW**
2020 (L/H): **6,000/7,000 MW**
Avg annual 2009-2020 (L/H): **417/500**

TWh
2008 TWh (%): **2.7 TWh (9.3%)**
2020 TWh (L/H): **17.6/20.4 TWh (47.8%/55.4%)**

ITALY

MW
2008: **3,736 MW**
2020 (L/H): **15,500/18,000 MW**
Avg annual 2009-2020 (L/H): **980/1,189**

TWh
2008 TWh (%): **7.9 TWh (2.2%)**
2020 TWh (L/H): **33.5/38.1 TWh (7.6/8.6%)**

LATVIA

MW
2008: **27 MW**
2020 (L/H): **200/300 MW**
Avg annual 2009-2020 (L/H): **14/23**

TWh
2008 TWh (%): **0.1 TWh (0.8%)**
2020 TWh (L/H): **0.5/0.8 TWh (5.0/8.9%)**

LITHUANIA

MW
2008: **54 MW**
2020 (L/H): **1,000/1,100 MW**
Avg annual 2009-2020 (L/H): **79/87**

TWh
2008 TWh (%): **0.1 TWh (1%)**
2020 TWh (L/H): **2.4/2.7 TWh (11.1/12.8%)**

LUXEMBOURG

MW
2008: **35 MW**
2020 (L/H): **300/700 MW**
Avg annual 2009-2020 (L/H): **22/55**

TWh
2008 TWh (%): **0.1 TWh (0.9%)**
2020 TWh (L/H): **0.6/1.5 TWh (14.1/33.1%)**

MALTA

MW
2008: **0 MW**
2020 (L/H): **100/200 MW**
Avg annual 2009-2020 (L/H): **8/17**

TWh
2008 TWh (%): **0 TWh (0%)**
2020 TWh (L/H): **0.2/0.4 TWh (11.2/22.4%)**

NETHERLANDS

MW
2008: **2,225 MW**
2020 (L/H): **9,500/11,400 MW**
Avg annual 2009-2020 (L/H): **606/765**

TWh
2008 TWh (%): **5.0 TWh (4.2%)**
2020 TWh (L/H): **27.6/34.0 TWh (18.1/22.3%)**

POLAND

MW
2008: **472 MW**
2020 (L/H): **10,500/12,500 MW**
Avg annual 2009-2020 (L/H): **836/1,002**

TWh
2008 TWh (%): **1.0 TWh (0.7%)**
2020 TWh (L/H): **25.4/30.1 TWh (12.5/14.8%)**

PORTUGAL

MW
2008: **2,862 MW**
2020 (L/H): **7,500/9,000 MW**
Avg annual 2009-2020 (L/H): **387/512**

TWh
2008 TWh (%): **6.3 TWh (11.4%)**
2020 TWh (L/H): **16.8/20.2 TWh (21.8/26.2%)**

By June 2010, the 27 EU Member States must provide the European Commission with indicative targets – in terms of both capacity (MW) and energy production (MWh) - for all energy technologies, including onshore and offshore wind energy.

This map illustrates, for each of the 27 Member States, a) the current capacity (MW) and electricity production (TWh), b) the "Low" and "High" 2020 targets for capacity and electricity and the corresponding share of national demand and c) the amount of average capacity needed to meet the "Low" and "High" targets. In addition, the colour code of the map indicates the average annual level of MW needed between 2009 and 2020 to meet the "High" scenario.

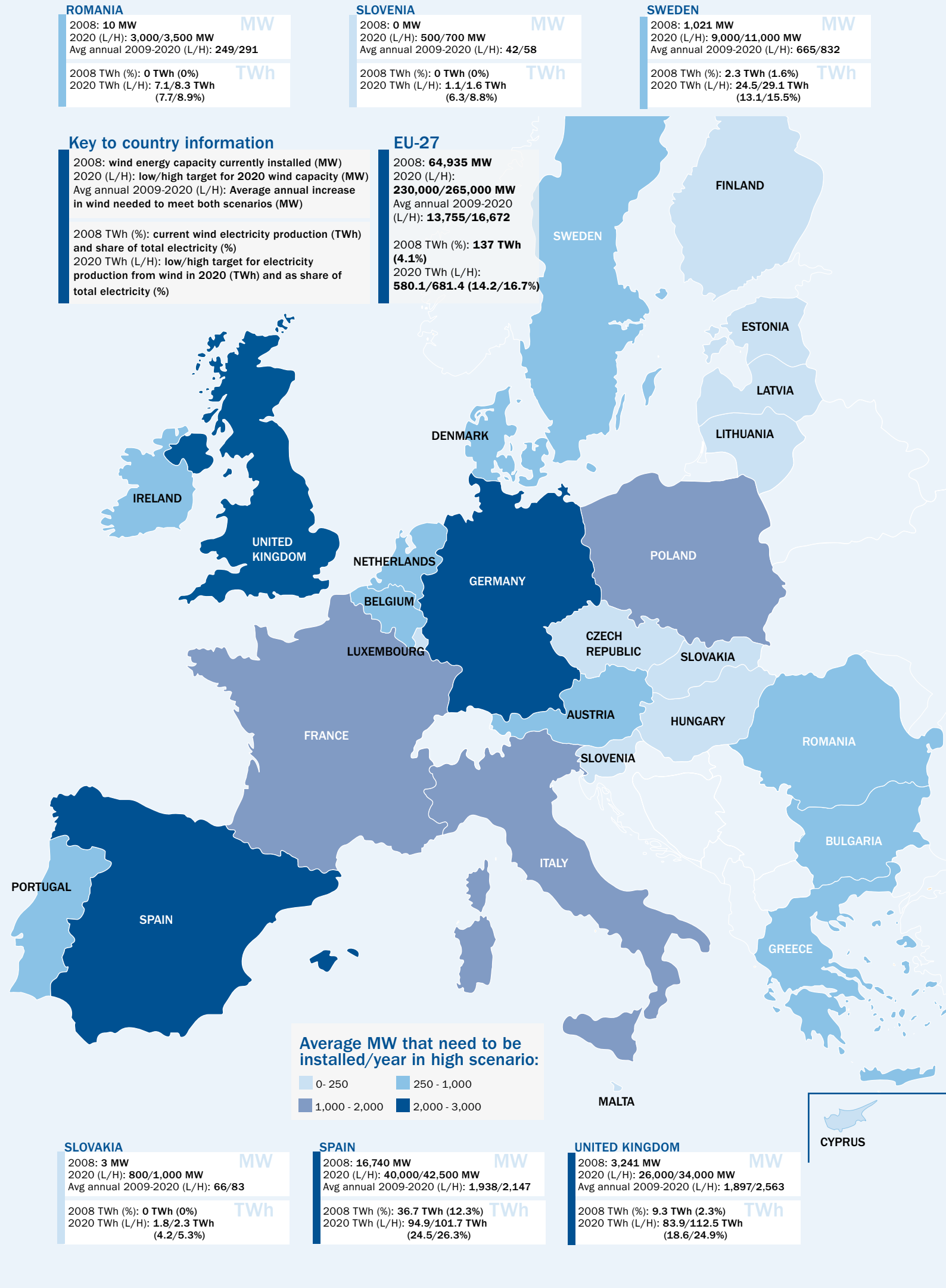
Low scenario for the EU

For the EU as a whole, the "Low" scenario requires installed capacity to increase from 65 GW by end 2008 to 230 GW in 2020. That would require an average annual increase in capacity of 13.8 GW in 2009-2020. Wind energy production would increase from 137 TWh (2008) to 580 TWh (2020) and wind energy's share of total electricity demand would increase from 4.1% in 2008 to 14.2% in 2020.

High scenario for the EU

For the EU as a whole, the "High" scenario requires installed capacity to increase from 65 GW by end 2008 to 265 GW in 2020. That would require an average annual increase in capacity of 16.7 GW in 2009-2020. Wind energy production would increase from 137 TWh (2008) to 681 TWh (2020) and wind energy's share of total electricity demand would increase from 4.1% in 2008 to 16.7% in 2020.

Please note that the calculation of total EU electricity production in this chapter differs slightly from the EU totals calculated in subsequent chapters of this report, due to a different methodology. For more details, including a breakdown of the national scenarios on onshore and offshore wind, see Table 1.1.


ROMANIA
2008: 10 MW
2020 (L/H): 3,000/3,500 MW
Avg annual 2009-2020 (L/H): 249/291
MW
2008 TWh (%): 0 TWh (0%)
2020 TWh (L/H): 7.1/8.3 TWh (7.7/8.9%)
TWh
SLOVENIA
2008: 0 MW
2020 (L/H): 500/700 MW
Avg annual 2009-2020 (L/H): 42/58
MW
2008 TWh (%): 0 TWh (0%)
2020 TWh (L/H): 1.1/1.6 TWh (6.3/8.8%)
TWh
SWEDEN
2008: 1,021 MW
2020 (L/H): 9,000/11,000 MW
Avg annual 2009-2020 (L/H): 665/832
MW
2008 TWh (%): 2.3 TWh (1.6%)
2020 TWh (L/H): 24.5/29.1 TWh (13.1/15.5%)
TWh
Key to country information
2008: wind energy capacity currently installed (MW)
2020 (L/H): low/high target for 2020 wind capacity (MW)
Avg annual 2009-2020 (L/H): Average annual increase in wind needed to meet both scenarios (MW)
2008 TWh (%): current wind electricity production (TWh) and share of total electricity (%)
2020 TWh (L/H): low/high target for electricity production from wind in 2020 (TWh) and as share of total electricity (%)
EU-27
2008: 64,935 MW
2020 (L/H): 230,000/265,000 MW
Avg annual 2009-2020 (L/H): 13,755/16,672
2008 TWh (%): 137 TWh (4.1%)
2020 TWh (L/H): 580.1/681.4 (14.2/16.7%)
FINLAND
SWEDEN
ESTONIA
LATVIA
LITHUANIA
DENMARK
IRELAND
UNITED KINGDOM
NETHERLANDS
GERMANY
POLAND
BELGIUM
CZECH REPUBLIC
SLOVAKIA
LUXEMBOURG
AUSTRIA
HUNGARY
FRANCE
ROMANIA
SLOVENIA
BULGARIA
ITALY
PORTUGAL
SPAIN
GREECE
MALTA
CYPRUS
Average MW that need to be installed/year in high scenario:
0- 250
250 - 1,000
1,000 - 2,000
2,000 - 3,000
SLOVAKIA
2008: 3 MW
2020 (L/H): 800/1,000 MW
Avg annual 2009-2020 (L/H): 66/83
MW
2008 TWh (%): 0 TWh (0%)
2020 TWh (L/H): 1.8/2.3 TWh (4.2/5.3%)
TWh
SPAIN
2008: 16,740 MW
2020 (L/H): 40,000/42,500 MW
Avg annual 2009-2020 (L/H): 1,938/2,147
MW
2008 TWh (%): 36.7 TWh (12.3%)
2020 TWh (L/H): 94.9/101.7 TWh (24.5/26.3%)
TWh
UNITED KINGDOM
2008: 3,241 MW
2020 (L/H): 26,000/34,000 MW
Avg annual 2009-2020 (L/H): 1,897/2,563
MW
2008 TWh (%): 9.3 TWh (2.3%)
2020 TWh (L/H): 83.9/112.5 TWh (18.6/24.9%)
TWh

TWO SCENARIOS UP TO 2020*

TABLE 1.1

	MW installed end 2008			MW installed 2020 low			MW installed 2020 high			Avg annual MW low (2009-2020)	Avg annual MW high (2009-2020)
Country	Onshore	Offshore	Total	Onshore	Offshore	Total	Onshore	Offshore	Total		
Austria	995	0	995	3,500	0	3,500	4,000	0	4,000	209	250
Belgium	354	30	384	2,100	1,800	3,900	2,500	2,000	4,500	293	343
Bulgaria	158	0	158	3,000	0	3,000	3,500	0	3,500	237	279
Cyprus	0	0	0	300	0	300	500	0	500	25	42
Czech Republic	150	0	150	1,600	0	1,600	1,800	0	1,800	121	138
Denmark	2,771	409	3,180	3,700	2,300	6,000	4,000	2,500	6,500	235	277
Estonia	78	0	78	500	0	500	500	100	600	35	44
Finland	119	24	143	1,500	400	1,900	2,000	1,000	3,000	146	238
France	3,404	0	3,404	19,000	4,000	23,000	20,000	6,000	26,000	1,633	1,883
Germany	23,891	12	23,903	41,000	8,000	49,000	42,000	10,000	52,000	2,091	2,341
Greece	985	0	985	6,500	0	6,500	8,300	200	8,500	460	626
Hungary	127	0	127	900	0	900	1,200	0	1,200	64	89
Ireland	977	25	1,002	5,000	1,000	6,000	6,000	1,000	7,000	417	500
Italy	3,736	0	3,736	15,000	500	15,500	17,000	1,000	18,000	980	1,189
Latvia	27	0	27	200	0	200	200	100	300	14	23
Lithuania	54	0	54	1,000	0	1,000	1,000	100	1,100	79	87
Luxembourg	35	0	35	300	0	300	700	0	700	22	55
Malta	0	0	0	100	0	100	200	0	200	8	17
Netherlands	1,978	247	2,225	5,000	4,500	9,500	5,400	6,000	11,400	606	765
Poland	472	0	472	10,000	500	10,500	12,000	500	12,500	836	1,002
Portugal	2,862	0	2,862	7,500	0	7,500	9,000	0	9,000	387	512
Romania	10	0	10	3,000	0	3,000	3,500	0	3,500	249	291
Slovakia	3	0	3	800	0	800	1,000	0	1,000	66	83
Slovenia	0	0	0	500	0	500	700	0	700	42	58
Spain	16,740	0	16,740	39,000	1,000	40,000	41,000	1,500	42,500	1,938	2,147
Sweden	888	133	1,021	6,000	3,000	9,000	8,000	3,000	11,000	665	832
UK	2,650	591	3,241	13,000	13,000	26,000	14,000	20,000	34,000	1,897	2,563
EU-27	**63,464**	**1,471**	**64,935**	**190,000**	**40,000**	**230,000**	**210,000**	**55,000**	**265,000**	**13,755**	**16,672**

*Source: Eurostat and EWEA. The national wind power shares are calculated by taking the electricity that the capacity installed by the end of 2008 will produce in a normal wind year and dividing it by the actual 2007 electricity demand, which is the latest available figure from Eurostat. Average capacity factors are assumed by EWEA for each country. The statistical methodology used differs from the methodology otherwise used throughout this report. The figures may differ from the shares reported by national wind energy associations due to differences in methodology.

	TWh end 2008			Twh 2020 low			TWh 2020 high			Final Electricity Consumption (2007)	Final Electricity Consumtion (2020)	Wind share 2008	Wind Share 2020 low	Wind share 2020 high
Country	Onshore	Offshore	Total	Onshore	Offshore	Total	Onshore	Offshore	Total					
Austria	2.0	0.0	2.0	7.5	0.0	7.5	8.6	0.0	8.6	70.0	78.5	2.9%	9.5%	10.9%
Belgium	0.7	0.1	0.8	4.7	6.6	11.3	5.6	7.4	13.0	95.6	109.5	0.9%	10.4%	11.9%
Bulgaria	0.3	0.0	0.3	7.1	0.0	7.1	8.3	0.0	8.3	38.8	56.1	0.9%	12.6%	14.7%
Cyprus	0.0	0.0	0.0	0.6	0.0	0.6	1.0	0.0	1.0	4.9	6.5	0.0%	8.9%	14.8%
Czech Republic	0.3	0.0	0.3	3.5	0.0	3.5	3.9	0.0	3.9	72.0	103.3	0.4%	3.4%	3.8%
Denmark	6.3	1.4	7.7	8.6	8.4	17.0	9.3	9.1	18.5	38.2	40.0	20.3%	42.5%	46.2%
Estonia	0.2	0.0	0.2	1.2	0.0	1.2	1.2	0.4	1.6	9.8	14.5	1.8%	8.4%	10.9%
Finland	0.3	0.0	0.4	3.7	1.5	5.1	4.9	3.7	8.6	93.8	101.6	0.4%	5.0%	8.4%
France	8.1	0.0	8.1	47.7	14.7	62.4	50.2	22.1	72.3	513.0	633.0	1.6%	9.9%	11.4%
Germany	42.9	0.0	42.9	77.4	29.4	106.8	79.4	36.8	116.2	620.5	674.1	6.9%	15.8%	17.2%
Greece	2.5	0.0	2.5	17.5	0.0	17.5	22.4	0.7	23.1	67.9	80.2	3.7%	21.8%	28.8%
Hungary	0.3	0.0	0.3	2.1	0.0	2.1	2.8	0.0	2.8	43.9	53.0	0.6%	4.0%	5.3%
Ireland	2.7	0.0	2.7	13.9	3.7	17.6	16.7	3.7	20.4	29.6	36.8	9.3%	47.8%	55.4%
Italy	7.9	0.0	7.9	33.5	0.0	33.5	38.1	0.0	38.1	360.2	441.6	2.2%	7.6%	8.6%
Latvia	0.1	0.0	0.1	0.5	0.0	0.5	0.5	0.4	0.8	7.8	9.5	0.8%	5.0%	8.9%
Lithuania	0.1	0.0	0.1	2.4	0.0	2.4	2.4	0.4	2.7	12.6	21.3	1.0%	11.1%	12.8%
Luxembourg	0.1	0.0	0.1	0.6	0.0	0.6	1.5	0.0	1.5	8.0	4.4	0.9%	14.1%	33.1%
Malta	0.0	0.0	0.0	0.2	0.0	0.2	0.4	0.0	0.4	2.3	1.7	0.0%	11.2%	22.4%
Netherlands	4.2	0.9	5.0	11.0	16.5	27.6	12.0	22.0	34.0	120.8	152.1	4.2%	18.1%	22.3%
Poland	1.0	0.0	1.0	23.6	1.8	25.4	28.3	1.8	30.1	154.0	203.7	0.7%	12.5%	14.8%
Portugal	6.3	0.0	6.3	16.8	0.0	16.8	20.2	0.0	20.2	54.7	77.4	11.4%	21.8%	26.2%
Romania	0.0	0.0	0.0	7.1	0.0	7.1	8.3	0.0	8.3	59.6	92.6	0.0%	7.7%	8.9%
Slovakia	0.0	0.0	0.0	1.8	0.0	1.8	2.3	0.0	2.3	29.8	43.0	0.0%	4.2%	5.3%
Slovenia	0.0	0.0	0.0	1.1	0.0	1.1	1.6	0.0	1.6	15.3	18.2	0.0%	6.3%	8.8%
Spain	36.7	0.0	36.7	91.3	3.7	94.9	96.2	5.5	101.7	297.5	387.0	12.3%	24.5%	26.3%
Sweden	1.9	0.5	2.3	13.5	11.0	24.5	18.1	11.0	29.1	150.2	187.3	1.6%	13.1%	15.5%
UK	7.2	2.1	9.3	36.2	47.7	83.9	39.0	73.5	112.5	401.4	452.3	2.3%	18.6%	24.9%
EU-27	**131.9**	**5.2**	**137.0**	**435.0**	**145.1**	**580.1**	**482.9**	**198.4**	**681.4**	**3,372.2**	**4,079.3**	**4.1%**	**14.2%**	**16.7%**

2. The EU Energy Mix

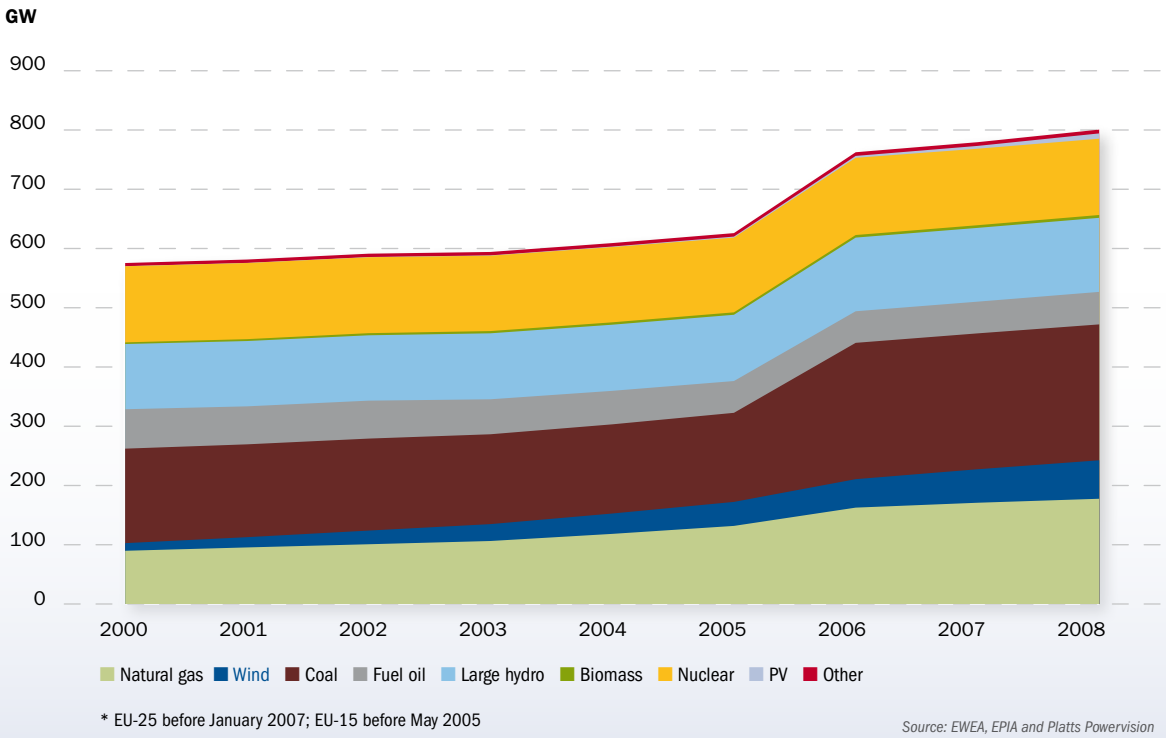
Photo: GWEC

Between 2000 and 2008, the EU's total installed power capacity increased by 225 GW, reaching 800 GW by the end of 2008 (see also Table 2.1 and Table 2.2). The most notable change in the energy mix is the 75% increase in gas capacity to 177 GW. Wind energy increased five-fold over the same period – from 13 GW to 65 GW.

The ten countries that became new Member States in May 2004 added another 112 GW to the EU's energy generation mix in 2005, 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.

Natural gas' share of total EU capacity has increased by 50% since 2000, reaching 22% by end 2008. Coal's share is unchanged while oil (down by 5%-points), large hydro (down 3%-points) and nuclear (down 6%-points) have all decreased their share. Wind energy's share has increased from 2% in 2000 to 8% in 2008.

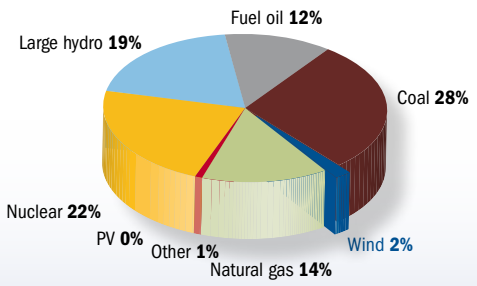
INSTALLED POWER CAPACITY EU (2000-2008)* FIGURE 2.1



* EU-25 before January 2007; EU-15 before May 2005

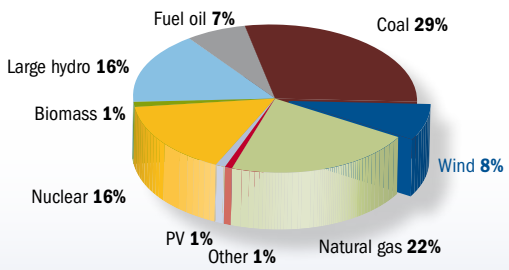
Source: EWEA, EPIA and Platts Powervision

EU POWER CAPACITY MIX (2000) (TOTAL: 575 GW) FIGURE 2.2



EWEA, EPIA and Platts Powervision

EU POWER CAPACITY MIX (2008) (TOTAL: 801 GW) FIGURE 2.3



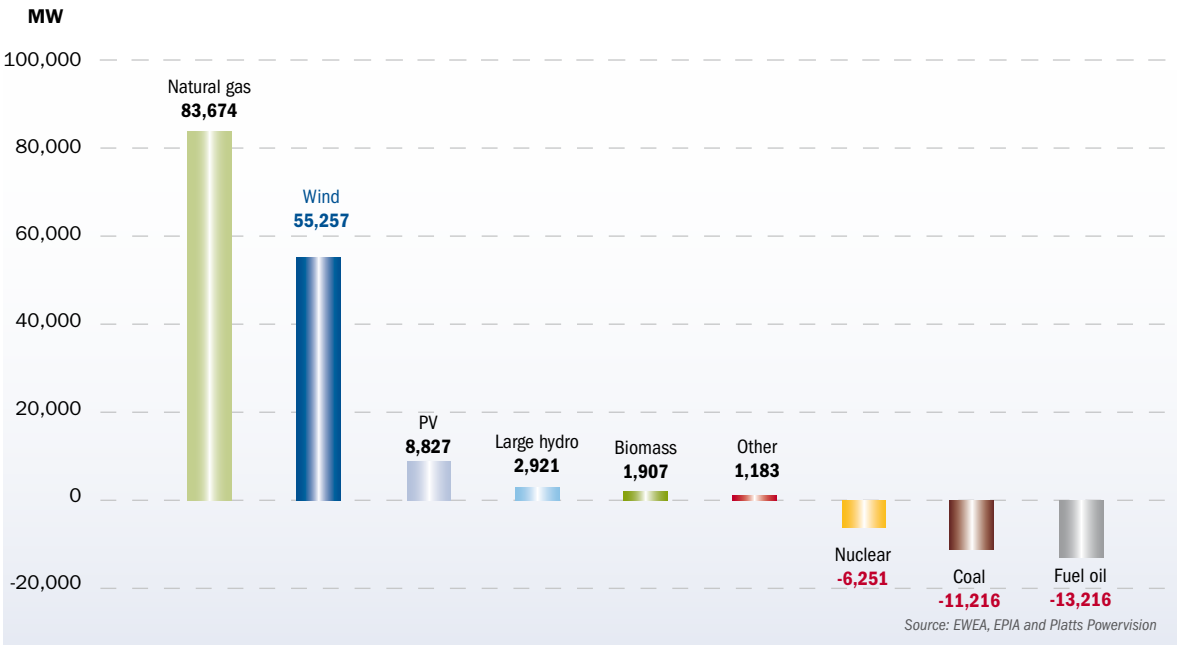
Source: EWEA, EPIA and Platts Powervision

Changes in EU net installed capacity for the various electricity generating technologies from 2000 to 2008 are shown in Figure 2.4. Over the eight year period, net capacity increased by 123 GW. The growth of natural gas (84 GW) and wind power (55 GW) came about at the expense of fuel oil (down 13 GW), coal (down 11 GW) and nuclear power (down 6 GW). In 2008, 23.9 GW of new capacity was installed in the EU-27, of which 8.5 GW (36%) was wind, 6.9 GW (29%) was natural gas and 4.2 GW (18%) was solar PV.

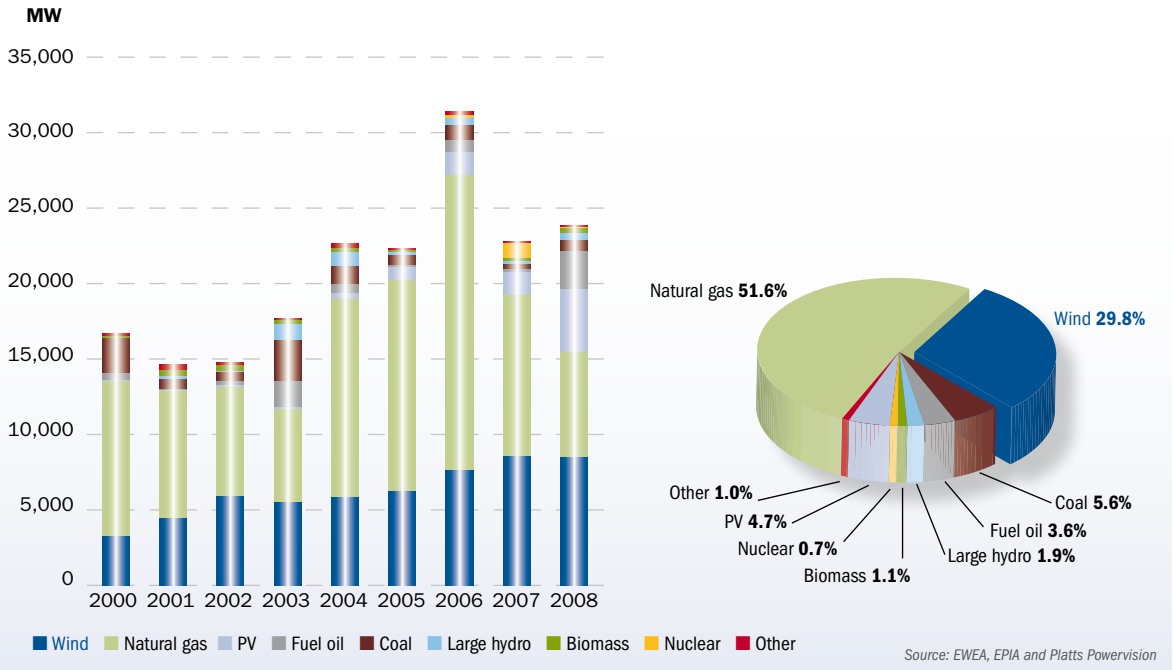
Wind energy increased its share of total power capacity in the EU to 8% in 2008. But it is wind's contribution to new generation capacity that is even more striking. 30% of all power capacity installed since 2000 has been wind power, making it the second largest contributor to new EU capacity over the last ten years after natural gas (52%). 5.6% of all new capacity over the eight year period was coal, 4.7% solar PV, 3.6% fuel oil, 1.9% large hydro, 1.1% biomass and 0.7% nuclear power (Figure 2.5).

2008 was the first year in which more new wind energy capacity was installed in the EU than any other electricity generating capacity. 23.8 GW of new capacity was installed, of which 8.5 GW (36%) was wind and 6.9 GW (29%) was gas. Another renewable energy technology – solar PV - came in third at 4.2 GW (18%). In total, 57% (14 GW) of all new generating capacity installed in the EU in 2008 was renewable energy (Figure 2.6).

NET INCREASE/DECREASE IN POWER GENERATING TECHNOLOGIES (2000-2008) (TOTAL INCREASE: 123 GW) FIGURE 2.4

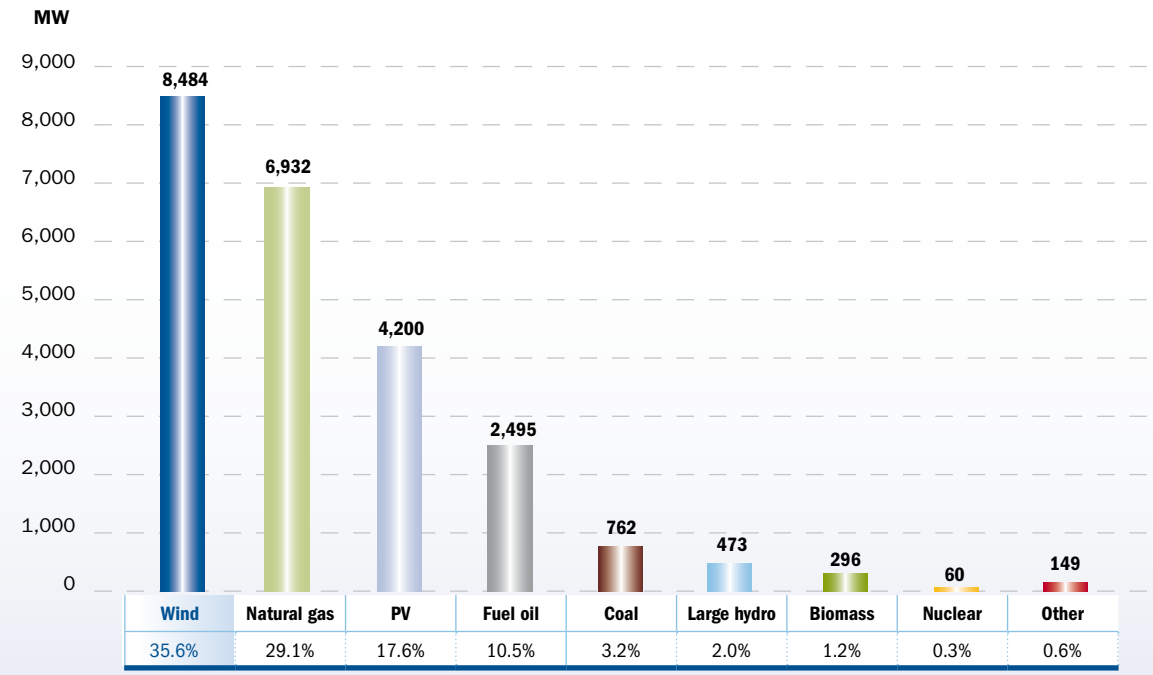


NEW EU POWER GENERATING CAPACITY (2000-2008) (TOTAL: 187 GW) FIGURE 2.5



Source: EWEA, EPIA and Platts Powervision

NEW EU INSTALLED POWER CAPACITY (2008) (TOTAL: 23,581 MW) FIGURE 2.6



Wind	Natural gas	PV	Fuel oil	Coal	Large hydro	Biomass	Nuclear	Other
35.6%	29.1%	17.6%	10.5%	3.2%	2.0%	1.2%	0.3%	0.6%

Source: EWEA, EPIA and Platts Powervision

NEW ANNUAL POWER CAPACITY IN THE EU 1995-2008 (MW)* TABLE 2.1

Year	Natural gas	Wind	Coal	Fuel oil	Large hydro	Biomass	Nuclear	PV	Other	Total
1995	4,661	814	847	1,273	377	0	1,258	0	282	9,511
1996	7,401	979	899	1,165	150	569	0	14	176	11,353
1997	9,130	1,277	2,792	964	482	82	1,516	18	143	16,403
1998	4,836	1,700	2,783	898	416	126	0	16	148	10,923
1999	4,855	3,225	62	269	352	9	4,548	31	45	13,396
2000	10,320	3,209	2,352	438	18	117	0	54	178	16,686
2001	8,391	4,428	703	52	161	383	0	97	416	14,631
2002	7,231	5,913	606	283	72	412	0	69	172	14,758
2003	6,166	5,462	2,725	1,718	1,050	244	0	184	116	17,665
2004	13,130	5,838	1,204	603	935	235	40	348	292	22,625
2005	14,025	6,204	677	118	225	101	50	816	104	22,320
2006	19,543	7,592	1,010	819	433	32	163	1,530	291	31,413
2007	10,670	8,535	332	212	203	196	987	1,529	93	22,755
2008	**6,932**	**8,484**	**762**	**2,495**	**473**	**296**	**60**	**4,200**	**149**	**23,851**

* EU-25 before January 2007; EU-15 before May 2005

Source: EWEA, EPIA and Platts Powervision

TOTAL INSTALLED CAPACITY IN THE EU 1995-2008 (MW)* TABLE 2.2

Year	Natural gas	Wind	Coal	Fuel oil	Large hydro	Biomass	Nuclear	PV	Other	Total
1995	58,482	2,497	160,926	69,723	108,797	1,928	125,065	47	4,748	532,213
1996	65,055	3,476	161,001	69,694	108,901	2,496	125,065	61	4,924	540,674
1997	72,982	4,753	163,095	69,019	109,382	2,579	126,522	79	5,066	553,476
1998	77,797	6,453	162,051	68,937	109,719	2,705	125,322	95	5,214	558,293
1999	82,192	9,678	160,686	66,490	110,048	2,673	128,471	126	5,219	565,583
2000	89,801	12,887	159,482	66,518	110,066	2,790	128,471	180	5,282	575,476
2001	95,457	17,315	156,671	64,119	110,252	3,173	128,471	277	5,618	581,353
2002	100,825	23,098	155,235	64,024	110,325	3,585	128,179	346	5,619	591,236
2003	106,311	28,491	151,644	59,038	111,374	3,760	127,267	530	5,735	594,151
2004	118,320	34,372	150,493	56,540	111,649	3,995	127,067	878	5,817	609,132
2005	131,797	40,500	150,333	53,650	111,859	4,096	126,160	1,694	5,881	625,971
2006	162,651	48,031	230,072	53,303	124,337	4,329	130,309	3,224	6,172	762,427
2007	170,877	56,517	229,322	53,515	124,540	4,498	129,107	4,753	6,265	779,394
2008	**177,613**	**64,935**	**229,338**	**54,879**	**125,013**	**4,780**	**128,727**	**8,953**	**6,402**	**800,640**

* EU-25 before January 2007; EU-15 before May 2005

Source: EWEA, EPIA and Platts Powervision

3. The Current Status of Wind Power

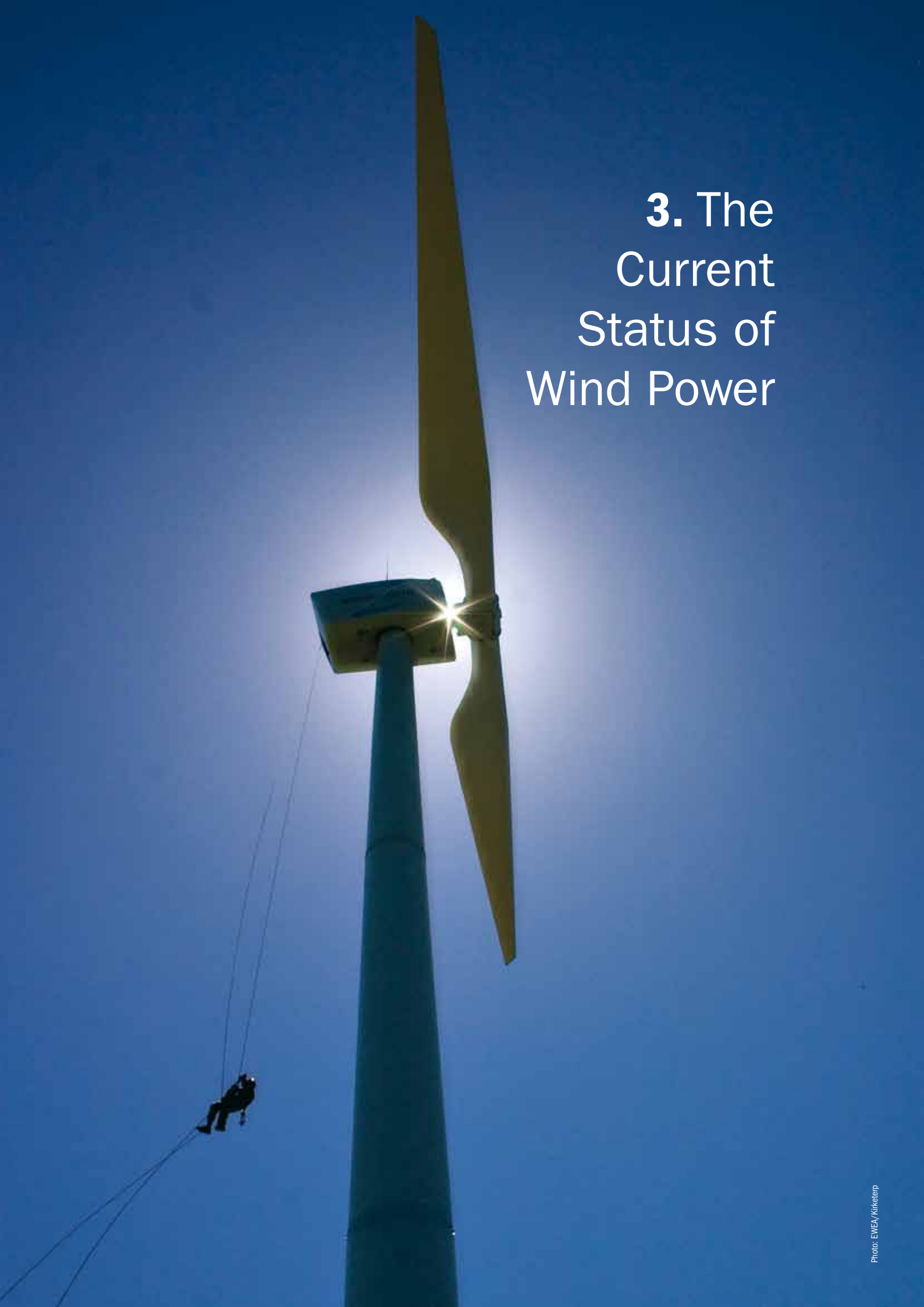


Photo: EWEA/Kiketerp

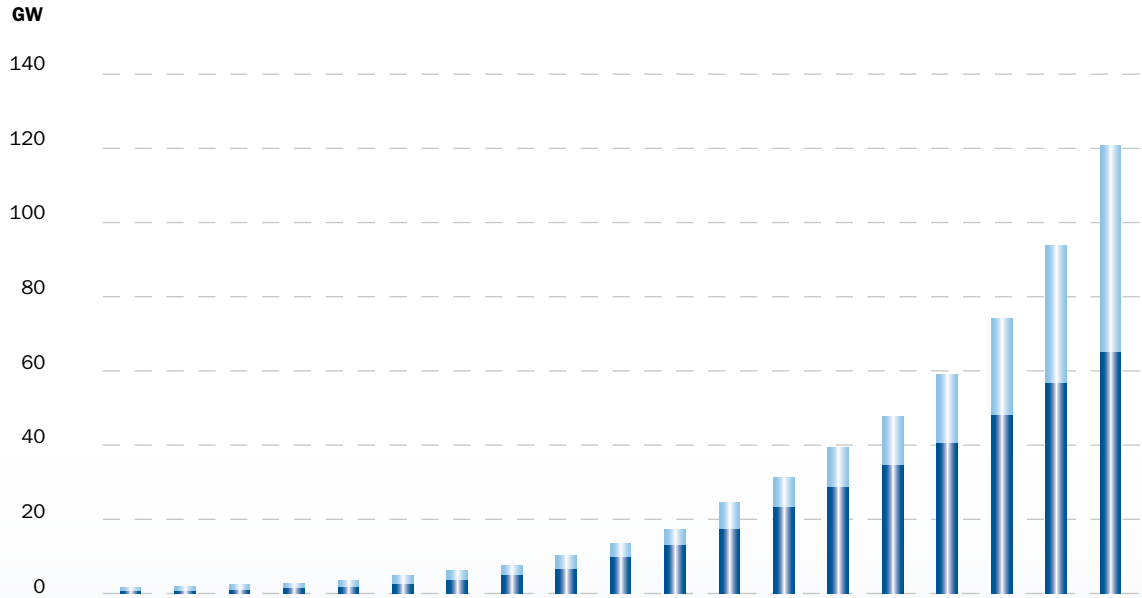
27.1 GW of wind power capacity was installed globally during 2008, reaching a total of 121 GW by the end of the year (Figure 3.1). The global annual market for wind turbines increased by 37% in 2008, following growth of 31% in both 2006 and 2007, and 40% in 2005 (Figure 3.2). Over the past four years, the annual global market for wind turbines has more than tripled from 8.3 GW in 2004 to 27.1 GW in 2008. The total installed wind power capacity increased from 48 GW to 121 GW over the same period.

The development of wind and nuclear energy

All around the world, wind energy is developing rapidly, and following the same development as conventional power sources in the past. Figure 3.3 compares the global development of wind energy over the 18 years from 1991 to 2008 with the development of nuclear power capacity from a similar stage of development – over the 18 years from 1961 to 1978.

Despite much hype about a global nuclear energy revival there is little market evidence to support it. In the last ten years - from 1999 to 2008 - a total of 111.3 GW of wind power capacity was built globally, compared to 27.1 GW of nuclear capacity (see Figure 3.4). As much wind energy capacity was installed globally in 2008 as the amount of nuclear capacity installed in the whole of the last decade (27.1 GW).

GLOBAL CUMULATIVE WIND ENERGY CAPACITY (1990-2008) FIGURE 3.1

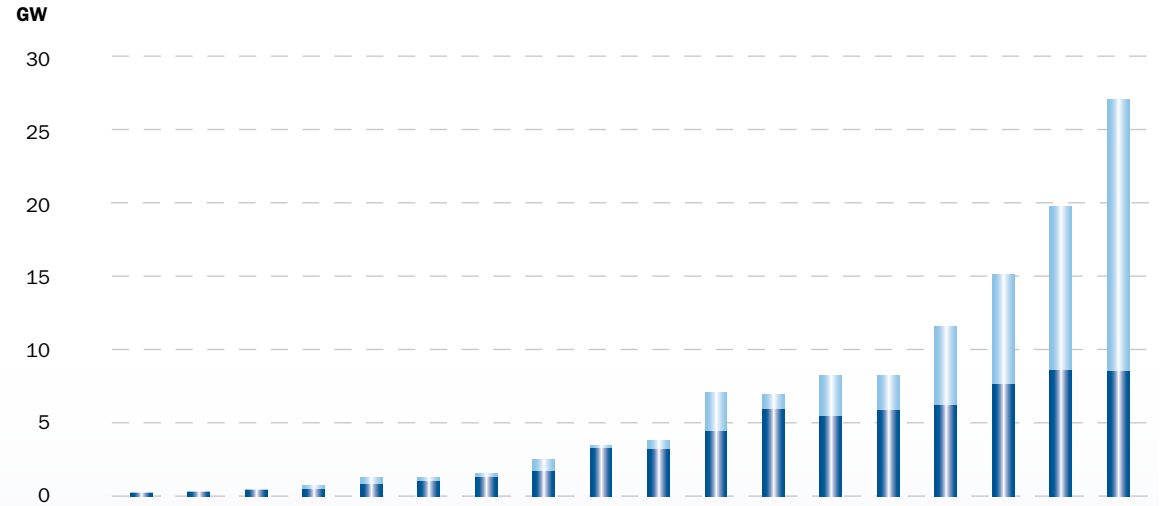


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rest of World	1.304	1.354	1.477	1.590	1.848	2.324	2.628	2.883	3.700	3.916	4.470	7.133	8.150	10.940	13.248	18.591	26.102	37.285	55.856
EU	0.439	0.629	0.844	1.211	1.683	2.497	3.476	4.753	6.453	9.678	12.887	17.315	23.098	28.491	34.372	40.500	48.031	56.517	64.935
TOTAL	1.743	1.983	2.321	2.801	3.531	4.821	6.104	7.636	10.153	13.594	17.357	24.448	31.248	39.431	47.620	59.091	74.133	93.802	120.791

Source: EWEA and GWEC

GLOBAL ANNUAL WIND ENERGY CAPACITY (1990-2008)

FIGURE 3.2

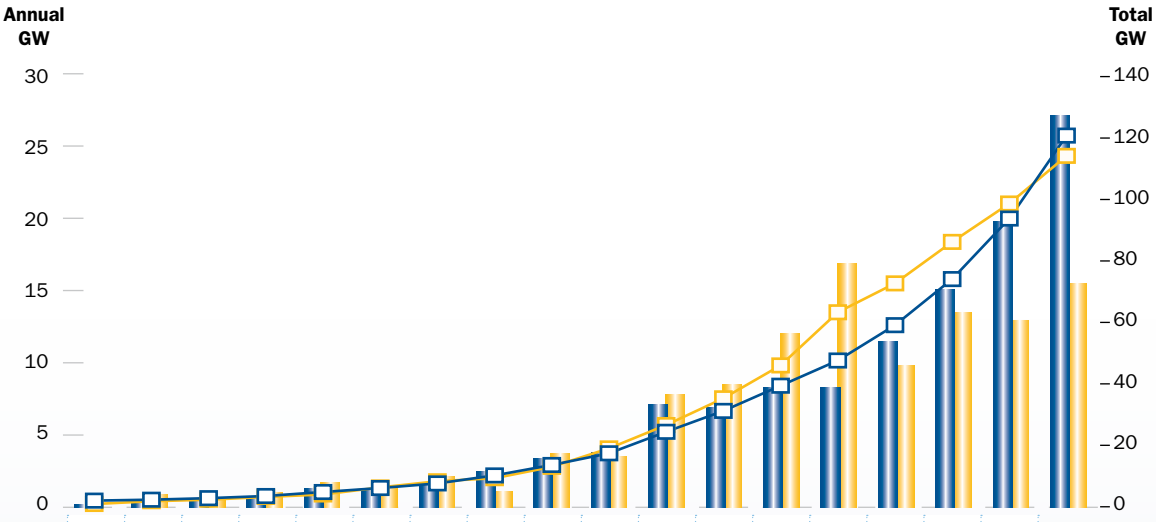


	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rest of World	50	123	113	258	476	304	255	817	216	554	2,663	1,017	2,790	2,415	5,343	7,512	11,221	18,571
EU	190	215	367	472	814	979	1,277	1,700	3,225	3,209	4,428	5,913	5,462	5,838	6,204	7,592	8,535	8,484
TOTAL	240	338	480	730	1,290	1,283	1,532	2,517	3,441	3,763	7,091	6,930	8,252	8,254	11,547	15,103	19,756	27,056

Source: EWEA and GWEC

GLOBAL WIND DEVELOPMENT (1991-2008) COMPARED TO NUCLEAR DEVELOPMENT (1961-1978)

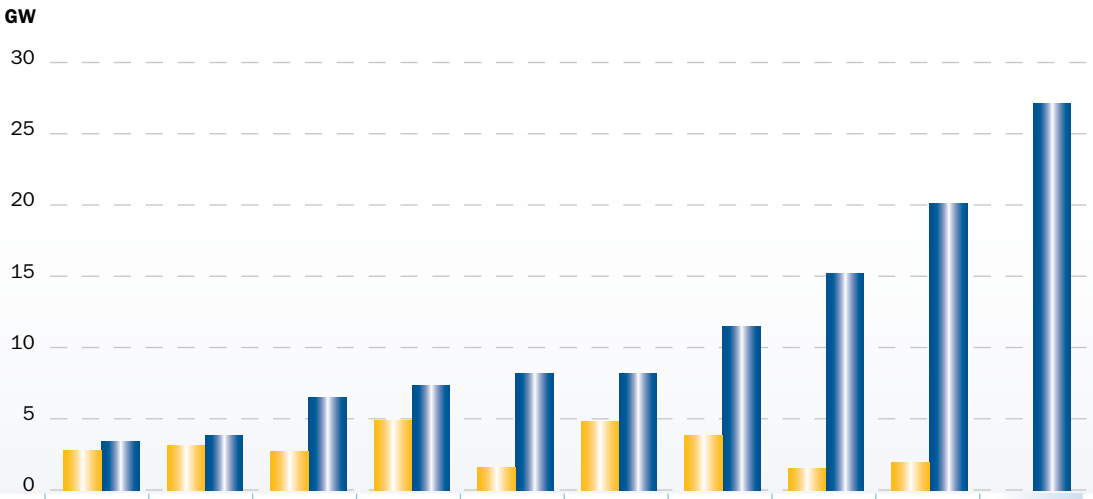
FIGURE 3.3



	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual Wind GW	0.2	0.3	0.5	0.7	1.3	1.3	1.5	2.5	3.4	3.8	7.1	6.9	8.3	8.3	11.5	15.1	19.8	**27.1**
Annual Nuclear GW	0.0	0.9	0.5	1.0	1.7	1.4	2.1	1.1	3.7	3.5	7.8	8.5	12.0	16.9	9.8	13.5	12.9	**15.5**
Total Wind GW	2.0	2.3	2.8	3.5	4.8	6.1	7.6	10.2	13.6	17.4	24.4	31.2	39.4	47.6	59.1	74.1	93.8	**120.8**
Total Nuclear GW	0.9	1.8	2.3	3.2	4.0	6.3	8.3	9.3	13.0	19.0	26.6	35.3	46.0	63.3	72.7	86.2	98.7	**114.2**

Source: EWEA and International Atomic Energy Agency (IAEA)

NEW WIND ENERGY AND NUCLEAR CAPACITY INSTALLED (1999-2008) FIGURE 3.4



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Nuclear	2.8	3.1	2.7	4.9	1.6	4.8	3.8	1.5	1.9	0	27.1 GW
Wind	3.4	3.8	6.5	7.3	8.2	8.2	11.5	15.2	20.1	27.1	111.3 GW

Source: EWEA and International Atomic Energy Agency (IAEA)

In Europe, the European Commission's 1997 White Paper target of 40 GW of wind power capacity by 2010 in the EU was reached in 2005, five years ahead of time.

By the end of 2008, there was 64.9 GW of wind power capacity installed in the EU-27, of which 63.9 GW was in the EU-15. In the scenario that EWEA drew up in October 2003[4], we expected 61.1 GW to be installed in the EU-15 by the end of 2008. Thus the total capacity was underestimated by 2.8 GW over the six year period. In 2003, EWEA expected total annual installations in 2008 to be 6.8 GW, whereas the actual market was significantly higher at 8.1 GW in the EU-15 (8.5 GW in the EU-27).

In the EU, cumulative installed wind power capacity has increased by an average of 26% year on year over the past decade, from 6.5 GW in 1998 to 64.9 GW in 2008. In terms of annual installations, the EU market for wind turbines has grown by an average of 17% annually in the past decade, from 1.7 GW in 1998 to 8.5 GW in 2008.

Wind energy and the EU Member States

Germany (24 GW) and Spain (17 GW) continue to be Europe's undisputed leaders in terms of total installed wind energy capacity (Table 3.1). 63% of the EU's installed capacity is located in the two countries. In 2008, three large countries – Italy (3.7 GW), France (3.4 GW) and the UK (3.2 GW) - overtook Denmark (3.2 GW – the third wind energy pioneer country with Germany and Spain) in total capacity.

[4] Source: EWEA, 2003a.

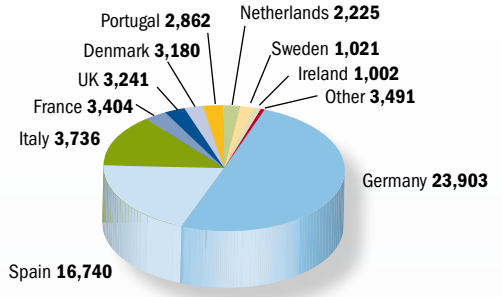
TOTAL INSTALLED WIND POWER CAPACITY IN THE EU-27 (2005-2008) (MW) TABLE 3.1

Country	2005	2006	2007	2008
Austria	819	965	982	995
Belgium	167	194	287	384
Bulgaria	10	36	57	158
Cyprus	-	-	-	-
Czech Republic	28	54	116	150
Denmark	3,128	3,136	3,125	3,180
Estonia	32	32	59	78
Finland	82	86	110	143
France	757	1,567	2,454	3,404
Germany	18,415	20,622	22,247	23,903
Greece	573	746	871	985
Hungary	17	61	65	127
Ireland	496	746	795	1,002
Italy	1,718	2,123	2,726	3,736
Latvia	27	27	27	27
Lithuania	6	48	51	54
Luxembourg	35	35	35	35
Malta	-	-	-	-
Netherlands	1,219	1,558	1,747	2,225
Poland	83	153	276	472
Portugal	1,022	1,716	2,150	2,862
Romania	2	3	8	10
Slovakia	5	5	5	3
Slovenia	-	-	-	-
Spain	10,028	11,623	15,131	16,740
Sweden	510	571	788	1,021
UK	1,332	1,962	2,406	3,241
EU total	**40,500**	**48,031**	**56,517**	**64,935**

Source: EWEA

In 2008, Germany (1.665 GW) installed marginally more wind power than Spain (1.609 GW). They were followed by Italy, (1.010 GW), France (0.950 GW) and the UK (0.836 GW). Ten countries – Germany, Spain, Italy, France, the UK, Denmark, Portugal, the Netherlands, Sweden and Ireland – now have more than 1 GW installed each.

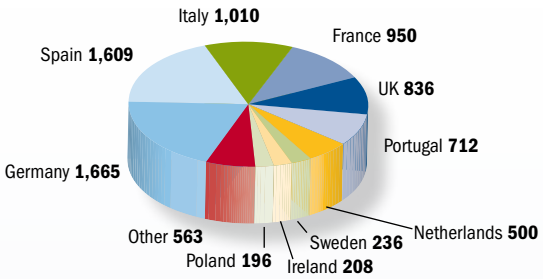
MEMBER STATE MARKET SHARES FOR TOTAL CAPACITY (AS OF END 2008) (Total 64,935 MW) FIGURE 3.6



Other	
Austria	995 MW
Greece	985 MW
Poland	472 MW
Belgium	384 MW
Bulgaria	158 MW
Czech Republic	150 MW
Finland	143 MW
Hungary	127 MW
Estonia	78 MW
Lithuania	54 MW
Luxembourg	35 MW
Latvia	27 MW
Romania	10 MW
Slovakia	3 MW
Cyprus	0 MW
Malta	0 MW
Slovenia	0 MW

Source: EWEA

MEMBER STATE MARKET SHARES FOR NEW CAPACITY (2008) (Total 8,484 MW) FIGURE 3.5

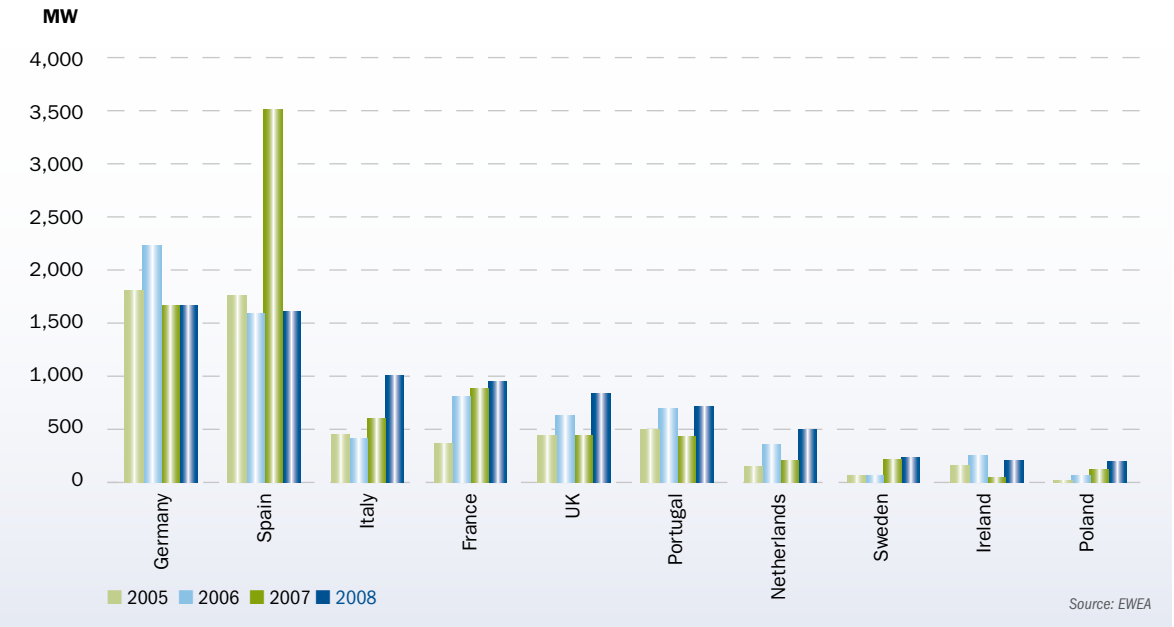


Other	
Greece	114 MW
Belgium	104 MW
Bulgaria	101 MW
Denmark	77 MW
Hungary	62 MW
Czech Republic	34 MW
Finland	33 MW
Estonia	20 MW
Austria	14 MW
Lithuania	3 MW
Romania	2 MW

Cyprus, Latvia, Luxembourg, Malta, Slovenia and Slovakia installed no capacity in 2008.

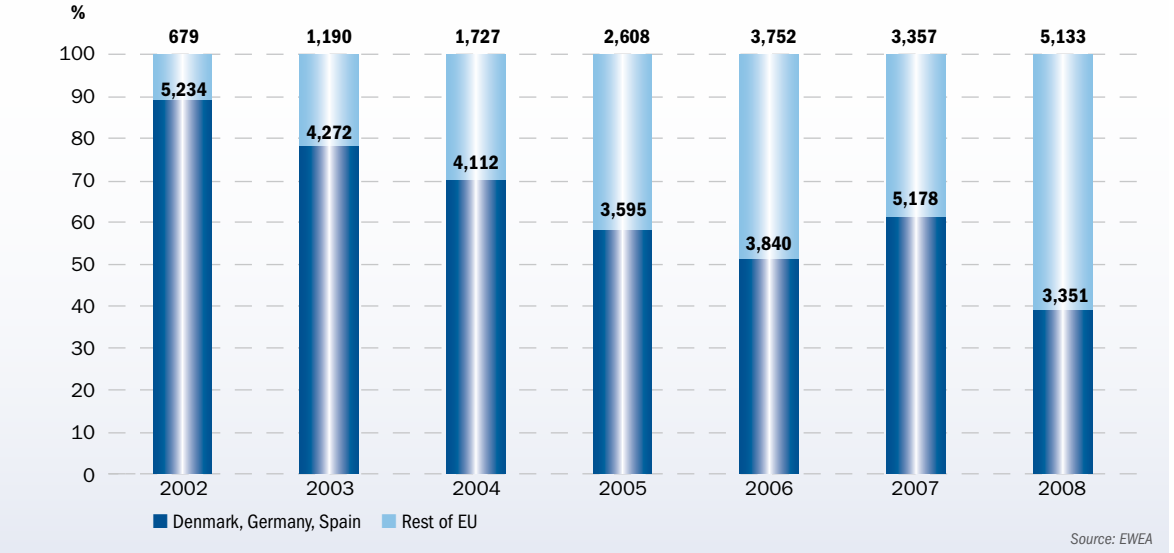
Source: EWEA

TOP 10 EU WIND ENERGY MARKETS (2005-2008) FIGURE 3.7

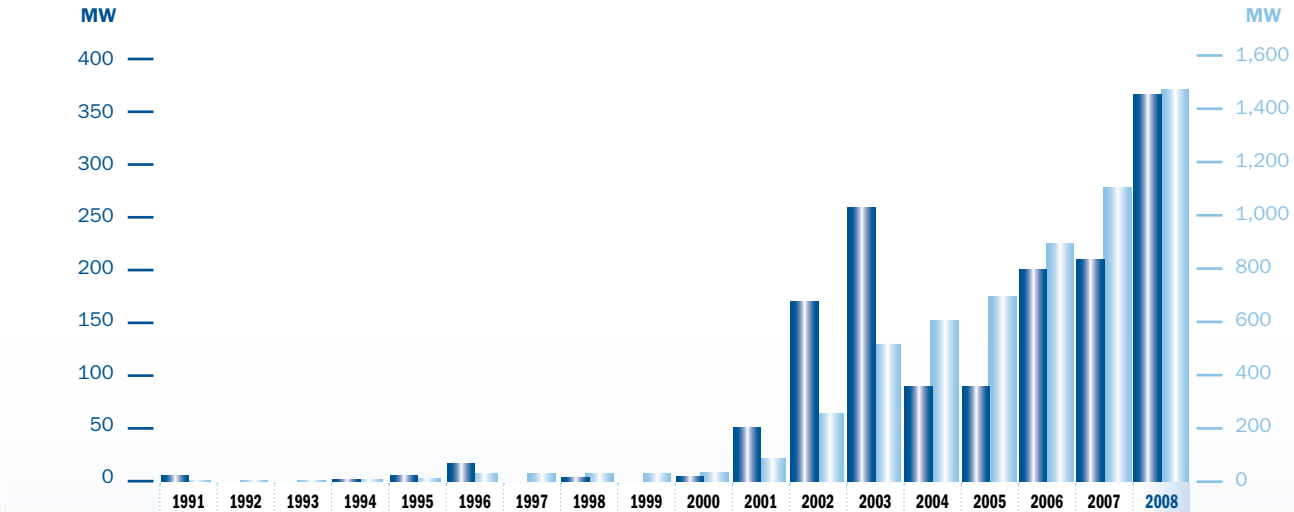


Germany, Spain and Denmark – the three pioneering countries of wind power, as mentioned above - are home to 67.5% of the installed wind power capacity in the EU. However, their share of annual installations has dropped from 89% in 2002 to 39% in 2008 (Figure 3.8). Germany and Spain continue to attract the majority of investments, but strong market growth is taking place in other European countries. In 2002, 0.679 GW of European wind power capacity was installed outside Germany, Spain and Denmark. In 2008, the figure was 5.133 GW – more than a seven-fold increase. A second wave of European countries is investing in wind power, partly as a result of the EU Renewable Electricity Directive passed in 2001.

GERMANY, SPAIN AND DENMARK'S SHARE OF THE EU MARKET (2002-2008) FIGURE 3.8



ANNUAL AND CUMULATIVE INSTALLED EU OFFSHORE WIND CAPACITY (1991-2008) FIGURE 3.9



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual	5	0	0	2	5	17	0	3	0	4	51	170	259	90	90	201	210	**366**
Cumulative	5	5	5	7	12	29	29	32	32	35	86	256	515	605	695	895	1,105	**1,471**

Source: EWEA

The growth of offshore wind

With 1.5 GW by the end of 2008, offshore accounted for 2.3% of installed EU wind energy capacity (up from 1.9% in 2007) and 4.3% of annual capacity. 366 MW of offshore capacity was installed during 2008, beating the previous record of 259 MW installed in 2003.

In 2008 the UK, with 591 MW of total offshore capacity, overtook Denmark, the former offshore front-runner with 409 MW. Both the UK and the Netherlands installed more than 100 MW during 2008. By the end of the year, there were nine countries, all in Europe, with operating offshore wind farms.

OFFSHORE WIND POWER IN EUROPE (2008) TABLE 3.2

	Installed in 2008	Total by end 2008
UK	187	591
Denmark	0	409
Netherlands	120	247
Sweden	0	133
Belgium	30	30
Ireland	0	25
Finland	24	24
Germany	5	12
Italy*	0	0
Total	**366**	**1,471**

Source: EWEA

*As of the end of 2008 Italy had one offshore test turbine with a capacity of 0.08 MW, but it was not grid connected.

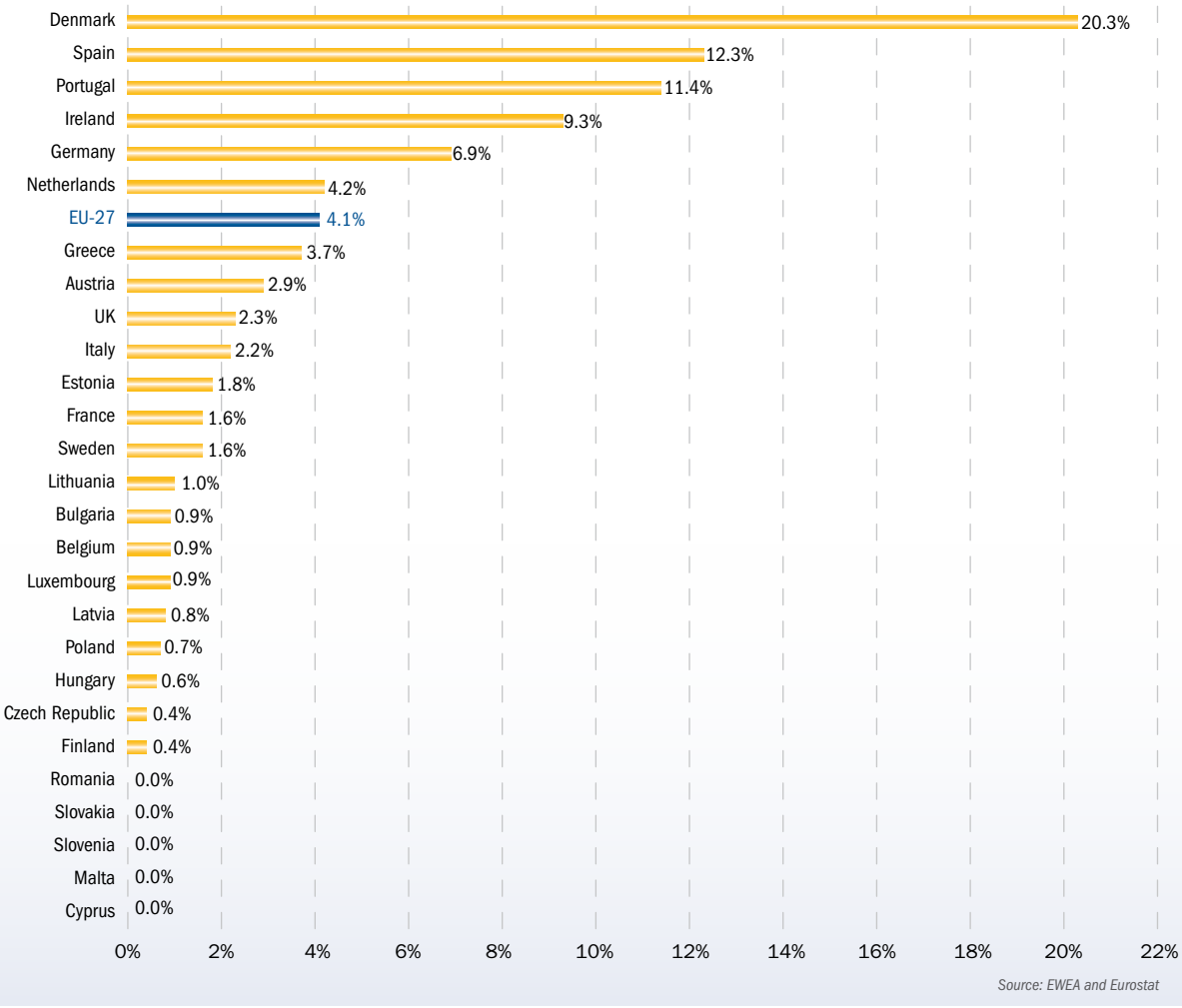
Wind energy capacity compared to country size and population

The total wind power capacity installed at the end of 2008 will produce 4.1% of the EU-27's electricity demand in a normal wind year. Wind power in Denmark covers more than 20% 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% of their electricity demand produced by wind energy[5] (Figure 3.10).

By the end of 2008, 133 kW of wind energy capacity was installed for every 1,000 people in the EU – up from 116 kW at the end of 2007 (Figure 3.11). Denmark tops the list with 589 kW/1,000 people followed by Spain (405 kW) and Germany (290 kW). If all EU countries had the same amount of installed wind power capacity per capita as Spain, the EU total would be 198 GW instead of the end 2008 figure of 65 GW. If all EU countries had the same amount of capacity per capita as Denmark, total EU installations would be 287 GW.

There are 14 MW of wind power capacity installed per 1,000 km^2 of land area in the EU (Figure 3.12). Not surprisingly, being a small country, wind power density is highest in Denmark, but Germany comes a close second. The Netherlands has the third highest turbine density in the EU. It is interesting that Spain's wind power density is less than half that of Germany,

WIND POWER'S SHARE OF NATIONAL ELECTRICITY DEMAND (END 2008) FIGURE 3.10



Source: EWEA and Eurostat

[5] Source: Eurostat and EWEA. The national wind power shares are calculated by taking the electricity that the capacity installed by the end of 2008 will produce in a normal wind year and dividing it by the actual 2007 electricity demand, which is the latest available figure from Eurostat. Average capacity factors are assumed by EWEA for each country. The statistical methodology used differs from the methodology otherwise used throughout this report. The figures may differ from the shares reported by national wind energy associations due to differences in methodology.

indicating a large remaining potential - at least from a visual perspective. Portugal and Ireland are also above the EU average.

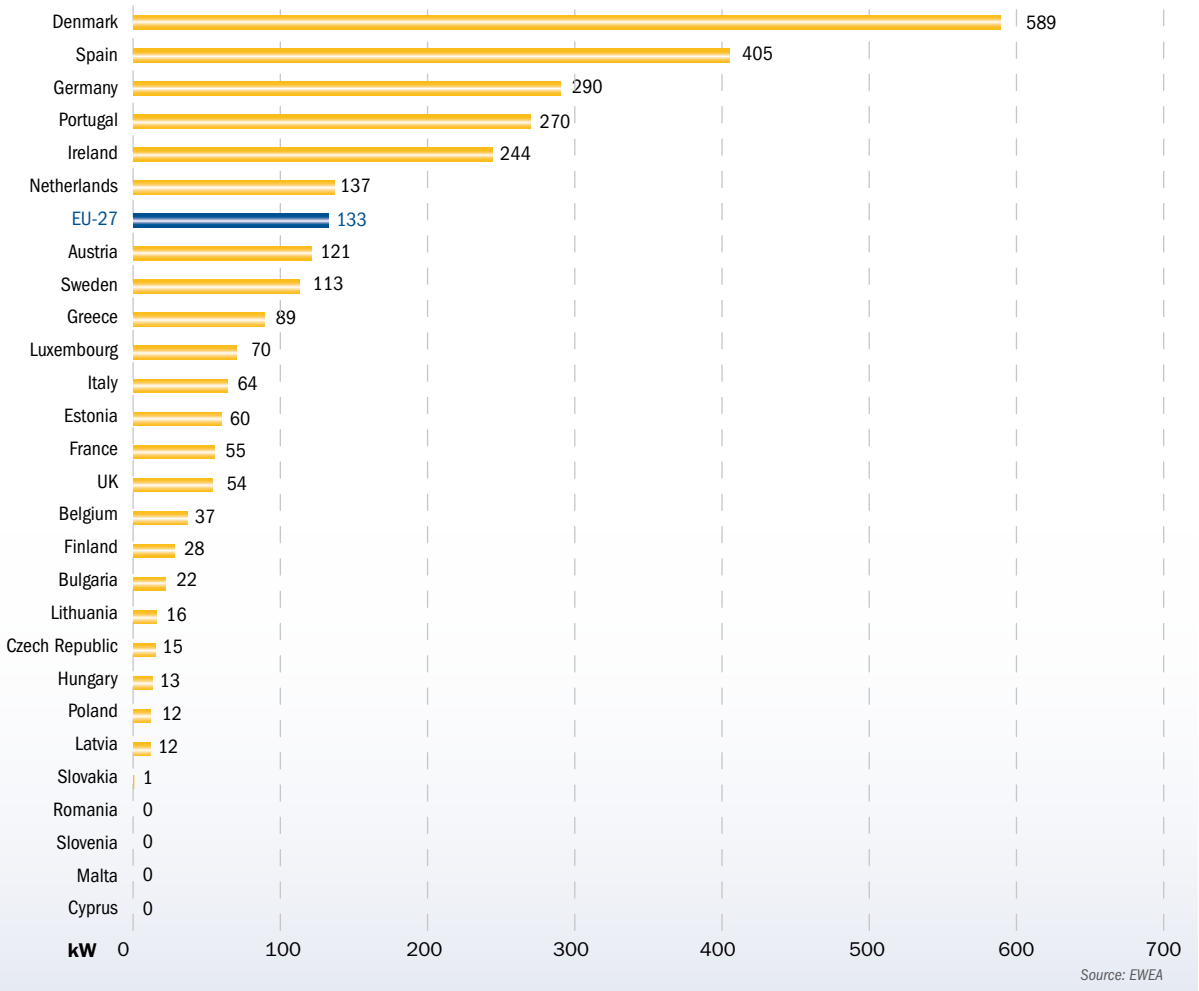
Many geographically large Member States, such as France, the UK, Sweden, Finland, Poland and Italy, still have very low wind power densities compared to the first-mover countries. If France had the same wind power density as Denmark, there would be 40 GW of wind power capacity installed in France (3.4 GW was operating by end 2008); the UK would also have 40 GW (3.2 GW by end 2008), Sweden would have 33 GW (1 GW by end 2008), Finland 25 GW (0.1 GW by end 2008), Poland 23 GW (0.5 GW by end 2008) and Italy 22 GW (3.7 GW by end 2008).

If the eight geographically largest Member States had a "capacity-density" equivalent to that of Denmark, they would have a combined installed wind power capacity of 250 GW. This is equal to EWEA's target for onshore wind energy capacity in the EU by 2030. If all 27 EU Member States had the same capacity-density as Denmark, it would make a total of 341 GW, compared with 65 GW at the end of 2008.

Avoiding CO_2 with wind energy

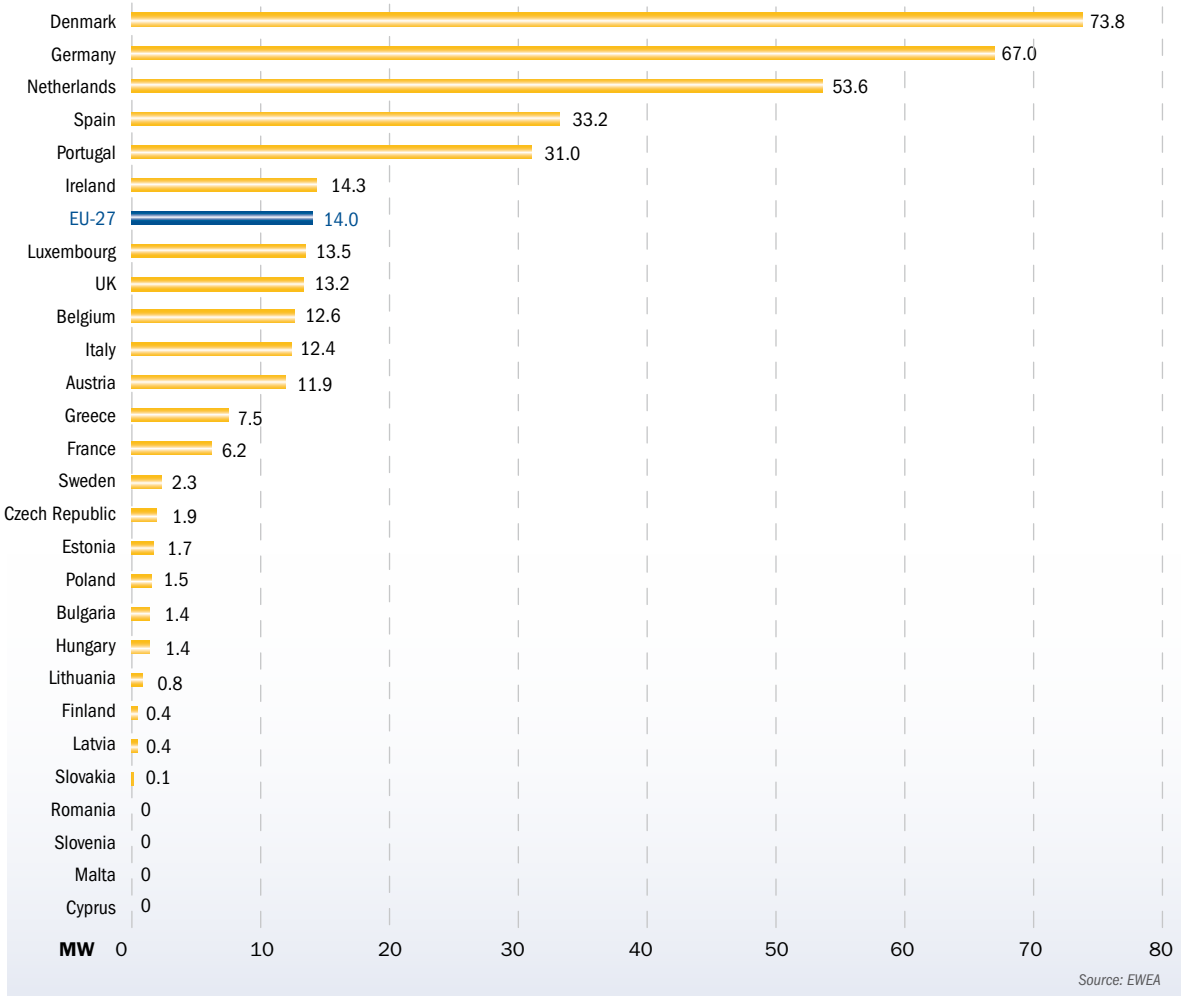
The total installed capacity of wind power by the end of 2008 will, in an average wind year, avoid the emission of 91 Megatonnes (Mt) of CO_2. Figure 3.13 shows the CO_2 avoided due to turbines installed by end

kW OF WIND ENERGY CAPACITY PER 1,000 PEOPLE (END 2008) FIGURE 3.11



Source: EWEA

MW OF WIND ENERGY CAPACITY PER 1,000 KM² (END 2008) FIGURE 3.12



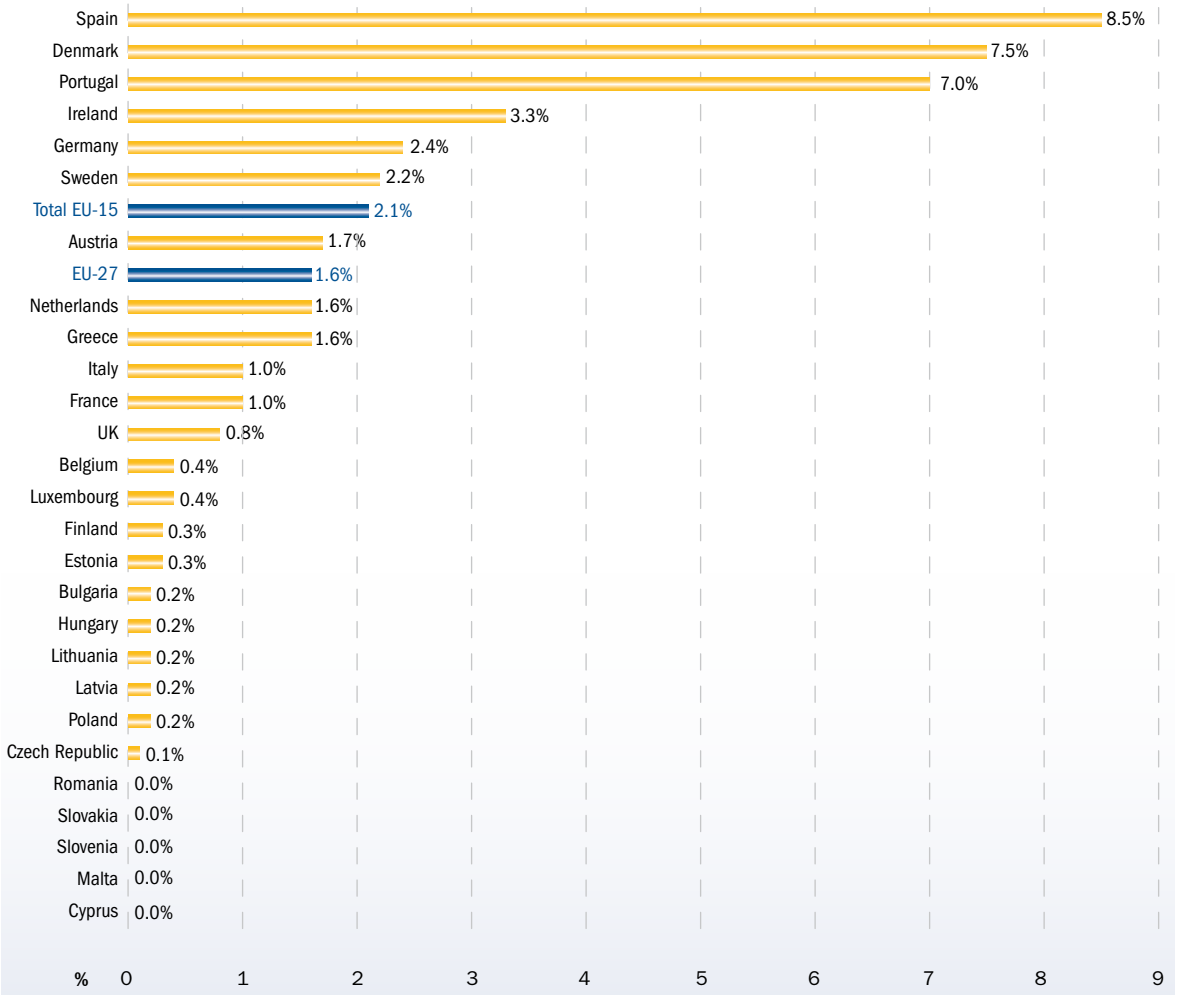
Source: EWEA

2008. It presents the avoided CO_2 as a percentage of the amount of greenhouse gases (GHG) emitted by Member States in 1990, the base-year for most countries' emissions reductions targets in the Kyoto Protocol. The figures assume that 1 TWh of wind power displaces 0.667 Mt of CO_2 – based on the average energy mix in the EU. (See Chapter 10 'CO_2 reductions from wind power' for a detailed explanation of the methodology).

However, caution must be applied when interpreting the results since 1 TWh of wind power avoids far more CO_2 in - for example – Poland, where the share of coal power production is much higher than the EU average, and avoids less in France, for example, where wind power mainly replaces gas at the intermediate load.

Overall, the wind power capacity installed by the end of 2008 avoids the emission of 91 Mt of CO_2. Of this, 89.8 Mt are avoided in the EU-15 countries, which have a shared obligation under the Kyoto Protocol to reduce their GHG emissions by 8% compared to 1990 levels. The 8% reduction compared to 1990 equals approximately 340 Mt of CO_2 equivalents. The new Member States have individual targets (excluding Malta and Cyprus which have no obligation). The wind power installed in the EU-15 by the end of 2008 reduces CO_2 emissions by 2.1% of 1990 GHG emissions, equal to 27% of the bloc's Kyoto Protocol obligation.

CO_2 AVOIDED FROM WIND ENERGY AS A PERCENTAGE OF 1990 GREENHOUSE GAS EMISSIONS (2008) FIGURE 3.13

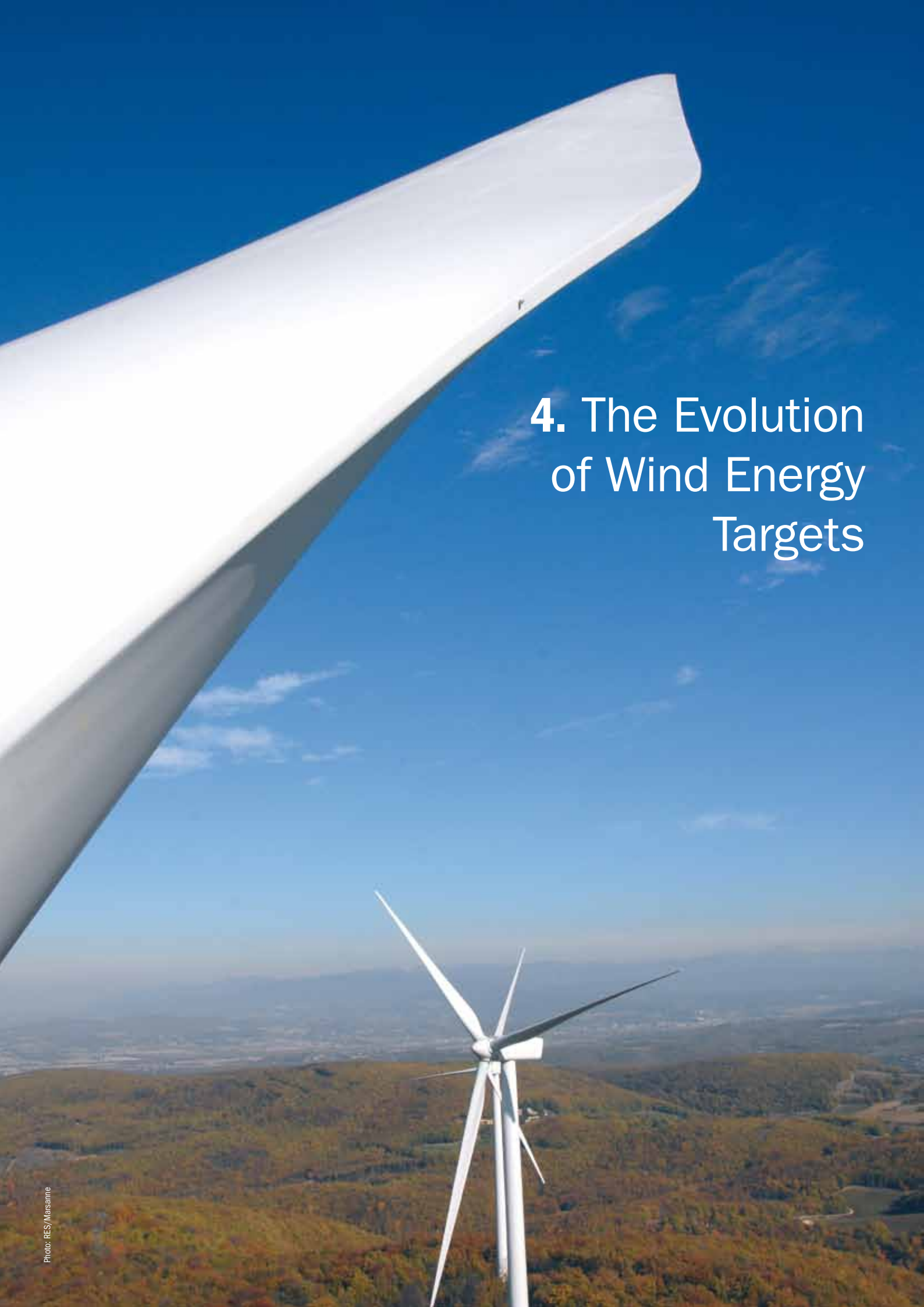


Source: EWEA and European Environment Agency (EEA)

Summary of wind energy in the EU-27 in 2008

- 65 GW installed capacity: 63.5 GW onshore and 1.5 GW offshore
- Annual installations of 8.5 GW: 8.1 GW onshore (95%) and 0.4 GW offshore (5%)
- Annual investments of €11 billion: €10.1 onshore and €0.9 billion offshore
- Meeting 4% of EU electricity demand
- 36% of all new electricity generating capacity in the EU (Total 2008: 23.9 GW)
- 8% of total electricity generating capacity in the EU (Total end 2008: 801 GW)
- Producing 137 TWh: 132 TWh onshore and 5 TWh offshore, equivalent to the consumption of 34 million average EU households
- Avoiding 91 Mt CO_2 annually, equal to 27% of the EU-15's Kyoto obligation
- Avoiding €2.3 billion[6] of CO_2 cost annually
- Avoided fuel cost of €6.5 billion

[6] Assuming €25/tCO_2.



4. The Evolution of Wind Energy Targets

Photo: RES/Marsanne

The 1997 European Commission White Paper on Renewable Sources of Energy set the goal of doubling the share of renewable energy in the EU's energy mix from 6% to 12% by 2010. It included a target of 40 GW for wind power in the EU by 2010, which would produce 80 TWh of power and save 72 Mt of CO_2. The 40 GW target was reached in 2005. Another target set out in the White Paper was to increase the share of electricity from renewable energy sources (RES-E) from 337 TWh in 1995 to 675 TWh in 2010.

By the end of 2008, there was 65 GW of wind power capacity installed in the EU, producing 137 TWh of electricity – 40% of the European Commission White Paper target for 2010. EWEA expects wind energy to produce 179 TWh by 2010, meeting 53% of the 2010 White Paper target for all renewable electricity.

The European Commission's White Paper was followed by Directive 2001/77/EC on the Promotion of Electricity from Renewable Energy Sources. When adopted in 2001, it was the most important piece of legislation ever introduced for renewables, and led the then 15 Member States to develop political frameworks and financial instruments to encourage investment in renewables and help overcome administrative barriers and grid access barriers.

The directive sets national indicative targets for the contribution of electricity from renewables as a percentage of gross electricity consumption by 2010. The overall goal set out in the directive is to increase the share of electricity coming from renewables from 14% in 1997 to 22% in 2010. With the enlargement, the overall EU target was adjusted to 21% of electricity consumption.

The 40 GW goal from the European Commission's White Paper naturally formed EWEA's target in 1997, but three years later, due to strong development in the German, Spanish and Danish wind energy markets, EWEA increased its target by 50% to 60 GW by 2010 and 150 GW by 2020 (Table 4.1). In 2003, EWEA once again increased its target, this time by 25% to 75 GW by 2010 and 180 GW in 2020. In 2007, due to the expansion of the EU with ten new Member States, EWEA increased its target for 2010 to 80 GW, while maintaining its 2020 target of 180,000 MW and setting a target of 300 GW by 2030.

Following the adoption of the EU's 2009 Renewable Energy Directive, which aims to increase the share of electricity from renewables from 15% in 2005 to 34% in 2020, EWEA in March 2009 again raised its 2020 target for wind energy – this time to 230 GW.

EWEA now expects 82.5 GW of wind power capacity to be operating in the EU by the end of 2010 and is increasing its 2030 target from 300 GW to 400 GW, including 150 GW offshore.

Baseline scenarios from the International Energy Agency (IEA) and the European Commission

Both the European Commission and the International Energy Agency publish baseline scenarios for the development of various electricity generation technologies, including wind energy (see Table 4.1). In 1996, one year before adopting its White Paper target of 40 GW of wind power by 2010, the European Commission estimated that 8 GW would be installed by 2010 in the EU. The 8 GW was reached, three years later, in 1999. The Commission's target for 2020 was set at 12.3 GW and reached, two decades ahead of schedule, in 2000.

Since 1996, the European Commission has changed its baseline scenario five times. Over the ten year period between 1996 and 2006, its targets for wind energy in 2010 and 2020 gradually increased tenfold - from 8 GW to 79 GW (for 2010) and from 12 GW to 129 GW (for 2020). EWEA's 2010 target for wind energy doubled from 40 GW (in 1997) to 80 GW (in 2006) during the same period.

The International Energy Agency (IEA) also makes baseline scenarios for the development of wind power. In 2002 the IEA estimated that 33 GW would be installed in Europe in 2010, 57 GW by 2020 and 71 GW by 2030. Two years later, in 2004, it doubled its forecast for wind energy to 66 GW in 2010 and more than doubled its 2020 and 2030 Business As Usual scenario for wind in the EU to 131 GW in 2020 and 170 GW in 2030. In 2006, the IEA again increased its 2030 target for wind power in the EU to 217 GW (its alternative policy scenario assumes 227 GW). In 2008, the IEA increased its wind energy targets once again[7].

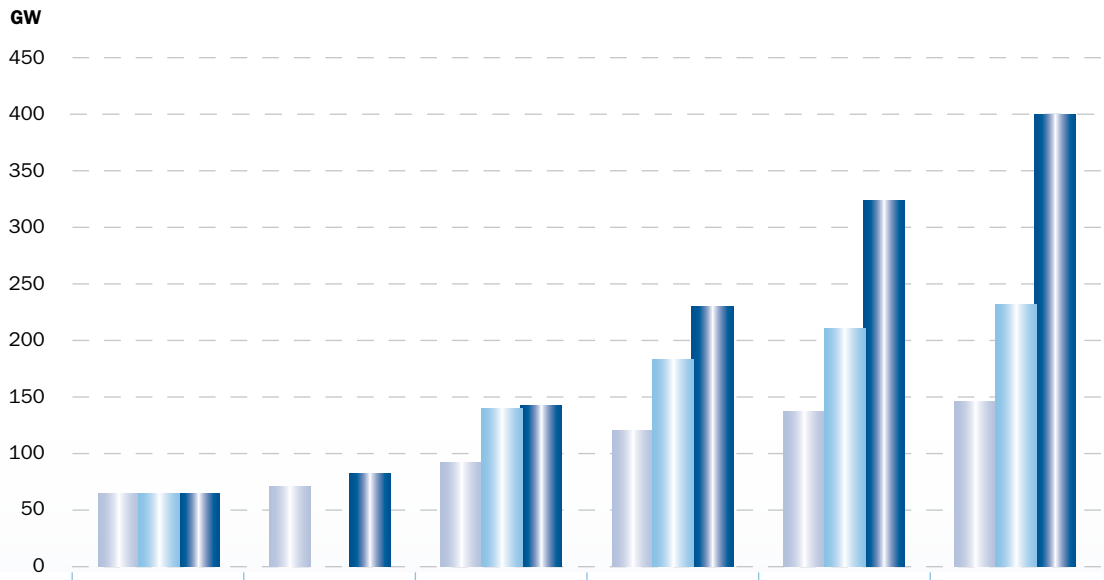
[7] Source: IEA, 2008a.

WIND BASELINE SCENARIOS FOR EU-27 FROM THE EUROPEAN COMMISSION[8], THE IEA[9] AND EWEA (GW) TABLE 4.1

	1995	2000	2005	2008	2010	2015	2020	2025	2030
European Commission scenarios									
EC 1996		4	6		8	10	12		
EC 1999			15		23		47		
EC 2003					70		95		120
EC 2004					73		104		135
EC 2006					79	104	129	166	185
EC 2008					**71**	**92**	**120**	**137**	**146**
IEA scenarios									
IEA 2002					33		57		71
IEA 2004					66		131		170
IEA 2006					68	106	150		217
IEA 2008						**140**	**183**	**211**	**232**
EWEA targets									
EWEA 1997					40				
EWEA 2000					60		150		
EWEA 2003					75		180		
EWEA 2007					80	125	180	240	300
EWEA 2009					**82.5**	**143**	**230**	**324**	**400**
Actual market	**3**	**13**	**41**	**65**					

Source: EC, IEA and EWEA

WIND BASELINE SCENARIOS FOR EU-27 FROM THE EUROPEAN COMMISSION, THE IEA AND EWEA (2008-2030) (GW) FIGURE 4.1



	2008	2010	2015	2020	2025	2030
EC 2008	64.9	71.3	92.2	120.4	137.2	145.9
IEA 2008	64.9	N/A	140	183	211	232
EWEA 2009	64.9	82.6	142.9	230	323.5	400

Source: EC, IEA and EWEA

[8] Source: EC, 2008a.

[9] Source: IEA, 2008a.

In 2008, the European Commission, rather surprisingly, reduced its wind energy targets for the first time ever[10]. It lowered its 2010 target by 10% from 79 GW to 71 GW and its 2015 forecast by 12% from 104 GW to 92 GW. The current Commission Baseline scenario implies that the annual market for wind power would fall by an astonishing 62% from 8.5 GW in 2008 to 3.2 GW in 2009 and 2010. In contrast, EWEA expects 8.6 GW to be installed during 2009.

It is unclear what led the European Commission to reduce its targets for wind energy in 2008. In the same year, the IEA dramatically increased its 2015 forecast by 24% from 106 GW to 140 GW, in line with EWEA's 2015 target of 143 GW.

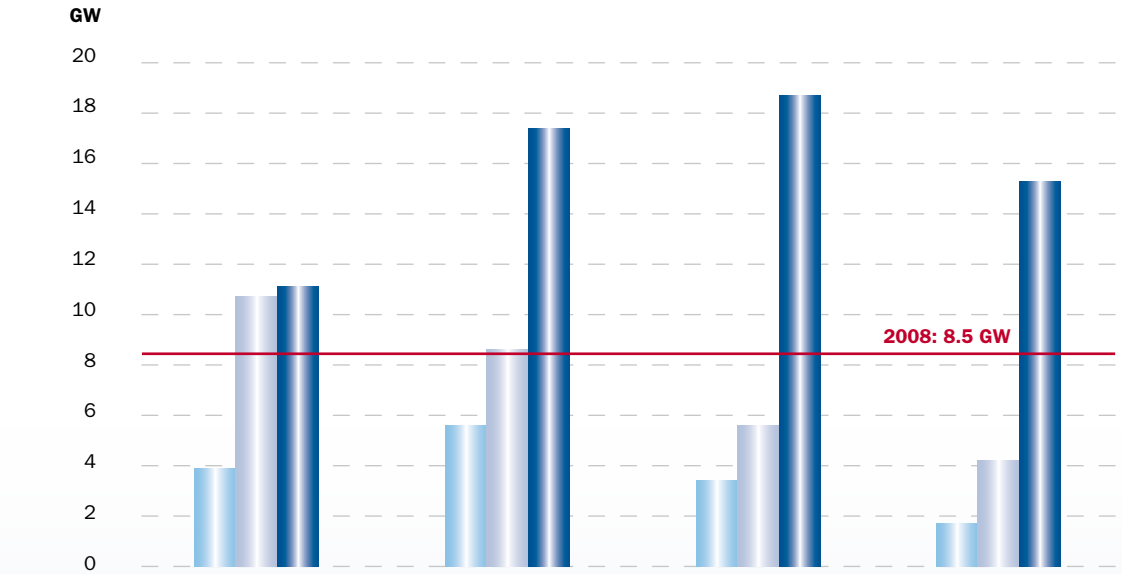
Similarly, the Commission lowered its 2020 wind energy target from 129 GW to 120 GW, while the IEA increased its target from 150 GW to 183 GW (exceeding EWEA's then 2020 target of 180 GW). For 2030, the European Commission reduced its wind energy target by a massive 39 GW – reducing it by 21% from an already very low level of 185 GW to 146 GW - while the IEA raised its target 28% from 170 GW to 217 GW (see Table 4.1).

It is clear that there is a major discrepancy between the European Commission and the IEA's views on the future of wind energy in Europe. The IEA says there will be 143 GW of wind energy capacity installed by 2015 – seven years from now - while the European Commission believes this amount will only be reached in 2030.

The European Commission figures suggest that the annual growth in wind energy capacity in the EU will drop by 46% as of 2009 - from 8.5 GW in 2008 to an average of 3.9 GW per year from 2009 to 2015 (see Figure 4.2). In contrast, the IEA expects the annual increase in capacity to average 10.7 GW while EWEA expects 11.1 GW. From 2021 to 2030, the European Commission expects wind energy to increase by an average of 2.6 GW per year.

AVERAGE ANNUAL INCREASE IN WIND ENERGY CAPACITY IN THE EU-27 - THE EUROPEAN COMMISSION, THE IEA AND EWEA COMPARED

FIGURE 4.2



	2009-2015	2016-2020	2021-2025	2026-2030
EC 2007	3.9	5.6	3.4	1.7
IEA 2008	10.7	8.6	5.6	4.2
EWEA 2009	11.1	17.4	18.7	15.3

Source: IEA, EC and EWEA

[10] Source: EC, 2008a.

The European Commission scenario is obtained with the PRIMES energy model by the E3M Lab at the National Technical University of Athens. It would appear from the wind energy scenarios described above that the E3M Lab's model is more than a little unreliable and has been so since its introduction in 1996.

Unfortunately, it is not only wind energy that the PRIMES model fails to predict. In its 2008 scenario, the European Commission's PRIMES model even suggests that EU investments in "other renewables" (that is, renewables excluding biomass and wind) will be negative in 2009 and 2010 (see Figure 4.3). It predicts that more than 6 GW of "other renewables" will be taken off the grid in 2009 and 2010. In sharp contrast to this, 4.8 GW of "other renewables" was installed in 2008 alone.

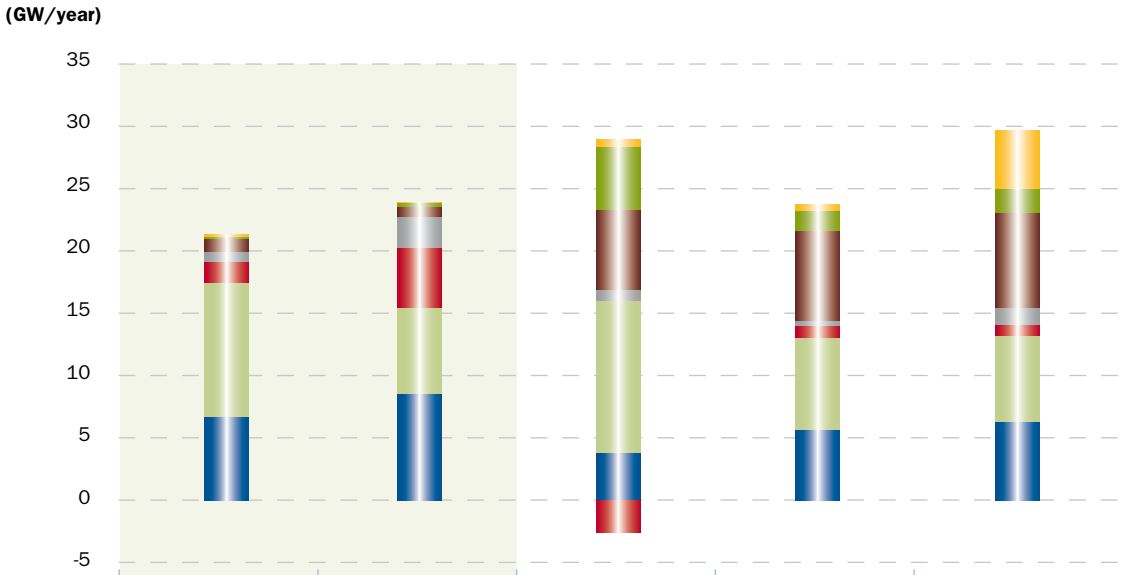
Over the years, the E3M Lab – and thereby the European Commission – have consistently overestimated fossil fuel and nuclear energy's future development, while grossly underestimating the development of renewable energy technologies. The following developments in the EU power sector are implied by the latest (2008) scenario from the European Commission's PRIMES energy model:

- In 2009-2010, investment in new coal capacity will increase by 745% and investment in "other renewables" will decrease by 163% compared to 2008.
- In the decade 2011-2020, annual investment in coal will be 625% higher than annually in 2001-2008 and annual investments in nuclear capacity will be 223% higher, while annual investments in "other renewables" will be 50% lower and wind energy 15% lower than annually in the period 2001-2008.
- For the ten years from 2021 to the end of 2030, the European Commission's PRIMES model assumes that the EU will build 7.6 GW of new coal capacity annually, 6.9 GW of gas, 6.2 GW of wind, 4.8 GW of nuclear (five new nuclear plants per year) and 1.9 GW of biomass. The model assumes that a meagre 0.9 GW of "other renewables" will be built per year over the decade – down from actual installations of 4.8 GW in 2008.

The European Commission claims that its baseline scenario "projects that oil and gas prices will remain at a rather high level". However, its oil price assumption for 2015 is almost 50% lower than that of the IEA. The European Commission assumes an oil price in 2010 of $54.5/barrel and $61.1/barrel in 2020 (in $_{2005}$). In its 2008 scenario, the IEA assumes an oil price of $100 in 2015 and $110 in 2020 (in $_{2007}$). By the end of October 2009, Nymex Crude was trading at $80/barrel.

EWEA strongly recommends that the European Commission revise its PRIMES energy model. Over the past 12 years, the European Commission has allowed the E3M Lab to feed Member States and the general public with misleading information about the future of European energy. It is clear that the PRIMES scenarios are consistently marginalising renewable energy sources, while overestimating fossil fuels and nuclear energy. The model was peer reviewed by the European Commission back in 1997-1998. A new review is urgently needed.

AVERAGE ANNUAL CAPACITY ADDITIONS EU 2009-2030 ACCORDING TO THE EUROPEAN COMMISSION, 2008 FIGURE 4.3



	2001-2008	2008	2009-2010	2011-2020	2021-2030
Nuclear	0.162	0.060	0.550	0.525	4.840
Biomass	0.237	0.296	5.051	1.620	1.900
Coal	1.002	0.762	6.441	7.270	7.850
Oil	0.787	2.495	0.851	0.400	1.400
Other renewables	1.745	4.823	-3.030	0.880	0.940
Gas	10.761	6.932	12.256	7.380	6.930
Wind	6.557	8.484	3.372	5.550	6.230

Source: 2001-2008: EWEA and Platts Powervision; 2009-2030: European Energy and Transport – Trends to 2030, update 2007; European Commission 2008.

5. Three Short-Term Predictions for the Development of the EU Wind Power Market (2009-2013)

Photo: GWEC

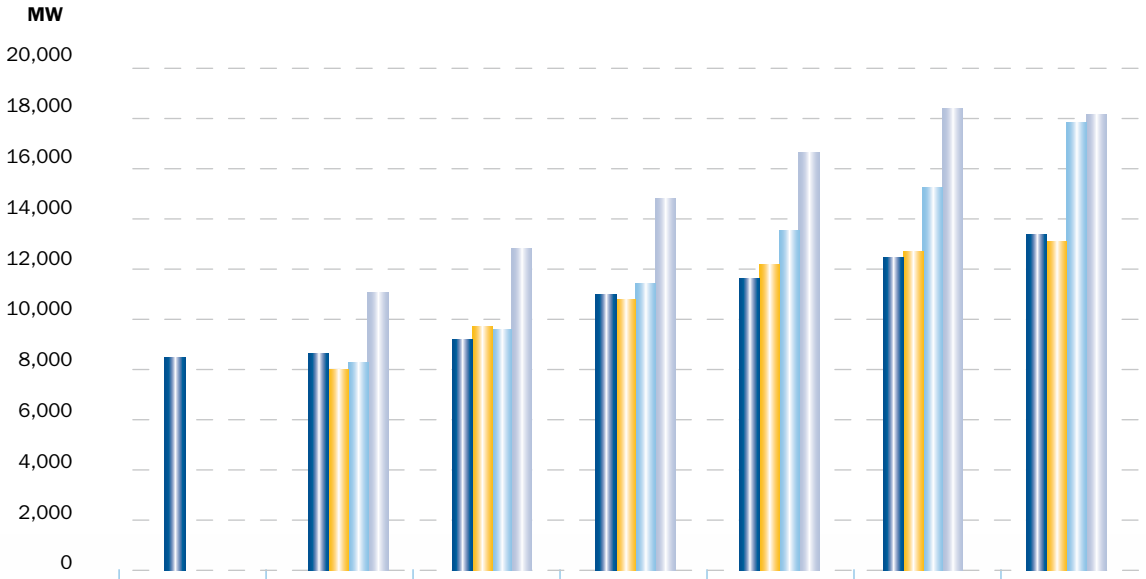
As illustrated in the previous chapter, the European Commission's baseline scenarios using its PRIMES energy model have consistently underestimated the development of wind energy and other renewable energy technologies. Its latest (2008) projection for wind energy forecasts an average annual increase in wind energy capacity for the period from 2009 to 2015 of 3.9 GW, compared to the latest annual wind power installation in 2008 of 8.5 GW.

The Commission's scenarios are clearly lower than EWEA's short-term forecast, which assumes an average annual market from 2009 to 2015 of 11.1 GW. As was also illustrated in the previous chapter, EWEA has always been rather conservative in setting targets and has, as a consequence, found it necessary to raise its targets four times since 2000. As depicted in Figure 5.1, EWEA's new scenario is significantly below those of market analysts BTM Consult[11] and MAKE Consulting[12] for every year up to 2013. The sole exception is 2009, for which MAKE Consulting's prediction is below EWEA's. For example, while EWEA expects annual installations of 12.5 GW in 2013, MAKE Consulting predicts 15.3 GW and BTM Consult forecasts 18.4 GW in Europe.

It is evident that EWEA – which expects a total of 66.3 GW to be installed in the European Union over the next five years - is more conservative than the three independent market analysts. Over the five year period, MAKE Consulting expects 75.9 GW to be installed, BTM Consult expects 91.9 GW and EER[13] expects 66.5 GW to be installed.

Although EWEA is quite certain about the outlook for 2009, some uncertainty about the 2010 market is inevitable given the current turmoil in global financial markets and constrained liquidity in the capital markets.

ANNUAL MARKET FORECASTS (2009-2013) EWEA, EER, MAKE CONSULTING AND BTM CONSULT COMPARED FIGURE 5.1



	2008 (actual)	2009	2010	2011	2012	2013	2014	Total
EWEA	8,484	8,630	9,199	11,001	11,629	12,469	13,394	66,323
EER 2009*		8,000	9,700	10,800	12,200	12,700	13,100	66,500
Make 2009**		8,280	9,600	11,445	13,540	15,260	17,825	75,950
BTM 2009***		11,075	12,805	14,825	16,655	18,400	18,150	91,910

* Wind Turbine Supply Chain Strategies: 2009-2020; Emerging Energy Research, July 2009 (figures are for all Europe).
** The Wind Forecast; Market Outlook 2009; MAKE Consulting, September 2009.
*** Global Wind Power Development; A 2030 Scenario; BTM Consult October 2009.

Sources: EWEA, EER, Make Consult and BTM Consult

[11] Source: BTM, 2009a.
[12] Source: MAKE, 2009a.
[13] Source: EER, 2009a.

6. EWEA's 2020 Target

Photo: Siemens

The December 2008 agreement on the 2009 Renewable Energy Directive is the main reason EWEA increased its targets for 2020 in March 2009 and is now increasing its 2030 target from 300 GW to 400 GW. The directive sets mandatory and binding national targets for the share of renewable energy in each of the 27 EU Member States in 2020 (see Figure 6.1). It is by far the most significant legislative effort to promote renewable energy, including wind power, anywhere in the world.

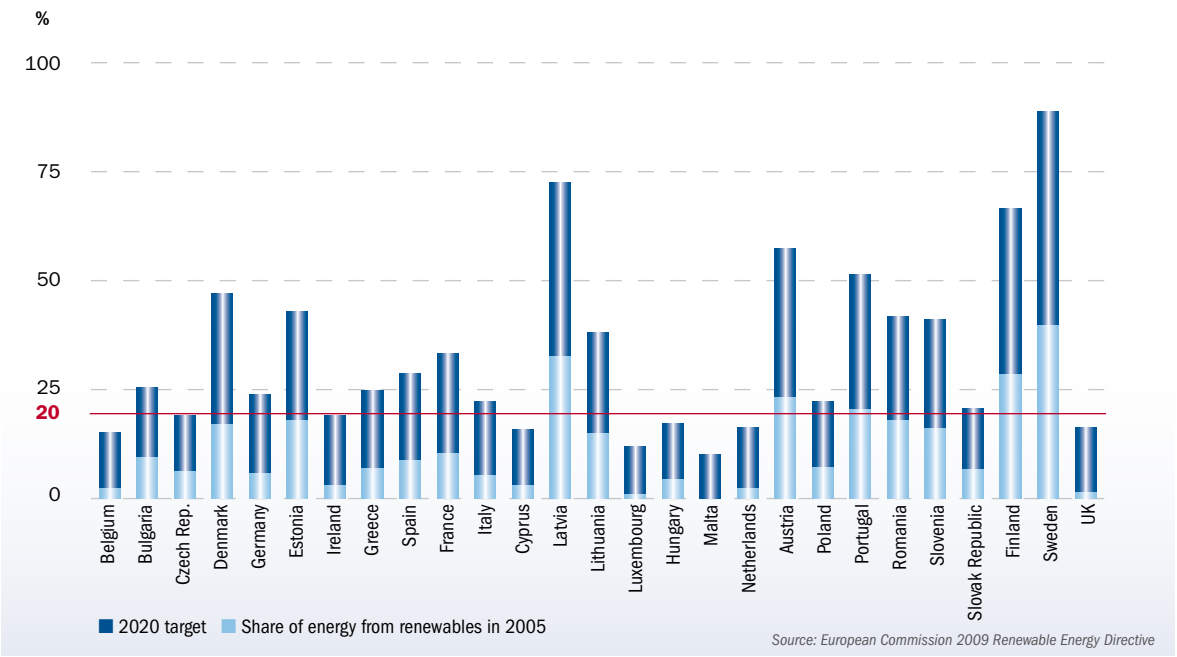
The 2009 Renewable Energy Directive[14] ("the directive") also sets out indicative trajectories for renewable energy in each Member State for each of the years 2010, 2012, 2014, 2016 and 2018. This is to ensure that efforts are not pushed towards the end of the target period.

The directive sets out to increase the overall share of renewable energy from 8.6% in 2005 to 20% in 2020 (see Figure 6.1). For electricity, the European Commission expects that the share of renewable energy will need to increase from 15% to 34% in 2020.

The European Commission expects wind energy to be supplying 12% of the EU's electricity demand by 2020[15], equivalent to around 180 GW of wind energy capacity. This corresponds to EWEA's previous target of 180 GW, including 35 GW offshore. To reach the 180 GW and the 12% of electricity, wind energy capacity would need to increase by an average of 9.6 GW annually over the next 12 years. Given the increase of 8.5 GW in 2008, and that wind energy is the most affordable of the renewable energy technologies in most Member States, it is clear that 180 GW of wind energy in the EU will be achieved before 2020.

Assuming the European Commission's "New Energy Policy" projections[16] for electricity demand in 2020, wind energy would meet 16.9% of EU electricity demand in 2020, including 4.3% of overall demand being met by offshore wind. Using the European Commission's baseline scenario[17] for electricity demand, wind energy's share would be 14.3% (3.6% offshore) in 2020.

NATIONAL OVERALL TARGETS FOR THE SHARE OF ENERGY FROM RENEWABLES IN FINAL CONSUMPTION (2020) FIGURE 6.1



Source: European Commission 2009 Renewable Energy Directive

[14] Source: EU, 2009a.
[15] Source: EC, 2007a.
[16] Source: EC, 2008c.
[17] Source: EC, 2008a.

RENEWABLES' AND WIND'S SHARES IN THE EU ENERGY MIX TABLE 6.1

	2005	2020
Renewable energy share*	8.6%	20%
Renewable electricity share*	15%	34%
Wind energy share**	2.5%	16.9%
of which offshore**	0.1%	4.3%

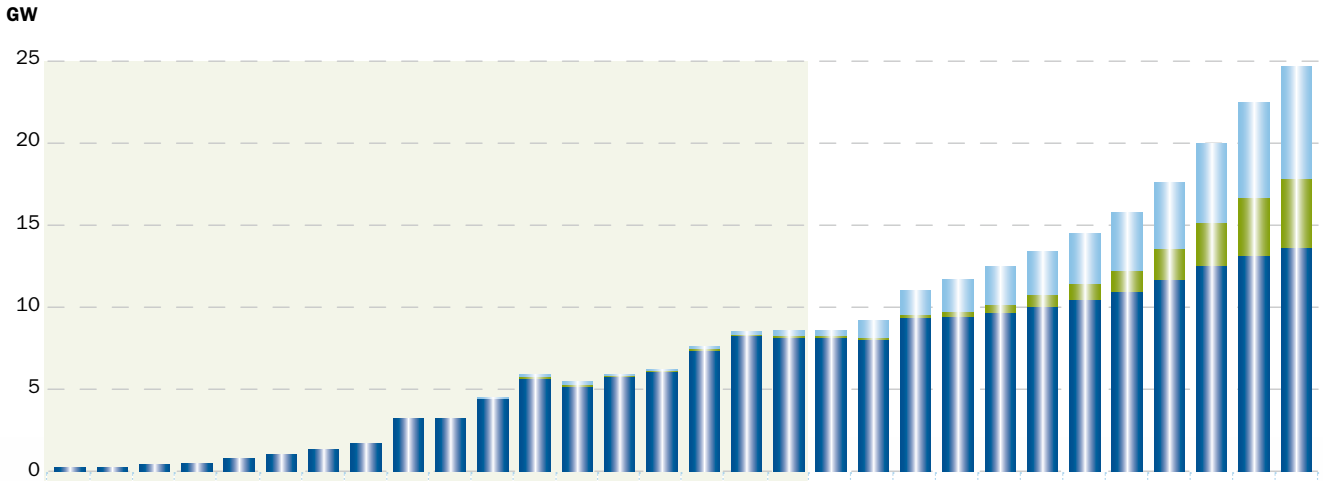
* 2009 Renewable Energy Directive / European Commission
** EWEA, assuming European Commission's "New Energy Policy" electricity demand scenario

Figure 6.2 shows the annual market for wind power up to 2020, according to EWEA's new 2020 targets. In 2010, the market for offshore wind is expected to exceed 1 GW per year for the first time ever. During the second half of the next decade, an increasing amount of existing wind power capacity will be decommissioned. The market for replacement is expected to increase from 1 GW in 2015 to 4.2 GW in 2020. By 2020, 28% of the annual market for new wind power capacity will be offshore. Annual investment in wind power will increase from €11 billion in 2008 to €23.5 billion in 2020 (see Chapter 12). Annual investment in offshore wind will increase from €900 million in 2008 to €8.8 billion in 2020, equal to 37% of total investment.

Figure 6.3 shows the development of total installed capacity in the EU according to EWEA's new targets. In addition to the 2020 target increase, the target for 2010 has been increased from 80 GW to 82.6 GW, and for 2015 we expect 143 GW, compared to 125 GW previously. Offshore wind energy's share of total wind power capacity will increase gradually from 2.3% in 2008 to 10.3% in 2015 and 17.4% in 2020.

The wind energy capacity installed by end 2008 will, in a normal wind year, produce 137 TWh of electricity. If the new scenarios are met, wind energy will produce 179 TWh in 2010, 335 TWh in 2015 and 582 TWh in 2020. Offshore wind energy's share of EU wind power production will increase from 3.9% in 2008 to over 25% in 2020.

NEW ANNUAL EU WIND ENERGY CAPACITY (1991-2020) FIGURE 6.2

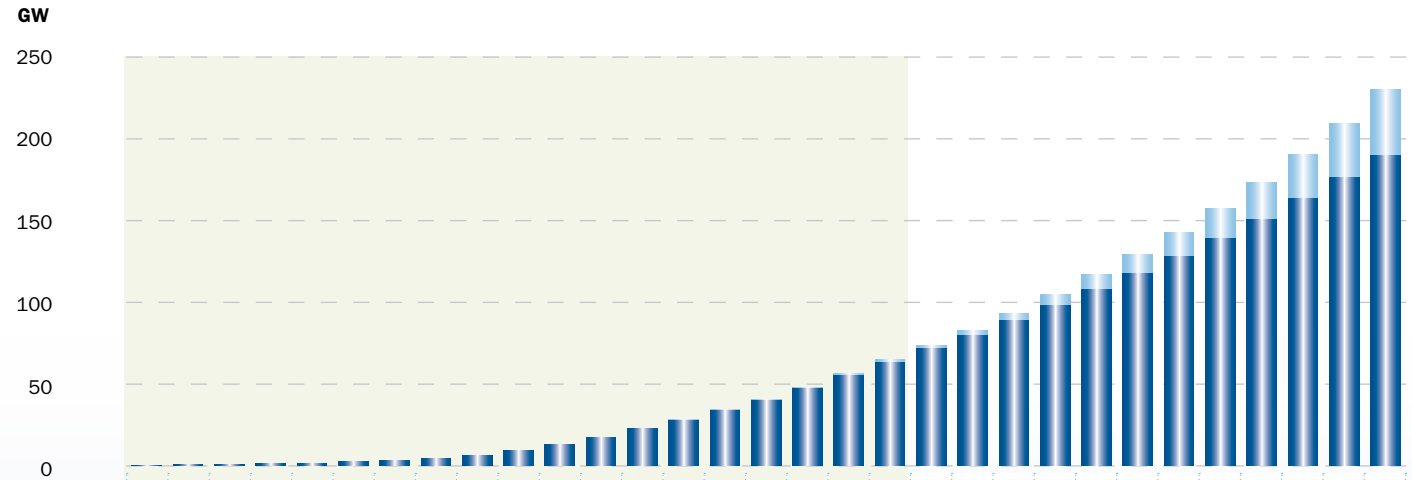


	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Offshore repowering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New offshore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.1	0.1	0.2	0.2	0.4	0.4	1.1	1.5	2.0	2.4	2.7	3.1	3.6	4.1	4.9	5.9	6.9
Onshore repowering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.9	2.6	3.5	4.2
New onshore	0.2	0.2	0.4	0.5	0.8	1.0	1.3	1.7	3.2	3.2	4.4	5.6	5.1	5.7	6.0	7.3	8.2	8.1	8.1	8.0	9.3	9.4	9.6	10.0	10.4	10.9	11.6	12.5	13.1	13.6
TOTAL	0.2	0.2	0.4	0.5	0.8	1.0	1.3	1.7	3.2	3.2	4.4	5.9	5.5	5.8	6.2	7.6	8.5	8.5	8.6	9.2	11.0	11.6	12.5	13.4	14.5	15.8	17.6	20.0	22.5	24.8

Source: EWEA

CUMULATIVE EU WIND ENERGY CAPACITY (1990-2020)

FIGURE 6.3

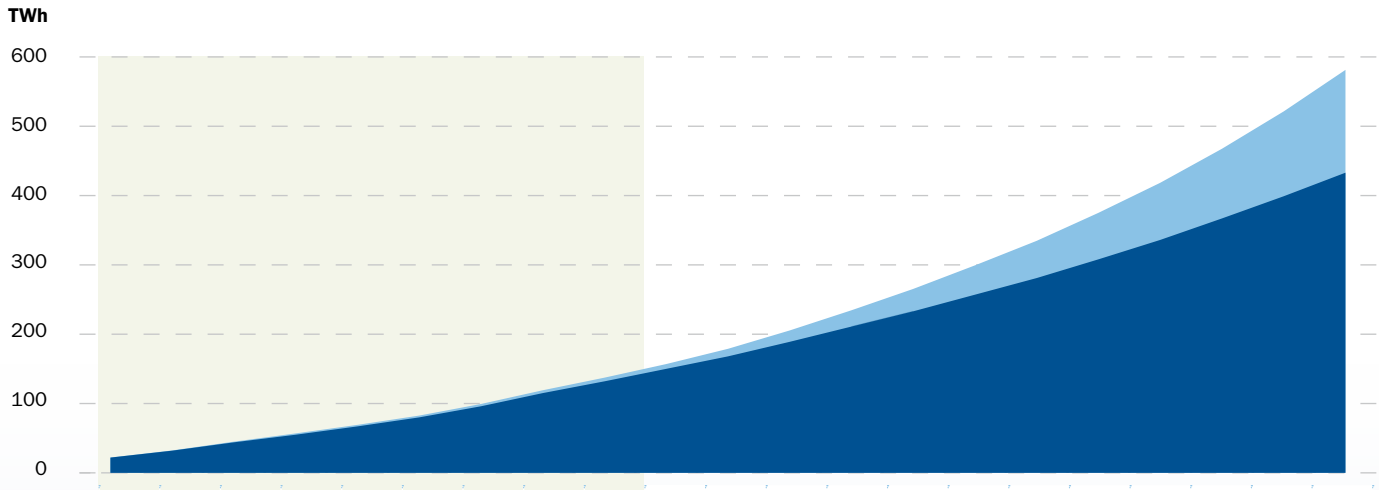


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Offshore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.6	0.7	0.9	1.1	1.5	1.9	3.0	4.5	6.5	8.9	11.6	14.7	18.3	22.4	27.2	33.1	40.0
Onshore	0.4	0.6	0.8	1.2	1.7	2.5	3.4	4.7	6.4	9.6	12.9	17.2	22.8	28.0	33.8	39.8	47.1	55.4	63.5	71.6	79.5	88.9	98.3	107.9	117.9	128.3	139.2	150.8	163.3	176.4	190.0
TOTAL	**0.4**	**0.6**	**0.8**	**1.2**	**1.7**	**2.5**	**3.5**	**4.8**	**6.5**	**9.7**	**12.9**	**17.3**	**23.1**	**28.5**	**34.4**	**40.5**	**48.0**	**56.5**	**64.9**	**73.5**	**82.5**	**93.4**	**104.7**	**116.7**	**129.4**	**142.9**	**157.5**	**173.2**	**190.5**	**209.5**	**230.0**

Source: EWEA

WIND POWER PRODUCTION IN THE EU (2000-2020)

FIGURE 6.4



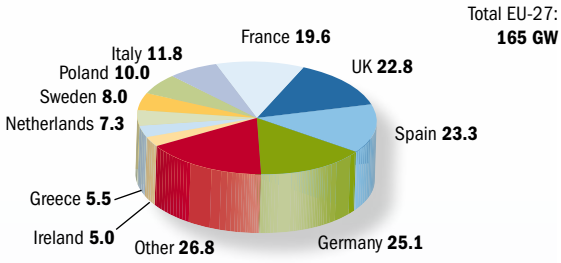
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Offshore	0.1	0.3	1.0	1.9	2.2	2.6	3.3	4.1	5.3	6.9	10.9	16.4	23.5	32.3	42.3	53.7	67.1	82.4	100.5	122.4	148.3
Onshore	22	32	44	55	67	80	96	115	132	150	168	189	211	233	257	281	308	336	367	399	433
TOTAL	**23**	**32**	**44**	**57**	**70**	**83**	**100**	**119**	**137**	**157**	**179**	**205**	**234**	**265**	**299**	**335**	**375**	**419**	**467**	**522**	**582**

Source: EWEA

Figure 6.5 shows the national breakdown of the increase in wind power capacity, according to EWEA's 230 GW scenario (see also Chapter 1). In total, wind energy capacity in the EU will increase by 165 GW by 2020. Germany and Spain will continue to be in the lead over the next 12 years, increasing their installed capacities by 25.1 GW and 23.3 GW respectively – making up 29% of the total EU increase. However, both the UK, which will add 22.8 GW by 2020 and France, which will add 19.6 GW are closing in on the leaders. They are followed by Italy (11.8 GW), Poland (10 GW) and Sweden (8 GW). It is a positive sign that the group labelled "others" have more than 25% of the total increase in capacity, indicating a wide deployment of renewables throughout the European countries. Today, 24 EU Member States have wind power. All 27 Member States are expected to have operating wind farms by 2020.

EWEA's 40 GW target for offshore wind energy by 2020 requires annual average market growth of 28% - from 0.366 GW in 2008 to 6.915 GW in 2020 – over the next 12 years. For comparison, the onshore market grew by an annual average of 32% over the 12-year period - from 0.215 GW in 1992 to 5.749 GW in 2004 (see Figure 6.6). EWEA is confident that the development of onshore can be replicated at sea, but it requires increased efforts, not least the construction of offshore power grids.

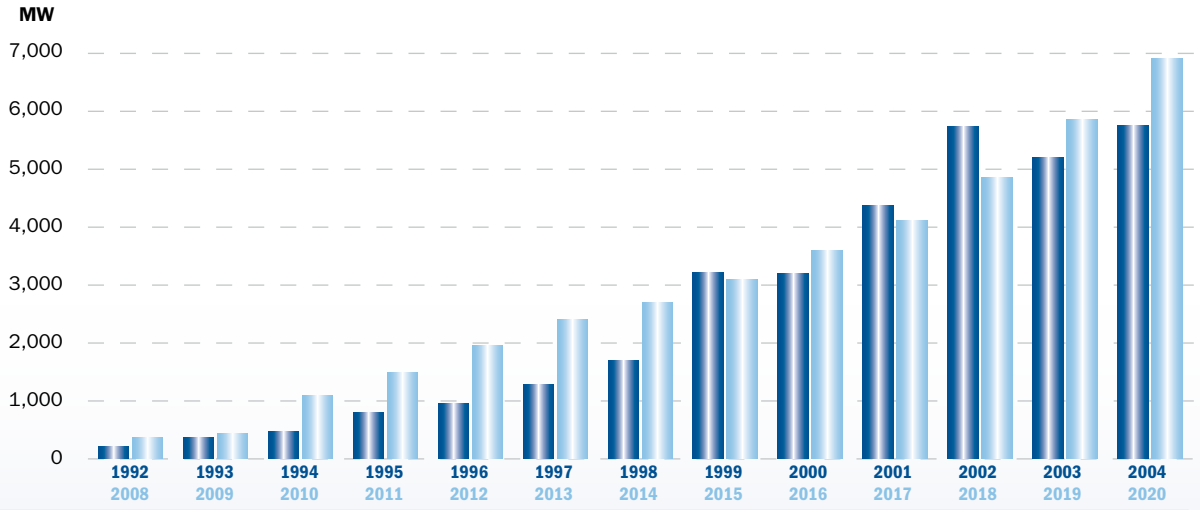
TOP 10 EU COUNTRIES FOR INCREASED WIND POWER CAPACITY IN GW (2009-2020) FIGURE 6.5



Other	Increase in wind energy capacity 2009-2020	% of EU-27 increase in wind energy capacity 2009-2020
Portugal	4.6	2.8%
Belgium	3.5	2.1%
Romania	3.0	1.8%
Denmark	2.8	1.7%
Bulgaria	2.8	1.7%
Austria	2.5	1.5%
Finland	1.8	1.1%
Czech Republic	1.5	0.9%
Lithuania	0.9	0.6%
Hungary	0.8	0.5%
Slovakia	0.8	0.5%
Slovenia	0.5	0.3%
Estonia	0.4	0.3%
Luxembourg	0.3	0.2%
Cyprus	0.3	0.2%
Latvia	0.2	0.1%
Malta	0.1	0.1%

Source: EWEA

HISTORICAL ONSHORE GROWTH 1992-2004 COMPARED TO EWEA'S OFFSHORE PROJECTION 2008-2020 (MW) FIGURE 6.6



	1992 2008	1993 2009	1994 2010	1995 2011	1996 2012	1997 2013	1998 2014	1999 2015	2000 2016	2001 2017	2002 2018	2003 2019	2004 2020
Onshore (1992-2004)	215	367	470	809	962	1,277	1,697	3,225	3,205	4,377	5,743	5,203	5,749
Offshore (2008-2020)	366	430	1,100	1,500	1,958	2,400	2,700	3,100	3,605	4,116	4,865	5,852	6,915

Summary of wind energy in 2020, according to EWEA 2008 targets

- 230 GW installed capacity: 190 GW onshore and 40 GW offshore
- Annual installations of 24.8 GW: 17.9 GW (72%) onshore and 6.9 GW offshore (28%)
- Annual investments of €23.5 billion: €14.7 onshore and €8.8 billion offshore
- Meeting 14-17% of EU electricity demand depending on total demand
- 24% of total electricity generating capacity in the EU (Total end 2020: 951 GW)
- Producing 582 TWh of electricity: 433 TWh onshore and 148 TWh offshore, equivalent to the consumption of 131 million average EU households
- Avoiding 333 Mt CO_2 annually
- Avoided fuel cost of €28 billion (assuming IEA forecast[18]: fuel cost equivalent to $110/bbl of oil)
- Avoiding €8.3 billion of CO_2 cost annually (assuming €25/t CO_2).

[18] Source: IEA, 2008a.

7. EWEA's 2030 Target

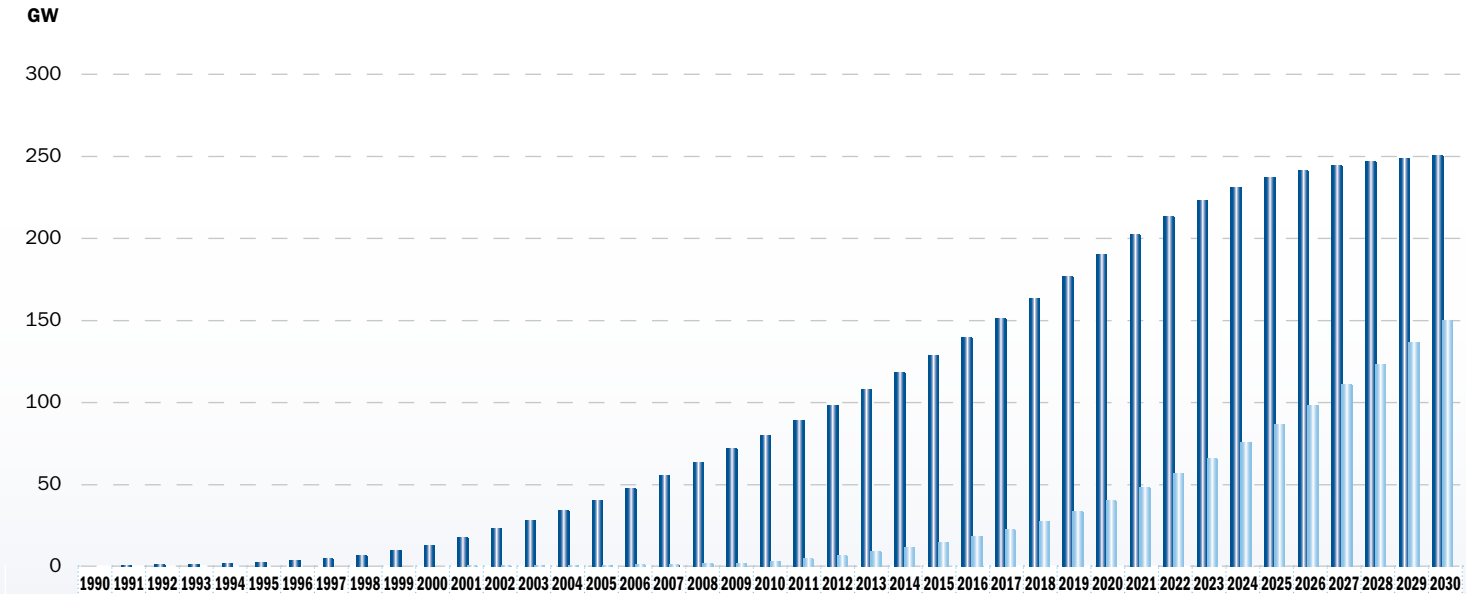
Photo: EWEA/Flaime

By 2030, EWEA expects 400 GW of wind energy capacity to be operating in the EU – 250 GW on land and 150 GW offshore. Figure 7.1 shows the development in cumulative wind energy capacity according to these new targets. The onshore development forms a classic S-curve of early exponential growth being replaced by saturation towards 2030. In terms of total capacity, offshore is currently (end 2008) at the level of onshore wind in 1994. By 2023, offshore capacity is expected to reach the 63.5 GW of wind that was operating onshore at the end of 2008. According to the target, offshore wind is following onshore wind in Europe with a 15 year time-lag. Given its larger potential, it can be expected that total offshore wind capacity will exceed onshore capacity at some point beyond 2030.

A comparison of EWEA's scenarios up to 2030 with those of independent analysts shows that EWEA's targets are conservative (see Chapter 5). As Figure 7.2 reveals, EWEA's scenario has 129 GW of installed capacity in 2014 compared with 133 GW for Emerging Energy Research (EER) and 165 GW for BTM Consult. By 2020, EWEA has 230 GW to BTM's 312 GW, although EER has a lower target of 221 GW. In 2030, EWEA's 400 GW target is well exceeded by BTM's more ambitious 509 GW (although it is important to note that BTM is looking at the whole of Europe, not just the EU-27). There is no available 2030 figure from EER.

By 2030, wind power in the EU will produce 1,155 TWh – 592 TWh onshore and 563 TWh offshore (Figure 7.3), meeting between 26% and 34% of EU electricity demand, depending on the level of demand (see the next chapter). Due to the higher capacity factor of offshore turbines, the 150 GW offshore wind capacity will produce almost as much power as the 250 GW onshore wind power in 2030. By 2020, the production of offshore wind electricity (148 TWh) will exceed the current electricity production from onshore wind (132 TWh).

CUMULATIVE ONSHORE AND OFFSHORE WIND IN THE EU (1990-2030) FIGURE 7.1

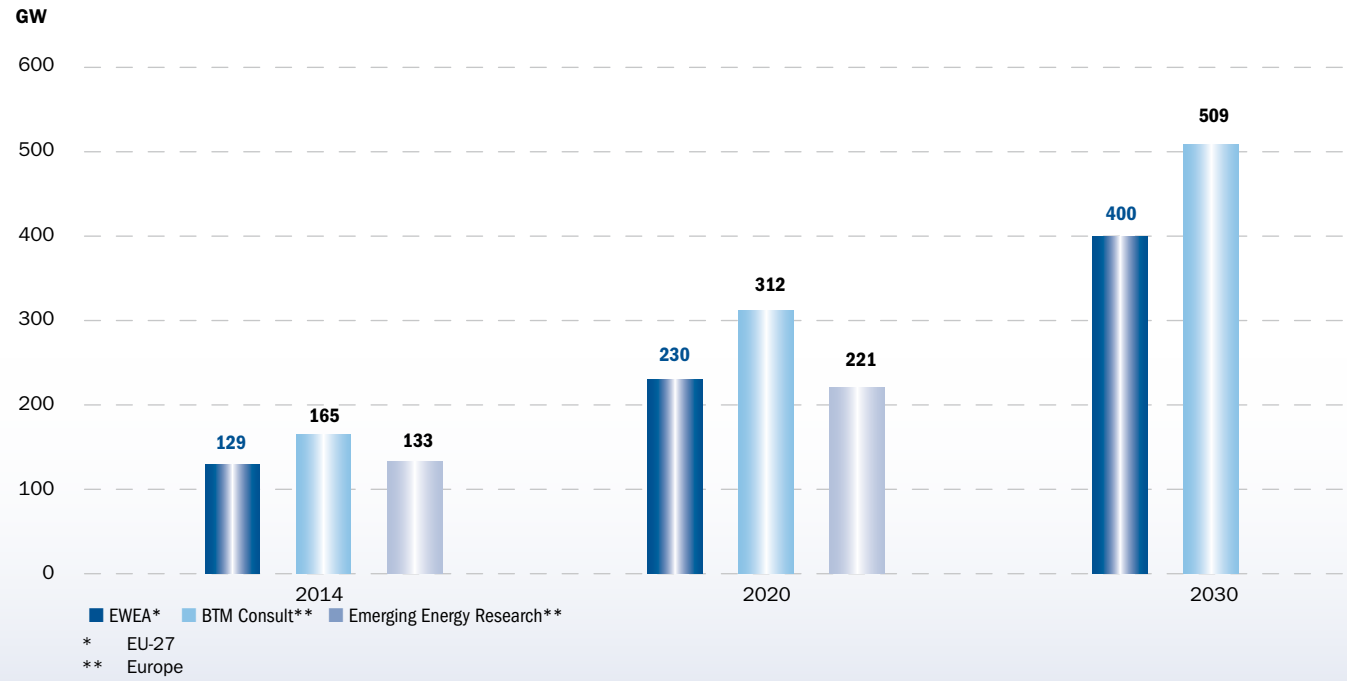


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Onshore	0.4	0.6	0.8	1.2	1.7	2.5	3.4	4.7	6.4	9.6	13	17	23	28	34	40	47	55	63.5	72	80	89	98	108	118	128	139	151	163	176	190	202	213	223	231	237	241	244	246	248	250
Offshore	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1.5	1.9	3	5	6	9	12	15	18	22	27	33	40	48	56	66	76	87	98	110	123	136	150
Total	0.4	0.6	0.8	1.2	1.7	2.5	3.5	4.8	6.5	9.7	13	17	23	28	34	41	48	57	65	73	83	93	105	117	129	143	157	173	191	209	230	250	269	288	307	323	339	354	370	385	400

Source: EWEA

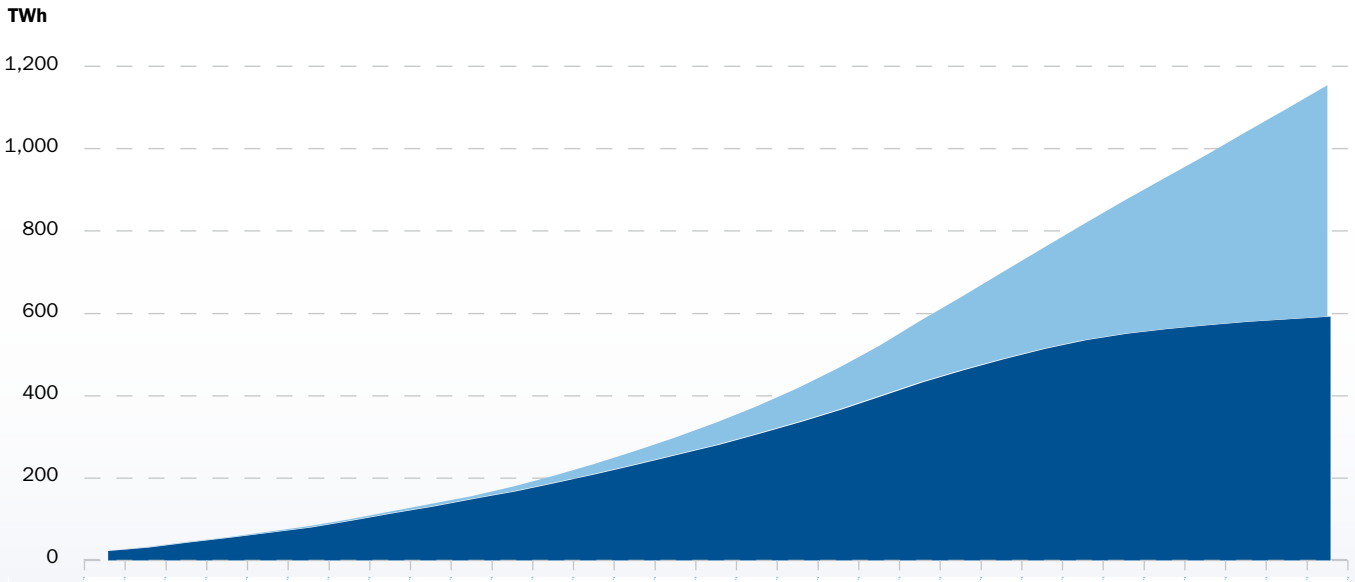
TOTAL INSTALLED CAPACITY IN EUROPE – EWEA, BTM AND EER SCENARIOS COMPARED

FIGURE 7.2



POWER PRODUCTION FROM ONSHORE AND OFFSHORE WIND IN THE EU (2000-2030)

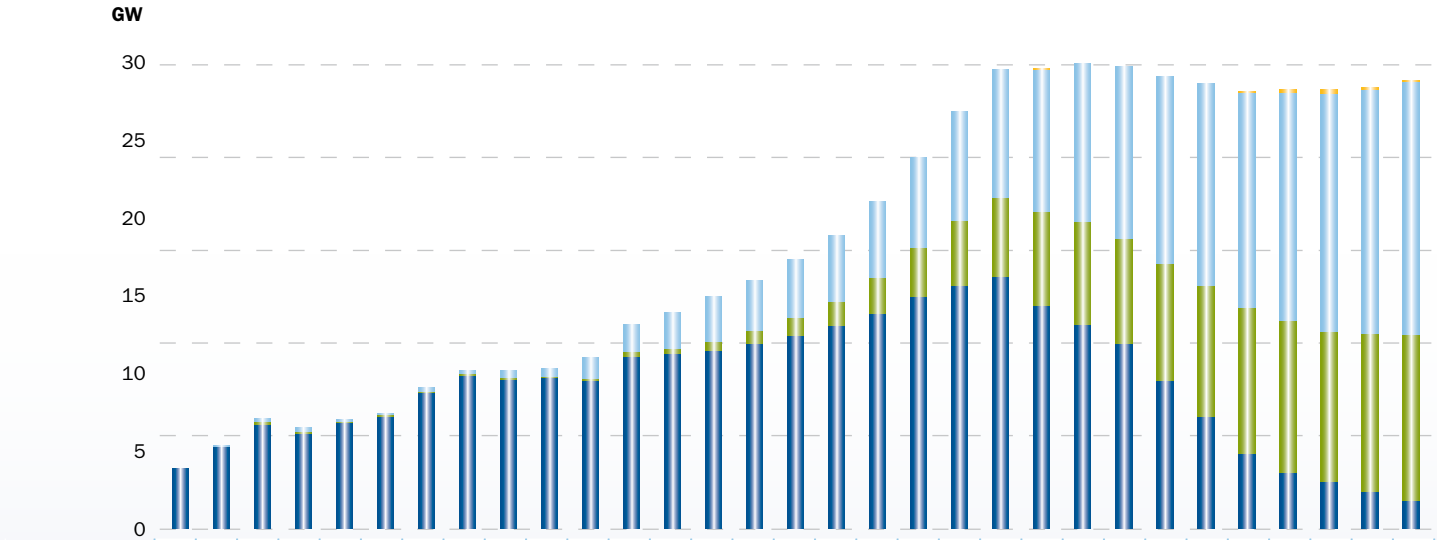
FIGURE 7.3



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offshore	0	0	1	2	2	3	3	4	5	7	11	16	24	32	42	54	67	82	101	122	148	177	209	244	282	323	366	413	461	511	563
Onshore	22	32	44	55	67	80	96	115	132	150	168	189	211	233	257	281	308	336	367	399	433	462	489	514	535	551	562	571	579	586	592
Total	23	32	44	57	70	83	100	119	137	157	179	205	234	265	299	335	375	419	467	522	582	639	698	758	816	873	928	984	1,040	1,097	1,155

Source: EWEA

ANNUAL WIND POWER INSTALLATIONS EU (2000-2030) FIGURE 7.4



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offshore repowering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.1	0.1
New offshore	0.0	0.1	0.2	0.3	0.1	0.1	0.2	0.2	0.4	0.4	1.1	1.5	2.0	2.4	2.7	3.1	3.6	4.1	4.9	5.9	6.9	7.7	8.5	9.3	10.1	10.9	11.6	12.3	12.8	13.2	13.6
Onshore repowering	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.9	2.6	3.5	4.2	5.1	5.6	5.6	6.3	7.1	7.9	8.2	8.1	8.5	9.0
New onshore	3.2	4.4	5.6	5.1	5.7	6.0	7.3	8.2	8.1	8.1	8.0	9.3	9.4	9.6	10.0	10.4	10.9	11.6	12.5	13.1	13.6	12.0	11.0	10.0	8.0	6.0	4.0	3.0	2.5	2.0	1.5

Source: EWEA

Figure 7.4 shows that the market for onshore wind power will increase up to 2020, then decline steadily in the decade up to 2030, while an increasing share of the onshore market will come from the replacement of existing capacity. No significant decommissioning of offshore wind turbines is envisaged until after 2030. The market for offshore wind will continue to expand beyond 2030, but the EWEA scenario conservatively assumes that the overall wind market will be stable from 2021 to 2030. The reason is the higher political uncertainty once the 2009 EU Renewable Energy Directive expires in 2020. Wind energy development after 2020 will to a large degree be determined by the price and availability of fuel and the price of CO_2.

In total, the new EWEA targets suggest that 181 GW of new capacity will be built in the 12 years from 2009 to 2020, and that an additional 242 GW will be constructed in the decade from 2021 to 2030 (see Table 7.1). The table also shows the historic and future growth rates in annual installations for the period 1991 to 2030.

As mentioned in the previous chapter, EWEA expects the annual market for offshore to reach 1.1 GW in 2010, which would translate into an average annual growth rate for offshore of 76% this decade – more than twice the annual growth rate in onshore in the ten years from 1991 to 2000. To meet the 230 GW target in 2020 would require an average growth in annual installations of 10.1% from 2009 to 2020: 7.3% growth in the onshore market and 28.7% growth in the offshore market.

In total, average annual installations are assumed to more than double from 7 GW this decade (2001 to 2010) to 15.1 GW in the ten years from 2011 to 2020. In the ten years after that (2021 to 2030), average annual installations will be some 50% higher (24.2 GW) than the decade before.

NEW WIND CAPACITY (1991-2030) TABLE 7.1

New wind capacity (MW)	Onshore	Offshore	Total
1991-2000	12,413	35	12,448
2001-2010	67,320	2,966	70,286
2009-2020	142,896	38,541	181,437
2011-2020	126,596	37,011	163,607
2021-2030	131,376	110,683	242,059
Annual growth rate	**Onshore**	**Offshore**	**Total**
1991-2000	37.3%	-2.9%	36.9%
2000-2010	9.7%	76.3%	11.1%
2009-2020	7.3%	28.7%	10.1%
2010-2020	8.2%	20.2%	10.4%
2020-2030	-5.2%	7.1%	-0.2%
1992-2004 onshore			32%
2008-2020 offshore			28%
Average MW / year	**Onshore**	**Offshore**	**Total**
1991-2000	1,241	4	1,245
2001-2010	6,732	297	7,029
2009-2020	11,908	3,212	15,120
2011-2020	12,660	3,701	16,361
2021-2030	13,138	11,068	24,206

Source: EWEA

Summary of wind energy in 2030, according to EWEA 2008 targets

- 400 GW installed capacity: 250 GW onshore and 150 GW offshore
- Annual installations of 24.2 GW: 10.5 GW onshore (43%) and 13.7 GW offshore (57%)
- Annual investments of €24.8 billion: €8.3 onshore and €16.5 billion offshore
- Meeting 26-34.7% of EU electricity demand depending on total demand
- 38% of total electricity generating capacity in the EU (Total end 2030: 1,061 GW)
- Producing 1,155 TWh of electricity: 592 TWh onshore and 563 TWh offshore, equivalent to the consumption of 241 million average EU households
- Avoiding 600 Mt CO_2 annually
- Avoided fuel cost of €56 billion (assuming IEA forecast: fuel cost equivalent to $122/bbl of oil)
- Avoiding €15 billion of CO_2 cost annually (assuming €25/t CO_2)

8. Wind Power's Share of EU Electricity Demand

Photo: EWEA/Winter

The 64.9 GW of installed capacity in the EU-27 by the end of 2008 will, in a normal wind year, produce 137 TWh of electricity, enough to meet 4% of EU electricity demand.

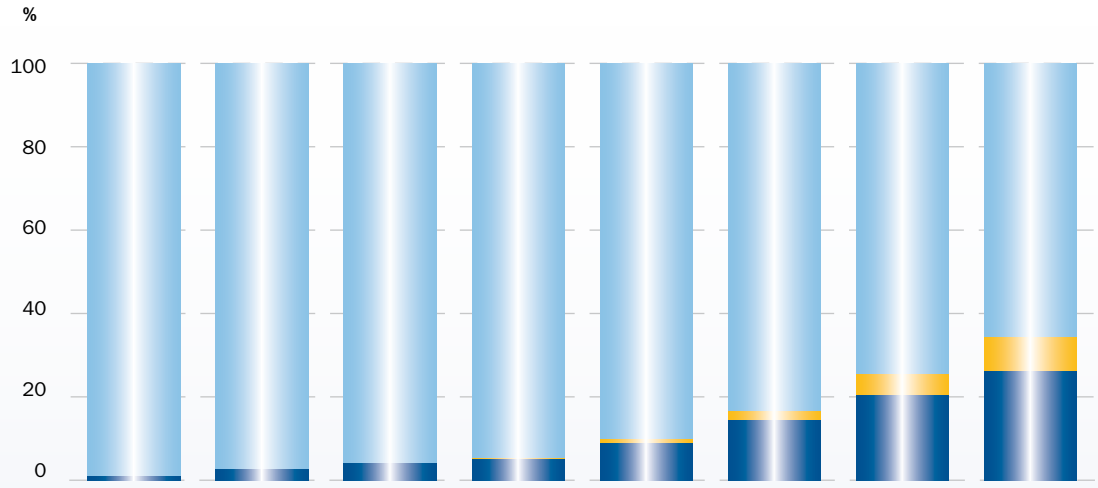
Wind power's share of the total EU power demand depends on whether total electricity demand in the EU increases in line with the European Commission's baseline scenario[19] or stabilises in accordance with its New Energy Policy scenario[20].

As can be seen from Table 8.1, wind power will produce 179 TWh in 2010, 582 TWh in 2020, and 1,155 TWh in 2030. Wind power will meet between 5% (baseline) and 5.2% (New Energy Policy) of EU electricity demand in 2010, between 14.3% and 16.6% in 2020, and between 26.2% and 34.3% in 2030, depending on how overall electricity consumption develops in the EU between now and 2030.

The calculations in the following chapters of this report are based on the European Commission's baseline scenario for electricity demand, unless otherwise stated.

It is assumed that the average capacity factor of all wind turbines in the EU will increase from 24.1% in 2008 to 24.7% in 2010, 28.9% in 2020 and 33% in 2030. The increase will be due to better design, exploiting the resources in more windy areas of Europe, technology improvements and a larger share of offshore wind. In Germany, average capacity factors will only start increasing if older turbines are replaced and offshore wind power takes off. It should be noted that for a technology that makes use of a free resource, a high capacity factor is not a goal in itself. It is not technically problematic to increase capacity factors, but doing so affects grid integration, modelling and generation costs.

WIND POWER'S SHARE OF EU ELECTRICITY DEMAND (1995-2030) FIGURE 8.1



	2000	2005	2008	2010	2015	2020	2025	2030
Wind energy production (TWh)	22.6	82.9	136.9	178.7	335.2	581.6	873.4	1,154.6
EU Baseline (TWh)	2,993.7	3,320.3	3,386.6	3,569.8	3,840.9	4,066.0	4,273.9	4,408.9
Wind energy share - Baseline scenario	0.8%	2.5%	4.0%	5.0%	8.7%	14.3%	20.4%	26.2%
New Energy Policy (TWh)	2,993.7	3,320.3	3,386.6	3,404.5	3,449.2	3,494.0	3,431.1	3,368.1
Wind energy share - New Energy Policy	0.8%	2.5%	4.0%	5.2%	9.7%	16.6%	25.5%	34.3%

Wind energy share - Baseline scenario Wind energy share - New Energy Policy Other energy sources

Source: EWEA; European Commission

[19] Source: EC, 2008a.
[20] Source: EC, 2008c.

ELECTRICITY PRODUCTION FROM WIND (TWh) TABLE 8.1

Electricity production from wind	Onshore	Offshore	Total	EU baseline consumption	EU consumption NEP
2000	22.5	0.1	**22.6**	2,993.7	2,993.7
2005	80.3	2.6	**82.9**	3,320.3	3,320.3
2008	131.6	5.3	**136.9**	3,386.6	3,386.6
2010	167.8	10.9	**178.7**	3,569.8	3,404.5
2015	281.5	53.7	**335.2**	3,840.9	3,449.2
2020	433.3	148.3	**581.6**	4,066.0	3,494.0
2025	550.9	322.5	**873.4**	4,273.9	3,431.1
2030	592.0	562.6	**1 154.6**	4,408.9	3,368.1

Source: EWEA; European Commission

WIND SHARE OF ELECTRICITY CONSUMPTION (%) TABLE 8.2

	Onshore	Offshore	Total
1995			**0.2%**
2000	0.8%	0.0%	**0.8%**
2005	2.4%	0.1%	**2.5%**
2008	3.9%	0.2%	**4.0%**
2010 Baseline	4.7%	0.3%	**5.0%**
2010 New Energy Policy	4.9%	0.3%	**5.2%**
2015 Baseline	7.3%	1.4%	**8.7%**
2015 New Energy Policy	8.2%	1.6%	**9.7%**
2020 Baseline	10.7%	3.6%	**14.3%**
2020 New Energy Policy	12.4%	4.2%	**16.6%**
2025 Baseline	12.9%	7.5%	**20.4%**
2025 New Energy Policy	16.1%	9.4%	**25.5%**
2030 Baseline	13.4%	12.8%	**26.2%**
2030 New Energy Policy	17.6%	16.7%	**34.3%**

Source: EWEA; European Commission

Wind power's share of EU household demand

The wind power production derived from the new EWEA scenarios can be expressed in terms of household electricity consumption. Household consumption is expected to increase from 790 TWh in 2006 to 1,114 TWh in 2030[21].

By 2030 some 25% of total electricity demand will be consumed by households. Other sectors that consume electricity include industry, agriculture, and public and private services.

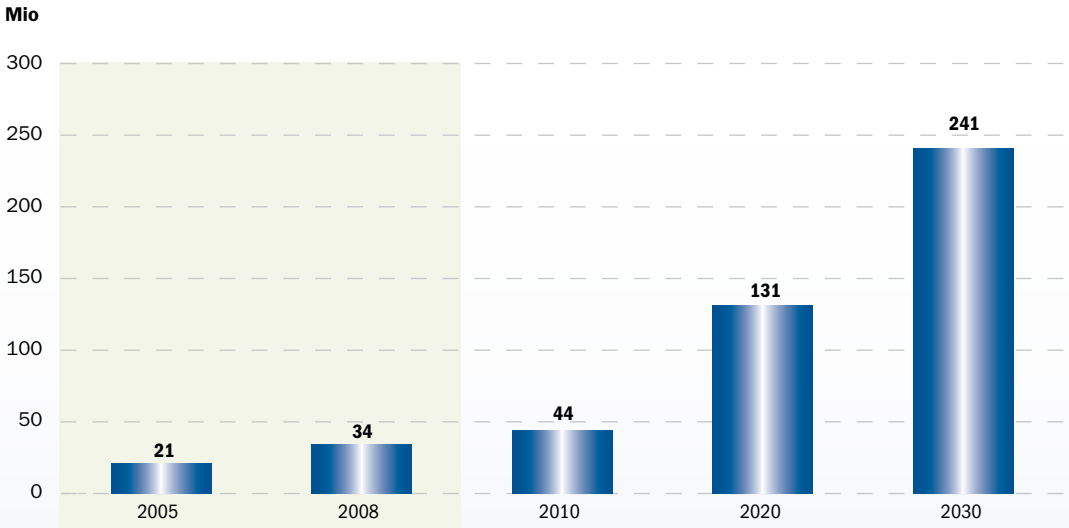
While the total EU population is estimated to remain relatively stable, the number of households will increase by approximately 30 million between 2008 and 2030, indicating a reduction in the average household size from 2.3 in 2008 to 2.0 in 2030. The average annual household consumption, nevertheless, will increase by 19% from 4,037 kWh per year in 2008 to 4,787 kWh in 2030 (Figure 8.2).

The wind power capacity installed by the end of 2008 will produce 137 TWh in an average wind year, equivalent to the electricity needs of 34 million average EU households. If the EWEA targets are reached, wind power will produce electricity equivalent to the needs of 44 million households in 2010, 131 million households in 2020 and 241 million EU households in 2030. By 2030 wind power would produce electricity equivalent to more than all the electricity consumed by the EU's 233 million households (see Figure 8.2).

Wind energy and electric cars

Car manufacturers have started to develop "hybrid vehicles" and "electric vehicles" (EVs) in recent years. EWEA's scenarios to 2030 do not take into account any increase in electricity demand from electric cars. It is generally recognised that electric motors are much more efficient than the combustion engine. Consequently, a shift from the current petrol

WIND POWER'S SHARE OF EU HOUSEHOLD DEMAND — FIGURE 8.2



	2005	2008	2010	2020	2030
Average household consumption (kWh)	3,973	4,037	4,079	4,441	4,787
Number of households (Mio)	196	201	205	221	233
Wind power production (TWh)	83	137	179	582	1,155
Equivalent electricity demand met by wind power (million households)	21	34	44	131	241
Equivalent electricity demand met by wind power (% of households)	**11%**	**17%**	**21%**	**59%**	**104%**

Source: EWEA

[21] Source: Eurelectric and European Commission, 2005.

and diesel cars to electric cars could save large amounts of fossil fuels. It is important to stress that an electric vehicle is only as "clean" as the technology used to produce the electricity that it runs on. Consequently, the larger the share of renewable energy in Europe's power mix, the cleaner the electric vehicles of the future will be.

Conservatively assuming that an average electric car consumes 0.2 kWh per kilometre and has an average mileage of 10,000 kilometres per car[22], an electric car will consume 2,000 kWh per year. Consequently, the wind power produced in Europe in 2008 could power 68.5 million electric cars (see Table 8.3). If the new EWEA targets are met, enough wind power would be produced to power 291 million cars in 2020 and 577 million cars in 2030. In 2006, there were around 230 million cars in Europe[23].

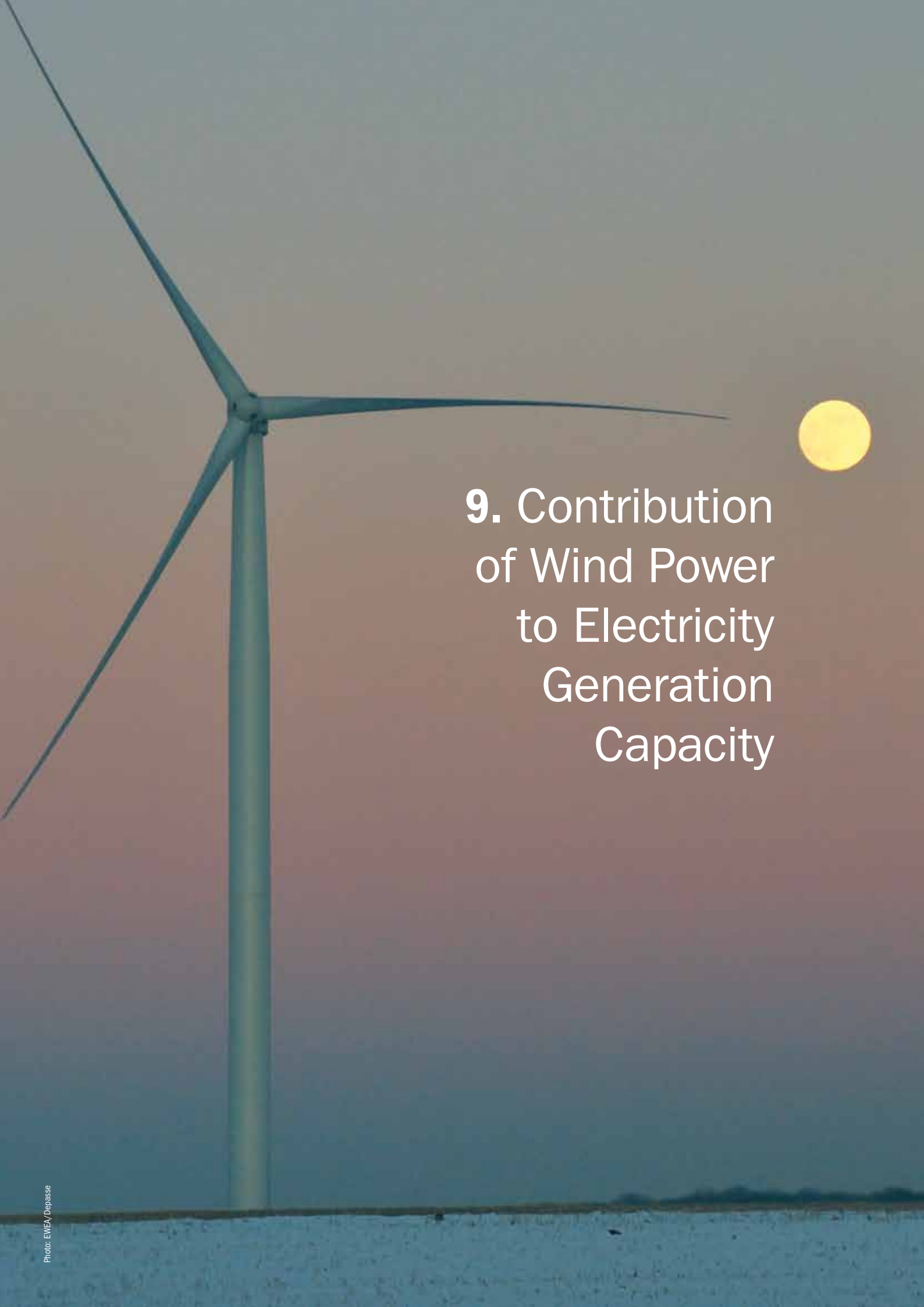
WIND ENERGY AND ELECTRIC CARS TABLE 8.3

	Wind energy production (TWh)	Average annual energy consumption per car (kWh)	Number of electric cars powered by wind (mio)
2008	137	2,000	68.5
2020	582	2,000	291.0
2030	1,155	2,000	577.5

Source: EWEA,

[22] The European Environment Agency (2009) estimates that Electric Vehicles (EV) will consume between 0.11 and 0.2 kWh/km – the lower estimate through likely technology developments in the future. The Brussels-based NGO "Transport & Environment" assumes that EVs have an annual mileage of 8,640 kilometres (80% of that of petrol cars).

[23] According to Eurostat, there were 466 cars per 1,000 inhabitants in the EU-27 in 2006. There were 495 million inhabitants of the EU-27 in 2007.



9. Contribution of Wind Power to Electricity Generation Capacity

Photo: EWEA/Depasse

The IEA[24] expects 4,528 GW of electricity generating capacity to be installed worldwide in the period 2007-2030, requiring investments of $5,034 billion in generation, $2,106 billion in transmission grids and $4,657 billion in distribution grids. For OECD Europe, the IEA expects 686 GW to be built, requiring investments of $922 billion in new generation, $187 billion in transmission and $567 billion in distribution grids.

As already mentioned, wind power's contribution to new power capacity in the EU was exceeded only by gas in the last decade. 30% of all installed capacity was wind power from 2000 to 2008. 52% was natural gas, 6% was coal and 0.7% was nuclear. In 2008, the EU countries installed more wind energy capacity than any other power technology.

Europe has to invest in new capacity to replace ageing plants and meet future demand. 801 GW of electricity generating capacity was operating in the EU by the end of 2008[25]. Total installed capacity will increase to 901 GW in 2020 and 966 GW in 2030, according to the European Commission (see Table 9.1). It expects new capacity worth 287 GW to be built between 2009 and 2020 and an additional 298 GW between 2021 and 2030. In total, 585 GW of new capacity will need to be constructed over the coming 22 years in the EU, equal to 73% of the total capacity installed by end 2008.

Consequently, 187 GW of existing capacity will be decommissioned until 2020 and an additional 233 GW between 2021 and 2030.

As mentioned in Chapter 4, the European Commission's scenario for the future development of wind energy is significantly lower than EWEA's. Hence, it is necessary to adjust the European Commission figures for total generating capacity and new capacity in Table 9.1 to take account of wind energy's capacity factor being lower than that of the average coal, gas or oil plant. Adjusting for the difference in capacity factors adds 95 GW to the total generating capacity in 2030 to make a total of 1,061 GW (Figure 9.1). It adds 94.5 GW to the new generating capacity installed between 2009 and 2030, taking the total for the period to 680 GW.

In 2008, 8.1% of all capacity in the EU was wind energy. That share is forecast to increase to 9.9% in 2010, 24.2% in 2020 and 37.7% in 2030. Wind power's share of new generating capacity is forecast to be 32% in 2009-2010, 59% in 2011-2020 and 70% in the decade leading up to 2030.

NEW CAPACITY, DECOMMISSIONING AND TOTAL CAPACITY (2009-2030) (GW) TABLE 9.1

	New capacity	Decommissioning	Total capacity ultimo
2009-2010	51	16.6	835
2011-2020	236.3	170.3	901
2021-2030	298.3	233.3	966

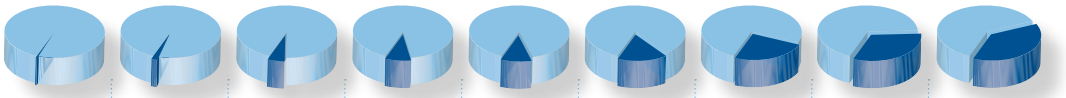
Source: EWEA based on European energy and transport trends to 2030 (update 2007), European Commission 2008

[24] Source: IEA World Energy Outlook, 2008.

[25] The figures in this chapter are all derived by EWEA from EC, 2008a; Platts Powervision.

WIND POWER'S SHARE OF INSTALLED EU POWER CAPACITY (1995-2030)

FIGURE 9.1

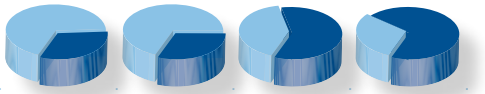


	1995	2000	2005	2008	2010	2015	2020	2025	2030
Total installed capacity (GW)	539	695	747	801	841	886	951	1,014	1,061
Total installed wind capacity (GW)	2.5	13	41	65	83	143	230	324	400
Wind power's share of installed capacity	**0.46%**	**1.9%**	**5.4%**	**8.1%**	**9.9%**	**16.1%**	**24.2%**	**31.9%**	**37.7%**

Source: European Commission 2008, Platts Powervision, EWEA

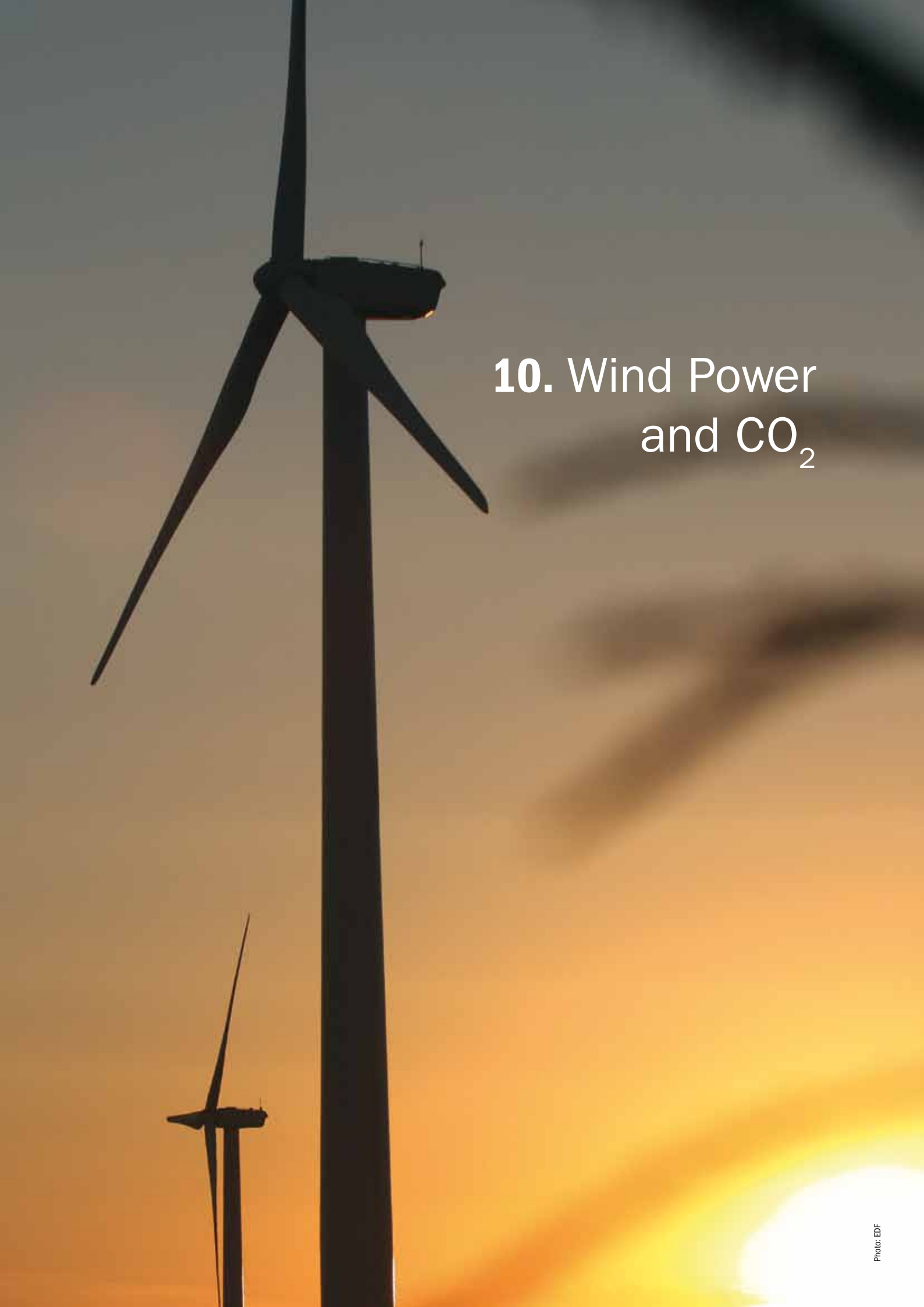
WIND POWER'S SHARE OF NEW CAPACITY

FIGURE 9.2



	2009-2010	2001-2010	2011-2020	2021-2030
New generating capacity (GW)	56	226	276	348
New wind generating capacity (GW)	18	71	163	242
Wind power's share of new capacity	**32%**	**31%**	**59%**	**70%**

Source: European Commission 2008, Platts Powervision, EWEA



10. Wind Power and CO_2

Photo: EDF

In 1997 in Kyoto, the EU-15 made a commitment to reduce its emissions of greenhouse gases (GHG) by 8% compared to its 1990 level of emissions by 2008-2012. A 'burden sharing' approach sets targets for each of the 15 Member States. The new Member States have individual reduction targets of 8% except Hungary and Poland who must reduce their GHGs by 6%. Cyprus and Malta have no obligation. The overall Kyoto reduction target for the EU-25 (excluding Malta and Cyprus) is 7.8%, or 450 Mt of CO_2 equivalents. The EU-15 needs to reduce its emissions by 342 Mt of CO_2 equivalents[26].

In 2006, total GHG emissions in the EU-27 were 7.7% below 1990 levels.

CO_2 reductions from wind power

The most important GHG by far is CO_2. There are different ways of calculating how much CO_2 wind energy avoids, and the results depend on the assumptions made about which fuels are displaced when wind electricity is produced. The energy mix and base load differ between Member States, so ideally wind power's avoided CO_2 emissions should be based on the energy mix at the intermediate load in each Member State. Here, it is assumed that wind energy avoids CO_2 at the intermediate load but at the average EU-27 generation mix.

Nuclear power is rather inflexible and can not easily be regulated up and down. Hence, wind power does not displace operating nuclear production, except during scheduled and unscheduled nuclear shutdowns and if nuclear capacity is decommissioned. Neither does wind energy replace hydropower because hydropower is like a storage technology for electricity. Electricity from hydro that is not used when wind power is operating will be saved for production later, but total production from hydro is constant over time.

For the EU as a whole it is assumed that each kWh of wind power displaces a kWh defined by the energy mix of coal, oil and gas at the time of production. This approach underestimates wind energy's CO_2 avoidance because wind energy in reality avoids the most expensive and CO_2 intense production rather than the average production mix.

Naturally, the EU energy mix will change during the period up to 2030. According to the European Commission[27], thermal power stations in the EU produced 1,899 TWh in 2005 and emitted 1,375 Mt of CO_2. Consequently, 1 TWh produced by wind energy saved 0.724 Mt CO_2/TWh in 2005. The same approach is applied to the European Commission's data for 2010, 2015 and 2030 and a linear variation is assumed in the intermediate years. Using this approach it is assumed that wind energy in 2020 will avoid 0.572 Mt CO_2/TWh and 0.518 Mt CO_2/TWh in 2030. In 2008, wind energy avoided 91 Mt of CO_2. In EWEA's reference scenario, annual CO_2 avoided from wind energy will increase to 113 Mt in 2010, 333 Mt in 2020 and 599 Mt in 2030.

Figure 10.1 shows the total annual CO_2 emissions avoided by wind energy for the years 2000 to 2030 and the value of the CO_2 avoided for different potential future CO_2 prices.

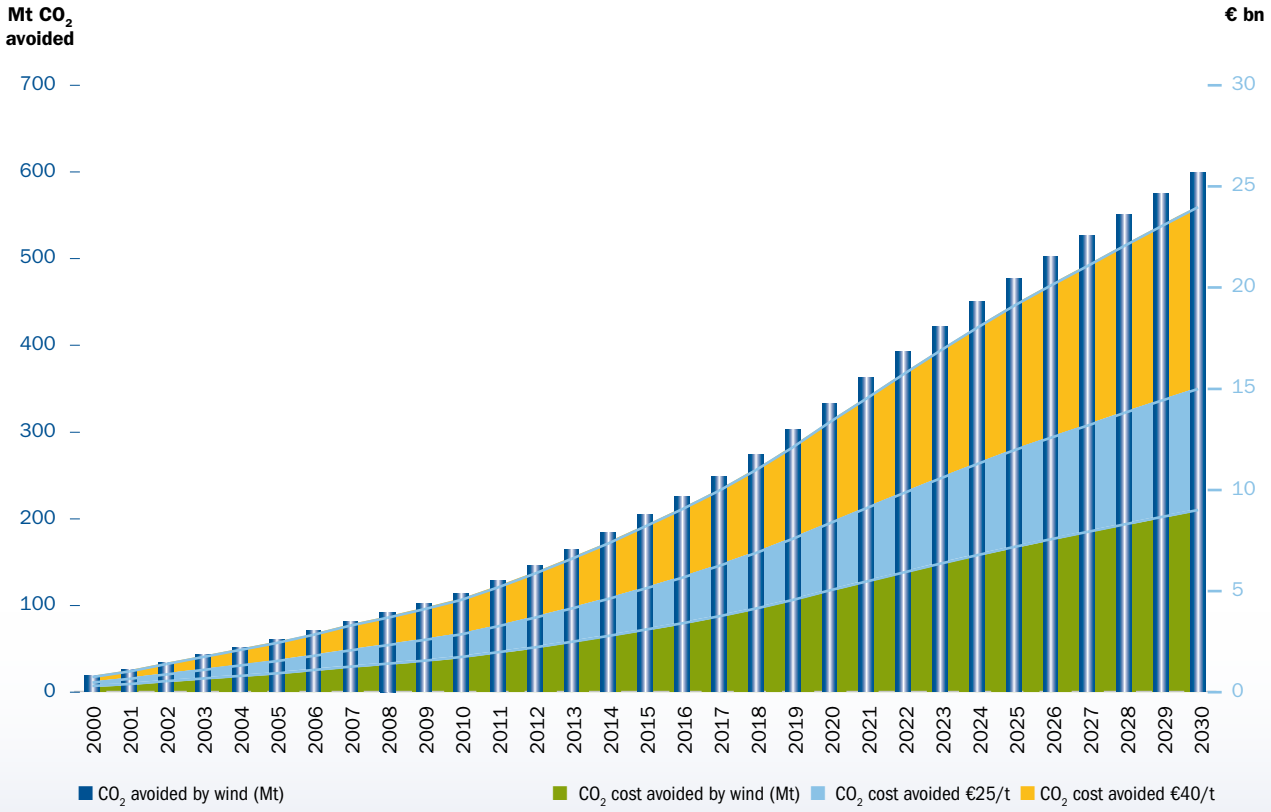
At a CO_2 price of €25/t, wind power avoided €2.3 billion in carbon costs in 2008. At the same CO_2 price, wind power will avoid carbon costs of €2.8 billion in 2010, €8.3 billion in 2020 and €15 billion in 2030.

It is important to note that the total CO_2 reductions from the wind power installations needed to reach EWEA's 2030 reference scenario greatly exceed the figures for the annual reductions illustrated in Figure 10.1 because the turbines installed in a given year will deliver CO_2 reductions for 20 to 25 years from the year they are installed and, hence, far beyond 2030.

[26] Source: EEA, 2007a.
[27] Source: EC, 2008a.

CO_2 AVOIDED ANNUALLY BY WIND ENERGY AND ANNUAL CO_2 COST AVOIDED BY WIND ENERGY FOR VARIOUS CO_2 PRICES (2000-2030)

FIGURE 10.1



Source: EWEA

11. Avoided Fuel Costs

Photo: Denis Schwartz

Wind power requires no fuel input. When wind energy is produced, it saves significant amounts of fuel costs in the form of the coal, gas and oil that would otherwise have been needed for power production. In addition to these avoided costs, the production of wind energy reduces demand for imported fuel (and thereby brings down the cost of fuel) while reducing the rate of depletion of Europe's remaining fossil fuel reserves.

The avoided fuel costs of wind energy depend on the assumptions made about future fuel prices. Oil and gas prices are very closely linked, and coal also follows – to a lesser extent - the price of oil. Both the IEA and the European Commission have for many years made predictions on future coal, gas and oil prices, and most governments base their energy policies on the IEA's fuel price scenarios. The European Commission[28] assumptions on fuel prices are significantly lower than those of the IEA[29] (see Table 11.1). For 2010, the IEA assumes an oil price (in $\$_{2007}$) of $100 per barrel - 35% higher than the European Commission's assumption of €74 per barrel (bbl). For 2030, the IEA assumes an oil price of $122 – 85% higher than the European Commission's assumption of $66.1.

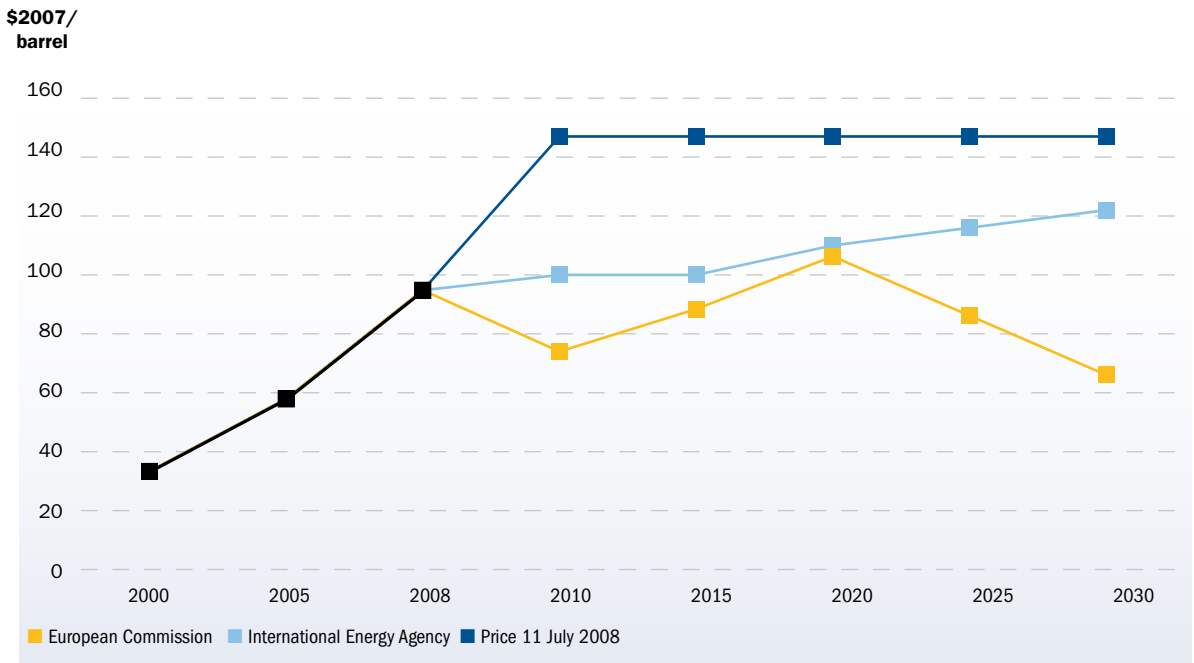
On 11 July 2008, the oil price reached a historic high of $147/BBL. In October 2009, oil was trading at $80/bbl during the worst global recession since the 1930s.

OIL PRICE ASSUMPTIONS TABLE 11.1

Fuel price assumptions (in $07)*	2000	2005	2008	2010	2015	2020	2025	2030
European Commission	33.3	57.9	94.8	74.0	88.4	106.3	86.2	66.1
International Energy Agency	33.3	57.9	94.8	100.0	100.0	110.0	116.0	122.0

Price 11 July 2008
* Adjusted to 2007 prices / actual prices until 2008
$1.25/€

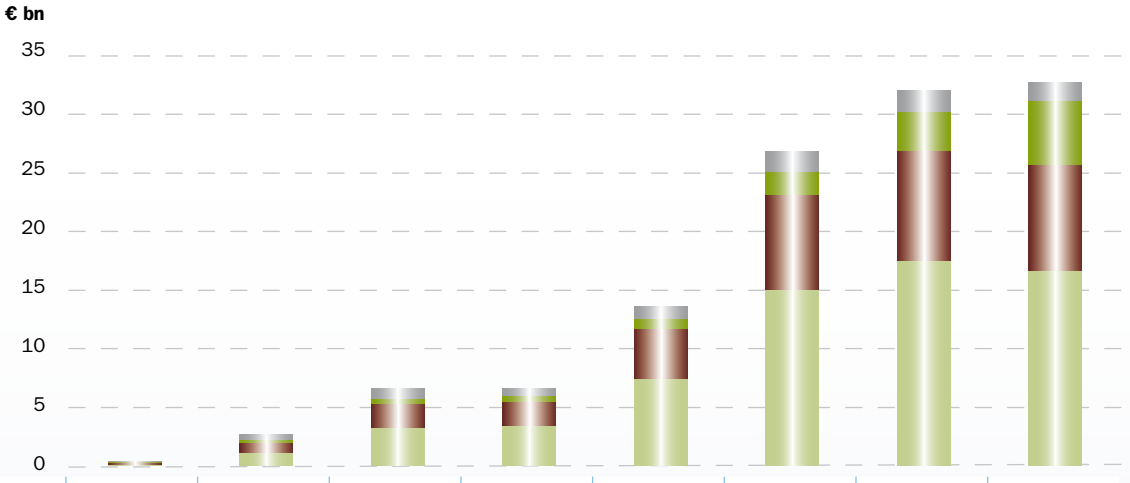
OIL PRICE ASSUMPTIONS FIGURE 11.1



[28] Source: EC, 2008a.
[29] Source: IEA, 2008a.

AVOIDED FUEL COST FROM WIND - EUROPEAN COMMISSION FUEL PRICES

FIGURE 11.2

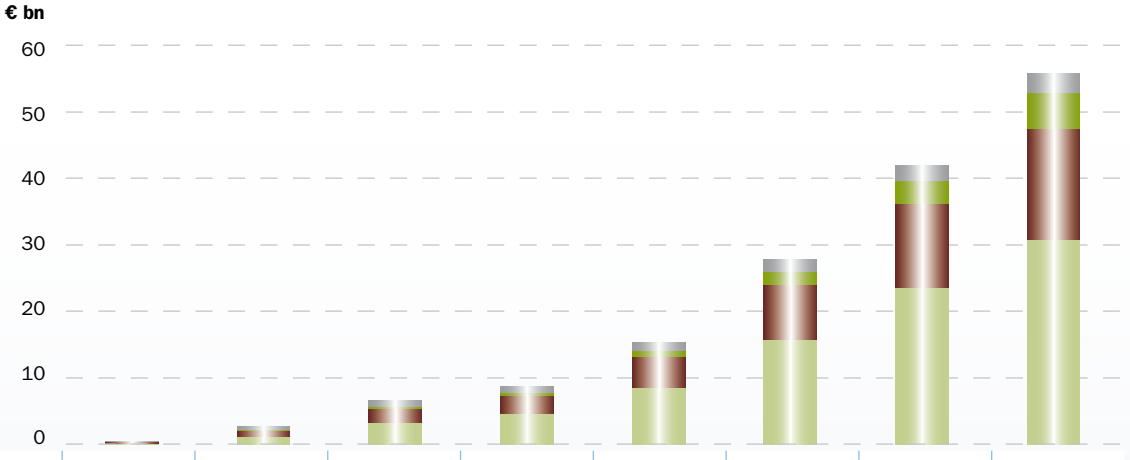


	2000	2005	2008	2010	2015	2020	2025	2030
Coal	138,657,387	860,662,002	2,087,161,024	1,996,139,722	4,226,195,981	8,081,560,946	9,340,710,000	9,016,924,943
Oil	96,593,513	408,288,766	794,045,950	627,102,308	1,029,842,935	1,743,755,209	1,727,753,248	1,557,742,969
Gas	127,489,673	1,170,115,022	3,284,902,995	3,445,399,156	7,478,596,992	15,107,539,046	17,572,295,494	16,667,059,745
Biomass and waste	35,919,841	213,703,525	381,491,603	502,290,342	874,207,217	1,933,700,405	3,389,174,465	5,513,193,047
Total (€07)	**398,660,414**	**2,652,769,315**	**6,547,601,572**	**6,570,931,528**	**13,608,843,125**	**26,866,555,607**	**32,029,933,207**	**32,754,920,704**
Avoided fuel cost / TWh wind	17,641,167	31,982,109	47,811,122	36,476,993	40,599,670	46,196,738	36,672,798	28,368,368

Source: EWEA and European Commission

AVOIDED FUEL COST FROM WIND - INTERNATIONAL ENERGY AGENCY (IEA) FUEL PRICES

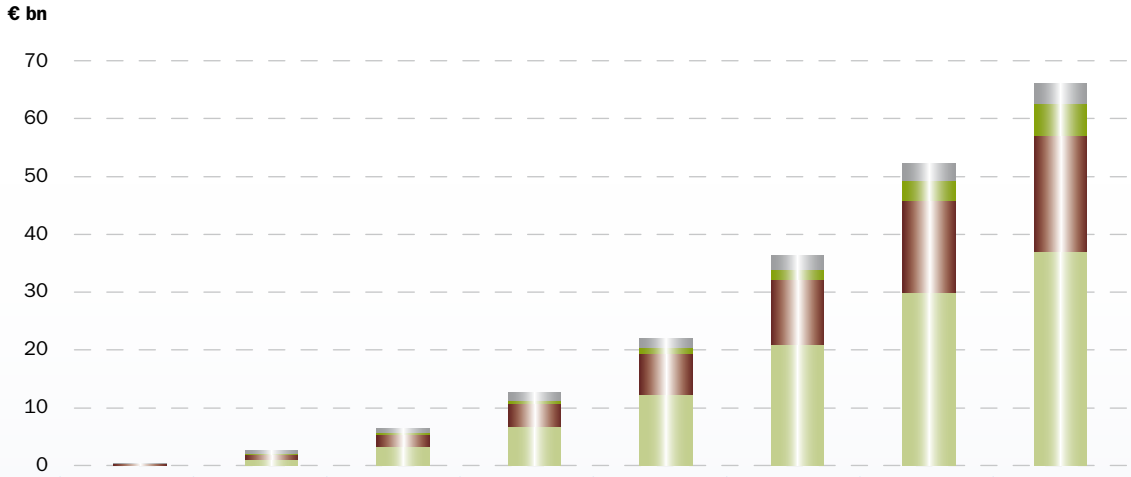
FIGURE 11.3



	2000	2005	2008	2010	2015	2020	2025	2030
Coal	138,657,387	860,662,002	2,087,161,024	2,697,486,111	4,780,764,685	8,362,857,047	12,569,864,965	16,642,433,329
Oil	96,593,513	408,288,766	794,045,950	847,435,552	1,164,980,696	1,804,450,357	2,325,050,774	2,875,108,051
Gas	127,489,673	1,170,115,022	3,284,902,995	4,655,944,805	8,459,951,348	15,633,389,418	23,647,172,591	30,762,198,016
Biomass and waste	35,919,841	213,703,525	381,491,603	502,290,342	874,207,217	1,933,700,405	3,389,174,465	5,513,193,047
Total (€07)	**398,660,414**	**2,652,769,315**	**6,547,601,572**	**8,703,156,810**	**15,279,903,945**	**27,734,397,227**	**41,931,262,795**	**55,792,932,444**
Avoided fuel cost / TWh wind	17,641,167	31,982,109	47,811,122	48,313,543	45,584,995	47,688,982	48,009,364	48,321,120

Source: EWEA and International Energy Agency (IEA)

AVOIDED FUEL COST FROM WIND - HISTORIC HIGH FUEL PRICE OF 11 JULY 2008 (€147/BBL) FIGURE 11.4



	2000	2005	2008	2010	2015	2020	2025	2030
Coal	138,657,387	860,662,002	2,087,161,024	3,965,304,584	7,027,724,087	11,175,818,053	15,929,053,016	20,052,768,027
Oil	96,593,513	408,288,766	794,045,950	1,245,730,261	1,712,521,622	2,411,401,841	2,946,400,550	3,464,269,537
Gas	127,489,673	1,170,115,022	3,284,902,995	6,844,238,863	12,436,128,482	20,891,893,131	29,966,675,611	37,065,927,118
Biomass and waste	35,919,841	213,703,525	381,491,603	502,290,342	874,207,217	1,933,700,405	3,389,174,465	5,513,193,047
Total (€07)	**398,660,414**	**2,652,769,315**	**6,547,601,572**	**12,557,564,050**	**22,050,581,408**	**36,412,813,431**	**52,231,303,642**	**66,096,157,730**
Avoided fuel cost / TWh wind	17,641,167	31,982,109	47,811,122	69,710,386	65,784,160	62,611,421	59,802,437	57,244,533

Source: EWEA

The fuel costs avoided due to wind energy production can be calculated on the basis of the European Commission's fuel price assumptions for coal, oil and gas up to 2030[30]. As Figure 11.2 shows, wind energy avoided €6.5 billion of fuel costs in 2008: €3.3 billion worth of gas; €2.1 billion worth of coal; €0.8 billion worth of oil and €.04 billion worth of biomass / waste. According to EWEA's new targets, wind energy will avoid fuel costs of €6.6 billion in 2010, €26.9 billion in 2020 and €32.8 billion in 2030, based on the European Commission's fuel price assumptions. Assuming the IEA fuel price scenario, wind power will avoid €55.8 billion in 2030. And if fuel prices in 2030 equal the level reached on 11 July 2008, wind energy would avoid fuel costs of €66.1 billion. The calculation is based on an exchange rate of $1.25/€.

[30] Source: Up to 2020: Commission staff working document - Europe's current and future energy position; SEC(2008) 2871 of 13 November 2008 (New Energy Policy scenario). 2021-2030: European Energy and Transport – Trends to 2030; European Commission, 2008.

12. Wind Energy Investments up to 2030

Photo: EWEA/Winter

One of the most attractive features of wind power is that the fuel is free. Therefore, the total cost of producing wind energy throughout the 20 to 25 year lifetime of a wind turbine can be predicted with great certainty. Neither the future prices of coal, oil or gas, nor the price of carbon, will affect the cost of wind power production.

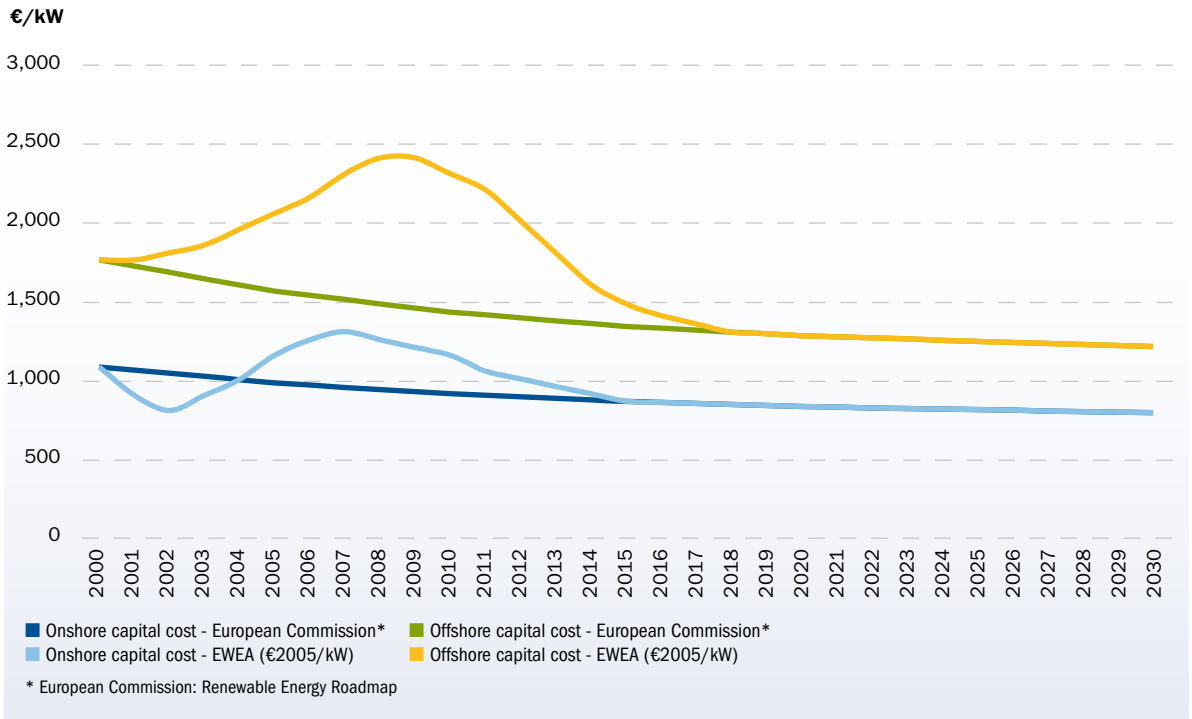
In order to calculate the wind power investments needed to reach EWEA's reference scenario, it is necessary to make assumptions as to the future cost of installed wind power capacity. For some years, it was assumed that installed wind power capacity cost around €1,000/kW. That is probably still a valid rule of thumb. However, since 2000 there have been quite large variations in the price (not necessarily the cost) of installing wind power capacity.

From 2001 to 2004, the global market for wind power capacity grew less than expected and created a surplus in wind turbine production capacity. Consequently, the price of wind power capacity went down dramatically – for some projects to €700-800/kW. In the past four years - 2005 to 2008 – the global market for wind energy increased by 30-40% annually, and demand for wind turbines surged, leading to increases in prices. Since 2008, turbine prices seem to have continued their long-term downwards trend.

The European Commission, in its Renewable Energy Roadmap of 2007[31], assumed that onshore wind energy would cost €935/kW in 2008 (in $€_{2005}$). It assumes that costs will drop to €826/kW in 2020 and €788/kW in 2030. That long term cost curve may still apply for a situation where there is balance between demand and supply for wind turbines.

Figure 12.1 shows the European Commission's assumptions on the development of onshore and offshore wind power capacity cost up to 2030. In addition, there are two curves that reflect the effect of the demand / supply on wind turbine prices in recent years. EWEA assumes onshore wind energy prices of €1,250 / kW in 2008 ($€_{2005}$ prices) and offshore prices of €2,400/kW. The increase in offshore costs reflects the limited number of manufacturers in the offshore market, the current absence of economies of scale due to low market deployment and bottlenecks in the supply chain.

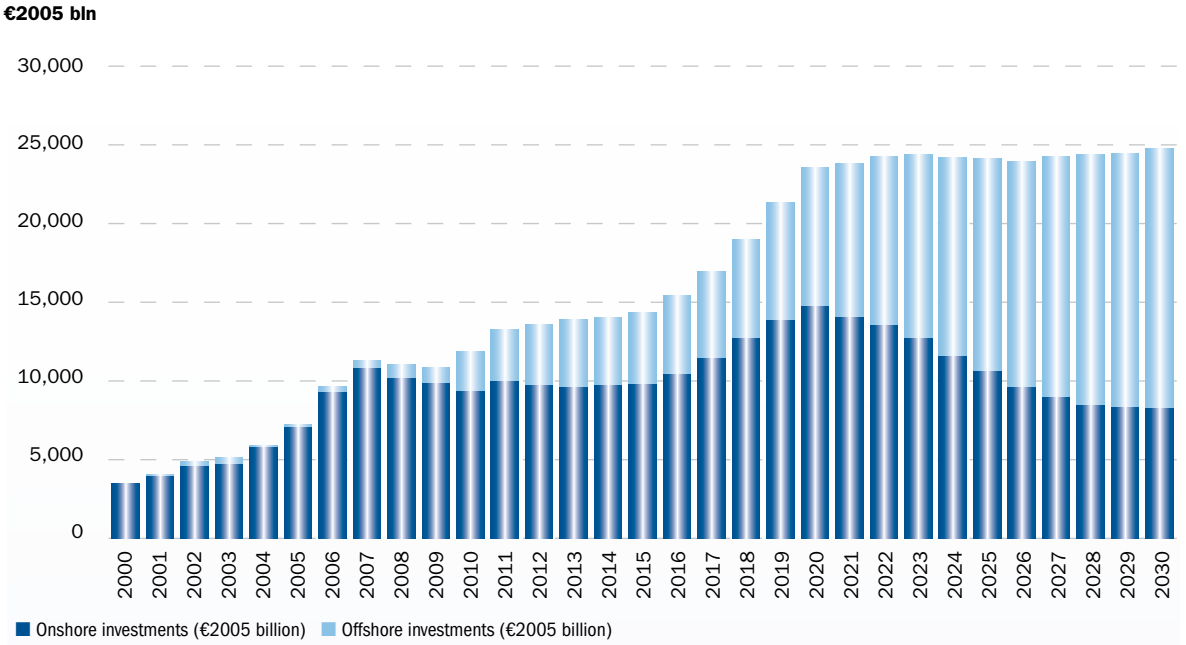
CAPITAL COST OF ONSHORE AND OFFSHORE WIND — FIGURE 12.1



[31] Source: EC, 2007a.

Based on the new EWEA targets for installed capacity up to 2030 and the wind power capacity prices above, Figure 12.2 shows expected annual wind power investments from 2000 to 2030. The annual market is to increase gradually from €11 billion in 2008 to €23.5 billion in 2020. In the decade up to 2030, the market will be stable - just below €25 billion annually, with a gradually increasing share of investments going to offshore.

WIND ENERGY INVESTMENTS 2000-2030 FIGURE 12.2



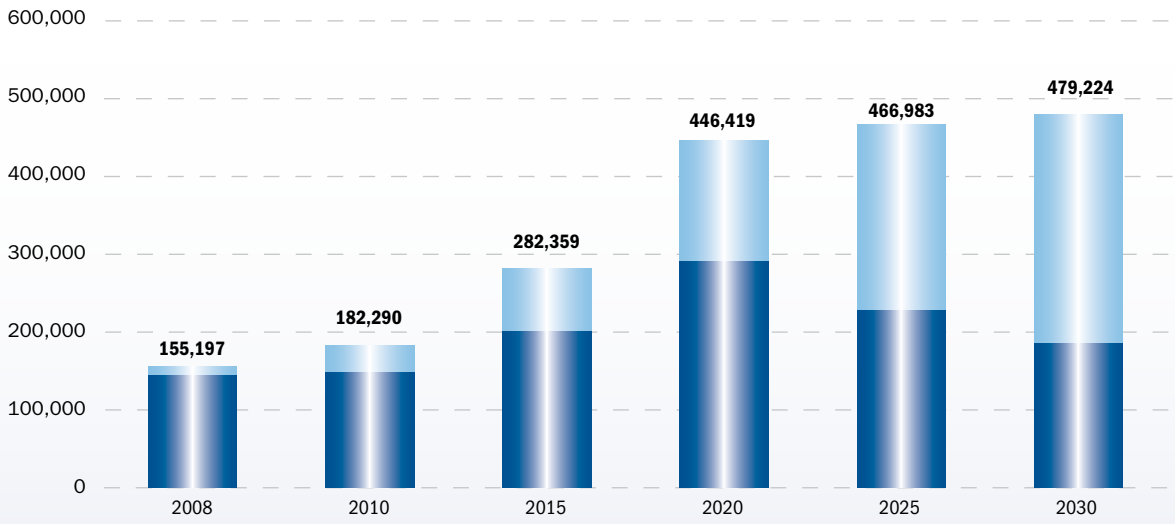
	Onshore investments (€2005 billion)	Offshore investments (€2005 billion)	Total investments (€2005 billion)
2000	3.455	0.007	3.462
2001	3.940	0.089	4.028
2002	4.595	0.306	4.901
2003	4.683	0.480	5.162
2004	5.749	0.175	5.924
2005	7.031	0.185	7.215
2006	9.239	0.431	9.670
2007	10.822	0.483	11.305
2008	10.148	0.879	11.026
2009	9.840	1.032	10.872
2010	9.315	2.529	11.844
2011	9.976	3.300	13.276
2012	9.693	3.916	13.609
2013	9.611	4.320	13.931
2014	9.697	4.320	14.017
2015	9.775	4.573	14.348
2016	10.404	5.047	15.451
2017	11.428	5.557	16.984
2018	12.679	6.315	18.994
2019	13.826	7.526	21.352
2020	14.744	8.810	23.554
2021	14.028	9.779	23.807
2022	13.549	10.713	24.262
2023	12.725	11.662	24.387
2024	11.584	12.593	24.177
2025	10.583	13.521	24.103
2026	9.558	14.367	23.925
2027	8.970	15.293	24.264
2028	8.467	15.927	24.394
2029	8.306	16.118	24.424
2030	8.261	16.510	24.771

Source: EWEA

Wind energy and employment

In 2008, the wind energy industry employed 155,000 people directly or indirectly in Europe. Assuming EWEA's new targets are met, the wind energy sector will employ 182,000 people in 2010, 282,000 in 2015 and 446,000 by 2020. By 2025, employment in the European offshore wind sector is expected to exceed onshore wind energy employment. By 2030, wind energy will employ 479,000 people in the EU, of which 294,000 – 61% of the total - will be in offshore wind energy.

WIND ENERGY SECTOR EMPLOYMENT (2008-2030) FIGURE 12.3



	2008	2010	2015	2020	2025	2030
Onshore	143,782	148,057	200,870	290,276	228,104	185,478
Offshore	11,415	34,232	81,489	156,143	238,879	293,746

Source: EWEA

13. Wind Energy After 2030

Photo: Dong Energy

On 7 October 2009, the European Commission published its Communication on "Investing in the Development of Low Carbon Technologies (SET-Plan)" – COM (2009) 519. The European Commission stated that the development of wind energy "must be underpinned by a comprehensive research programme to improve the conversion efficiency of wind turbines."

It is estimated in the Communication that €6 billion of investment in wind energy research is needed in Europe over the next 10 years. According to the European Commission's Communication, "The return would be fully competitive wind power generation capable of contributing up to 20% of EU electricity by 2020 and as much as 33% by 2030. More than 250,000 skilled jobs could be created."

EWEA agrees with the Commission's assessment. With additional research efforts and significant progress in building the necessary grid infrastructure over the next ten years, wind energy could meet one fifth of the EU's electricity demand in 2020, one third in 2030 and half by 2050.

Meeting the European Commission's ambitions for wind energy would require 265 GW of wind power capacity, including 55 GW of offshore wind by 2020 (see Table 13.1). That would require Member States to adopt the "high" scenarios for wind energy (described in Chapter 1) in their National Renewable Energy Action Plans, combined with the European Commission's New Energy Policy scenario for 2020 demand. The Commission's 2030 target of 33% of EU power from wind energy can be reached by meeting EWEA's 2030 installed capacity target of 400 GW wind, as outlined in Chapter 7. A total of 600 GW of wind energy would be needed in 2050 to meet 50% of the EU's electricity demand: 250 GW would be onshore and 350 GW offshore. With a higher proportion of offshore wind energy, wind energy could produce more than the 2,015 TWh indicated in the table.

WIND ENERGY CAPACITY NEEDED TO MEET THE EUROPEAN COMMISSION'S SET-PLAN TARGETS TABLE 13.1

	Onshore wind (GW)	Offshore wind (GW)	Total wind energy capacity (GW)	Average capacity factor onshore	Average capacity factor offshore	TWh onshore	TWh offshore	TWh Total	EU-27 gross electricity consumption*	Wind power's share of electricity demand*
2020**	210	55	265	26,0%	42,3%	479	204	683	3,494	20%
2030	250	150	400	27,0%	42,8%	592	563	1,155	3,368	34%
2050	250	350	600	29,0%	45,0%	635	1,380	2,015	4,000	50%

* Electricity demand assumes the European Commission's New Energy Policy $100 oil/barrel scenario until 2020 and High Renewables / Energy Efficiency scenario for 2030. Demand in 2050 is assumed to be 4,000 TWh.

** Assuming 265 GW by 2020 in accordance with EWEAs "high" scenario - see Chapter 1 - combined with the European Commission's "New Energy Policy" assumption for demand.

Annex

Photo: EWEA/Hennaux

ANNEX 1: CUMULATIVE INSTALLATIONS OF WIND POWER IN THE EU (MW)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	77	94	140	415	606	819	965	982	995
Belgium	13	32	35	68	96	167	194	287	384
Bulgaria	0	0	0	0	10	10	36	57	158
Cyprus	0	0	0	0	0	0	0	0	0
Czech Republic	0	0	3	9	17	28	54	116	150
Denmark	2,417	2,489	2,889	3,116	3,118	3,128	3,136	3,125	3,180
Estonia	0	0	2	2	6	32	32	59	78
Finland	39	39	43	52	82	82	86	110	143
France	66	93	148	257	390	757	1,567	2,454	3,404
Germany	6,113	8,754	11,994	14,609	16,629	18,415	20,622	22,247	23,903
Greece	189	272	297	383	473	573	746	871	985
Hungary	0	0	3	3	3	17	61	65	127
Ireland	118	124	137	190	339	496	746	795	1,002
Italy	427	682	788	905	1,266	1,718	2,123	2,726	3,736
Latvia	0	0	24	27	27	27	27	27	27
Lithuania	0	0	0	0	6	6	48	51	54
Luxembourg	10	15	17	22	35	35	35	35	35
Malta	0	0	0	0	0	0	0	0	0
Netherlands	446	486	693	910	1,079	1,219	1,558	1,747	2,225
Poland	0	0	27	63	63	83	153	276	472
Portugal	100	131	195	296	522	1,022	1,716	2,150	2,862
Romania	0	0	1	1	1	2	3	8	10
Slovakia	0	0	0	3	5	5	5	5	3
Slovenia	0	0	0	0	0	0	0	0	0
Spain	2,235	3,337	4,825	6,203	8,264	10,028	11,623	15,131	16,740
Sweden	231	293	345	399	442	510	571	788	1021
UK	406	474	552	667	904	1,332	1,962	2,406	3,241
EU Total	**12,887**	**1,7315**	**23,157**	**28,598**	**34,372**	**40,500**	**48,031**	**56,453**	**64,935**

Source: EWEA

ANNEX 2: ANNUAL INSTALLATIONS OF WIND POWER IN THE EU (MW)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	43	17	46	276	192	218	146	19	14
Belgium	7	19	3	33	28	71	28	93	104
Bulgaria	0	0	0	0	10	0	26	21	101
Cyprus	0	0	0	0	0	0	0	0	0
Czech Republic	0	0	0	6	9	11	26	63	34
Denmark	646	72	506	249	9	22	12	3	77
Estonia	0	0		0	3	26	0	27	20
Finland	0	0	4	9	30	4	4	24	33
France	41	27	55	109	138	367	810	888	950
Germany	1,671	2,641	3,240	2,645	2,037	1,809	2,233	1,667	1,665
Greece	77	83	25	86	90	100	173	125	114
Hungary	0	0	0	0	0	14	43	4	62
Ireland	44	6	13	53	149	157	250	49	208
Italy	150	255	106	117	361	452	417	603	1,010
Latvia	0	0	0	3	0	0	0	0	0
Lithuania	0	0		0	6	0	42	89	3
Luxembourg	0	4.8	2.2	5	14	0	0	0	0
Malta	0	0		0	0	0	0	0	0
Netherlands	13	40	222	224	199	154	354	210	500
Poland	0	0		36	0	20	69	1239	196
Portugal	39	31	64	104	226	500	694	434	712
Romania	0	0	0	0	0	1	1	4.95	2
Slovakia	0	0	0	3	3	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0
Spain	423	1,102	1,488	1,378	2,065	1,764	1,595	3,508	1,609
Sweden	11	62	52	54	43	68	62	217	236
UK	44	68	87	121	237	445	634	443	836
EU-27* Total	**3,209**	**4,428**	**5,973**	**5,510**	**5,838**	**6,204**	**7,592**	**8,535**	**8,484**

Source: EWEA

*EU-25 from 2005; EU-27 from 2007

ANNEX 3: WIND ENERGY INSTALLATIONS 2000-2030 (GW)

	Onshore annual	Onshore total	Onshore decommis-sioning	Offshore annual	Offshore total	Offshore decommis-sioning	Total new wind capacity annual	Total installed wind capacity
2000	3.2	12.9	0.0	0.0	0.0	0.0	3.2	12.9
2001	4.4	17.2	0.0	0.1	0.1	0.0	4.4	17.3
2002	5.7	22.8	0.1	0.2	0.3	0.0	5.9	23.1
2003	5.2	28.0	0.1	0.3	0.5	0.0	5.5	28.5
2004	5.7	33.8	0.1	0.1	0.6	0.0	5.8	34.4
2005	6.1	39.8	0.1	0.1	0.7	0.0	6.2	40.5
2006	7.4	47.1	0.1	0.2	0.9	0.0	7.6	48.0
2007	8.3	55.4	0.1	0.2	1.1	0.0	8.5	56.5
2008	8.1	63.5	0.1	0.4	1.5	0.0	8.5	64.9
2009	8.2	71.6	0.1	0.4	1.9	0.0	8.6	73.5
2010	8.1	79.6	0.1	1.1	3.0	0.0	9.2	82.6
2011	9.5	88.9	0.2	1.5	4.5	0.0	11.0	93.4
2012	9.7	98.3	0.3	2.0	6.5	0.0	11.6	105
2013	10.1	107.9	0.5	2.4	8.9	0.0	12.5	117
2014	10.7	117.9	0.7	2.7	11.6	0.0	13.4	129
2015	11.4	128.3	1.0	3.1	14.7	0.0	14.5	143
2016	12.2	139.2	1.3	3.6	18.3	0.0	15.8	157
2017	13.5	150.8	1.9	4.1	22.4	0.0	17.6	173
2018	15.1	163.3	2.6	4.9	27.2	0.0	20.0	191
2019	16.6	176.4	3.5	5.9	33.1	0.0	22.5	209
2020	17.8	190.0	4.2	6.9	40.0	0.0	24.8	230
2021	17.1	202.0	5.1	7.7	47.7	0.0	24.8	250
2022	16.6	213.0	5.6	8.5	56.2	0.0	25.1	269
2023	15.6	223.0	5.6	9.3	65.5	0.0	24.9	288
2024	14.3	231.0	6.3	10.1	75.6	0.0	24.4	307
2025	13.1	237.0	7.1	10.9	86.5	0.0	24.0	323
2026	11.9	241.0	7.9	11.7	98.1	0.1	23.6	339
2027	11.2	244.0	8.2	12.5	110.4	0.2	23.7	354
2028	10.6	246.5	8.1	13.1	123.2	0.3	23.7	370
2029	10.5	248.5	8.5	13.3	136.4	0.1	23.8	385
2030	10.5	250.0	9.0	13.7	150.0	0.1	24.2	400

Source: EWEA

ANNEX 4: WIND ENERGY PRODUCTION AND SHARE OF ELECTRICITY CONSUMPTION 2000-2030

	Avg. capacity factor onshore	Avg. capacity factor offshore	Avg. capacity factor	Onshore wind energy production (TWh)	Offshore wind energy production (TWh)	Total wind energy production (TWh)	Gross electricity consumption - 'Baseline scenario'*	Gross electricity consumption 'New Energy Policy'**	Wind energy's share of electricity consumption - Baseline	Wind energy's share of electricity consumption - New Energy Policy
2000	19.9%	44.9%	20.0%	22	0	23	2,994	2,994	0.8%	0.8%
2001	21.0%	43.1%	21.1%	32	0	32	3,059	3,059	1.0%	1.0%
2002	21.7%	42.4%	22.0%	44	1	44	3,124	3,124	1.4%	1.4%
2003	22.4%	42.2%	22.7%	55	2	57	3,190	3,190	1.8%	1.8%
2004	22.7%	42.3%	23.1%	67	2	70	3,255	3,255	2.1%	2.1%
2005	23.0%	42.7%	23.4%	80	3	83	3,320	3,320	2.5%	2.5%
2006	23.3%	42.6%	23.7%	96	3	100	3,357	3,357	3.0%	3.0%
2007	23.6%	42.5%	24.0%	115	4	119	3,372	3,372	3.5%	3.5%
2008	23.7%	41.2%	24.1%	132	5	137	3,387	3,387	4.0%	4.0%
2009	23.9%	41.3%	24.3%	150	7	157	3,478	3,391	4.5%	4.6%
2010	24.1%	41.4%	24.7%	168	11	179	3,570	3,396	5.0%	5.3%
2011	24.3%	41.5%	25.1%	189	16	205	3,624	3,401	5.7%	6.0%
2012	24.5%	41.6%	25.5%	211	24	234	3,678	3,406	6.4%	6.9%
2013	24.7%	41.7%	26.0%	233	32	265	3,732	3,410	7.1%	7.8%
2014	24.9%	41.8%	26.4%	257	42	299	3,787	3,415	7.9%	8.8%
2015	25.1%	41.9%	26.8%	281	54	335	3,841	3,420	8.7%	9.8%
2016	25.2%	41.9%	27.2%	308	67	375	3,889	3,425	9.6%	10.9%
2017	25.4%	42.0%	27.6%	336	82	419	3,936	3,430	10.6%	12.2%
2018	25.6%	42.1%	28.0%	367	101	467	3,984	3,434	11.7%	13.6%
2019	25.8%	42.2%	28.4%	399	122	522	4,032	3,439	12.9%	15.2%
2020	26.0%	42.3%	28.9%	433	148	582	4,079	3,444	14.3%	16.9%
2021	26.1%	42.4%	29.2%	462	177	639	4,118	3,436	15.5%	18.6%
2022	26.2%	42.4%	29.6%	489	209	698	4,157	3,429	16.8%	20.4%
2023	26.3%	42.5%	30.0%	514	244	758	4,196	3,421	18.1%	22.2%
2024	26.4%	42.5%	30.4%	535	282	816	4,235	3,414	19.3%	23.9%
2025	26.5%	42.6%	30.8%	551	323	873	4,274	3,406	20.4%	25.6%
2026	26.6%	42.6%	31.3%	562	366	928	4,301	3,398	21.6%	27.3%
2027	26.7%	42.7%	31.7%	571	413	984	4,328	3,391	22.7%	29.0%
2028	26.8%	42.7%	32.1%	579	461	1,040	4,355	3,383	23.9%	30.8%
2029	26.9%	42.8%	32.5%	586	511	1,097	4,382	3,376	25.0%	32.5%
2030	27.0%	42.8%	33.0%	592	563	1,155	4,409	3,368	26.2%	34.3%

* "European Energy and Transport. Trends to 2030 - update 2007"; European Commission 2008.

** Up to 2020: Figures based on Commission staff working document accompanying "Second Strategic Energy Review - An EU energy security and solidarity action plan" {COM (2008) 781}; European Commission November 2008. From 2021-2030: "European Energy and Transport, Scenarios on energy efficiency and renewables" - Combines high renewables and efficiency case.

ANNEX 5: WIND ENERGY INVESTMENTS UP TO 2030

	Investment cost onshore (€$_{2005}$/kW)	Investment cost offshore (€$_{2005}$)/kW	Annual investmenst onshore (€$_{2005}$ billion)	Annual investments offshore (€$_{2005}$ billion)	Total wind power capital investments (€$_{2005}$ billion)
2000	1,078	1,755	3.5	0.0	3.5
2001	900	1,755	3.9	0.1	4.0
2002	800	1,800	4.6	0.3	4.9
2003	900	1,850	4.7	0.5	5.2
2004	1,000	1,950	5.7	0.2	5.9
2005	1,150	2,050	7.0	0.2	7.2
2006	1,250	2,150	9.2	0.4	9.7
2007	1,300	2,300	10.8	0.5	11.3
2008	1,250	2,400	10.1	0.9	11.0
2009	1,200	2,400	9.8	1.0	10.9
2010	1,150	2,300	9.3	2.5	11.8
2011	1,050	2,200	10.0	3.3	13.3
2012	1,002	2,000	9.7	3.9	13.6
2013	955	1,800	9.6	4.3	13.9
2014	907	1,600	9.7	4.3	14.0
2015	859	1,475	9.8	4.6	14.3
2016	852	1,400	10.4	5.0	15.5
2017	846	1,350	11.4	5.6	17.0
2018	839	1,298	12.7	6.3	19.0
2019	833	1,286	13.8	7.5	21.4
2020	826	1,274	14.7	8.8	23.6
2021	822	1,267	14.0	9.8	23.8
2022	818	1,260	13.5	10.7	24.3
2023	815	1,254	12.7	11.7	24.4
2024	811	1,247	11.6	12.6	24.2
2025	807	1,240	10.6	13.5	24.1
2026	803	1,233	9.6	14.4	23.9
2027	799	1,226	9.0	15.3	24.3
2028	796	1,220	8.5	15.9	24.4
2029	792	1,213	8.3	16.1	24.4
2030	788	1,206	8.3	16.5	24.8

ANNEX 6: CO_2 AVOIDED FROM WIND

	Mt CO_2 avoided/ TWh wind	CO_2 avoided from onshore wind (Mt)	CO_2 avoided from onshore wind (Mt)	Total CO_2 avoided from wind (Mt)	Oil price (in $\$_{2007}$/ barrel)*	Annual avoided fuel cost $€_{2007}$ billion
2000	0.789	18	0	18		
2001	0.775	25	0	25		
2002	0.761	33	1	34		
2003	0.748	41	1	42		
2004	0.736	49	2	51		
2005	0.724	58	2	60		
2006	0.704	68	2	70		
2007	0.685	78	3	81		
2008	0.667	88	4	91	94.8	6.5
2009	0.649	97	4	102		
2010	0.633	106	7	113	100	8.7
2011	0.627	118	10	129		
2012	0.622	131	15	146		
2013	0.617	144	20	164		
2014	0.613	157	26	183		
2015	0.608	171	33	204	100	15.3
2016	0.600	185	40	225		
2017	0.593	199	49	248		
2018	0.585	215	59	274		
2019	0.579	231	71	302		
2020	0.572	248	85	333	110	27.7
2021	0.566	262	100	362		
2022	0.561	275	117	392		
2023	0.556	286	135	421		
2024	0.550	294	155	449		
2025	0.545	300	176	476	116	41.9
2026	0.540	304	198	501		
2027	0.535	305	221	526		
2028	0.529	307	244	550		
2029	0.524	307	268	575		
2030	0.518	307	292	599	122	55.8

* Fuel price assumptions based on: "World Energy Outlook 2008"; International Energy Agency (IEA) 2008.

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About EWEA

EWEA is the voice of the wind industry, actively promoting the utilisation of wind power in Europe and worldwide. It now has over 600 members from almost 60 countries including manufacturers with a 90% share of the world wind power market, plus component suppliers, research institutes, national wind and renewables associations, developers, electricity providers, finance and insurance companies and consultants.

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