

Wind Power

The twin threats of climate change caused by burning fossil fuels and escalating fossil fuel prices make the further rapid development of renewable energy sources a global imperative. Energy provided by the power in the winds is destined to become ever more important. Though no panacea, wind power has the potential to make a substantial contribution to meeting electricity needs in many countries. This concise and accessible account of the history and future development of wind power technology will appeal to a wide audience of engineers, scientists, policymakers and students, and anyone interested in learning more about the potential of wind power.

Wind power has been used increasingly to generate electricity since the early 1990s in Europe, the United States and elsewhere, and the global installed wind power capacity has been doubling every three to four years. It is now making the transition from being a minor contributor to becoming an important source of electricity. However, the level of understanding of what can be expected from wind systems in the future – and at what cost – is generally poor. This book requires no prior technical knowledge, and describes the development of wind power technology from medieval times to the present. It looks forward to the important role that wind power is expected to play – as a clean, competitive and abundant energy source – in helping to meet our future energy needs.

- Considers the factors underpinning wind power's exponential growth since 1990, to help understand what we can expect from wind power in the future.
- Shows how the cost of wind energy compares with electricity produced by burning fossil fuels.
- Explains simply how wind turbines (and windmills) work.
- Explains why wind power's intermittency does not prevent its large-scale use.

PETER MUSGROVE's wind power interests go back to 1974 when he was teaching engineering at the University of Reading. Though wind power was then the UK's least favoured renewable energy option he strongly argued the case for large offshore wind farms and gained recognition for their potential. He was also very much involved in the UK vertical axis wind turbine programme through the 1970s and 1980s. He was one of the prime movers in the 1978 formation of the British Wind Energy Association (BWEA) and was its first Chairman. He left academia for industry in 1988 and as National Wind Power's Head of Development through the 1990s was involved in all aspects of wind farm development and wind turbine assessment. He retired in 2003 and was given the BWEA's first Lifetime Achievement Award.

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For my grandchildren
James, Terry, Faith, Jonathan and Euan
and their generation

Contents

<i>Preface</i>	<i>page</i> xiii
<i>Acknowledgements</i>	xiv
1 Wind power and our energy needs: an overview	1
Traditional windmills	1
Power and energy in the modern world	2
Global warming and climate change	3
Renewable energy sources	6
Wind energy conversion	7
Energy payback and wind energy costs	8
Intermittency issues	9
Wind or nuclear?	9
Costs compared with conventional generation	10
Wind power’s growth and potential	11
2 The first windmills	15
Hero’s toy windmill	15
Early Persian drag-driven windmills	15
Chinese drag-driven windmills	19
The European windmill	20
How post mills work	21
Origins and economics	22
3 Seven centuries of service	27
Post mills	27
Diffusion through Europe	27
Medieval milling capacity	28
Controlling the mill	29
Sail developments	30

	Milling the grain	33
	Design evolution	35
	Smock mills and tower mills	37
	Control refinements	40
	The power output from traditional windmills	41
	Land drainage and other applications	46
	The windmill's nineteenth-century peak	47
	Causes of decline	48
	Steam power	48
	White bread	49
	Roller mills	51
	The American multi-bladed windpump	52
4	Generating electricity: the experimental years, 1887 to 1973	57
	The first wind-powered electricity generation	58
	Danish beginnings: Poul la Cour	63
	The inter-war years	65
	Small wind-electric systems	68
	Grandpa's Knob, Vermont: the first megawatt-plus machine	70
	Wartime shortages rekindle Danish interest	73
	Post-war energy concerns, and Denmark's Gedser mill	75
	French and German post-war programmes	79
	The UK post-war programme	81
5	The evolution of the modern wind turbine, 1973 to 1990	87
	The 1973 oil crisis	87
	The American Federal wind power program	89
	First generation machines, Mod-0 and Mod-1	89
	Second- and third-generation machines, Mod-2 and Mod-5	92
	The American/Swedish WTS-4	94
	The Darrieus vertical-axis wind turbine	95
	European national wind power programmes	99
	Sweden	99
	Germany	101
	Denmark	102
	A different Danish way forward	105
	The Tvind machine	105
	Small grid-connected wind turbines	106
	The Californian wind boom	112
	The first wind farms	113
	Danish imports	115

	The market peaks	118
	Environmental concerns	119
	Design evolution	120
	Danish success factors	123
6	Progress and economics in Europe, 1973 to 1990	125
	Denmark	125
	Stall control or pitch control?	126
	Shut-down in high wind speeds	128
	Costs relative to the annual energy output	129
	Costs per unit energy output	131
	Cost comparisons	132
	The Netherlands and Germany	133
7	UK progress, 1973 to 1990	137
	Wind power: the least promising renewables option?	137
	The offshore wind potential	138
	Managing wind power's variability	140
	The Department of Energy wind programme	142
	The Orkney multi-megawatt wind turbine	142
	Offshore wind farm assessment	143
	Vertical-axis wind turbines	145
	Other UK wind turbine developments	149
	Lawson-Tancred	149
	Fair Isle	150
	Carmarthen Bay wind turbine test centre	151
	Howden	151
	Wind Energy Group	153
	Institutional barriers	153
	Privatisation and the Non-Fossil Fuel Obligation (NFFO)	155
8	Development and deployment, 1990 to 2008	159
	Global overview	159
	Denmark	162
	The 1990s, a decade of growth	162
	Offshore wind makes progress	165
	Danish overview	169
	Germany	171
	1991: a feed-in tariff established	171
	Domestic manufacture	172
	From 2000: the Renewable Energy Law	174
	German overview	176

Spain	178
The 1994 feed-in tariff	178
Spanish overview	180
United Kingdom	181
The disappointing 1990s	181
Why NFFO failed	185
The Renewables Obligation	187
Offshore wind farms	189
UK overview	193
United States	194
Low growth beginnings	194
The Production Tax Credit (PTC) and ‘green power’	195
Momentum builds	197
US overview	199
Canada, Netherlands and Japan	202
India	203
China	205
9 The future: from marginal to mainstream	209
Low-carbon options for electricity generation	210
Carbon capture and storage	210
Nuclear power	211
Renewables	212
Wind power’s progress	214
Cost-of-energy comparisons	216
Variability: keeping the lights on	219
Wind power’s global growth	221
 <i>Appendix A The power output from wind turbines</i>	 227
<i>The Betz limit</i>	229
<i>How many blades? The effect of solidity</i>	229
<i>Efficiency</i>	231
<i>Rotor drag</i>	231
<i>Appendix B The performance of traditional windmills</i>	233
<i>The power required to grind wheat</i>	233
<i>Smeaton’s 1759 measurements using model windmills</i>	234
<i>Coulomb’s 1781 measurements on working windmills</i>	236
<i>Dutch measurements on windmills in the 1920s and 1930s</i>	239
<i>Smeaton’s anomalous results</i>	241
<i>The power available from traditional windmills</i>	243
<i>Comparison with drag-driven Persian windmills</i>	245

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[More information](#)

Contents xi

<i>Appendix C</i>	247
<i>Wind characteristics</i>	
<i>Wind speed variation with height</i>	247
<i>Wind speed distribution</i>	247
<i>Notes</i>	250
<i>References</i>	306
<i>Index</i>	320

Preface

The high standard of living that we in developed countries enjoy is underpinned by the massive consumption of oil, gas and coal, the so-called fossil fuels. However we now recognise that the carbon dioxide emissions caused by the combustion of these fuels is changing the global climate, with potentially devastating consequences for us all. Electricity generation is the largest single source of carbon dioxide emissions, and the need to move to the production of electricity in ways that avoid these emissions has stimulated an upsurge of interest in renewable sources of energy.

Wind power is the renewables technology that has made most progress in recent years. And though modern wind turbines have much in common with traditional windmills they are very much larger and much more efficient. Since 1973, when the first oil crisis encouraged a number of countries to commence their development, wind turbines have progressed to the point where they can generate electricity at a cost that is comparable with that produced by burning fossil fuels, though without the carbon dioxide emissions and price volatility. In 2008 the global installed wind power capacity passed 100 000 MW and wind power provided just over 1% of global electricity; by 2020 the installed capacity is likely to exceed 1 million MW, with wind power providing about 10% of global electricity, a percentage that is expected to grow steadily in the following decades.

This book tells the story of the development of wind power technology from its medieval beginnings through many centuries of success to its nineteenth-century decline and its late-twentieth-century revival, and looks forward to the important role that wind power seems likely to play – as a clean, competitive, reliable and abundant energy source – in helping to meet twenty-first-century energy needs. The core text of Chapters 1 to 9 requires no prior technical knowledge – just a reasonably numerate interest in how we can meet our future energy needs without causing further damage to the climate. The appendices and extensive notes give more detail for those who require it.

Acknowledgements

My interest in wind power began in 1974 when I was a Lecturer in the Engineering Department at the University of Reading and I am grateful to all my colleagues there, and in particular to Peter Dunn who was then Head of the Department, for their encouragement and support.

In 1988 I left academia to go into industry and I would like to thank David Lindley, then Managing Director of the Wind Energy Group, for inviting me to join him at WEG and for his support in facilitating my transition. I moved as Head of Development to National Wind Power (NWP), a related wind farm development company, when it was formed in 1991 and remained there until my retirement in 2003. I am very happy to acknowledge the debt that I owe to my many former NWP colleagues for all that I learnt from them, and though I cannot name them all – the list would be too long – I particularly wish to express my thanks to Alan Moore, Pam McEvoy and John Warren for their friendship, encouragement and support.

I have learnt from, and enjoyed the company of, many who have contributed to the global development of wind power. Again space does not allow me to name them all but I would particularly like to thank Henrik Stiesdal for his friendship over many years, and for the many technical discussions which greatly improved my understanding of wind turbine technology; I am happy also to take this opportunity to express my appreciation to him for reading my draft of Chapters 4, 5 and 6, and for making many constructive suggestions.

Last, but certainly not least, I wish to express my thanks and gratitude to my wife Sonja for her patience and support over many years, and in particular through the past four years when ‘the book’ has taken priority over a host of other potential retirement activities.