2
Wind Energy Resource Potential

How much of the world’s electricity needs could actually be met using wind energy? This is a question of fundamental importance. Detractors of wind energy, and of renewable energy in general, often assert that modern renewable energy will never contribute more than a few per cent of world energy demand and is therefore not worthy of serious consideration. Is such scepticism justified?

This question can be briefly examined in two ways. First, a quick look at Denmark, which has to date pursued the world’s most intensive wind energy development, reveals that in 1998 wind accounted for 9 per cent of Denmark’s total electricity production. This share is set to continue growing in the future, contributing a major portion of Denmark’s total electricity demand. Secondly, electricity generation is one of the world’s largest industries, and global electricity demand is expected to surpass 25 000 TWh/yr (25 trillion kWh/yr)\(^1\) around the year 2020 or 2025. If wind energy supplies only 1 per cent of this demand, then assuming a wholesale electricity price of 0.03 US$/kWh, wind energy’s annual electricity production would still be worth US$7.5 billion (thousand million) per year, more than many other entire industries. Furthermore, with an installed capacity of nearly 18 500 MW in 2000 and assuming a capital cost of US$1000 per kW, the world’s investment in installed wind capacity was already worth approximately US$18.5 billion in 2000. Wind energy is therefore of interest not only because it can potentially meet a large fraction of countries’ electricity demand, but also because even a small fraction of the global electricity market amounts to a major industry in terms of both investment and annual revenue.
More formal analysis is necessary, however, to better understand the size and potential of the world’s wind energy resource. This chapter therefore examines both the physical and practical potential of wind energy. We begin with a summary of worldwide installed wind turbine capacity to date, followed by a brief primer on wind resource assessment. These are then followed by longer-term scenarios for future wind energy utilisation, as well as the European Union’s strategy for reaching its long-term wind turbine installation goals. Lastly, the chapter presents an analysis of the physical and economic feasibility of more ambitious wind power development, highlighting a Danish study to meet 50 per cent of Danish electricity demand through wind by the year 2030.

**Worldwide installed capacity**

Since 1980, modern grid-connected wind turbines have been installed in more than 50 countries around the world. Early installations were predominantly in industrialised countries, with the USA and Denmark accounting for almost 90 per cent of installed capacity in the early 1990s. Though the USA dominated the field in the 1980s, its wind capacity growth rate slowed dramatically in the 1990s and was even negative for a period as old units were taken out of service and not replaced. Meanwhile, as shown in Table 2.1, Germany and Spain have experienced very dramatic wind capacity growth in the 1990s and surpassed the USA in total installed capacity. As of late 1998, however, installations have significantly picked up again in the USA, though not at the levels seen in Germany. Other major European players include the Netherlands and the UK.

A number of European countries not specified in Table 2.1 have also recently initiated significant wind energy programmes. By the end of 2000, the installed wind power capacity in these European countries included: Portugal 111 MW, Austria 69 MW, France 63 MW and Finland 39 MW (BTM Consult, 2001). Activity in developing countries has also picked up significantly in recent years, particularly in India and China. India currently ranks fifth in the world in total installed wind power capacity. Argentina, Cape Verde, Costa Rica, Egypt, Iran and Mexico are other countries not specified in Table 2.1 with notable recent wind energy growth.