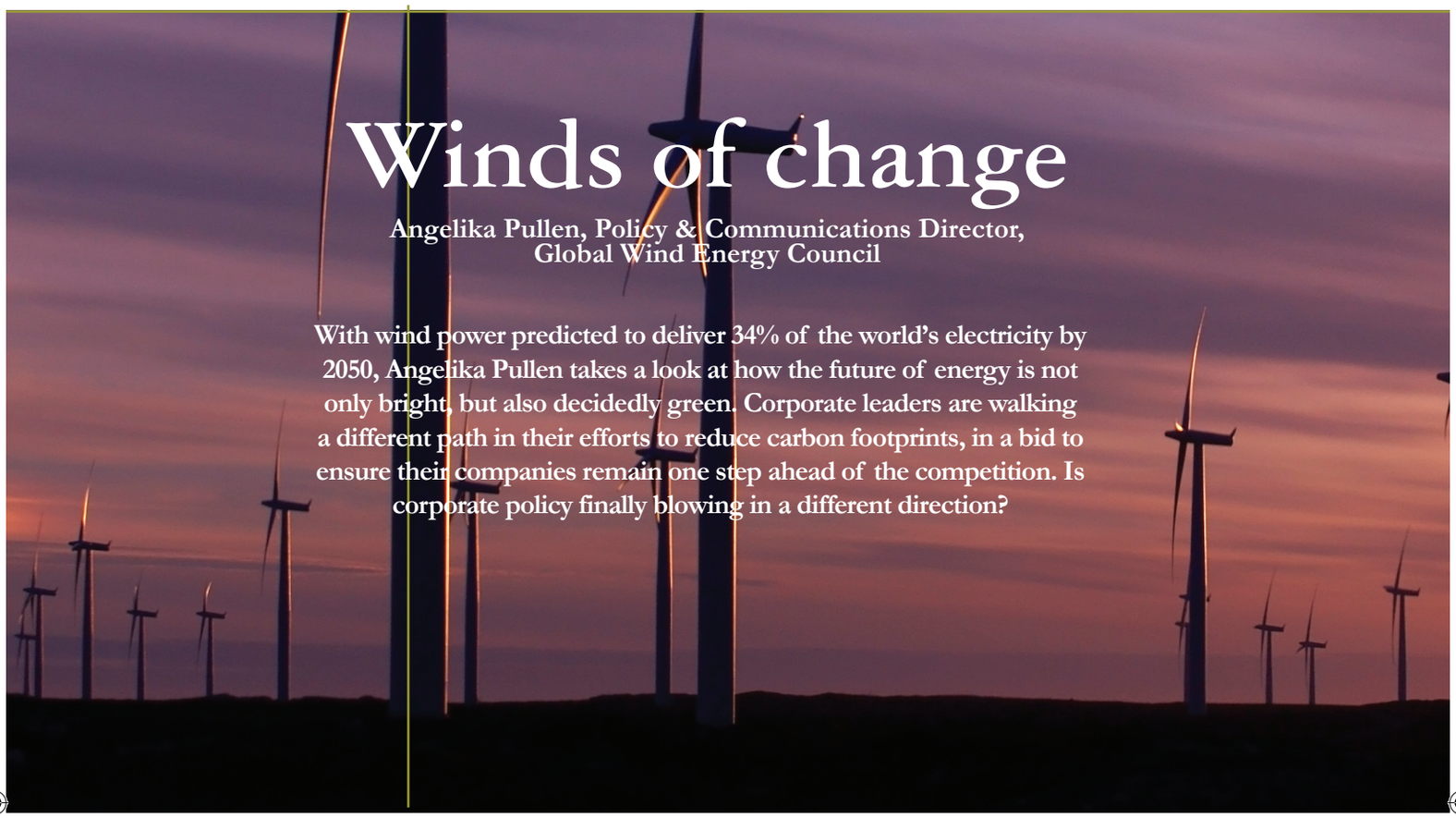

Winds of change

Angelika Pullen, Policy & Communications Director, Global Wind Energy Council

With wind power predicted to deliver 34% of the world's electricity by 2050, Angelika Pullen takes a look at how the future of energy is not only bright, but also decidedly green. Corporate leaders are walking a different path in their efforts to reduce carbon footprints, in a bid to ensure their companies remain one step ahead of the competition. Is corporate policy finally blowing in a different direction?

The Global Energy Challenge

The 21st century will be marked by a 'Global Energy Challenge' that requires urgent action in three areas: tackling the threat of climate change, meeting the rising demand for energy and safeguarding the security of energy supply.

World energy demand is expected to grow at a staggering rate over the next 25 years. In its recently published World Energy Outlook 2006, the International Energy Agency (IEA) predicts that the world's energy needs will grow by over 50% by 2030. Increasingly, governments are realising the threats that the current shaky supply situation is posing to their economic growth. Over-reliance on energy imports from few, mostly politically unstable countries and volatile oil and gas prices are already now inflicting a multi-billion Euro drain on the global economies.

Moreover, decision makers around the world are now acknowledging the urgent need to combat global climate change, which is one of the greatest threats the world is facing. There is a broad consensus that greenhouse gas emissions must be cut drastically to limit the wide-reaching environmental consequences. The use of fossil fuels is responsible for 70% of global greenhouse gas emissions. A shift in the way we produce and consume energy is thus essential.

The Role of Wind Energy

Renewable energies, and in particular wind energy, can and must be part of the solution to combat climate change, help meet increasing energy demand and stabilise the global security of supply situation.

Wind power is now a state of the art technology, and is already deployed on a large scale in many countries. All over the world, wind energy is growing to be a mainstream energy source for electricity production, and it is already now the fastest growing energy source in the world with an average annual growth rate of more than 28% in the last ten years. The world's wind energy generating capacity stood at over 59 Gigawatts (GW) at the end of 2005, and this strong growth has continued throughout 2006 (see Chart 1).

However, the global potential for wind energy remains largely untapped. Historically, five countries have mainly driven the market: Germany, Spain, the United States, India and Denmark. If other countries were to match the efforts of these countries, the impact on electricity production and Carbon Dioxide (CO_2) emissions savings would be far-reaching. Experts predict that the next decades will see a broadening of the global wind markets to include new countries across all continents.

Several countries outside of Europe and North America are now taking the first steps to develop large-scale commercial wind markets. Policy targets for renewable energy, which are crucial to kick-start the development, now exist in 49 countries worldwide, including 12 developing countries.

The Potential of Wind Power: GWEC's 'Global Wind Energy Outlook'

In its recently published 'Global Wind Energy Outlook', the Global Wind Energy Council (GWEC) examines the future potential of wind power up to the year 2050, against a range of projections for both the wind energy industry's expected development and the anticipated global growth in demand for electricity. This exercise has been carried out as a collaboration between the Global Wind Energy Council (GWEC), Greenpeace International and the German Aerospace Centre (DLR), the largest engineering research organisation in Germany.

The report clearly demonstrates that wind technology is not a dream for the future – it is real, it is mature and it can be deployed on a large scale. The political choices in the coming years will determine the world's environmental and economic situation for many decades to come.

The results of the Global Wind Energy Outlook scenarios show that wind power could be supplying as much as 29% of the world's electricity by 2030 and 34% by 2050, given that the political will to realise this potential is present in all countries and that extensive energy efficiency measures are put into place. These results show not only that wind energy can make a major contribution towards satisfying the global need for clean, renewable electricity within the next 30 years but that its penetration in the supply system can be substantially increased if serious energy efficiency measures are implemented at the same time.

The Methodology: Three Scenarios

Three different scenarios are outlined for the future growth of wind energy around the world. The most conservative "Reference" scenario is based on the projection in the (2004) World Energy Outlook report from the International Energy Agency (IEA). This projects the growth of all renewables, including wind power, up to 2030. The IEA assessment has then been extrapolated up to 2050.

The "Moderate" scenario takes into account all policy measures to support renewableenergy either under way or planned around the world. It also assumes that the targets set by many countries for either renewables or wind energy are successfully implemented. The assumption here is that the success achieved in Europe in meeting the goals for wind energy implementation set by the European Union will be repeated globally.

The most ambitious scenario, the "Advanced" version, assumes that all policy options in favour of renewable energy, along the lines of the report's policy recommendations, have been selected, with significant political will to carry them out.

Wind Could Provide up to 34% of the World's Electricity in 2050

A more detailed analysis of the Global Wind Energy Outlook scenario shows that a range of outcomes is possible for the global wind energy market, depending on the choice of demand side options and different assumptions for growth rates on the wind power supply side.

Under the basic Reference wind energy scenario, a 15% annual growth rate of wind power capacity is assumed until 2010, followed by 10% until 2014. After that it declines rapidly, falling to 3% per annum by 2031.

The result is that by the end of this decade, cumulative global capacity would have reached almost 113 Gigawatts (GW). By 2020, global capacity would be over 230 GW and by 2030 almost 364 GW. By the end of the scenario period in 2050 the capacity of worldwide wind power would be more than 577 GW. The annual rate of installation of new capacity would by then be running at 34 GW.

Given this scenario, the relative penetration of wind energy in the global electricity supply system would then range from 1.5 - 1.8 % in 2010, up to 6.6 - 4% in 2050, depending on the underlying energy efficiency measures and the resulting level of energy demand.

Under the Moderate wind energy scenario growth rates are expected to be substantially higher than under the Reference version. Up to 2010, the annual growth rate is 19%, from 2011 to 2014 it is 1%, and from 2015 to 2020 it is 15%. It then declines to 10% until 2025 before falling to 5%.

The result is that by 2020, global wind power capacity would have reached a level of 560 GW and by 2030 almost 1,129 GW. By the end of the scenario period in 2050 the capacity of worldwide wind power would have reached almost 1,557 GW. The annual rate of installation of new capacity would by then be running at almost 71 GW.

Here, the relative penetration in the global electricity supply system, wind energy's contribution would increase from 1.8-2.2% in 2010 to 10.8-17.7% in 2050, depending on the demand projection used.

Under the Advanced wind energy scenario, an even more rapid expansion of the global wind power market is envisaged. Growth rates are faster in the first two decades. Up to 2015, a growth rate in annual wind power capacity of 20% is assumed, falling to 17%. It then reduces to approx 10% for the five years to 2025, before falling below 5%.

The result is that by the end of this decade, global capacity would have reached almost 154 GW. By 2020, global capacity would be almost 1,073 GW and by 2030 almost 2,110 GW. By the end of the scenario period in 2050 the capacity of worldwide wind power would be more than 3,010 GW. The size of the annual market for new wind power capacity would by then be 150 GW.

In terms of penetration in the global electricity supply system, wind's contribution would increase from 2.1-2.4% in 2010 up to

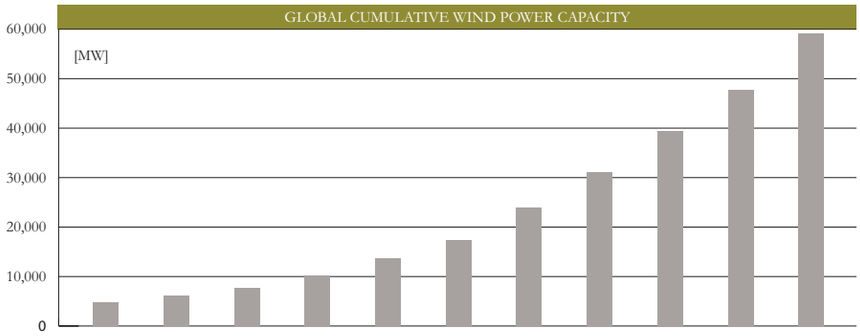

Figure 1

SUMMARY OF GLOBAL WIND ENERGY OUTLOOK SCENRIO FOR 2030							
Global Scenario	Cumulative wind power capacity (GW)	Electricity output (TWh)	Percentage of world electricity (High Energy Efficiency)	Annual installed capacity (GW)	Annual investment (€bn)	Jobs (million)	Annual CO_2 saving (million tonnes)
Reference	364	892	5%	24.8	21.2	0.48	535
Moderate	1,129	2,769	15.6%	58.3	45.0	1.14	1,661
Advanced	2,107	5,186	29.1%	129.2	84.8	1.44	3,110

SUMMARY OF GLOBAL WIND ENERGY OUTLOOK SCENRIO FOR 2050							
Global Scenario	Cumulative wind power capacity (GW)	Electricity output (TWh)	Percentage of world electricity (High Energy Efficiency)	Annual installed capacity (GW)	Annual investment (€bn)	Jobs (million)	Annual CO_2 saving (million tonnes)
Reference	557	1,517	6.6%	34.3	28.8	0.65	910
Moderate	1,557	4,092	17.7%	71.0	54.2	1.39	2,455
Advanced	3,010	7,911	34.3%	168.6	112.0	2.80	4,747

Figure 2

20.9 - 34.3% in 2050 for the reference or the high energy efficiency demand projection respectively.

Europe's Dominance Expected to Decrease

All three scenarios for wind power are broken down by region of the world. Europe would continue to dominate the world market under the least ambitious Reference scenario. By 2030 Europe would still have 51% of the global wind power marker, followed by North America with 26%. The next largest region would be China with 7%.

The two more ambitious scenarios envisage much stronger growth in regions outside the currently dominant European Union. Under the Moderate scenario, Europe's share will have fallen to 26% by 2030, with North America contributing a dominant 3% and major contributions coming from Central and South America (11%), China (8%), the Pacific region (8%) and South Asia, which includes India (7%).

Under the Advanced scenario, an even stronger input would come from Asia and South America, with China's share of the world market increasing to 16% by 2030, South America's share rising to 9% and the Pacific region's to 7%. Europe's share would make up only 19% of the world's total wind capacity.

Implications for the Global Economy

Already, wind energy has become big business, with annual investments exceeding €2 billion in 2005. Given the strong growth of the industry, this investment is expected to increase significantly over the next decade, contributing substantially to the economic development of the regions promoting wind energy as a mainstream energy source.

In the Reference scenario the annual increase in value of global investment in the wind power industry reaches €21.2 billion by 2030, with a peak at €28.8 billion in 2050.

In the Moderate scenario the annual value of global investment in the wind power industry reaches €18.2 billion in 2010; increases to €62.4 billion by 2020 with a peak at €74.9 billion in 2040.

In the Advanced scenario the annual value of global investment reaches €23.2 billion in 2010, peaks at €141 billion by 2020 and decreases slowly to €112.1 billion until 2050.

All these figures take into account the value of re-powering older turbines after their 20 year lifespan comes to an end. Although these figures may appear large, they should be seen in the context of the total level of investment in the global power industry. During the 1990s, for example, annual investment in the power sector was running at some €158 -186 billion each year.

The Generation Costs of Wind Energy

Wind energy is competitive with conventional energy sources on a good site. Various parameters need to be taken into account when calculating the generation costs of wind power. The most important of these are the capital cost of wind turbines and the expected electricity production.

The capital cost of producing wind turbines has fallen steadily over the past 20 years as manufacturing techniques have been optimised, turbine design has been largely concentrated on the three-bladed downwind model, and mass production and automation have resulted in economies of scale.

Studies of the past development of the wind power industry show that progress through R&D efforts and by improved production efficiency have already resulted in a 15-20% price reduction, and the industry is recognised as having entered the "commercialisation phase". However, the wind turbine manufacturing industry has not yet gained the full benefits from series production, especially due to the rapid upscaling of products. Neither has the full potential of future design optimisations been utilised.

For the purpose of this study, it was assumed that the cost of turbines goes down by 10% each time the number of units produced doubles until 2010. This rate then gradually decreases to 2% by 2025, when production processes are assumed to have been optimised and the level of global manufacturing output has reached a peak.

Capital costs per kilowatt of installed capacity are taken as an average of €1,000 in 2005. They are then assumed to fall steadily to €912 in 2010 and to €784 by 2025. From then onwards the scenario assumes a leveling out of costs (see Chart 2). All figures are given at 2005 prices.

The second parameter for calculating generation costs is the expected electricity production. This is highly dependent on the wind conditions at a given site, making selection of a good location essential to achieving economic viability. Other important factors include operation and maintenance (O&M) costs, the lifetime of the turbine and the discount rate (the cost of capital).

The unit cost of generation is calculated as an average cost over the lifetime of a turbine, which is normally estimated at 20 years. In reality, however, the actual costs will be lower at the beginning of a turbine's operation, due to lower O&M costs, and increase over the lifespan of the machine.

Taking into account all these factors, the cost of generating electricity from wind energy currently ranges from approximately 4-5 €/kWh at high wind speed sites up to approximately 6-8 €/kWh at sites with low average wind speeds.

However, over the past 15 years the efficiency of wind turbines has improved considerably thanks to better equipment design, better siting and taller turbines. As a result, efficiency has been increasing by 2% to 3% annually. Furthermore, it can be assumed that as a result of optimised production processes, the investment costs for wind turbines will decrease as described above.

It is expected that by 2020, the costs of producing electricity will have fallen to 3 - 3.8 €/kWh at a good site and 4 - 6 €/kWh at a site with low average wind speeds. By 2050, these costs could be as low as 2.8 - 3.5 €/kWh and 4.2 - 5.6 €/kWh respectively.

Strong Implications for Job Creation

The employment effect of this scenario is a crucial factor to weigh alongside its other costs and benefits. High unemployment rates continue to be a drain on the economies in many countries worldwide. Any technology which demands a substantial level of both skilled and unskilled labour is therefore of considerable economic importance, and likely to feature strongly in any political decision-making over different energy options.

A number of assessments on the implications for wind power on employment have been carried out in Germany, Denmark and the Netherlands. The assumption made in the GWEC report is that for every megawatt of new capacity, the annual market for wind energy will create employment at the rate of 16 jobs through manufacture and component supply. A further five jobs will be contributed by wind farm development, installation and indirect employment. As production processes are optimised, this level will decrease, falling to 11 manufacturing jobs and five in development and installation by 2030. In addition, employment in regular operations and maintenance work at wind farms will contribute a further 0.33 jobs for every megawatt of cumulative capacity.

Under the Reference scenario this means that more than 241,000 jobs would be created by 2010, over 481,000 jobs by 2030 and almost 653,000 jobs by 2050. In the Moderate scenario these numbers would increase to more than 390,000 jobs by 2010, almost 1.1 million by 2030 and then leveling out at about 1.4

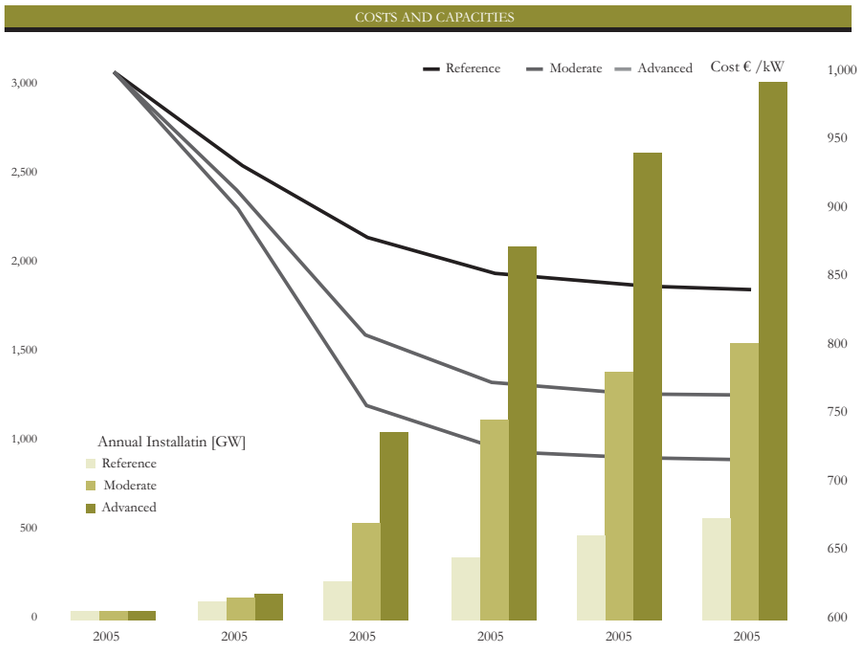

Figure 3

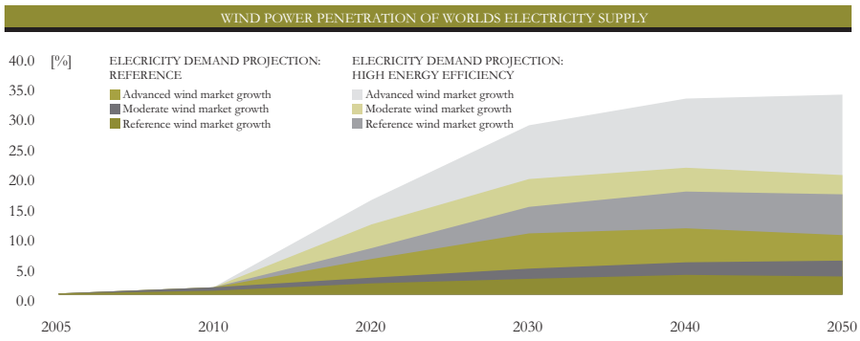

Figure 4

million by 2050. Under the Advanced scenario, the results show increases in the employment level to 2.9 million jobs by 2020, leveling out to 2.8 million by 2050.

Wind's Contribution to the Fight Against Climate Change

A reduction in the levels of carbon dioxide (CO_2) being emitted into the global atmosphere is the most important environmental benefit from wind power generation. Modern wind technology has an extremely good energy balance. The CO_2 emissions related to the manufacture, installation and servicing over the average 20 year lifecycle of a wind turbine are "paid back" after the first three to six months of operation. The benefit to be obtained from carbon dioxide reductions is dependent on which other fuel, or combination of fuels, any increased generation from wind power will displace.

Calculations by the World Energy Council show a range of CO_2 emission levels for different fossil fuels. Based on these assumptions, the expected annual saving in CO_2 from the Reference scenario will be 339 million tonnes in 2020, rising to 910 million tonnes in 2050 (see Chart 3). The cumulative saving over the whole scenario period would be 22,800 million tonnes.

Under the Moderate scenario the saving would be 825 million tonnes of CO_2 annually in 2020, rising to 2,455 million tonnes in 2050. The cumulative saving over the scenario period would be just over 62,150 million tonnes.

Under the Advanced scenario, the annual saving in 2020 would increase to 1,582 million tonnes and by 2050 to 4,700 million tonnes. The cumulative saving over the whole scenario period would be 113,600 million tonnes. ■

Angelika Pullen is the Policy and Communications Director for the Global Wind Energy Council (GWEC). For more information please email angelika.pullen@gwec.net or visit www.gwec.net