Market Research Analyst: Wind Power, Economics and Feasibility

Growth and cost trends

Global Wind Energy Council (GWEC) figures show that 2006 recorded an increase of installed capacity of 15,197 megawatts (MW), taking the total installed wind energy capacity to 74,223 MW, up from 59,091 MW in 2005. Despite constraints facing supply chains for wind turbines, the annual market for wind continued to increase at an estimated rate of 32% following the 2005 record year, in which the market grew by 41%. In terms of economic value, the wind energy sector has become one of the important players in the energy markets, with the total value of new generating equipment installed in 2006 reaching €18 billion, or US$23 billion.

In 2004, wind energy cost one-fifth of what it did in the 1980s, and some expected that downward trend to continue as larger multi-megawatt turbines are mass-produced. However, installation costs have increased significantly in 2005 and 2006, and according to the major U.S. wind industry trade group, now average over US$1,600 per kilowatt, compared to $1200/kW just a few years before. Not as many facilities can produce large modern turbines and their towers and foundations, so constraints develop in the supply of turbines resulting in higher costs.

Wind and hydro power have negligible fuel costs and relatively low maintenance costs; in economic terms, wind power has a low marginal cost and a high proportion of capital cost. The estimated average cost per unit incorporates the cost of construction of the turbine and transmission facilities, borrowed funds, return to investors (including cost of risk), estimated annual production, and other components, averaged over the projected useful life of the equipment, which may be in excess of twenty years. Energy cost estimates are highly dependent on these assumptions so published cost figures can differ substantially. A British Wind Energy Association report gives an average generation cost of onshore wind power of around 3.2 pence per kilowatt hour (2005). Cost per unit of energy produced was estimated in 2006 to be comparable to the cost of new generating capacity in the United States for coal and natural gas: wind cost was estimated at $55.80 per MWh, coal at $53.10/MWh and natural gas at $52.50. Other sources in various studies have estimated wind to be more expensive than other sources.

Similar methods apply to other electrical energy sources. Existing generation capacity represents sunk costs, and the decision to continue production will depend on marginal costs going forward, not estimated average costs at project inception. For example, the estimated cost of new wind power capacity may be lower than that for "new coal" (estimated average costs for new generation capacity) but higher than for "old coal" (marginal cost of production for existing capacity). Therefore, the choice to increase wind capacity will depend on factors including the profile of existing generation capacity.

Research from a wide variety of sources in various countries shows that support for wind power is consistently between 70 and 80 per cent amongst the general public.

Theoretical potential

Wind power available in the atmosphere is much greater than current world energy consumption. The most comprehensive study to date found the potential of wind power on land and near-shore to be 72 TW, equivalent to 54,000 MToE (million tons of oil equivalent) per year, or over five times the world's current energy use in all forms. The potential takes into account only locations with mean annual wind speeds ≥ 6.9 m/s at 80 m. It assumes 6 turbines per square km for 77 m diameter, 1.5 MW-turbines on roughly 13% of the total global land area (though that land would also be available for other compatible uses such as farming). The authors acknowledge that many practical barriers would need to be overcome to reach this theoretical capacity.

The practical limit to exploitation of wind power will be set by economic and environmental factors, since the resource available is far larger than any practical means to develop it.

Direct costs

Many potential sites for wind farms are far from demand centres, requiring substantially more money to construct new transmission lines and substations.

Since the primary cost of producing wind energy is construction and there are no fuel costs, the average cost of wind energy per unit of production is dependent on a few key assumptions, such as the cost of capital and years of assumed service. The marginal cost of wind energy once a plant is constructed is usually less than 1 cent per kilowatt-hour. Since the cost of capital plays a large part in projected cost, risk (as perceived by investors) will affect projected costs per unit of electricity.

The commercial viability of wind power also depends on the pricing regime for power producers. Electricity prices are highly regulated worldwide, and in many locations may not reflect the full cost of production, let alone indirect subsidies or negative externalities. Customers may enter into long-term pricing contracts for wind to reduce the risk of future pricing changes, thereby ensuring more stable returns for projects at the development stage. These may take the form of standard offer contracts, whereby the system operator undertakes to purchase power from wind at a fixed price for a certain period (perhaps up to a limit); these prices may be different than purchase prices from other sources, and even incorporate an implicit subsidy.

In jurisdictions where the price for electricity is based on market mechanisms, revenue for all producers per unit is higher when their production coincides with periods of higher prices. The profitability of wind farms will therefore be higher if their production schedule coincides with these periods. If wind represents a significant portion of supply, average revenue per unit of production may be lower as more expensive and less-efficient forms of generation, which typically set revenue levels, are displaced from economic dispatch. This may be of particular concern if the output of many wind plants in a market have strong temporal correlation. In economic terms, the marginal revenue of the wind sector as penetration increases may diminish.

External costs

Most forms of energy production create some form of negative externality: costs that are not paid by the producer or consumer of the good. For electric production, the most significant externality is pollution, which imposes social costs in increased health expenses, reduced agricultural productivity, and other problems. In addition, carbon dioxide, a greenhouse gas produced when fossil fuels are burned, may impose even greater costs in the form of global warming. Few mechanisms currently exist to internalize these costs, and the total cost is highly uncertain. Other significant externalities can include military expenditures to ensure access to fossil fuels, remediation of polluted sites, destruction of wild habitat, loss of scenery/tourism, etc.

If the external costs are taken into account, wind energy may be competitive in more cases. Wind energy costs have generally decreased due to technology development and scale enlargement. Wind energy supporters argue that, once external costs and subsidies to other forms of electrical production are accounted for, wind energy is amongst the least costly forms of electrical production. Critics argue that the level of required subsidies, the small amount of energy needs met, and the uncertain financial returns to wind projects make it inferior to other energy sources. Intermittency and other characteristics of wind energy also have costs that may rise with higher levels of penetration, and may change the cost-benefit ratio.

Incentives

Some of the over 6,000 wind turbines at Altamont Pass, in California. Developed during a period of tax incentives in the 1980s, this wind farm has more turbines than any other in the United States, producing about 125 MW. Considered largely obsolete, these turbines produce only a few tens of kilowatts each.

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Wind energy in many jurisdictions receives some financial or other support to encourage its development. A key issue is the comparison to other forms of energy production, and their total cost. Two main points of discussion arise: direct subsidies and externalities for various sources of electricity, including wind. Wind energy benefits from subsidies of various kinds in many jurisdictions, either to increase its attractiveness, or to compensate for subsidies received by other forms of production or which have significant negative externalities.

In the United States, wind power receives a tax credit for each kilowatt-hour produced; at 1.9 cents per kilowatt-hour in 2006, the credit has a yearly inflationary adjustment. Another tax benefit is accelerated depreciation. Many American states also provide incentives, such as exemption from property tax, mandated purchases, and additional markets for "green credits." Countries such as Canada and Germany also provide incentives for wind turbine construction, such as tax credits or minimum purchase prices for wind generation, with assured grid access (sometimes referred to as feed-in tariffs). These feed-in tariffs are typically set well above average electricity prices.