Wind turbine power plant

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A wind farm or wind park, or wind power plant,[1] is a group of wind turbines in the same location used to produce electricity. Wind farms vary in size from a small number of turbines to several hundred wind turbines covering an extensive area. Wind farms can be either onshore or offshore.

Location is critical to the overall success of a wind farm. Additional conditions contributing to a successful wind farm location include: wind conditions, access to electric transmission, physical access, and local electricity prices.

The faster the average wind speed, the more electricity the wind turbine will generate, so faster winds are generally economically better for wind farm developments.[7] The balancing factor is that strong gusts and high turbulence require stronger more expensive turbines, otherwise there is a risk of damage. The average power in the wind is not proportional to the average wind speed. For this reason, the ideal wind conditions would be strong but consistent winds with low turbulence coming from a single direction.

Usually sites are screened on the basis of a wind atlas, and validated with on-site wind measurements via long term or permanent meteorological-tower data using anemometers and wind vanes. Meteorological wind data alone is usually not sufficient for accurate siting of a large wind power project. Collection of site specific data for wind speed and direction is crucial to determining site potential[10][11] in order to finance the project.[12] Local winds are often monitored for a year or more, detailed wind maps are constructed, along with rigorous grid capability studies conducted, before any wind generators are installed.

The wind blows faster at higher altitudes because of the reduced influence of drag. The increase in velocity with altitude is most dramatic near the surface and is affected by topography, surface roughness, and upwind obstacles such as trees or buildings. At altitudes of thousands of feet/hundreds of metres above sea level, the power in the wind decreases proportional to the decrease in air density.[13]

A major factor in wind-farm design is the spacing between the turbines, both laterally and axially (with respect to the prevailing winds). The closer the turbines are together, the more the upwind turbines block wind from their rear neighbors (wake effect). However, spacing turbines far apart increases the costs of roads and power cables, and raises the amount of land needed to install a specific capacity of turbines. As a result of these factors, turbine spacing varies by site. Generally speaking, manufacturers require a minimum of 3.5 times the turbine"s rotor diameter of clear space between each adjacent turbine"s respective spatial envelope.

Closer spacing is possible depending on the turbine model, the conditions at the site, and how the site will be operated.[citation needed] Airflows slow as they approach an obstacle, known as the "blockage effect", reducing available wind power by 2% for the turbines in front of other turbines.[17][18]

The capacity of the world"s first wind farm was 0.6 MW, produced by 20 wind turbines rated at 30 kilowatts each, installed on the shoulder of Crotched Mountain in southern New Hampshire in December 1980.[19][20]

[24]

Onshore turbine installations in hilly or mountainous regions tend to be on ridges generally three kilometres or more inland from the nearest shoreline. This is done to exploit the topographic acceleration as the wind accelerates over a ridge. The additional wind speeds gained in this way can increase energy produced because more wind goes through the turbines. The exact position of each turbine matters, because a difference of 30 metres could potentially double output. This careful placement is referred to as "micro-siting".

Europe is the leader in offshore wind energy, with the first offshore wind farm (Vindeby) being installed in Denmark in 1991. As of 2010, there were 39 offshore wind farms in waters off Belgium, Denmark, Finland, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom, with a combined operating capacity of 2,396 MW. More than 100 GW (or 100,000 MW) of offshore projects are proposed or under development in Europe. The European Wind Energy Association set a target of 40 GW installed by 2020 and 150 GW by 2030.[38]

As of 2017[update], The Walney Wind Farm in the United Kingdom is the largest offshore wind farm in the world at 659 MW, followed by the London Array (630 MW) also in the UK.