THE FUTURE OF OFFSHORE WIND

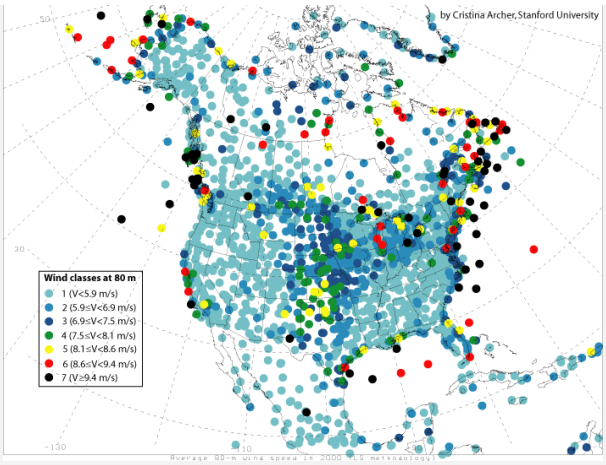
Advances in the Wind Industry

Wind power is one of the most promising renewable energy sources in the market today. The energy potential of wind is vast, with a recent study estimating that there are 72 Terra-watts of wind power that can be harvested globally, which is over five times the world's energy needs.

While wind turbines have been in the market for a long time, they have only experienced strong popularity in the past two decades. The wind industry is expanding at a 20% annual growth rate, with energy installations in the U.S. growing from 1800 MW production capacity in 1990 to 9200 MW capacity in 2005. This growth is largely attributed to advances in wind turbine technology that are making wind farms more economical. Indeed, there has been a ten-fold reduction in the cost of wind-farms over the past twenty years. The growth is also facilitated by the public's recognition of renewable energy technologies and the introduction of policies supporting them – for instance, America's 1.9 cent/kWH tax credit for renewable energy sources.

Challenges to Onshore Wind

Despite the unprecedented growth of wind energy, the industry is facing a number of serious challenges. First, the regions with the most wind density are typically quite distant from the urban centers where demand for energy is highest. Transmitting electricity from high-energy regions to high-demand regions reduces the efficiency of the system and is also limited by geographic barriers. For example, in the U.S., wind installations were initially planned for the class 6 wind sites in remote western regions (note: regions are divided into wind-power density classes, from class 1 (lowest) to class 7 (highest) based on wind speed). However, mountains barred installation of transmission lines to cities on the eastern coast, and so production shifted to lower-energy regions close to urban centers.



Map of wind speed extrapolated to 80 m and averaged over all days of the year 2000 at sounding locations with 20 or more valid readings for the year 2000. Taken from 'Evaluation of Global WInd Power', credit to C. Archer and M. Jacobson

Setting up wind-farms close to cities often draws public opposition; while many people like the idea of green energy production, they prefer it be away from homes. Aesthetic disturbance and noise pollution are two of the biggest concerns raised by the public.

Potential of Offshore Wind

Offshore wind farms offer a promising solution to these problems, and a number of additional advantages. Wind power density over the ocean is much higher than inland, and the wind is more uniform, making it easier to integrate into the grid. Moving a few dozen km into the ocean opens up vast reserves of wind energy, and large wind farms can be set up away from the public eye. These farms would be relatively close to coastal cities which demand high amounts of energy, making them competitive to traditional energy sources.

While offshore wind shows great promise, the technology is still in it infancy; the first offshore wind turbine was only installed in 1990 in Sweden, with 18 wind farms arising since then throughout Denmark and the U.K. A number of offshore wind projects have been proposed throughout North America and are in the development stages, but there are still no operational offshore wind farms in place.

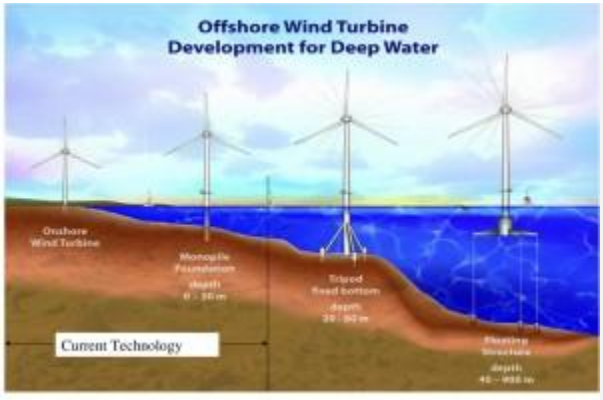
Challenges to Offshore Wind

Development of offshore wind operations has been slow because of a number of technical challenges that do not exist with land-based turbines. The biggest problem is the need for a strong foundation that can withstand

waves and storms. As water depth increases, more sophisticated (and more expensive) structures are needed to support the turbines.

Existing supporting structures for turbines are limited to shallow water, functioning at depths of 20-30 m. The most common technology is the *monopile*, a single column driven into the seabed by a 'pile-hammer'. As water depth increases, the column begin to resonate with the waves. Longer, thicker poles add stability, but there are limited by the capacity of the pile-hammer. The other option is the *gravity base* – a concrete foundation on the seabed for the pole. While it overcomes some of the flexibility issues of the monopiles, it requires careful soil analysis and requires specific conditions.
At higher depths (60 m), there is the possibility of using a wider base with a number of anchor points, similar to those employed by the oil and gas industries. To enter deep waters (up to 160 m), floating structures attached to the seabed by wires are required. These technologies are still in the research and development stage, and need to be refined before they are stable enough to be deployed on a large scale.

Beside the need for a sound foundation, there are a number of additional challenges created by the sea. Maintenance and installation costs are much higher offshore, so to minimize work at sea, more robust materials are required for turbine construction.



Foundation Technologies for Wind Turbines. Credit to W. Musial.

To optimally design offshore wind farms and integrate them into the grid, the wind-waves (and resulting energy produced) needs to be modeled accurately. While the winds are more uniform at sea, actually measuring the wind is quite challenging. On land, anemometers measuring wind patterns are fixed on poles – this becomes unreasonably expensive at higher depths, so floating anemometers, which are less reliable, are used to take measurements.

Due to the technical challenges faced by offshore wind farms, they are much more expensive than onshore projects. According to the European Wind Energy Association, offshore wind farms are twice as expensive per MW of energy produced compared to onshore farms.

The Future

Offshore wind farms are a promising technology that could one day harvest huge stores of renewable energy. However, many technological advances have to be made before they become widespread. Since the technology is still in its infancy, we must ensure that we approach its development intelligently. For example, according to Walter Musial, an engineer for the National Renewable Energy Laboratory in the U.S, offshore wind farms should be constructed with the help of the oil and gas and industry and underwater cable industry, who have experience with foundations of offshore systems and underwater electricity transmission respectively. Instead of reinventing the wheel, we should gather as much existing expertise on operating in rough ocean environments. It is difficult to say whether offshore wind will become a prevalent renewable source of energy; it depends on the state of the technology, which in turn depends on how much governments will subsidize research and development. Besides technological developments, the future of offshore wind also depends on public views towards offshore wind and policies towards implementation of offshore wind farms.

Source : http://www.sassweb.ca/3bb3/wind/the-future-of-offshore-wind