6. Wind energy and environment

Fossil fuel based power plants, contributing more than seventy per cent to our energy needs today, dominate the global energy scenario. These plants pollute the atmosphere with harmful gasses and particulates. As per the estimates of the International Energy Agency (IEA), 23683 Mt of CO$_2$ has been released to the atmosphere by the power sector during 2001 [15]. Emission of CO$_2$ due to power generation has registered an increase of 65 per cent in during the past three decades. With the increase in energy demand, level of environmental pollution caused by the power sector is expected to increase further in the coming years.

In contrast, wind energy does not pollute the air or water with harmful gases and materials. Nor does it generate hazardous wastes, which cannot be safely disposed as in case of nuclear power plants. Being a non depletable source, extracting energy from wind does not pose the threat of over exploiting the limited natural resources like coal, oil or natural gas. Hence wind is considered as one of the cleanest sources of energy available today.

If we can exploit even a small fraction of this abundant and environment-friendly source of energy, today’s power related emissions can be reduced to a much acceptable level. For example, if 10 per cent of the wind potential in US is effectively exploited, the total carbon dioxide emission from the country can be reduced by 33 per cent, which is equivalent to a reduction of 4 per cent in the global level. Similarly, by meeting 20 per cent of the countries energy demand from wind, the emission from coal fired power plants can be reduced by one third [5].

As in case of any human activities, wind energy generation is also not totally free from environmental consequences. The major environmental problem with wind energy is avian mortality due to collision with turbines and related structures. Noise emission and the visual impacts on landscapes are the other issues to be tackled. However, it should be noted that these environmental impacts are not global (as in case of atmospheric emissions and global warming) and thus can be monitored and resolved at local level.

In this chapter, let us examine the merits and demerits of wind energy in an environmental perspective. We will adopt a ‘life cycle’ approach in our discussions. This means that, while dealing with the atmospheric emissions, apart from the pollution due to power generation, possible emissions during the turbine manufacturing, plant construction etc. will also be accounted. The major environmental ill effects of wind energy are then considered with discussions on possible solutions.
6.1 Environmental benefits of wind energy

The most significant environmental advantage of wind energy is that it does not load the atmosphere with toxic chemicals. In contrast, the conventional power plants operating on fossil fuels release gases like sulphur dioxide, carbon dioxide and oxides of nitrogen during the energy conversion process. Similarly, particulates and toxic heavy metals which affect the environment adversely are also being generated during this process.

For example, the specific emission rates from a typical power plant based on pulverized coal is shown in Fig. 6.1[1]. The fuel used here is bituminous coal and the flue gases are undergone desulphurization using the lime stone/gypsum. It should be noted that ninety per cent of the sulfur dioxide are removed under this process and still the level of emission is higher than the acceptable limit.

Emission due to the fossil fuel based generation depends on the type and quality of fuel used and the technology of power conversion. For example, in case of a modern natural gas-combined cycle power plant, the level of SO\textsubscript{X} emission is relatively low. Here, the major problems are due to NO and NO\textsubscript{2} emissions. Typical concentration of CO\textsubscript{2} in such plants may be nearly 10 ppmv (parts per million by volume) whereas N\textsubscript{2}O levels may be around 1 ppmv. Even with advanced technologies like the Integrated Gasification Combined Cycle (IGCC), the CO\textsubscript{2} level could be as high as 794 kg /MWh.

Sulphur dioxide and nitrogen oxides released to the atmosphere due to the burning of fossil fuels cause acid rain. When SO\textsubscript{2} and NO\textsubscript{X} combine with water in the atmosphere, a mixture of sulfuric and nitric acid is formed. These acids are then