

Copper in Wind Power 1

Copper is a vital metal in making wind power possible. The outdoor environment places great demand on cables, connectors, and generator windings used for wind power installations, especially for those situated off shore.

Copper provides the conductivity, corrosion resistance, strength and flexibility to meet all the demands of harsh conditions, where servicing and repair are very expensive.

Copper is used in:

- generator windings
- power cables
- earthing and lightning protection
- transformers
- inverters
- control systems

It could be said that all electricity and the modern world that it powers is created using one phenomenon: when a magnet moves near a coil of wire, an electric current will flow in the wire. This is a generator, and the same thing in reverse is a motor. The generator is at the heart of a wind turbine, as it is what turns the rotation of the blades into electrical energy. A motor and generator look very similar, and many motors are used as generators with little or no modification.

Generator windings

To generate electricity, magnetic field lines must move at right angles to the wire in the coil.

In **Figure 1** (right), the wind turbine blades rotate the magnetic field, which induces a current in the windings as it passes by them. In a real turbine there will be more rotating magnetic fields, inducing currents in several windings at the same time.

Did You Know?

Renewable energy systems (solar, wind, hydro) on average require 8 to 12 times more copper per kilowatt than traditional power generation.

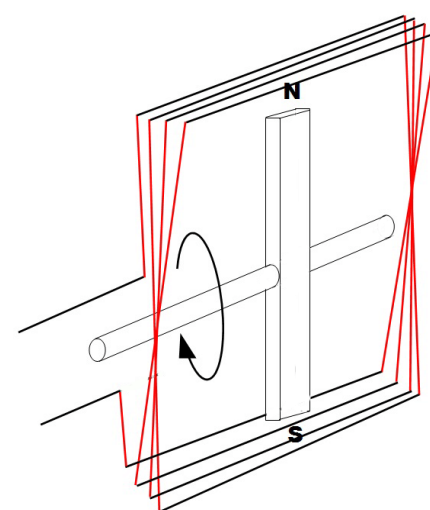


Figure 1: Operation of a basic generator with the rotating magnet inducing a current in each of the windings in turn.

Figure 2 (below) shows the windings on this machine being wound by hand. The coil is a continuous length of copper wire fed from the reels behind the stator. This part of the generator does not move and so is called the stator.



Figure 2: Manual insertion of the copper windings into the generator stator. (Courtesy of Enercon.)

Figure 3 (above right) shows the rotor, which is turned by the wind turbine blades. Magnets are attached to the outside of this rotor, which induce currents in the stator windings as they pass by. This is a simplified diagram showing how the rotor magnetic field rotates past all the stator wound coils in turn. **Figure 6** (below) shows the complete generator assembly being winched up to the wind turbine nacelle.

A different option is to place the moving magnets outside of the stator windings, as shown in **Figure 7** (below). In both designs, it is the wound stator that is fixed, as this avoids having to make and maintain moving electrical contacts to collect the current.



Figure 6: The assembled generator is lifted to the top of the wind turbine tower. It weighs 30 tonnes, and about a third of that weight is copper. (Courtesy of Enercon.)

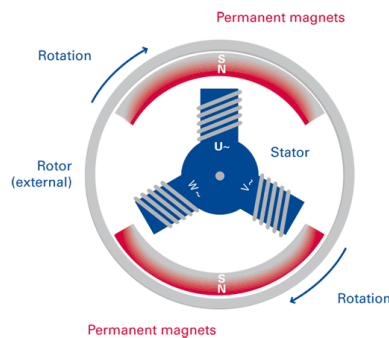


Figure 7: A generator where the magnets rotate around the windings, as used by Vensys wind turbines. (Courtesy of Vensys.)

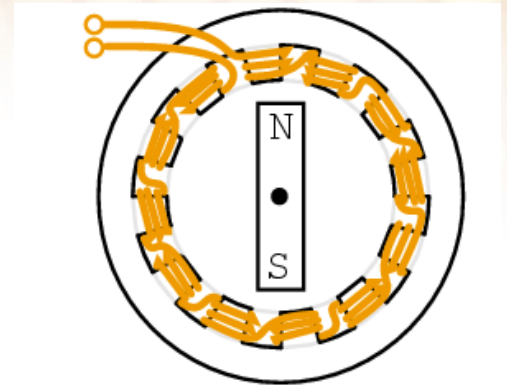


Figure 3: A simplified diagram of the rotor magnetic field passing the stator windings in turn.



Figure 4: This picture shows the size of the generator rotor. The workers are 2 metres tall. (Courtesy of Enercon.)



Figure 5: The huge magnetic rotor is lowered into the stator coil. Compare with Figure 4 to see how large the rotor is. (Courtesy of Enercon.)

Questions and Activities

- 1. Why is copper used for the coils in the generator?**
- 2. In Figure 2, the copper wire looks darker than pure copper. Suggest a reason why.**
- 3. Research the electrical power output of modern large wind turbines. What is the largest one you can find? Does there seem to be an upper limit?**

[Click here for answers](#)

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Copper Development Association is a non-profit organisation that provides information on copper's properties and applications, its essentiality for health, quality of life and its role in technology. It supports education through a collection of resources spanning biology, chemistry and physics. These materials have been developed in conjunction with the Association for Science Education, and reviewed by teachers.

For more resources, visit www.copperalliance.org.uk/education.