

Small scale wind turbine cost

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Wind turbines are expensive. Very expensive. But while the initial costs are high, what materials achieve the best cost-benefit ratio, and how best to maintain and prolong the life of their turbines. The current price of raw materials such as steel and copper has an effect on the initial cost, which can fluctuate over the course of a year. Costs are also affected by location, as the price of labor and the availability of materials can drastically affect the cost of building a wind farm. Even more so when you factor in taxes, government incentives, and tariffs.

Large wind turbines built for onshore and offshore wind farms can generate about 2 to 3 MW, while the largest offshore turbines can generate up to 12 MW of electricity. Needless to say, they're expensive. While costs can vary, they generally hover around \$1 million per MW. The total cost of an average turbine can range from \$2.5 million to \$4 million, though large offshore turbines can cost tens of millions. The most powerful 12 MW wind turbine costs up to \$400 million to manufacture and install. Costs for utility-scale wind turbines can be broken down into three categories: manufacturing, transport and installation, and operations and maintenance.

Manufacturing the wind turbine makes up the vast majority, about 70%, of the total cost. The costs depend on the size, materials used, and country of origin. The components of the wind turbine are manufactured separately, and may even be done at different locations. This is because each component requires specialized engineers, like the blades and the gearbox. The tower is the simplest piece to build, though still makes up a significant portion of the costs. The manufacturing costs primarily consist of labor and raw materials.

Blades make up approximately 20% of the total cost of the turbine. The cost varies based on the materials used. Blades are manufactured either with glass fiber or a hybrid of glass and carbon fiber. While glass fiber blades have lower material costs, hybrid blades require less labor. The price difference between the two ends up being negligible.

The size of the blades have a larger effect on price. Most wind turbines have three blades, we can say that the entire rotor costs anywhere from \$500,000 for average turbines to well over \$1 million on larger models.

The nacelle houses the generator, gearbox, and speed brakes. The transmission, axles, and driveshaft are also housed inside. This is where the electricity is generated. The generator components make up about 35% of the turbine's total cost, and over 50% of the manufacturing costs. The gearbox is the most important piece of the turbine, and must be durable, reliable, and made with precision engineering.

Though wind turbines are relatively minimalistic, the internal gearbox is a complex system. They are made to last around 25 years, but they require the most attention due to the number of moving parts. The gearbox might crack and fracture due to temperature fluctuations and load changes. Several parts may have to be replaced over the course of its lifetime, and the entire gearbox might even fail. The gearbox constitutes a large

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part of the service and maintenance cost of the wind turbine.

The tower and yaw mechanism compose around 15% of the total cost of a wind turbine. Taller towers cost more to manufacture in material and labor costs, but lead to lower costs per kW as they can take advantage of the high altitude wind speeds. The current goal is to lower the costs of raising the tower height, which depends on the innovation of new materials. Rolled tubular steel is currently the most common material. New designs incorporating taller concrete tower bases and lattice steel, as well as space frame designs, are in the works.

The typical 1.5 MW turbine is about 80 m tall, though some can reach as high as 140 to 160 m. Doubling the tower height requires doubling the diameter and quadrupling the amount of material in the tower. The cost of the tower is around \$200/kW. For a 1.5 MW turbine, the tower can cost around \$300,000, while towers for larger turbines can cost over \$1 million.

Transportation accounts for about 3% to 8% of the costs associated with wind power in the US. Costs increase as turbine size increases, and when the installation area is remote, costs increase even further, as access roads and infrastructure must be built. Wind turbines might be transported by rail, ship, or truck, sometimes a mix of all three. Costs include fuel, labor, storage, port fees, and tariffs, and may vary widely depending on the country of origin, destination, mode of transport, and political climate. Keep in mind that different components of the turbine might be manufactured separately, which adds to transport costs as some parts are manufactured further from the destination than others.

It takes about a year of serious logistical planning and 10 separate loads to transport a single wind turbine. Blades are the most difficult to transport, especially for larger turbines. They are considered oversized loads and require special attention when being transported by truck. Inattentive drivers are prone to drive directly under them if they're hanging over the back of a cargo truck, increasing the possibility of an accident. The cost of transporting a single wind turbine for a short-haul is between \$30,000 and \$40,000. Long haul transportation can exceed \$100,000 per turbine.

Installation costs revolve around the assembly and construction of the turbine. Crane rentals can cost upwards of \$80,000 per day, totaling \$100,000 to \$150,000 per MW. But first, the foundation must be built. The cost of the foundation depends on the height of the tower, the weight of the generator and rotor, and the soil conditions at the site. Turbine foundations may require between 8 and 20 truckloads of concrete, which can total up to \$250,000 per turbine when you include digging and engineering design. Access roads can cost up to \$25,000 per quarter-mile. The more remote the location, the higher the cost to build roads.

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