HOW DOES ONE UNDERSTAND EFFICIENCY NUMBERS?

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By Flower Turbines, copyright 2024

Efficiency is the percentage of energy flow captured in a certain area.
Let’s look at a completely symmetrical vertical axis turbine. Let’s assume that the height is 1 meter and the diameter is 1 meter. That cross-section is what is used to determine efficiency because the flow of wind per square meter carries a certain amount of energy. Some wind studies will give you the conclusion. For example, the average wind energy is 600 watts per square meter in x location at y height.
Here is how you reach that conclusion. We are going to simplify this by using average wind speed; see our other articles on why this is a simplification.
Assume the wind is traveling at an average of 10 meters per second. One uses the following arithmetic to determine the energy carried by that wind.
Power carried by the wind in watts = 0.5*1.2 (the usual air density)*1 (area in square meters)*10*10*10 = 600 watts
If, at that speed, the turbine produces 200 watts, then the efficiency of the turbine is 200/600= 33%
That efficiency is fairly typical for a small horizontal axis wind turbine and is good. Generally, vertical axis turbines are less efficient. Drag types are 5-15%, lift types 15-25%, more or less. Due to mathematics that makes part of the Betz equation, a wind turbine can never achieve more than 59% efficiency (except for certain types of shrouded turbines). The most efficient large turbines attain 45% efficiency. Solar panels are generally 15-20% and special expensive materials can bring them to 30%.
Flower Turbines are drag turbines with innovative design features. The theoretical efficiency of our Tulip turbines, as determined by a professor at Texas Tech University, is as follows, for wind at 6 meters per second:

Turbine Height, and Best RPM	Dia (m)	H (m)	Power (W)	Efficiency (%)
1m 110rpm	0.55	1.13	10.4	13.5%
2m 80rpm	1.03	2.11	46.6	17.4%
3m, 50rpm	1.52	3.11	175	30.0%
4m, 50rpm	2.07	4.12	432.2	41.0%

Theory does not always correlate with practice and is usually a little higher or lower and does not include mechanical and electrical losses and does not include gains from gusts. For example, we have measured in practice the efficiency of the 2m turbine at 25-30%. There are two interesting trends from this table, even if the numbers are not exactly correct:

1.Efficiency increases with size. That is true of almost all machines.
2.Different sizes require different rpm (revolutions per minute) to function at their best. This is a reason that many people who may be knowledgeable in wind energy have trouble understanding the relatively high efficiency of our turbines. Flower Turbines are a sub-type of drag turbines whose efficiency is highly dependent on rpm. Because a lot of people didn't understand this, they investigated a turbine type with non-optimal rpm and concluded it was less efficient than it really could be. There are other scientific implications that make Flower Turbines more efficient than previously thought.

The practical conclusion for our customers is that the larger the size of turbine they can get, the higher the efficiency. Another conclusion is that manufacturers and consultants who do not fully understand the science may make incorrect conclusions about which form of energy to use where.

In addition, one has to understand that high efficiency in a location of poor wind or solar resource is the equivalent of low efficiency in a location with a good resource. It is important to consider both the energy resource and the efficiency in planning a project.

In addition, with Flower Turbines, because of their clustering effect, one also has to use as many turbines as possible for overall better performance. That refers to the performance of the group, which is, technologically, different from efficiency.

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