

DO I NEED AN ANEMOMETER?

[HTTP://WWW.BARANIDESIGN.COM/WEB/WIND_SPEED.HTML](http://www.baranidesign.com/web/wind_speed.html)

WHY OR WHY NOT GET AN ANEMOMETER?

The first thing to do before purchasing a wind turbine is to perform a wind energy evaluation of your site. Wind energy (wind turbine power output) will vary with wind speed to the third power... V^3 . For example, in 11mph wind power output will be 33% higher than at 10mph (1331/1000). It is critical to pick the best location for the turbine and do use a very accurate anemometer in your wind energy site evaluation.

HOW ACCURATE IS ACCURATE ENOUGH?

Anemometer accuracies vary greatly. For most Wind Turbines, useful wind speeds range from 7mph to 80mph (3m/s to 36m/s) Within this wind speed range anemometer accuracy and measurement repeatability are of utmost importance. As stated in the paragraph above, any measurement error is amplified to the 3rd power (V^3). Below is a table illustrating anemometer measurement accuracy errors and their effects on your results.

WHERE IS THE WIND?

Plan you wind turbine placement carefully, as wind can significantly vary by micro-location. The exception being a flat area without trees or other obstructions for hundreds of yards. Local topography has a huge effect on speeding, slowing and channeling wind near ground level (even above 30yard heights). Verify your observations with an anemometer. Take data for at least a month before making conclusions, and if you are unsure, consider getting professional advice. Be careful who you choose, or obtain an extra anemometer and do a simultaneous comparison yourself.

WHAT ABOUT SEASONS?

To get a direct comparison between two locations, you need to measure the wind simultaneously since weather patterns differ month to month and year to year.

WHICH WIND TURBINE IS BEST FOR ME?

CHOOSING AND COMPARING DIFFERENT WIND TURBINES

The hardest part for most people is comparing between different wind turbine systems because every manufacturer quotes power output at a different wind speed. A calculator on www.wind101.org can help put in perspective two different wind turbines. Inputs are: A manufacturers quoted power output and wind speed, along with your local average wind speed. It does the rest and shows you how two wind turbines will compare at your location.

WILL I SAVE MONEY?

As you may already know, most wind turbines are expensive, and if not located properly, are a money losing proposition. Maintenance does not help the picture, so choose quality over price. The last thing you need, is to have to climb a pole or a roof in the middle of winter to replace worn bearings. So watch out for the cheap propeller type wind turbines from China; you will get what you pay for.

HOW DO I TELL WHICH TURBINE IS BEST FOR ME?

If you are unsure, feel free to contact us, and we will help you make the right choice free of charge.

ANEMOMETER ERROR CHARTS

Anemometer Accuracy Error Chart @ 5m/s (11mph)

WIND SPEED ERROR	WIND SPEED ERROR	WIND SPEED ERROR	V ³ WIND POWER ERROR
+/- 0.05 m/s	+/- 0.11 mph	+/- 1.0%	+/- 3.0%
+/- 0.10 m/s	+/- 0.22 mph	+/- 2.0%	+/- 6.1%
+/- 0.15 m/s	+/- 0.34 mph	+/- 3.0%	+/- 9.3%
+/- 0.20 m/s	+/- 0.45 mph	+/- 4.0%	+/- 12.5%
+/- 0.25 m/s	+/- 0.56 mph	+/- 5.0%	+/- 15.8%
+/- 0.30 m/s	+/- 0.67 mph	+/- 6.0%	+/- 19.1%
+/- 0.40 m/s	+/- 0.89 mph	+/- 8.0%	+/- 26.0%
+/- 0.50 m/s	+/- 1.12 mph	+/- 10.0%	+/- 33.1%
+/- 1.00 m/s	+/- 2.24 mph	+/- 20.0%	+/- 72.8%

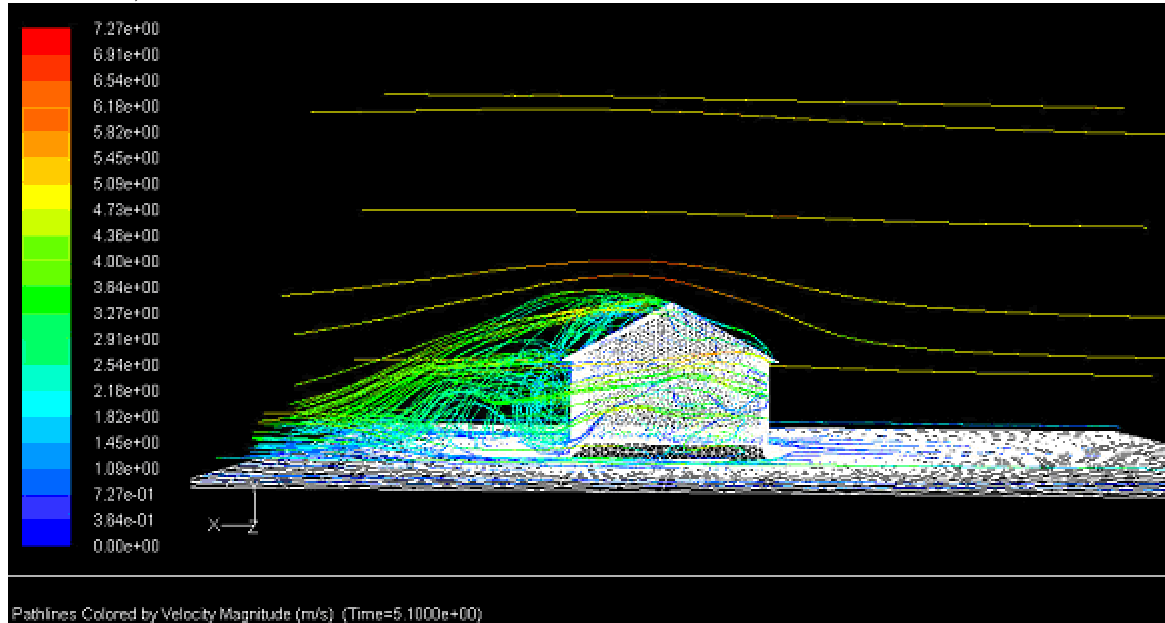
Anemometer Accuracy Error Chart @ 25m/s (56mph)

WIND SPEED ERROR	WIND SPEED ERROR	WIND SPEED ERROR	V ³ WIND POWER ERROR
+/- 0.05 m/s	+/- 0.11 mph	+/- 0.2%	+/- 0.6%
+/- 0.10 m/s	+/- 0.22 mph	+/- 0.4%	+/- 1.2%
+/- 0.15 m/s	+/- 0.34 mph	+/- 0.6%	+/- 1.8%
+/- 0.20 m/s	+/- 0.45 mph	+/- 0.8%	+/- 2.4%
+/- 0.25 m/s	+/- 0.56 mph	+/- 1.0%	+/- 3.0%
+/- 0.30 m/s	+/- 0.67 mph	+/- 1.2%	+/- 3.6%
+/- 0.40 m/s	+/- 0.89 mph	+/- 1.6%	+/- 4.9%
+/- 0.50 m/s	+/- 1.12 mph	+/- 2.0%	+/- 6.1%
+/- 1.00 m/s	+/- 2.24 mph	+/- 4.0%	+/- 12.5%

GEOGRAPHY AND WIND

SO YOU LIVE ON A HILL?

Since you live on a slope, to gain extra power output, you may be able to take advantage of your terrain. If prevailing wind direction is mostly up hill, try place a wind turbine as far up the slope as possible. You will find the highest wind speeds there...even up to 10% faster than the prevailing wind speed. This can give you up to 30% gain in power output! (Test it with an anemometer to see the difference.)



Guidelines for Anemometer or Wind Turbine Placement

FOR SPARSELY PLACED NON SOLID OBJECTS LIKE TREES:

- Stay at least 2x the tree height upwind.
- Stay at least 5x the tree height downwind.

FOR SPARSELY PLACED SOLID OBJECTS LIKE HOUSES:

- Stay at least 3x the house height upwind.
- Stay at least 10x the house height downwind.

FOR THIN OBJECTS LIKE POLES:

- Stay at least 20 pole diameters away.

SUMMARY

- If wind prevails from a single direction, the top of your house (or a hill) may be the best place. (up to 30% gain in wind speed!...see image above)
- Wind accelerates as it flows past most solid objects' tallest points (the top of a hill, edge of a cliff, roof line) (see above CFD picture)
- Object's shape and wind direction are critical to maximizing wind speed gains, and if improperly placed losses and noise can result. (If you are unsure, contact us and we will help you out, most of the time free of charge)

Watch Out!!!

Watch out for wind turbines which quote power output at high wind speeds (above 15mph or 7m/s) for the following reasons:

REYNOLDS NUMBER (RE) ...SAY THAT AGAIN!

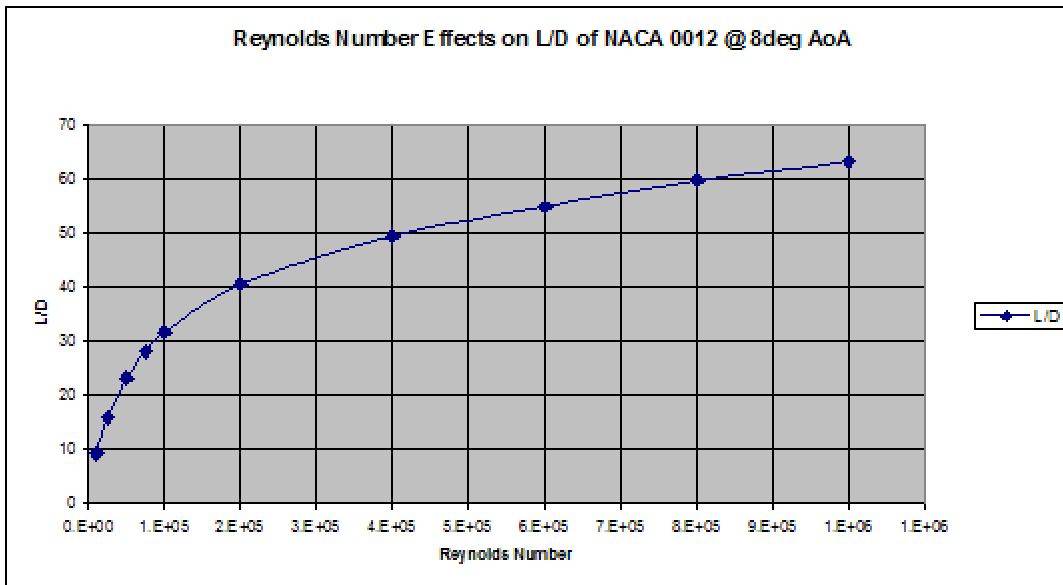
In simple terms, Reynolds Number denotes a relationship between air speed and an object's size. Basically, what Reynolds Number tells us is that if air is moving past 2 objects that are at the same Reynolds Number, then they will behave identically. To illustrate, let's compare a baseball and a softball, which is about twice as big. If we throw a curve ball with both at 60mph, they will curve differently. Now, since the baseball is half the size, if we throw it at 120mph, it will behave identically as far as the air is concerned. Thus, an object half the size needs to go twice as fast to maintain identical aerodynamic behavior.

WHAT DO BASEBALLS HAVE TO DO WITH WIND TURBINES?

What this means for Wind Turbines is that a wind turbine with small blade width, is that it needs to spin very fast to achieve good performance. So what? Well, as we all probably noticed from riding in cars, noise tends to greatly increase with increasing speeds.

AND IT GETS EVEN WORSE.

The darkest side of small blade width is inefficiency. Just look at the Reynolds Number Effects plot below. The Vertical Scale denotes L/D...which is an engineer's way of denoting aerodynamic efficiency and the horizontal scale is Reynolds Number. What the plot tells us is that at low Reynolds Numbers, we don't have a hope of achieving reasonable efficiency...that translates directly to Power Output.



10FT DIAMETER WIND TURBINE SPINNING IN 10MPH WIND

Average Reynolds Number = 110,000 (1.1E5) based on a 6 inch wide blade (@ 2/3 radius).

SO HOW DO WE FIX IT?

We can't...but we can sure as heck avoid it! Since it is much harder to design a good efficient airfoil for low Reynolds Numbers and because low wind speeds are prevalent over populated areas, here are some things to look for when choosing a Wind Turbine.

What to look for in a Wind Turbine:

- A good design will quote power output at reasonable wind speeds...below 9m/s or 20mph. Ideally below 7m/s (15mph).
- When comparing two designs, one with a larger blade width will stand a better chance of good power output at low wind speeds.
- Always ask for power output charts plotted against wind speed, and compare them to the average wind speed you measured around your house or wind every site with an accurate Anemometer.
- Choose quality over price. Maintenance of wind turbines is complicated expensive and dangerous.

NOISE!

Blade tip speed is the governing factor in noise, and it is proportional to diameter and rotation speeds (RPM). In simple terms: Power = Force * Speed. Thus, for identically sized wind turbines, one with less efficient airfoils will rotate faster to get to the same power output.

GENERATOR EFFICIENCY

Generator efficiency can vary from 70-98% and proper generator sizing for a wind turbine is crucial for higher efficiencies)

RESOURCES:

- [Table of Average Wind Speeds of Major US Cities](#)
- [Wikipedia Reynolds Number Page](#)
- [Atmospheric Calculator](#)
- [Understanding Wind Speed](#)