

WINDLETTER

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SMALL TURBINE COLUMN:

Incremental Tower Costs versus Incremental Energy

--Mick Sagrillo, Sagrillo Power & Light

Last month's column concluded with the fact that installing a taller tower will always result in the generation of more electricity. The reason is reduced ground drag. As you get away from the surface of the earth, ground drag (that is, the friction between moving air masses and the surface of the earth) decreases, and wind speed increases.

However, it does cost more to extend a tower up higher than the tree line at your site. In order to determine the "payback" for a taller tower, you must examine tower and installation costs relative to increased energy production.

Let's assume that we are interested in installing a 10-kW wind generator, and that the bare minimum tower that will work at the site is 60 feet. To make this example work, we'll use the wind speeds recorded at the Midwest Renewable Energy Association (MREA) site from last month's column. Using a wind turbine output calculator, we can determine the annual kilowatt-hour (kWh) output of this 10-kW wind turbine at the three tower heights.

Tower height (feet)	Wind speed (miles per hour)	kWh/year
60	7.3	2,709
80	9.3	6,136
100	10.7	9,338

The next thing we need to do is to determine the costs of the various materials and labor that go into the installation of a wind system. Assuming that all of the labor will be contracted out, I polled a number of installers and contractors to get an idea of the various costs. The table lays those costs out for the various tower heights.

Expense	60' tower	80' tower	100' tower
Excavation for foundation and backfilling	\$800	\$800	\$800
Firm up foundation, pour concrete	\$960	\$960	\$960
Concrete and rebar	\$750	\$750	\$750
Wind turbine and inverter	\$24,750	\$24,750	\$24,750
Shipping	\$800	\$800	\$800
Tower	\$7,400	\$8,100	\$9,200
Shipping	\$900	\$950	\$1,000

Tower wiring	\$800	\$860	\$930
Wiring and electrical supplies	\$1,800	\$1,800	\$1,800
Electrical labor	\$1,200	\$1,200	\$1,200
Crane	\$750	\$750	\$750
Installation labor for tower, turbine, commissioning, mileage, and expenses	\$5,000	\$5,300	\$5,500
Sales tax @ 6%	\$2,755	\$2,821	\$2,906
Total	\$48,665	\$49,841	\$51,346

An explanation is needed for some of the material and contracted labor costs.

- A guyed tower was chosen as they are the most cost effective to purchase and install.
- Excavation and backfilling of the foundation, amount of concrete and rebar, and labor are the same for any height for this tower, as the foundations for all three are the same per the tower installation specifications.
- Tower shipping is essentially the same, as rates are based more on the volume of what is shipped, rather than on the weight.
- A minimum wire run from the tower to the inverter was assumed. This is a highly variable expense depending on the distance from the tower to the control room.

Note that the expenses for excavation and backfilling, labor and materials for the foundation, the wind turbine and inverter with shipping, electrical supplies and labor, and crane are the same regardless of the tower height. Savings are seen only on the tower and shipping, tower wiring, and labor to assemble the tower.

We can now combine the tables to compare the total installed cost of the wind system, the incremental increase in system cost, and the incremental increase in expected output of the system.

Tower height (feet)	Wind speed (mph)	kWh/year	System cost	Incremental cost from 60'	Incremental energy output from 60'
60	7.3	2,709	\$48,665	---	---
80	9.3	6,136	\$49,841	\$1176 or 2.4%	226%
100	10.7	9,338	\$51,346	\$2681 or 5.5%	344%

In terms of “payback”, these are stunning returns on your investment! A 94-to-one return on investment on the 80 foot tower versus the 60 foot tower. And a 63-to-one return on the 100 foot tower. The only “investors” who make those types of returns are drug dealers. What’s going on? Why are taller towers such lucrative investments?

It all points back to the power equation, $P = 1/2dAV^3$. The gift of V^3 is that relatively small increases in wind speed yield dramatic increases in energy output of the wind system. And V^3 is something that you have control over, by installing a taller tower at your site.

The above example illustrates why wind generator dealers and installers advocate taller towers. It's certainly not to sell the customer something that she or he does not need. It's due to the fact that the least expensive way to increase the output of a wind system is to increase the tower height.

Next time we'll compare taller towers with a few other options.