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News From
Scheeser Buckley
Mayfield, LLC

THE ENGINEERING CONSULTANT

this issue

Preview of Upcoming Issues

- Fuel Cell Technology
- Geothermal Technology

WELCOME ABOARD

Scheeser Buckley Mayfield is reaching out to their clients with a new face. Please welcome Megan Gilbride to Scheeser Buckley Mayfield as our new Business Development Manager. She is a graduate of Miami University with a B.S. in Business Decision Sciences / Marketing. Megan is a member of the Board of Directors for the SMPS Columbus Chapter. Megan brings 10 years experience in management, marketing, and communications experience to our team.

Wind Power Technology

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The last issue of The Engineering Consultant discussed the following items:

- Solar Power System Components
- Solar Power System design rules of thumb.
- Solar Power System design requirements.
- Solar Power System design examples, construction costs and payback.

The next alternative energy source that we will discuss is wind power. While not as advantageous as solar, wind can still be a very viable alternative energy source. Wind turbines have many moving parts. Because of this turbines must be maintained on a regular basis. Wind is not as predictable as solar but there are many areas that do have consistent wind available. Wind turbine technology continues to improve with new types of turbines becoming available to harness the available wind in different applications. Wind turbines are classified in three categories. These categories are small, intermediate and large. Each category has different criteria including turbine size in kW, tower height and locations permitted. The criteria for each category is as follows:

- **Small**: 1-100 kW turbine, 30-120ft tower, can be installed in most areas
- **Intermediate**: 100-500 kW turbne, 100-200ft tower, permitting is more difficult than small
- **Large**: 500 kW - 500 MW turbine, 200ft-600ft tower, permitting is more difficult than Intermediate size

System Components:
Wind systems consist of three major components. These include the turbine, the tower and the controls.

The turbine is the most complex component of the wind system. The turbine contains all the moving parts and is what captures the wind and converts it into electrical energy. The turbine in general consists of the rotor, the generator/alternator, and the tail.

The rotor or blades can be either fixed or adjustable. The amount of power produced by the turbine is determined by the size of the blades. The blade length defines the "area" of wind capable of being captured and turned into energy. The power produced by the turbine increases by the increase in blade length squared. Foe example, increasing the blade length by two feet increases the turbine power output by a factor of 4.

The generator/alternator is the part of the turbine that converts the energy of the wind into electrical energy. The generator/alternator is the most complex and most expensive component of the wind system. The generator/alternator can be either direct connected to the tower wiring or it can be connected through slip rings.

The tail simply controls the yaw(the rotation about the vertical axis) of the assembly.

The height of the tower has a direct correlation to the power produced. The greater the tower height the more power the system will provide. Greater tower height also translates into greater initial installation cost. All towers will require a crane for installation.

Three different tower designs are available. These include the guyed tower, mono pole, and the self supporting tower.

The guyed tower is usually the least expensive tower overall but requires the most land area to install because of the guy wires. The self supporting tower requires less physical land than the guyed tower.

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Wind Power Technology *(Cont'd)*

The self supporting tower is more expensive than the guyed tower. This tower is very labor intense to install since all the pieces of the tower structure must be assembled. The most expensive tower is the mono pole tower. This tower requires less labor to install but the material costs are higher than the self supporting tower.

All towers require substantial foundations to support the weight of the tower and turbine as well as the physical stresses created by the assembly and the wind. Many tower manufactures will provide foundation details if a proper, specific soil survey is provided.

As with the turbine, all towers require some form of maintenance. This can include checking foundation and tower structural connections, painting and corrosion control.

The wind system controls include the voltage controller, the turbine braking and disconnect systems, the inverters and the lightning protection system. The turbines are self regulating in that if the wind velocity causes the turbine to exceed its rated speed or RPM, it will shut down. Without this control the turbine could self destruct. Turbines with variable pitch blades can adjust for excessive wind conditions and not require complete shutdown depending on the wind speed.

Wind System design rule of thumb:
$5.00 to $8.00 per watt installed depending on system complexity.

A minimum sustained average wind of between 8 to 12 mph are required for any wind power generation. This measurement is typically at 50 meters (150 feet) above the ground.

In general the rotor hub height should be at least 30 feet above any obstructions within a 500 foot radius of the tower.

Wind System design requirements:
The site must typically be free of obstructions including buildings, hills, trees, etc.

The first step is to determine capacity factor. This is the percentage of time (the hours) turbine will produce power per the year. 100% = 8760 hrs/year. The capacity factor for Ohio is between 10-30%. At 100% capacity factor, a 1kw turbine would produce 8,760 kWh per year.

The second step is to determine the wind speed either with public wind data, purchased wind reports or formal wind study. Public wind data is free. Wind reports and a formal wind studies can be expensive but they provide better data on a specific site that will give you a better idea of the energy that could be provided by the installation.

Determine approximate turbine size. At a 30% capacity factor the estimated energy that can be produced per kw per year is: 8760 hrs/year x .3 x 1kw = 2628 kwh/year

Next determine the estimated power output to be produced as follows: A 10kW turbine will produce 10kw x 2628 kWh/year = 26,280 kWh/year using a 30% capacity factor.

A site survey must be performed to include research of required state and local regulations, exact tower siting, soil survey, site constraints that could affect installation and interconnection to the electrical system.

Wind system design example:

- Assume 10kW 120/240 volt single phase load.
- The system will be installed in NW Ohio with approximately 30% capacity factor.
- This will be a simple small turbine with a guyed tower.
- The energy generated per year will be calculated as: 10kW x 2628 kWh/year = 26,280 kWh generated per year

Wind system cost:
$5.00/wtt x 10,000 watts = $50,000.00
Wind system financial analysis:
$50,000 estimated cost
$15,000 federal grant (30%)
12,500 USDA REAP loan (25%)
$22,500 Final Cost

Wind system payback:
At 12 cents per kWh
26,280 kWh generated per year
$3,153.60 per year savings

Payback:
$22,500 / $3,153.60 per year = 7.1 years

Maintenance
Wind power maintenance costs are generally $5.00 per MWh.

In conclusion, wind power is a viable alternative energy technology provided that proper application and design is incorporated. Final financial analysis must consider ongoing system maintenance.

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