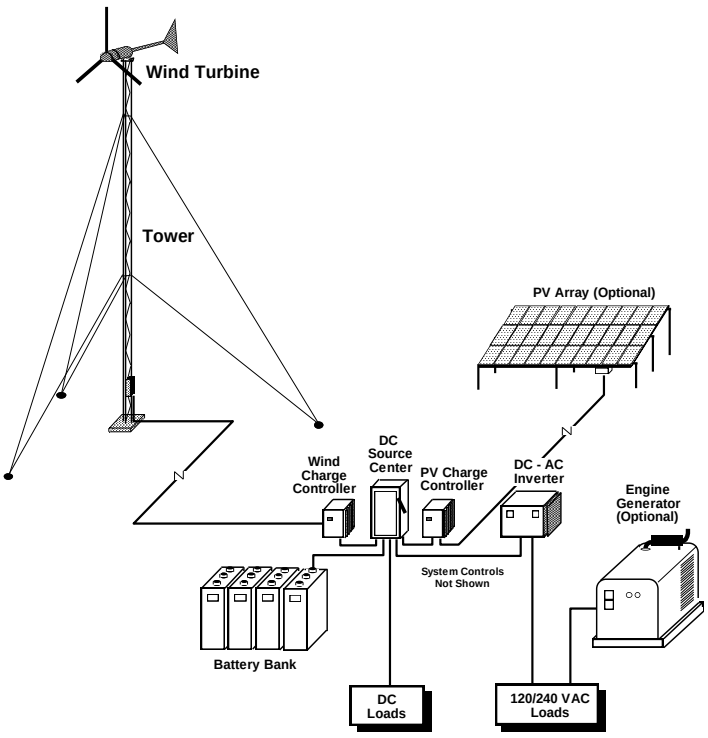
Small Wind Turbines for Microgrids

Frequently Asked Questions

What are the advantages of adding wind power to an off-grid solar/diesel hybrid microgrid?
For areas with even modest wind resources, adding wind generation to an off-grid microgrid will increase the renewable energy supply fraction, reduce back-up generator operation and fuel consumption, and increase battery life. Wind turbines operate at night, during rainy seasons, and in the winter, supplementing available solar energy. More renewable energy, less fuel and less energy cycled through the battery. For batteries that benefit from equalization, a wind system provides a reliable source of high energy output due to storms.

How do they work?
The wind turbine, which is installed on top of a tall tower, collects wind energy and converts it into electricity. The electricity is used to charge batteries, reduce the fuel consumption on a diesel generator, or drive a pump. Since the wind is intermittent, some sort of storage is usually incorporated into the system and back-up generators are often used.



The most common system architecture is the "Advanced DC-Bus Hybrid System", where the wind turbine produces direct current (DC) for serving loads and charging batteries (typically 48 VDC). As shown in the schematic below, wind and solar systems connect to a DC-bus, a DC Source Center, through separate charge regulators. Batteries, up to three parallel strings, connect to the DC-Bus, as do the DC loads and the advanced inverter/charger. Multiple wind turbines, solar arrays, battery strings, DC load centers, and inverter/chargers can be connected to the DC-Bus. These systems can be configured with or without a centralized control system.

In operation the wind and solar system(s) keep the batteries charged, supporting the DC and, through the inverter(s), AC loads. If the batteries are drained to ~20% state-of-charge (SOC) the advanced inverter(s) start the back-up diesel generator, transfer the AC loads to the diesel generator, and switch from inverter (DC to AC) to battery-charging (AC to DC) mode. The generator is run at its best

efficiency point (typically 80% of nameplate) and any excess AC power available after satisfying the site AC loads is converted to DC to recharge the batteries.

Thus the batteries are recharged with available wind and solar power and “excess” generator power. Once the batteries reach ~90% SOC the inverter returns to inverter mode, the AC loads are transferred back to the inverter, and the back-up generator is switched off.

What applications are they used for?
In developing countries small wind turbines are commonly used for rural energy applications. Rural electrification of schools, clinics, administration offices, homes, farms, whole villages, and small industries can often be done less expensively and more quickly with renewable energy, such as wind power, than by extending the utility grid.

Small wind turbines are also used to reduce operating costs (OPEX) at off-grid cell phone (BTS/RBS) sites. Properly sized wind/solar hybrid systems have been shown to save 70-90% of diesel fuel consumption and reduce diesel run times from 100% to ~10%. Small wind systems are also saving operating costs at numerous military sites around the world. These systems are particularly cost-effective where fuel is flown in by helicopter.

How does wind power compare with other renewable energy technologies suitable for decentralized rural electrification?
In areas with good wind resources (5.5 m/s+) wind power is competitive with photovoltaics, biomass, and diesel generators, but is usually more expensive than micro-hydro. Wind resources vary over a wide range and have a big impact on the cost of energy from a wind turbine. Coastal areas, open plains, and hilltops are good for wind resources. Solar will be less expensive on average than wind at many sites but may not have good seasonal availability, may have theft issues, and may not have a secure warranty.

Doesn't it take a really windy area to make wind turbines effective, limiting their range of application?
For daily loads as small as one kilowatt-hour per day a wind turbine will be less expensive than diesels or grid extension for virtually any wind resource above 5 m/s (11 mph). This wind resource is available in many parts of the world. It takes a wind resource of 6.5 m/s (14.5 mph) for small wind to compete with solar costs at today’s “below cost” solar prices.

Bergey Windpower subscribes to a worldwide wind resource data base with 5km x 5 km resolution (provided by 3Tier), so we can provide reliable performance predictions and weed out unsuitable locations.

Much of the wind data in developing countries shows average wind speeds in the 2-3 m/s (4.5-6.7 mph) range; should wind still be considered?
An all too common mistake made by project planners is to predict wind turbine performance based on historical wind data without first checking the reasonableness of that data. Meteorological services in developing countries often collect wind data in the middle of towns from well-worn wind sensors placed with poor exposure to the wind.

Thus, much of the available wind resource data from developing countries underestimates the actual resource available in rural areas. Macro-scale data and terrain-based analytical methods developed by the US-DOE have now enabled much more accurate wind mapping. The data base used by Bergey Windpower was developed using these techniques and verified with on-site wind measurements at hundreds of sites. This data does have limitations, however, in

complex terrain where wind sheltering is a factor. In these cases on-site judgments, and rarely, wind monitoring, are needed to avoid poor performance.

Are wind turbines too "high-tech" for rural areas?
The high technology of a wind turbine is in just a few manufactured components such as the blades. A wind turbine can actually be much simpler than a diesel engine. They also require substantially less attention and maintenance. Our turbines, for example, have only three moving parts and do not require any regular maintenance. They can operate for extended periods, five years or more, without any attention. Some Bergey 10 kW turbines have operated for over 20 years with no service or even inspections (not recommended).

How can I get more information? We would be happy to send you further information on small wind turbines for microgrids or answer any of your questions. Just call or write to Bergey Windpower Co. at the address below. You can also get further information on wind energy and its use in developing countries from the Alliance for Rural Electrification, Brussels, www.ruralelec.org .

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BWC was formed in 1977 and has been manufacturing small wind turbines since 1980. BWC wind turbines have been installed in all 50 U.S. states and over 100 countries.

Xinjiang Province, China