STEP 10

E³A: Small Wind Energy Applications for the Home, Farm, or Ranch

Steps in the Small Wind Series

E3A-SW.10
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Wind for Pumping Water

Water pumping with wind energy is a type of off-grid system with strong relevance to livestock producers. The use of wind energy for water pumping has a long history; the iconic mechanical windmill enabled the expansion of livestock production on semi-arid grasslands from the 1870s to the 1920s. Wind is no longer the only choice for remote, off-grid water pumping, as solar electric arrays are an increasingly popular source of energy for water wells. Despite the rise of solar powered livestock watering systems, wind energy can still be effectively harnessed to pump water for livestock and other needs. Wind energy is generally not a viable source for pumping the large quantities of water needed for irrigation systems.

Courtesy of NREL/DOE

How Pumping Systems Work

Wind energy can be used by both mechanical and electric water pumps. The simplest systems involve mechanical water pumps. Thousands of mechanical windmills, using positive displacement pumps, are still installed annually, and they are often a cost effective method to provide small quantities of water for livestock. Most new wind-powered pumping systems use a small wind turbine to power a direct current (DC) electric pump, either diaphragm or helical rotor. Wind turbines are often installed in conjunction with solar panels, as the solar array offers predictable performance while the wind turbine can more cost effectively pump larger quantities of water. Systems typically do not involve batteries to store energy, as batteries are expensive and require significant maintenance. Tanks and ponds are used to store water and provide a water supply when the wind and/or solar systems are not pumping water. This photo shows a typical wind-powered livestock watering system.

Key Considerations

The design of any water pumping system, regardless of energy source, is based upon the quantity and timing of the water required and the depth from which the water must be extracted. The location of the water well, the wind resource, and a direct comparison to solar power cost and efficiency are the most important considerations. First, a wind energy-based water pumping system should be compared with the option of connecting to the electrical grid. Although many factors must be considered, generally anytime electrical power is more than ¼ mile from the well, an off-grid renewable system should be considered. Second, like any other wind energy application, the availability of a suitable wind resource is a vital consideration (please see E³A Small Wind Series Step 3 for more information). The resource also needs to be in close proximity to the water well; for example, a sufficient wind resource may exist on a nearby by ridge top, but not near a dry creek bottom where the well is located. If considering a new well, a similar wind resource assessment should be completed. The seasonality and predictability of the wind resource also needs to be considered. Many areas with sufficient average annual wind speeds have significant seasonal variation, often with stronger winds in the winter and less wind in the summer when more water for livestock is typically required. The wind resource must also be able to pump storage water into tanks, above and beyond current livestock needs.

Once the viability of the resource is established, a cost comparison between remote solar and remote wind is suggested. Recent research from the USDA ARS suggests that for systems requiring less than 1.5 kW of power, photovoltaic systems are often the most practical and cost effective (Vick and Clark 2009). Solar-based pumping systems have fewer moving parts, increased durability, and more predictable production. Unfortunately, solar panels cost more per unit of pumping power than wind. Although prices are constantly changing, the purchase price of solar energy can often be two to three times as expensive as a comparable wind energy system. Therefore, in locations where wind resources are adequate and larger quantities of water are required, wind energy-based pumping systems should be examined. Users must remember that a wind-based system will generally require more maintenance and have a shorter life expectancy than a comparable solar-based system.

References

2009 Vick, B.D., Clark, R.N. 2009. *Determining the optimum solar water pumping system for domestic use, livestock water, or irrigation*. In: Proceedings of the 38th American Solar Energy Society Annual Conference, May 11-16, 2009, Buffalo, New York. 2009.

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