E3A: Micro-hydropower for the Home, Farm or Ranch

Steps in the Micro-hydro Series

Site assessment

Missouri residents are fortunate to possess two important pieces of a viable hydropower resource: water and elevation. Although Missouri may suffer from drought, many water resources come from perennial high-elevation resources that create ample opportunity for hydroelectric power generation. The scarcity of usable hydropower resources means landowners need to understand the two important characteristics of hydropower resources: head, or elevation, and water flow.

Determining head

Head is the vertical distance that water falls. Head is not a measure of the horizontal length of a pipeline, or penstock. Only the vertical distance affects available energy; longer pipelines can actually reduce available energy through losses to friction. The greater the head, the more energy is available. The figure on the right illustrates the importance of the vertical drop.

There is an important difference between gross head and net head. Gross head is the total vertical distance between the intake and turbine. The gross head is reduced over the length of the penstock by friction and turbulence. Standard friction loss tables, often used for irrigation calculations, can provide more precise calculations. Friction loss is often 20 percent of gross head.

Measuring head can be difficult, so you may want to seek the services of a professional surveyor or engineer. A U.S. Geologic Survey topographic map can be used to approximate the available head, as can an altimeter or GPS unit. These will provide rough estimates of available head. There are more precise methods for measuring head described in detail in *Micro-Hydro Power: A Beginners Guide to Design and Installation* from the National Sustainable Agriculture Information Service.

Determining flow

The other vital component of available energy is the amount of water available to be diverted to the penstock. Remember that Missouri stream water flows are highly regulated and can be quite seasonal. More water is often available in spring and early summer than in late summer. This variation can affect your expected energy production, and an average flow with high seasonal variation may not be the most accurate measure for sizing a micro-hydro system.

Some landowners already know how much water in a canal or pipeline is available based on documents provided as part of a water right. Consult your local USDA Natural Resource Conservation Service office to see if have the flows for your waterway. There are several do-it-yourself methods for estimating the volume of water available for a micro-hydro system, including the bucket-and-weir and float methods. The bucket measure involves diverting the waterway into a bucket of known volume and timing how long it takes to fill. The weir method involves a temporary structure that diverts water through an opening of known size and depth. A float is then used to measure the velocity of the water flowing through the opening. *Micro-Hydro Power: A Beginners Guide to Design and Installation* provides detailed descriptions of these methods.

Calculating available energy

Once the head and flow are known, the power available for a micro-hydropower system can be calculated. There are some losses converting kinetic energy of flowing water into electricity because micro-hydropower turbines are not 100 percent efficient.

For most micro-hydropower systems, a rough estimate of 50 percent efficiency is accurate. This equation will give a landowner a good estimate of the amount of power that can be extracted from a hydropower resource:

Net head, in feet × flow, in gallons per minute ÷ 10 = Power (watts)

Do you know the pressure on an existing pipeline?

If you know the available pressure on an existing pipeline, such as for irrigation or household water, then you also know the head. To convert pounds per square inch (psi) to feet of head, multiply by 2.31. For example:

40 psi of pressure × 2.31 = 92.4 feet of head

Characteristics of a viable location

Although anywhere with flowing water and adequate head can be a viable location for a micro-hydropower system, these characteristics help identify some of the better locations:

- Adequate head: Sites with at least 10 feet of head are generally necessary for a system to be economically viable.
- Existing civil works: Existing infrastructure, such as diversions, dams or penstocks, will often lower development costs.
- Proximity to a load: Many good micro-hydro locations are located in close proximity to electric loads. Transporting electricity over long distances increases cost and reduces efficiency.
- Minimal environmental disturbance: Consider the environmental effects a system may have on the environment.
- Clearly identified water rights: In Missouri, access to water is controlled by strictly defined water rights. Water flowing across your property does not necessarily give you access to the resource, even for non-consumptive use in a hydroelectric plant.

Hydro prospecting

In addition to knowing the characteristics of waterways and canals on your property, there are resources to help you identify potential locations for hydroelectric facilities. One of the best is Idaho National Laboratory's Virtual Hydro Prospector. This web-based geographic information system (GIS) resource lets you examine micro-hydropower potential on all naturally flowing waterways across Missouri. Visit *http://hydropower.inel.gov/prospector/index.shtml* to access the tool. You can also contact University of Missouri Extension for help using the tool.

In addition, the Missouri Department of Natural Resources has a database of Missouri streams that can be used to estimate the flow of some rivers and streams in the state, which can be found at *http://waterwatch.usgs.gov/index.php?r=mo&map_type=real&state=mo*.

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