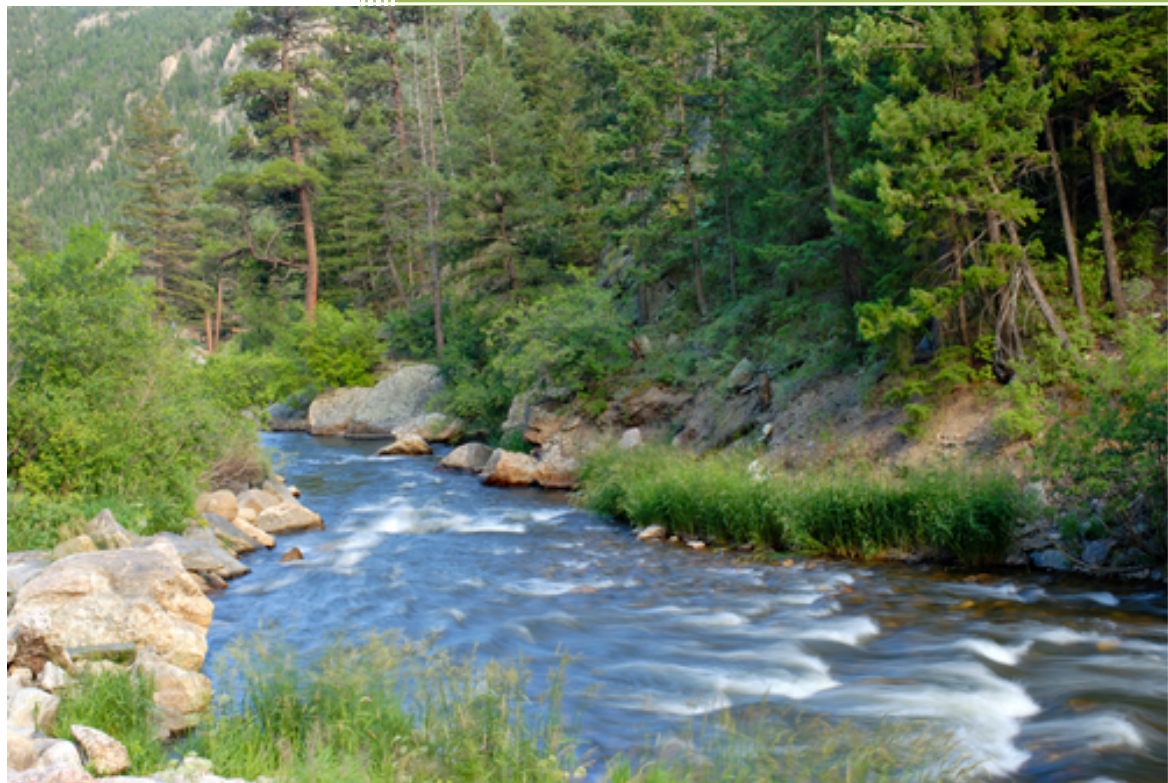




2011

A Quick Guide to Micro-Hydro Power Generation in Colorado



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Introduction to Micro-Hydro

According to the Department of Energy, hydro power facilities provided 2,998 billion



Figure 1: Municipal Micro-Hydro Facility

kilowatt hours of clean and renewable energy in 2006, approximately 20% of worldwide demand. (1) Undoubtedly, the majority of this energy was generated at larger facilities, but recently, micro-hydro technologies have begun to grow in number. Given a sufficient flow rate, micro-hydro power stations can be built on small streams, creeks and canals to help provide clean energy, for small communities. These facilities have much lower environmental impact than their larger counterparts, and typically consist of a small diversion of water used to turn a turbine and generate electricity. Depending on the amount of energy generated micro-hydro facilities can be used for private or municipal applications. In many cases, these facilities can be a profitable investment.

Purpose of this Guide Book

This guidebook tries to provide answers for land owners on what they must do in order to invest in a micro-hydro facility on their property?

This guide is designed to walk through a preliminary self assessment process to begin evaluating a micro-hydro facility for sites in Colorado. This is by no means a comprehensive design guide or feasibility document. Rather, the guidebook is intended for educational outreach purposes so that potential micro-hydro site owners can begin to familiarize themselves with the technology and potential opportunities. This guide

covers a preliminary technical and economic analysis that site owners will be able to do on their own so as to make an informed decision about whether to recruit a professional to continue with their project site evaluation. The steps are outlined below:



Figure 2: Private Micro-Hydro Facility

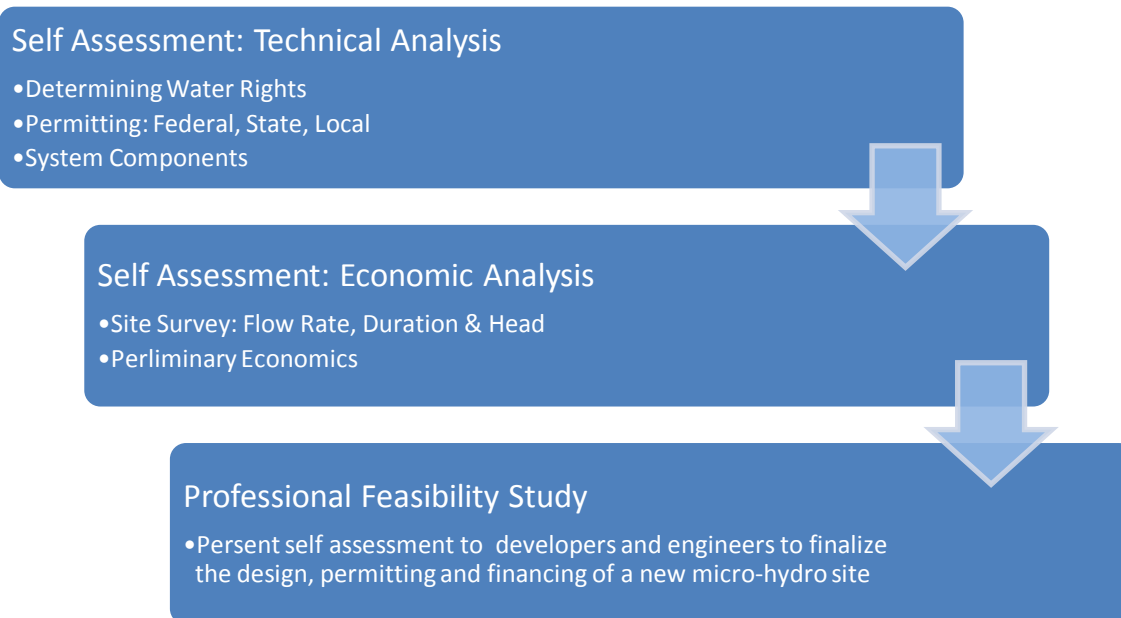


Figure 3 : Micro-Hydro Feasibility Flowchart

Self Assessment: Technical Analysis

Determining Water Rights

The current system of water rights in Colorado originated historically from western settlement. For the first settlers, the law was simple: first come, first serve. This basic rule best describes the heart behind Colorado’s current prior appropriation system: first in time, first in right. Appropriation is the act of deriving water from its source and putting it to beneficial use. Water rights are acquired through appropriation and are independent of land ownership. A water right is a property right to use a specified quantity of the state’s water resource for a specific purpose. It can be sold, leased or rented. Water rights are subject to abandonment, or can be lost if the resource is not going toward proper beneficial use. As illustrated in Figure 4, the oldest rights have the most priority, and receive the first allocations of water shares. (3) Seniority trumps equity in an appropriation system.

Permitting: Federal Energy Regulatory Commission (FERC)

All projects which produce electricity that is fed to the grid require a FERC permit.

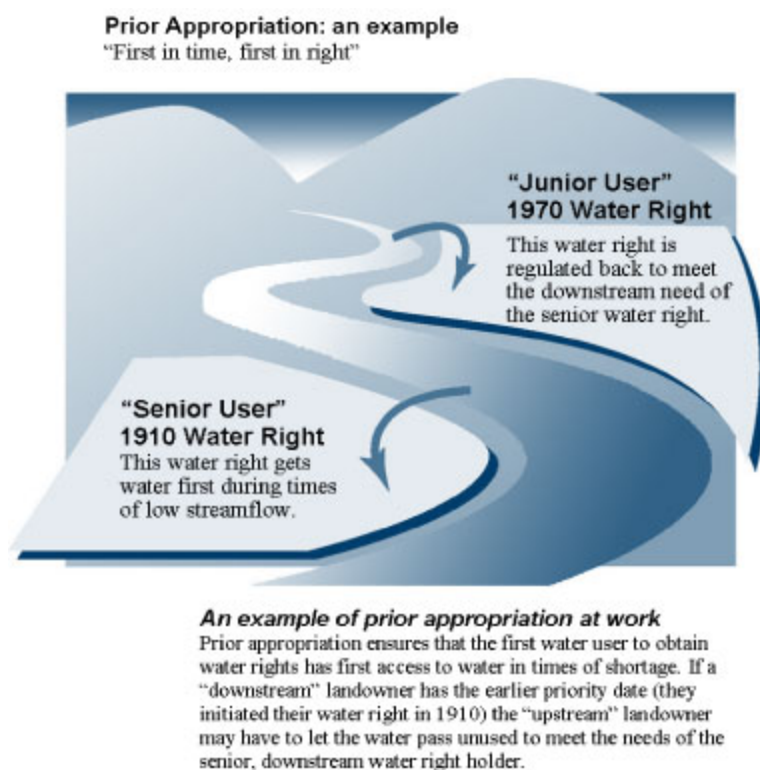


Figure 4: Water Rights in Colorado

Because permitting can be a lengthy process, it may be beneficial to file a FERC Preliminary Permit. The Preliminary Permit allows the owner three years to evaluate the feasibility of the site and apply for a license. Periodic reports on the status of the feasibility studies are required to maintain a Preliminary Permit. (4) For micro-hydro projects, there are two exemption routes which simplify FERC permitting. Applicants for either exemption are required to have all real property interests (or an option to obtain the interest) and cannot occupy federal lands.

1. *Conduit exemptions* apply to hydro projects which produce up to 15MW of electricity (or up to 40MW of electricity for a municipal project) that utilize existing man-made hydrological structures (irrigation ditches, canals, sluice gates, pipeline etc...). An Environmental Impact Statement or Environmental Assessment is not typically required *unless* the project presents a threat to the environment.
2. *Small megawatt exemptions* are issued for projects which produce less than 5MW. The applicant may install or add capacity to a natural water feature or pre-2005 dam.

A FERC license is required for all micro-hydro projects within the U.S. This license provides the applicant with the power of “eminent domain” to obtain lands or other rights needed to construct, operate and maintain the hydroelectric project. Licenses are issued every fifty years and must be renewed at the end of each term. (5) State and local permitting is not discussed in detail because they will vary from site to site.



Figure 5: Existing Hydrological Structure

System Components

The design of each micro-hydro system depends on the specifications of each individual location. However, to provide a context for design, the components of a typical micro-hydro system are presented below in Figure 6. (6) Micro-hydro projects are considered “run of the river” systems because they operate within the natural confines of water flow. Run of the river operations do not require a dam or the storage of large amounts of water. Each hydro project is unique and a site specific design must be developed as a local solution. Not all hydroelectric projects will require all of components shown Figure 6.

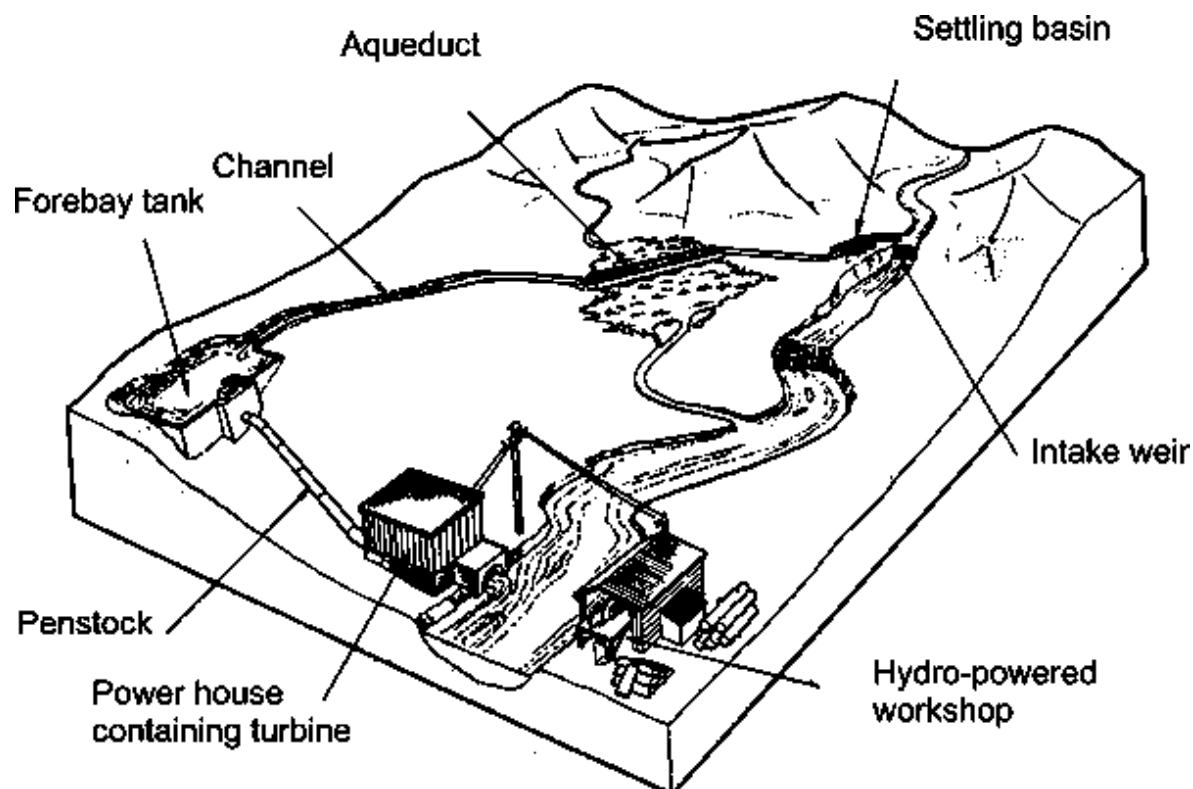


Figure 6: Run of the River System

Self Assessment: Economic Analysis

Site Survey

The goal of a site survey is to determine the flow rate, duration of flow and the head or elevation drop of the site. These pieces of data will allow vendors to provide a more specific estimate of costs for the turbine. When looking for the location of the micro hydro site, look for an area that has a vertical drop of at least five feet. If the drop is less than that, the amount of electricity generated may not be large enough to provide a rate of return for the investment. After gathering data from a site survey, the results can be used to calculate the potential power generated at the site.

$$\text{Potential Power (kW)} = \frac{(\text{Water Flow Rate in cfs}) \times (\text{Availabe Head in ft}) \times (0.8)}{(11.82)}$$

Given the potential power generated, and the price per kilowatt-hour site owners currently pay to their utility, they can make an informed decision about potential savings/revenues.

It is also important to consider if the renewable energy generated will be used onsite or sold back to the utility. Typically, it is always more beneficial for the power to be applied to onsite loads.

Ballpark Cost Estimates

To develop a ballpark cost estimate, it is important to list all possible expenses including:

Turbine & switchgear, structure & foundation, excavation, flow meter, electrical work, utility grid connection, labor, installation and contingency, feasibility study, system testing, survey work, engineering design and construction, project management, permitting fees and a FERC license. Estimates for these can be procured from various vendors.

Potential Funding

There are several potential funding options which are available for micro-hydro sites. Site owners can obtain equity from outside investors, or invest their own funds, and use secured or unsecured debt, and apply for a grant. Additionally there are several government incentives for utilizing renewable energy. The Database of State Incentives for

Renewables and Efficiency (DSIRE) provides a comprehensive list of state, local, federal and utility incentives and policies that promote energy efficiency and renewable energy. Each financial incentive listed on the DSIRE website <http://www.dsireusa.org/> includes an outline, brief description, as well as contact information for individuals associated with the rebate. (7)

Power Purchase Agreements

Project financing can also be obtained by selling the hydropower generated, back to the utility through a Power Purchase Agreement (PPA). A PPA is a legal contract between the utility and a site owner. The utility is specified as the power purchaser, or buyer and the site owner as the independent power producer, or provider. A PPA includes an explicit negotiation of all costs associated with the project, a clear explanation specification of which entity owns the renewable energy credit, and other costs deemed reasonable by both parties. The price (per kilowatt-hr for the hydro power) that the utility company will offer is a function of the amount of power produce, when the power will be produced (year round v. seasonally), the reliability of the energy source and how the utility company values renewable energy credits. Approach your local electric utility to determine the viability of a PPA.

Net Metering

Net metering is a consumer-based renewable energy incentive which monitors the production of renewable energy as it feeds back into the existing power grid. The term “net” refers to the excess energy that is produced, above and beyond the energy that is used to operate the system. The power generated by the customer offsets the electricity they should have purchased from the utility. (6) The owner accumulates “in store credit” from their utility which count toward reducing their electrical bill. Net metering also includes “roll over” energy credit from month to month. An electricity meter accurately monitors both the electricity produced by the micro-hydro system, as well as any electricity consumed. This fluxuation in production and consumption varies with peak and low flow rates. Net metering is available upon request by all utility companies in Colorado (8) so this technology is a viable option for all micro-hydro sites.



Figure 7: Micro-Hydro Penstock

Professional Feasibility Study

If the site is technically and financially viable per the above process, then we suggest the site owner hire a professional who can help with the accurate financial and technical assessment, design, permitting, interconnect, engineering, procurement and construction phases. While this guidebook provides an overview of the process to ascertain the viability of hydro for a site, additional details and a list of resources and professionals are available by contacting iCAST at info@icastusa.org or downloading the pdf from our website at www.icastusa.org/Resources

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