E3A

Micro-hydropower for the home, farm, or ranch: A brief overview

Milton Geiger, UW Extension

April 14, 2014

WESTERN SARE
Sustainable Agriculture Research & Education

Outline

- Hydropower Basics
  - Small and Micro-hydro specific issues
- Site Assessment
- Equipment & Design
- Regulations & Incentives
- Examples

E³A

Checklist

- Do you have access to flowing water on your property?
- Does the water resource have adequate flow?
- Do you have the legal right to utilize the water?
- Do you have an electric load within one mile of the resource?
- Are you willing to invest money and some maintenance time into a system?

The Basics – Size

- Hydropower comes in a great range of scales

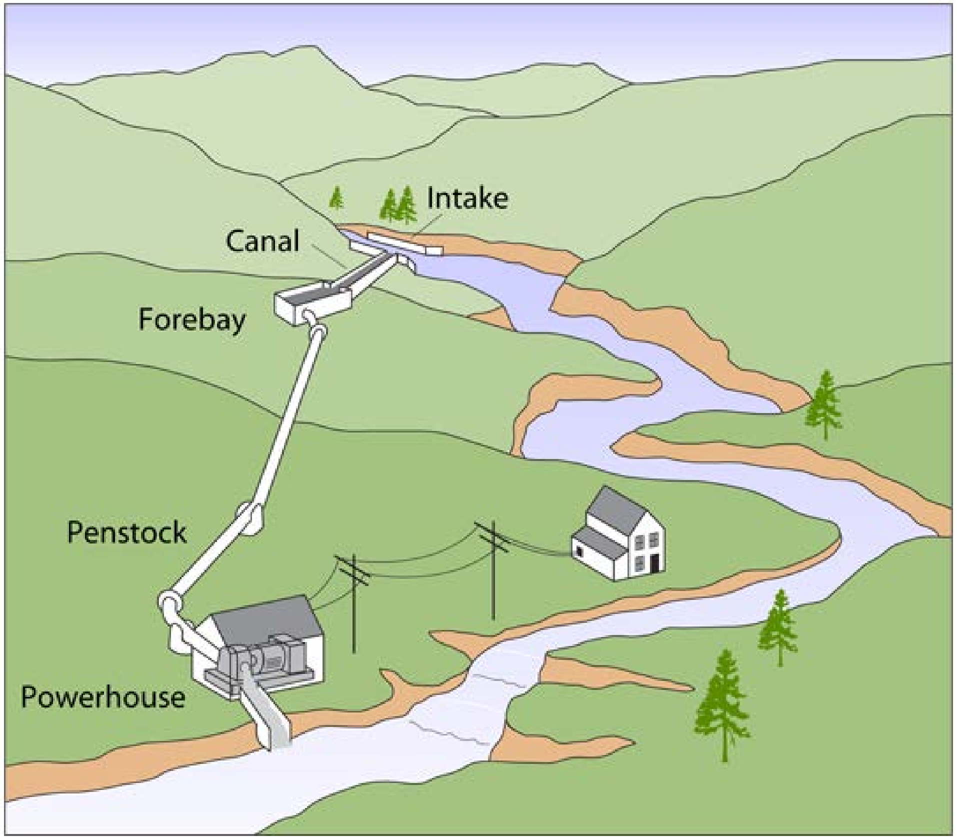
VS.

The Basics – Size

- Micro-hydro is still a large range
  - A high capacity (85%)100 kW capacity is a system capable of supply electricity to over 75 typical homes.
  - Presentation focuses on much smaller systems ~1-10 kW that would supply energy for one home or farm

E³A

The Basics – Components

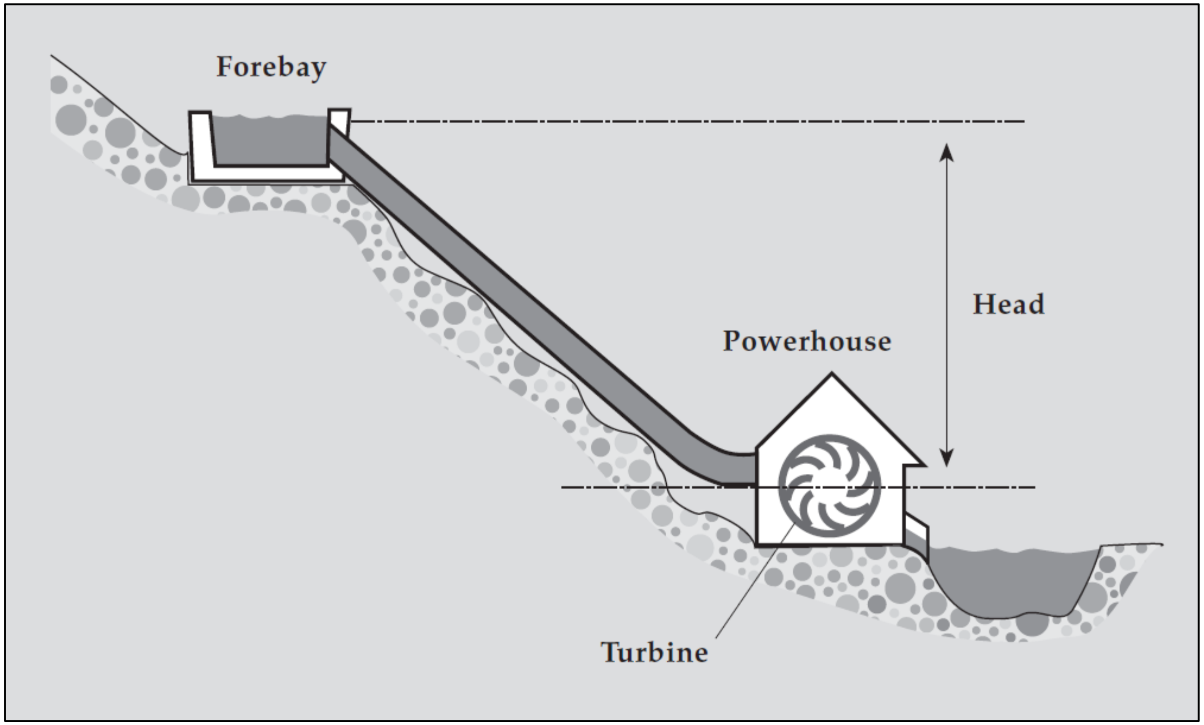


Source: United States Department of Energy: Energy Efficiency and Renewable Energy. Small Hydropower Systems. DOE/GO-102001-1173: July 2001

Site Assessment

- Head
  - Vertical drop of water in penstock
  - "Net head" is negatively impacted by horizontal distance
    - Pipeline loss
- Flow
  - Amount of water flowing into penstock

Site Assessment – Head and Flow



Source: United States Department of Energy: Energy Efficiency and Renewable Energy. Small Hydropower Systems. DOE/GO-102001-1173: July 2001

Site Assessment – Available Energy

The greater the head or flow, the more energy available!

$$\mathit{Power\ (watts)} = \frac{Net\ head\ (feet) x\ flow\ (gpm)}{10}$$

Power and energy are different, as energy is also a factor of time!

Site Assessment – Where would be good?

- Adequate head
  - Flow can make up for lower heads, but at least 10 feet is easier to develop
- Existing civil works
  - Irrigation or other diversions, penstocks, etc.
- Proximity to load
  - Closer the better due to expense and line loss
- Minimal environmental disturbance
  - Existing heavily impacted systems
- Clearly identified water rights
  - Just because it is there does not mean it is yours…

E³A

Hydro – Where

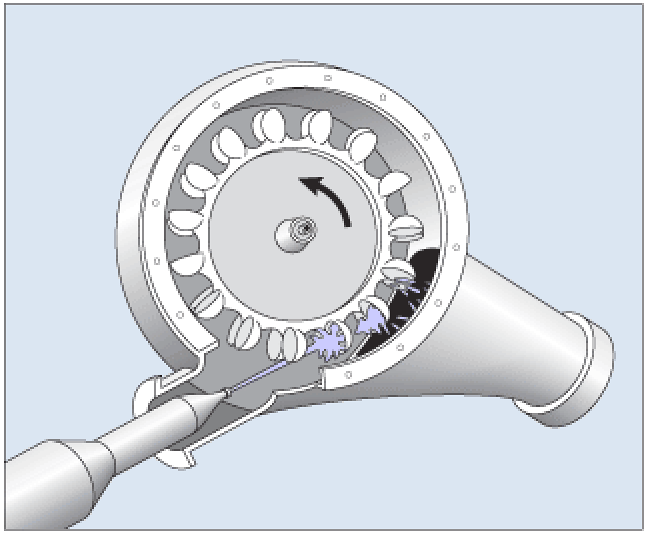
- Existing structures
  - Dams
  - Canals
  - Pipelines
  - Center pivots
- In-stream – No new storage capacity required

Much easier if new infrastructure is not required!

E3A

Equipment

- Impulse turbines
  - Use the velocity of water
- Reaction turbines
  - Use the pressure of water



Both types can be used in micro-hydro installations, although impulse turbines are more common, especially in high head situations.

Source: United States Department of Energy: Energy Efficiency and Renewable Energy. Small Hydropower Systems. DOE/GO-102001-1173: July 2001

Equipment – Cost

- Very site specific but can be the lowest cost renewable energy system compared to wind, solar electric, etc.
- Estimates provided by National Sustainable Agriculture Information Service
  - $21,450 for a 3.5 kW system

Source: Kindberg, Leif. *Micro-Hydro Power: A Beginners Guide to Design and Installation*. National Sustainable Agriculture Information Service. February 2011. Available at < http://attra.ncat.org/attra-pub/farm_energy/hydropower.html>.

E3A

Incentives

- Relatively few
  - Eligible for net metering if under 25 kW
  - Non-residential system can apply for USDA Rural Development, Rural Energy for America Program (REAP)
    - 25% grant

Regulation – Avoiding a fight

- Establish water right
  - Non-consumptive use, but still need to receive water right from State/County Engineers
- Federal Energy regulatory Commission (FERC)
  - Refined application process

E3A

Activity Time – Virtual Hydro Prospector

- Idaho National Lab (INL)
  - GIS-based tool that looks at natural waterways
    - No irrigation canals

http://hydropower.inel.gov/prospector/index.shtml

Hydro – Sample Calculation

KW = 0.0846 x E x Q x H

where: Q = water flow, cubic feet per second

H =head, feet

E = efficiency of hydroelectric plant, percent divided by 100

- Example: Existing 9" pipeline
  - 100 ft. of head
  - 3 cfs

Result 25 kW of potential power at 100% efficiency –

More likely 9-12.5 kW production depending on efficiency losses

E3A