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

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Outline

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

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

Site Assessment – Available Energy

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

\[
\text{Power (watts)} = \frac{\text{Net head (feet)} \times \text{flow (gpm)}}{10}
\]

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...
Hydro – Where

• Existing structures
  – Dams
  – Canals
  – Pipelines
  – Center pivots

• In-stream – No new storage capacity required

Much easier if new infrastructure is not required!
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.

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

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
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

\[ KW = 0.0846 \times E \times Q \times H \]

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