Pico Hydro: Powering Developing Communities with Run-of-Stream Hydroelectricity

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Mission Statement

We believe that all people deserve an opportunity to pursue financial prosperity for themselves and their families. We believe small-scale hydro can bring jobs and economic prosperity to underdeveloped communities.
What is the Problem?

The lack of renewable and affordable electric power in small, off-grid communities in the developing world limits both educational and economic opportunities. This makes it difficult for people to flourish and for these communities to prosper.

According to a 2016 study, there are roughly 1.7 billion people on earth without access to electricity, most of them living in developing countries. This is nearly 23% of the human population!
Solution - Hydro Power
What is Hydro?

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<th>Water Passage</th>
<th>Direct Flow (Vs = Stream Velocity)</th>
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<td>2</td>
<td>Turbine</td>
<td>Capture Hydrokinetic Energy (KE -&gt; Torque)</td>
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<td>3</td>
<td>Generator</td>
<td>Generate Electricity (Torque -&gt; EE)</td>
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<td>4</td>
<td>Transformer</td>
<td>Charge Controller / Shunt Load Regulator (Variable -&gt; Controlled Output)</td>
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<td>5</td>
<td>Data Collection</td>
<td>Measuring and Analyzing Variables</td>
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Advantages of Pico-Hydro over other forms of alternative energy:

• 24/7 year-round power generation
• Predictable source of energy production
• Cost-effective, low-maintenance systems
• Little to no environmental impact
Engineering Ministries International (EMI)
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EMI is a non-profit organization that seeks to serve the global Church to glorify God through design, discipleship and diversity.

Mission: To develop people, design structures, and construct facilities which serve communities and the Church.

Since 1982: 1000+ projects in 90 countries
W.E.D.G.E.

Water Energy Device for Generating Electricity
Project Goals

- Test WEDGE prototypes (1.0, 2.0, and 3.0) in the Yellow Breeches Creek and “in-house” to evaluate performance and identify design improvements.
- Construct and deliver a final design for an optimized, field-tested prototype (WEDGE 4.0) that meets EMI’s design specifications.
• Came with a data collection system that needed to be trouble shoted.
• Main question was how to get the data collection system to work.
• Problems solved by:
  – *Using an external battery pack attached to the data collection system*
• Reasons for Data Collection:
  – *Comparison of shaft RPM to Power production*
  – *Comparison of stream flow speed to shaft RPM*
• Future of Data Collection:
  – *New system that incorporates more transferable (to excel) data collection method*
• Tested the existing WEDGE 3.0 design in order to get a better understanding of our production capabilities.
• This involved draining a battery using a resistor bank, like the one pictured, and then hooking it up to the WEDGE 3.0 while it was submerged in the Yellow Breeches.
• Purpose of testing was to provide us with information about the outputs of our machine.
Continued testing on the alternator attached to the WEDGE 3.0 by constructing a controlled testing method.

Used a DC motor and a DC power supply in order to control the voltage to our motor and therefore find the power output of our machine.

This was tested together using a constructed testing rig, as shown on the right following a testing schematic (also shown right).
WEDGE 4.0

• Applies knowledge from the 3 EMI prototypes

• Specifications
  – 300-800W of power generation
  – Able to be run constantly
  – Last at least 3 years
  – Cost less than $500 or an efficiency of less than $.08/Watt
  – Easy to install, move, and maintain
  – Safe
Water Passage

• Water Passage can be broken up into 2 categories
  – Hydraulic Profile
  – Anchoring

• Design Factors
  – Materials
  – Size
  – Cost
  – Durability
  – Portability
Main Body

• PVC material
  – *Smooth surface*
  – *Standardized connections*

• 10in diameter pipe
  – *Compatible with a majority of Propellers*
  – *Cost effective*

• 36in long
  – *Space for shaft to exit the hydraulic profile*
  – *Long enough to help flow*
Entrance Funnel

• Goal of the funnel is to guide as much volume of water into the turbine propeller as gently as possible to avoid head losses due to turbulence.
Exit Funnel

- Split PVC design
- 2:1 ratio of cross-sectional areas
- Angled 10° from centerline
- 26.89in axial length
- Maintain flow immediately after the turbine
Current Design
Future Work

• Finalize the housing design
  – *Both hydraulic profile and anchorage*
  – *Build and test prototype of new design*

• Determine most efficient propeller/turbine

• Choose the appropriate shaft

• Select generator based on performance from the rest of the system.

• Create system to store/utilize power generated
Questions?