El Tigre Engineering

Jennifer Fuller
Grace Neuburg
Benjamin Coultes
Tristram Hokenson
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Benjamin Coultes

Tristram Hokenson
the communities
living
Jake Peace Corps Master's International & Jed aka El Tigre
...they have the most amazing views
our living
“To develop an economically and environmentally sustainable hydropower design to the communities of Mamey, Cerro Piedra, and Arena of the Comarca Ngöbe-Buglé, Panama to provide a better quality of life.”

Mission Statement
Hydropower System
Synonyms: hydroelectric power, hydraulic power, hydrokinetic power, water power

**hydroelectric power**  n, [hīdˈrō iˈlektrik ˈpouər]

a form of energy generated by the conversion of free-falling water to electricity; the generation of electricity by using the motive power of water
Design
Constraints

- dry season
- flashfloods
- remote location
- constructability
- material cost
Objectives

- produce power
- transmission / distribution system
- structural durability
  - minimum maintenance
  - low profile
Sustainable
Methods & Procedures
surveying
measuring
River profiling
Float Method Data Upstream of Waterfall

<table>
<thead>
<tr>
<th>Trial</th>
<th>Distance (ft)</th>
<th>Time (sec)</th>
<th>Velocity (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>11.1</td>
<td>3.06</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>7.7</td>
<td>4.42</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>8.6</td>
<td>3.95</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
<td>8.42</td>
<td>4.04</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>4.14</td>
</tr>
</tbody>
</table>
Global Positioning System
Design and Analysis
the waterfall
Penstock Design
Turbines
0.3 cubic meters / second

<table>
<thead>
<tr>
<th>Type</th>
<th>L (mm)</th>
<th>M (mm)</th>
<th>S (mm)</th>
<th>S3 (mm)</th>
<th>S3C (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>4600</td>
<td>2050</td>
<td>1260</td>
<td>800</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>1110</td>
<td>600</td>
<td>550</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>1700</td>
<td>1000</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Diameter of Pipe Flange (Inflow)</td>
<td>1350</td>
<td>600</td>
<td>300</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Diameter of Pipe Flange (Outflow)</td>
<td>1000</td>
<td>600</td>
<td>300</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Weight (Turbine &amp; Generator)*1</td>
<td>7.5</td>
<td>3.1</td>
<td>1.0</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*1: The weights will be changed dependent upon capacity, type, and rotating speed of the generators.
Transmission Line Map

Total:
12,973 feet (2.46 miles)
3,854.2 meters (3.95 km)
1,434 feet (0.27 miles)  
437.1 meters (0.44 km)

1,221 feet (0.23 miles)  
372.2 meters (0.37 km)

842 feet (0.16 miles)  
256.6 meters (0.26 km)

1,350 feet (0.26 miles)  
411.5 meters (0.41 km)

782 feet (0.15 miles)  
238.4 meters (0.24 km)

1,999 feet (0.38 miles)  
609.3 meters (0.61 km)

Total:  
12,973 feet (2.46 miles)  
3,954.2 meters (3.95 km)
generator connections
Switch Rated for 600V and 15A

600V Positive Line

Switch

500 VA Transformer

High Side

Low Side

Fuse

120V Positive Line

Neutral

Ground

Neutral

household connections
## Construction Schedule and Cost Estimate

### Crossflow Cost Estimate

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization</td>
<td>500</td>
</tr>
<tr>
<td>Inlet</td>
<td>8,000</td>
</tr>
<tr>
<td>Penstock</td>
<td>11,000</td>
</tr>
<tr>
<td>Mechanical Equipment / Housing</td>
<td>2,000</td>
</tr>
<tr>
<td>Power Distribution</td>
<td>15,000</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$36,500</td>
</tr>
<tr>
<td>Including 7% tax</td>
<td>$39,055</td>
</tr>
</tbody>
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### Toshiba Cost Estimate

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<td>Mechanical Equipment / Housing</td>
<td>70,500</td>
</tr>
<tr>
<td>Power Distribution</td>
<td>15,000</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$105,000</td>
</tr>
<tr>
<td>Including 7% tax</td>
<td>$112,350</td>
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</tbody>
</table>

**2013-2014**

Toshiba Turbine

Crossflow Turbine

62 days
Construction Schedule

2013-2014

Toshiba Turbine
Crossflow Turbine

62 days
<table>
<thead>
<tr>
<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Nov 24, '13</th>
<th>Dec 8, '13</th>
<th>Dec 22, '13</th>
<th>Jan 5, '14</th>
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<tbody>
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<td>28</td>
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<td>3</td>
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<td>Turbine Shelter</td>
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<td>10</td>
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<tr>
<td>19</td>
<td></td>
<td>Mechanical Equipment</td>
<td>5 days</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>14</td>
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<tr>
<td>22</td>
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<td>Inlet/Penstock</td>
<td>21 days</td>
<td>2</td>
<td>6</td>
<td>10</td>
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<td>31</td>
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<td>Power Distribution</td>
<td>57 days</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>14</td>
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recomendations

Toshiba

Crossflow

Donation Grant

Cost Effective

Technical Supervision

Transmission / Distribution System

Technical Supervision

40 Homes
Sustainable Design for a Hydropower System in the Comarca Ngöbe-Buglé
Acknowledgements
United States Peace Corps

Tim Burke, Volunteer
Kayla Howard-Anderson, Volunteer
Erin Kelley, Regional Coordinator
Jacob Midkiff, Master’s International
Department of Civil and Environmental Engineering

Dr. Brian Barkdoll, P.E., D.WRE
Michael Drewyor, P.E., P.S.
Dr. Kurt Paterson, P.E.
Dr. David Watkins
Department of Electrical and Computer Engineering

Dr. Duane Bucheger

John Lukowski

Dr. Wayne Weaver

Dr. Dennis Wiitanen
Spicer Group, Inc.

Russ Beaubien, P.E., CFM
References


Thank you