

Request for Proposal
December 8, 2009

**Final Design, Assembly and Demonstration of a Hydrokinetic Turbine
For Renewable Energy Generation in Water Channels**

Project Manager: Burt Hamner, CEO, Hydrovolts, burt@hydrovolts.com, 206-491-0945

Summary

Hydrovolts seeks a contractor to make a working hydrokinetic turbine out of large components provided by Hydrovolts on a work-for-hire basis. Very limited design or fabrication is needed; fast and practical assembly and brief demonstrations are required. The turbine must be completed by January 22, 2009 and demonstrated in operation by January 29, 2009. Most parts will be provided by Hydrovolts.

Background

Hydrovolts CEO Burt Hamner previously directed the Tacoma Narrows Tidal Power Feasibility Study and produced a “Gorlov” tidal turbine rotor in a steel frame. The rotor performance (it turns in a current) has been demonstrated in projects by others. Now Hydrovolts needs to accomplish two objectives: 1) Complete the assembly of the turbine including adding floatation, a generator, power electronics, anchoring/towing system, and power cable to a load and data collection, and demonstrate the turbine under tow; 2) then convert the Gorlov rotor blades to “Flipwing” rotor blades and demonstrate the turbine under tow. The company owns many of the parts needed to make a full working turbine.

Hydrovolts has an important short-term objective to exhibit the completed turbine at an event in February 2010. Ability to meet the schedule is a prime consideration for contract.

Task Objective

Assemble and successfully demonstrate a complete functioning turbine in a river or tidal channel near Seattle by January 29, 2010. Hydrovolts provides the major parts and the contractor makes them all work together to produce from one to four kilowatts (kW) of power for a rough prototype machine. At completion Hydrovolts will own all designs, specifications, drawings, hardware, data and other work products produced.

System Components Provided

- Turbine Frame: A steel cage about 12 x 6 x 6 feet supporting a rotating shaft down the length of the cage.
- “Gorlov” Rotor: A Gorlov helical rotor made of six blades in two set of three
- Generators: Three “SmartDrive” generators each capable of at least 800 watts at rated RPM.

System Components Needed

The budget for this project covers the costs of the items below. Proposals must specify the estimated cost of each item. This project is Proof of Concept and the components do not need to be engineered to commercial specs. Quick and Dirty is preferred.

- FlipWing Rotor: Replace Gorlov blades with Flipwing blades using same shaft in same frame. Fabricate new Flipwing blades using provided CAD or own CAD.
- Frame Floatation: Steel framework already designed, needs construction and assembly.
- Generator Housing(s): Watertight box(es) rated to 20 ft depth of about 3x3x2 ft size
- Shaft to Speed Increaser: Gearbox or belt drive to obtain 1:10 increase in RPM
- Speed Increaser to Generator: Attachment from increaser to generator through or inside housing.
- Power Electronics: Simple circuits to produce clean 120V 60Hz AC power from AC generators at given power generation profiles
- Power Cable: To send power to load
- Anchor System: Attachment points on the turbine frame to anchor turbine to bottom of channel
- Specifications for RPM Sensor with Data cable linked to power cable.

Approach

The desired prototype is a Proof of Concept which needs to perform on site without maintenance or adjustment for at least 2 hours. Extensive engineering design should not be needed by an experienced mechanical shop to build this turbine (though CAD is of course helpful and encouraged). All the focus is to assemble the parts and get it in the water making power by deadline of January 29, 2010.

There are two simultaneous work tasks. The first is to assemble and demonstrate the Gorlov turbine. The second is to build the Flipwing rotor blades. When the Gorlov is successfully demonstrated then the Gorlov blades will be replaced by the Flipwing blades for another demonstration.

Major Tasks

Pre-Bid General Meeting: Tues Dec 15, 10 am, at Williamson and Associates LLC, 1124 NW 53rd St, Seattle, WA 98107. Proposals are due Dec 18 at 5 pm. Contractor will be selected and notified by 9 am on Dec 21.

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|--------------------------------------|--------|
| 1. Pre-bid meeting | Dec 15 |
| 2. Proposals due | Dec 18 |
| 3. Award notification | Dec 21 |
| 4. Startup and data transfer meeting | Dec 23 |
| 5. Design new components | Dec 31 |
| 6. Fabricate new components | Jan 8 |
| 7. Assemble all components | Jan 15 |
| 8. In-water Test One | Jan 22 |
| 9. Replace Rotor Blades | Jan 27 |
| 10. In-water Test Two | Jan 29 |

Component Inventory

All components are available for visual inspection and measurement at the shop of Williamson and Associates Inc. in Ballard.

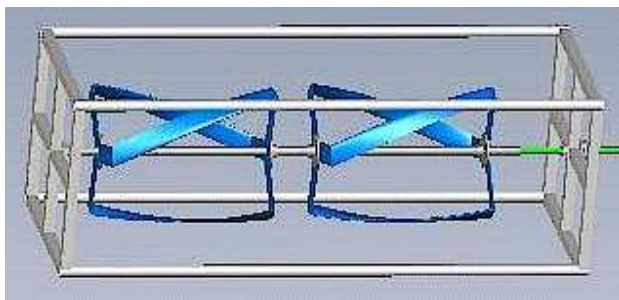
Gorlov Rotor and Frame

The steel rectangular frame holds a rotating shaft lengthwise. Two Gorlov rotors with three blades each are bolted to the shaft at flanges. The shaft and rotors can be unbolted and removed from the frame. The Gorlov blades will be removed from the shaft and new Flipwing blades installed. The round end plates for the Flipwing will be bolted to the shaft flanges closest to the shaft ends. (Testing will be done using both the Gorlov and Flipwing rotors.)

The frame and Gorlov rotor (at JK Fab in Seattle).



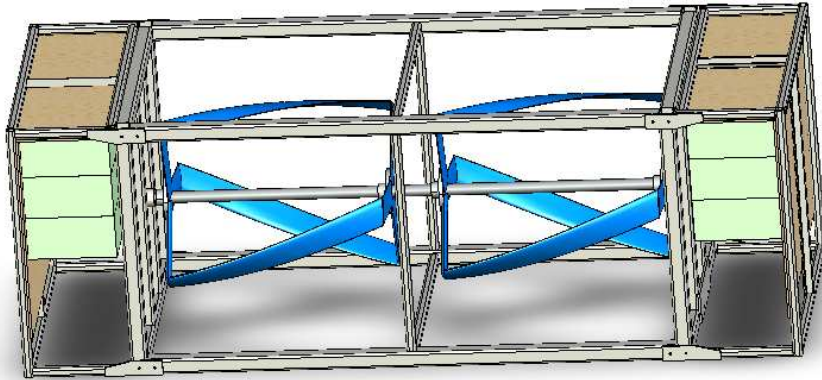
CAD of frame and rotor (in Solidworks, all dimensions accurate)



Floation System

A horizontal floation system for the steel frame and turbine has already been designed in Solidworks, see below. The cages at ends of the frame hold blocks of standard dock floation Styrofoam. The foam is packed so there is an open area around the shaft. This enables the generator to be installed on the shaft close to the frame end. The floation is adjusted by varying the number of foam blocks in the cages. Floation will be designed so the top of the frame is nominally about six inches above the water at rest. In a current the force of the water on

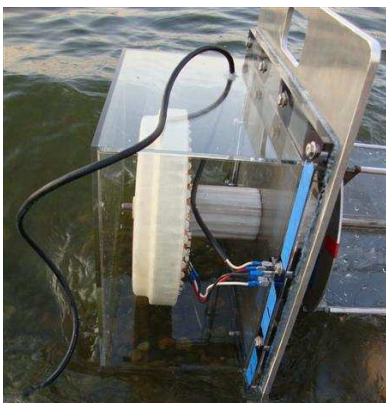
the upper blades will drive the turbine down so extra floatation is needed depending on the nominal current velocity (note that this is specific to the Flipwing design, it does not affect the Gorlov design). The float cages will be designed so that foam blocks can be easily inserted and removed.



Generator

There are two options for the generator. Hydrovolts has three “SmartDrive” generators as shown below that can generate up to 800 watts each depending on RPM. They can be used for the prototype if expected shaft RPM can be increased from approximately 80 RPM to 800 RPM. Hydrovolts will provide a complete instruction manual on using the SmartDrive. Alternatively the contractor can suggest and provide a different generator if it offers superior performance and price, and especially if it can produce the desired power at the expected shaft RPM without a speed increaser.

“Smartdrive” generator in waterproof case



Power Electronics

The generator produces “wild” AC of varying wattage. Details are in the provided manual. A basic power electronics board will be required to convert the raw output to 120v 60 Hz electric current.

Tow System

The floating turbine will be anchored using a yoke in which lines from the longitudinal corners of the frame come together at a joint about 20 feet from the turbine, then a single line goes to a tow boat. The power cable from the generator will be tied with the tow line so the power comes to the tow point on the boat.

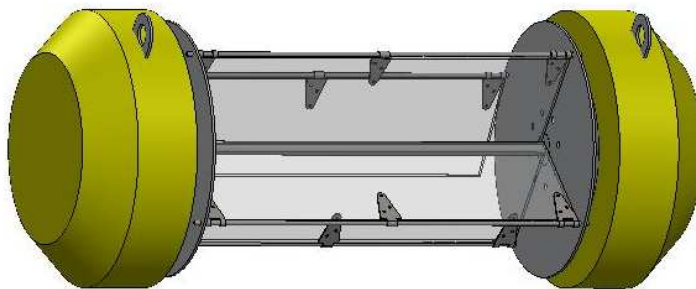
Flipwing Rotor Assembly

This task will happen concurrently with the turbine assembly. The intent is that the Flipwing rotor will be installed on the turbine immediately after the complete Gorlov turbine has been demonstrated. Then performance with the Flipwing rotor will be demonstrated.

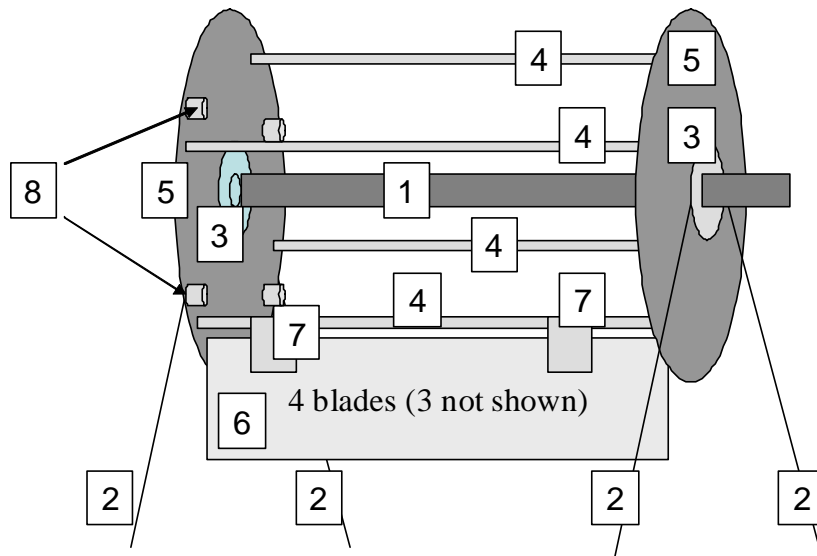
The Flipwing rotor has flat blades suspended by hinges from struts that connect two end disks. There are six blades. The blades are just wide enough for their inner edge to rest against the central shaft. See www.youtube.com/hydrovolts for video of the rotor mechanism. On the shaft in the frame, the end disks for the Flipwing will be secured by bolts to the outer flanges on the shaft. The six cross struts will be secured between the end disks and the flat blades will be secured to the hinges on the cross struts.

This is the most significant new construction for this project. The pieces to be milled are 2 end disks, six cross struts, six flat blades, and six sets of hinges for the struts. The end disks should be aluminum, the struts and hinges should be steel. Bearings and blade material are the contractor's choice. All materials exposed to water should be rust and corrosion-resistant.

Below Left: Prototype Flipwing rotor. The top blade is suspended by hinge from the cross strut, and its low edge rests against the shaft. So the water current pushes the blade over the shaft.
Below Right: CAD of Flipwing in a floating frame. The yellow end caps have floats and internal generators and tow points (this shows eventual final product, for this project the existing steel cage frame will be used instead)



Flipwing Rotor Components



1. Central axle shaft
2. Braces to hold the shaft
3. Bearings to allow the shaft to rotate freely in the braces
4. Cross – arms
5. End disks
6. Blades
7. Hinges
8. Stop-blocks for the wings

Demonstration

The turbine will be demonstrated by towing it behind a boat in Lake Union of Seattle. Hydrovolts will provide the towing vessel. The turbine will be put in the water at a boat launch ramp in the Ship Canal with the tow vessel standing offshore. Then the turbine will be gently towed out and up to speed. Total time for each on-water test is 8 hours. Two tests will be done, one for the Gorlov and one for the Flipwing configuration.

Unit Portability

The turbine will need to be transported by truck or trailer, and the ease of doing so is important. The turbine shall have lift points suitable for a crane to load/unload/deploy it. The turbine shall be capable of laying flat and flush on a flat-bed. It is desirable for the Flipwing blades to have a simple attachment mechanism that prevents their movement during transport.

Ease of Modification

The turbine's waterproof housings must be designed to that they can be opened and resealed using normal tools. Soldering or other permanent methods of enclosure are not acceptable. Preference will be given to designs that facilitate the changing of rotors between Flipwing and Gorlov designs. Preference will also be given to designs that allow rapid changes to the flotation, generators, electronics, or other components.

Performance Objectives

The turbine will be towed at speeds of 1 to 8 knots while logging generator electric output. In theory the turbine towed at 6 knots should be able to generate about 5 kW of continuous power with an optimal generator. With the provided generators we expect output of about 2 kW. The contractor is invited to provide generators that provide higher output at (nearly) the same cost.

The turbine must be able to operate for 2 hours at a speed of 8 knots and survive undamaged for 5 minutes at a speed of 10 knots.

It is critical that the demonstration deadlines be met. This is a condition of final payment.

Potential contractors that cannot meet the deadlines but could do the work if they had more time are encouraged to respond with a letter of interest for future work.

Pre-Bid Meeting

Pre-Bid General Meeting: Tues Dec 15, 10 a.m., at Williamson and Associates. Inc, 1124 NW 53rd St, Seattle, WA 98107. Near the Ballard Bridge and Market St.

Budget

The proposed budget for this project is under \$10,000. Proposals over this amount will be considered only if they show extraordinary merit or if accompanied by substantially deferred payment terms. Hydrovolts is looking for long term partners for design and commercial manufacturing and will consider creative proposals.

Proposals

Proposal shall include time and materials; basic approach or design for attaching the generators to the shaft and for speed increaser (belts or gears); specification of generator if other than Hydrovolts-supplied; basic description of electric power conditioning and waterproof enclosure(s); brief bios of project personnel; relevant experience of the company.

Selection Criteria

Design proposals must meet all requirements in this RFP to qualify for consideration. Proposals will be evaluated on the following criteria (ranked by importance):

1. Schedule confidence
2. Cost
3. Projected power output
4. Ease of modification

5. Unit portability
6. Design robustness
7. Design simplicity

Task Budgets

As part of the total budget proposal please provide estimated costs for each of the component design/build tasks described below.

Components Needed:

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Send proposals by 11:59 pm December 18, 2009 by email in Word or PDF format to Burt Hamner, CEO, Hydrovolts, Inc., burt@hydrovolts.com, tel 206-491-0945. Use same contact for questions about this RFP.