YOURBROOK ENERGY SYSTEMS LTD.

Yourbrook Tidal Technology for Inshore Waters

An example of Tidal Potential – Nakwakto Rapids, BC

Yourbrook Energy has designed a system which will harness the constant, predictable and powerful force of the tides. This is an environmentally benign system that produces clean, economical energy. Our unique design can utilize previously untapped tidal potential. The prototype is scheduled to be launched in 2016.

Yourbrook Tidal Technology for Shallow Water

Summary

Yourbrook's technology is designed to harness the abundant energy occurring over a large area of a cyclic tidal stream. The power is concentrated and delivered to the upland in the form of highly pressurized water. This high pressure water can then be used to generate power in conventional hydro turbines with direct pumped storage to stabilize output if required, without the typical efficiency losses associated with energy conversion.

The worldwide potential for tidal power is estimated to be 700 TWh a year.

Currently tidal power design is in the early stages of development and innovative problem solving is needed to create practical applications in order to utilize this green resource.

Tidal Power Advantages

- Renewable – emission free
- Completely predictable
- Reliable – A plant can last 100 years

Who We Are

Yourbrook Energy Systems Ltd. is a privately owned and operated Canadian firm based in Haida Gwaii, BC. The Yourbrook team is developing a new and innovative tidal power design as a solution to the diesel generation of electricity on Haida Gwaii. This tidal technology has potential to be marketed throughout the world.

Yourbrook Energy Systems Ltd, is in the process of testing a prototype that will demonstrate the feasibility of the tidal power design with a long-term goal to build a full scale demonstration of the technology on Haida Gwaii. Investigative Licence #V889228 and Department of Fisheries approval for Juskatla Narrows has been obtained for the prototype and demonstration phases.

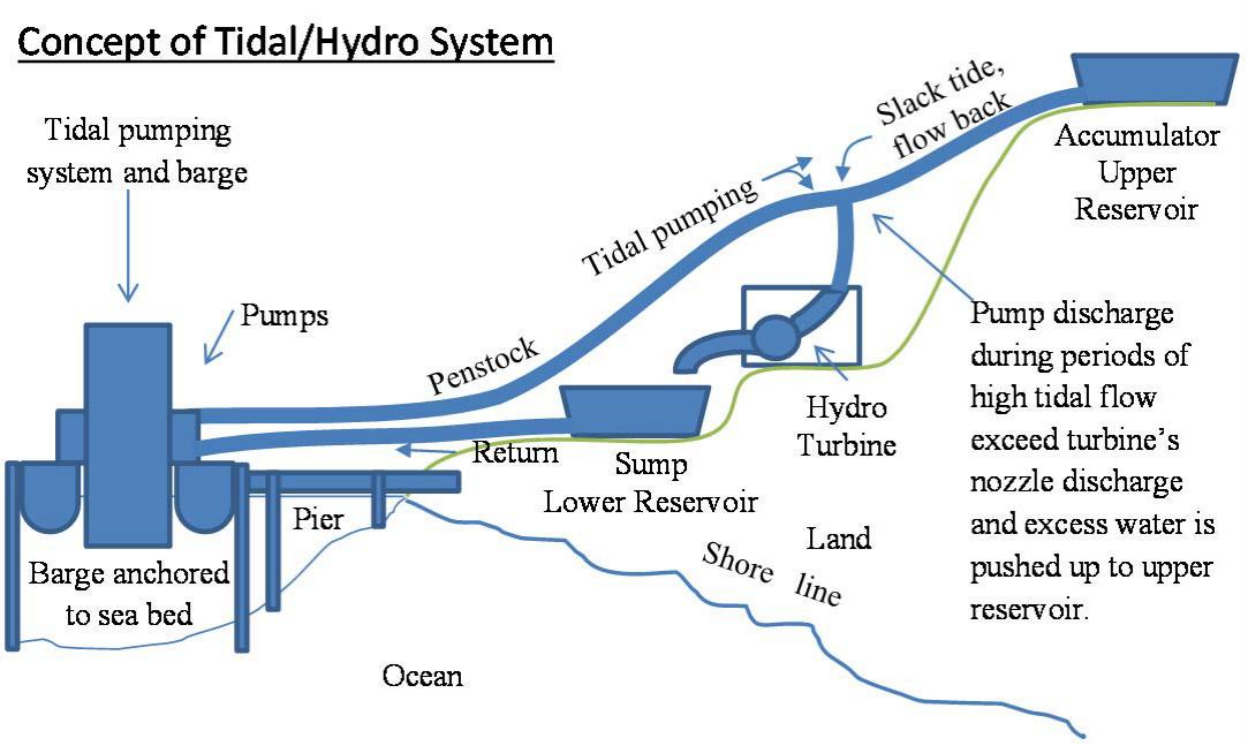
The Challenge on Haida Gwaii

Presently the entire north half of the Haida Gwaii power grid relies on electricity generated by diesel generators. The generators use 10,000,000 liters of diesel annually to provide power to approximately 2,500 people. With the rising cost of fossil fuels and the Greenhouse Gas Emissions that they cause, the BC government is searching for green alternatives to diesel power generation in remote communities. BC Hydro has been exploring alternative energy solutions for the Haida Gwaii power grid from wind power options to biomass, with no clear solutions in sight.

One of the challenges posed by the Haida Gwaii electrical grid is that it is not connected to the main power grid on the mainland. What that means is that a continuous 'firm' power source is required to provide constant power to Haida Gwaii's independent grid. Unlike the mainland power grid which can maintain power between energy fluctuations from intermittent power sources such as wind and solar, the Haida Gwaii system requires a continuous source.

Tidal power is considered an intermittent power source as tide activity slows to a halt at high and low tide cycles as the tides reverse direction. In looking at the complete predictability of tidal flows, Yourbrook began to develop a concept that would create firm (continuous) power from an

intermittent tidal power source by designing a unique pump storage system that would meet the islands' needs. The aim is not to augment the diesel generators, but to turn them off entirely.

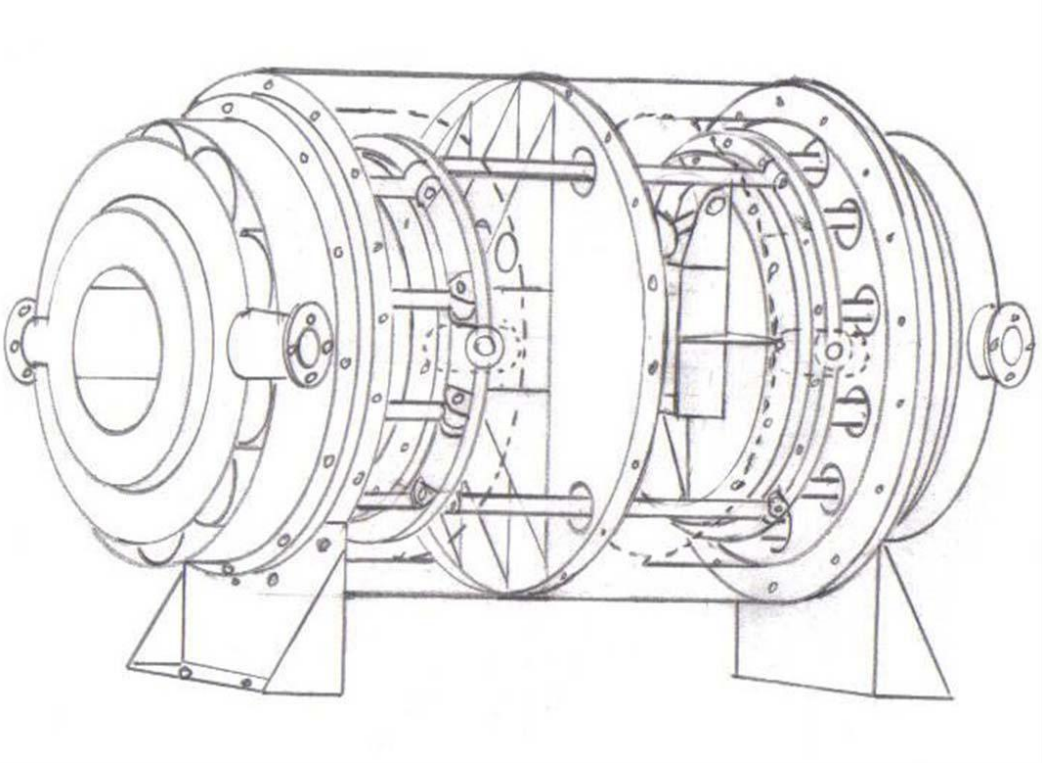


Pump Description

To the extent of the authors' knowledge (JP Pinard, PHD, P Eng.) and research on the topic, the swash plate configuration and pump design, as presented by the project proponent, shown above, is entirely novel and highly innovative. Variable displacement hydraulic pumps used in fluid power transmission have been around for decades. There are many possible configurations and variations. However, it does not appear that variable displacement axial piston pumps have been adapted for use as described, nor under the conditions proposed.

The sketch above shows the proposed pump configuration. Unlike most axial piston pumps, the piston block or cluster in the proposed arrangement is fixed, with the swashplate providing the rotational pumping force. Most configurations employ a rotating piston block with the swash rotating swash plate are generally fixed displacement.[1]

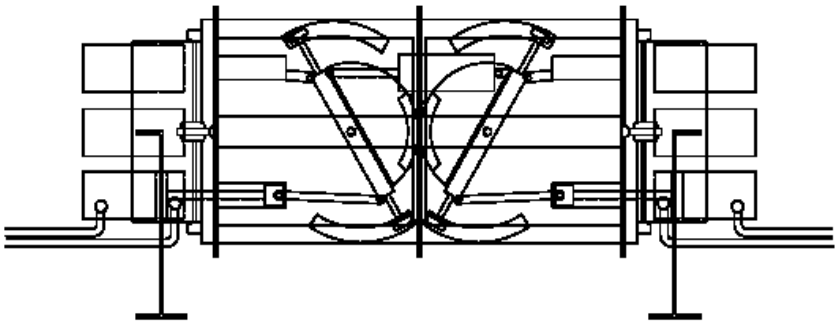
[1] From *An Engineering Analysis of a Tidal/Hydro System for Makaiii Point Power Project, JP Pinnard PHD, P.Eng.*



Pump Sketch

Pump under Construction

Side View of Internal Pump Workings



In the proposed arrangement, the waterwheel and the swash plates share a common mounting shaft and are directly coupled, such that as the water wheel rotates about the shaft, the in-board side of the swash plate is forced to rotate also. The design calls for a swash plate arrangement that allows for the in-board side of the swash plate to rotate freely and independently of the out-board side of the swash plate. The out-board side of the swash plate is attached to the piston rods via spherical plain bearings and retainer plate, and does not rotate, but generates the reciprocating pumping motion through the rotation of the inclined in-board portion.

The piston block (pump cylinders) comprises a number of cylinders connected via directional valves to the intake and output manifolds. The intake manifold draws water from the tail-race sump. The output manifold connects to the penstock.

The inclination or angle of the swash plate is adjusted using a simple hydraulic control system such that the primary control input is the pump output total head, or pressure. At low stream speeds, there is relatively less power available for pumping, and so the swash plate angle is set at a shallow inclination, thus shortening pump stroke, maximizing mechanical advantage and maintaining both the required pressure and some flow even at low speed. As stream speed increases, output force (torque) increases, and the angle of the swash plate can be increased, thus increasing the pump stroke and flow.

Overall Strategic Plan

This project is part of a five-phase plan to validate, demonstrate and market new tidal technology:

Phase A – the *Engineering Analysis* confirming the concept mathematically and with computer models (completed in 2011).

Phase B – build the small scale prototype and refine and adjust components. Refine the computer modelling from the results. Use the proto-type to test several locations within Juskatla Narrows under Investigative Licence #V889228 for future demonstration (in process).

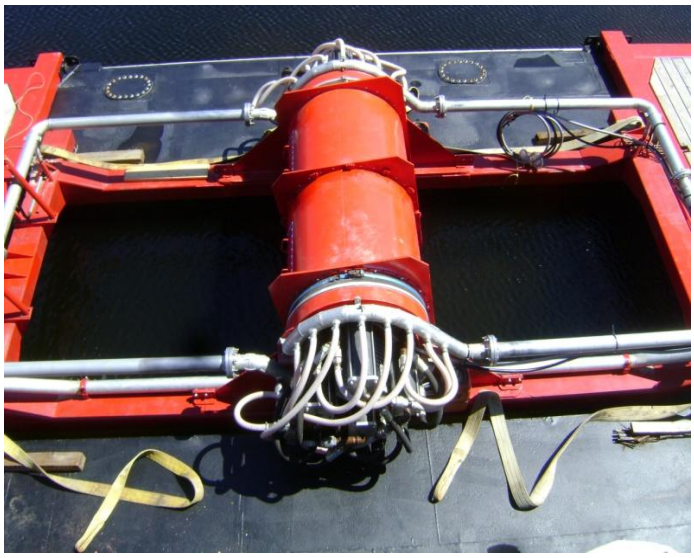
Phase C – business planning and market analysis for demonstration project (in process).

Phase D – the full scale demonstration project, located at Juskatla Narrows on Haida Gwaii with potential for power sales to BC Hydro (est. 2018).

Phase E – manufacture and market the technology; provide consulting services.

Patent

An International patent application for the *Hydroelectric Power System and Pump* was published under the Patent Cooperation Treaty (PCT) on August 8, 2013. International Publication Number: WO 2013/113/09 A1. International Application Number: PCT/CA2013/050039. The preliminary exam of the patent application by CIPO was completely favorable. Patent applications have been filed in Europe, Canada and the United States (has been published in US).



Pump on barge prior to attaching blades.

The Competition

There are three tidal designs currently in use, all of which have their own pros and cons. The *barrage* system is basically a dam which creates a reservoir of water. *Tidal fences* block a channel and redirect flows through turbines, and *tidal turbines* are underwater turbines that spin as tidal flows go through them.

The Yourbrook tidal power design effectively solves many of the issues that have negatively affected the utilization of tidal energy in the past. Waterway barrages and fences are not necessary for tidal flow capture; these designs can adversely affect tidal cycles, salinity, wildlife, access and the tide levels of surrounding areas. Unlike other tidal turbines, the Yourbrook turbine is slow moving and therefore harmless to marine life, mammals and birds, allowing natural tidal flows to continue unabated.

Climate Change and Need for the Product

Canada spends approximately 2 billion dollars annually powering remote communities.

International climate negotiators agreed at the 2009 UN climate change conference in Copenhagen that global warming this century shouldn't increase by more than 2 degrees Celsius to avoid the worst impacts of climate change.

According to the International Energy Agency, $36 trillion of global investment will be needed in clean energy by 2050 to meet this goal – which amounts to $1 trillion a year.

Renewable energy can contribute to "social and economic development, energy access, secure energy supply, climate change mitigation, and the reduction of negative environmental and health impacts". Under favourable circumstances, cost savings in comparison to non-renewable energy use exist.

The Canadian Government is making available vast amounts of funding for demonstration of new technologies in renewable energy. The Clean Energy Fund is providing nearly $795 million to support research, development and demonstration projects to advance Canadian leadership in clean energy technologies. The goal is to help create a suite of clean energy technologies and the knowledge to ensure uptake of the technologies.

Return on Investment

The simplicity of the design plus the availability of required component parts results in overall low production costs per unit. All components incorporated in this technology are expected to have an extremely long service life.

In many remote locations in BC for example where this technology can be deployed the cost of electrical power production through diesel generation is more than double BC Hydro's standing offer per kWh. In these circumstances, up to displacement cost of diesel may be negotiated.

Current Project Status June 2016

Yourbrook is currently in the field testing stage of product development, following shop testing during which the equipment performed as anticipated. The tidal power prototype was launched in June 2016, and data is being gathered to validate the concept. Presently the research is financed by Yourbrook and funds from the National Research Council of Canada through the Industrial Research Assistance Program (IRAP), with additional support from the Northern Development Initiative Trust (NDIT).

Pump on barge in the water preparing for field testing trials, June 2016.