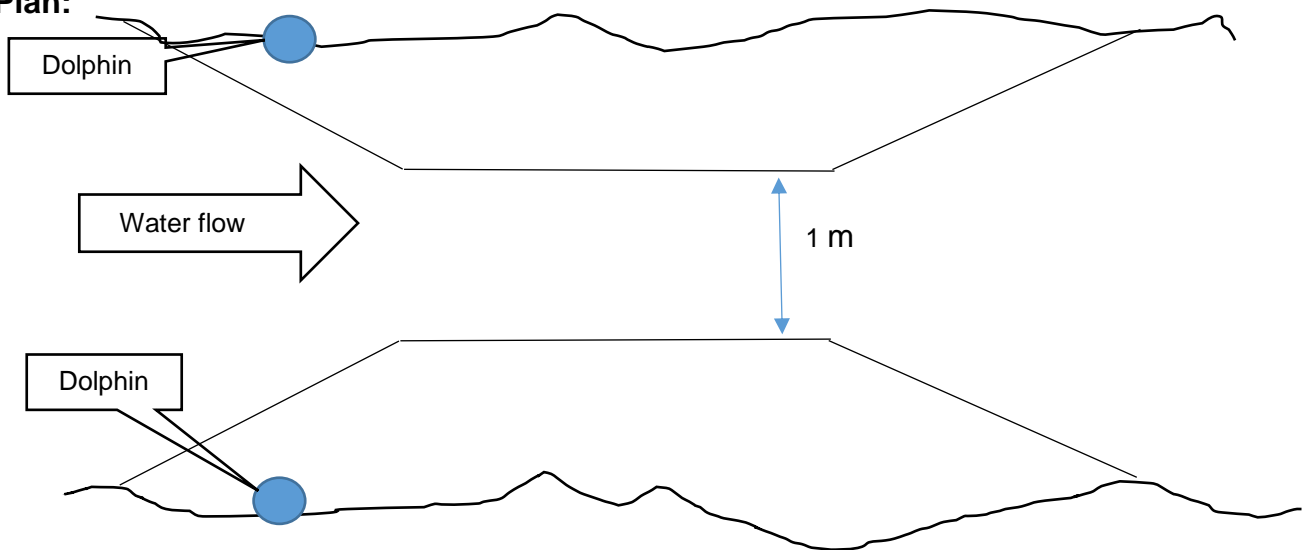


Kinetic Water-Power

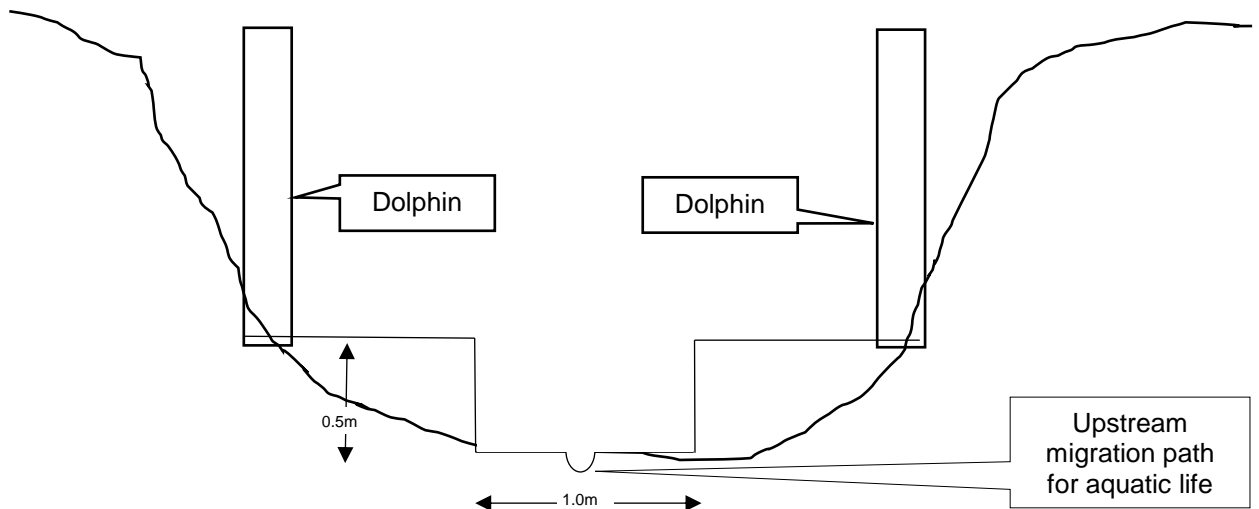
John McCulloch, B.Sc., M.Sc., C.Eng.

Most water wheels are designed to use the potential energy released by dropping the water onto the wheel; the weight of the water being the source of energy. The Kinetic Water Wheel is intended to use the kinetic energy of the flow of water to drive the wheel. It is intended for use in situations of high rainfall where photo-voltaic systems are not practicable because of high levels of cloud cover, or high mountains and steep-sided valleys that block the sun during much of the day. In such areas there are often numerous small streams or rivers that flow rapidly, and where the water depth may vary greatly between periods of high and low rainfall, and where the construction of a dam is not economically practicable or environmentally acceptable.

Plan:



Cross Section:



The system can be used in a wide variety of situations, and design details may need to be adjusted to match the specifics of each area. I have chosen as my example a situation where the water flows in a gully or creek of about 2 m depth, 2 m wide at the bottom and about 6 m wide at the top. During a dry spell, the water may be only 25 cm deep but can rise to the full depth of the gully after heavy rainfall, and in extreme weather may overflow

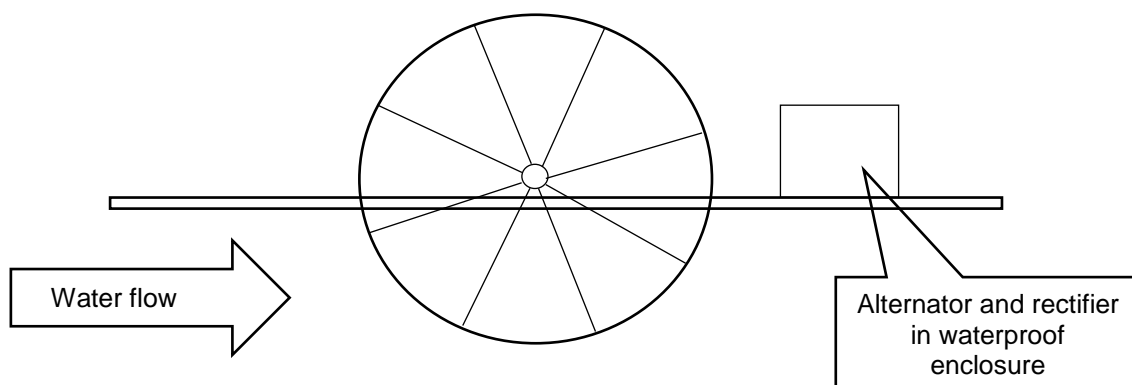
over flatter ground around the gully. The water flow rate is about 0.5 m/s when the level is at its lowest and rises to over 10 m/s when the gully is full.

A concrete venturi flume is set into the bed of the stream or river. This has a throat width of 1 m and a height of 50 cm. The venturi flume is sized to provide a sufficient water velocity at low flow conditions to provide some power, but to offer minimal obstruction to flow when the water is high.

All of the equipment for power generation, (the water wheel, alternator and rectifier), is mounted on a raft which floats on the water when the level is high and rests on the sides of the concrete flume when the water is low. Dolphins are smooth steel guides to restrain the raft from disappearing downstream when floating, allow it to follow the water level as it rises and falls but ensure accurate alignment of the raft with the venture throat when the water level is low. The power cable runs to shore close to one of the dolphins and connects to a grid-tied inverter. Alternatively, the electricity can be used to heat water in a well-insulated hot water storage vessel, or for an off-grid DC or AC electricity supply.

The water wheel and flume must be designed to allow upstream migration of aquatic life. For this reason a survey of the local species should be done to ensure that a sufficient space is provided to facilitate upstream migration. Alternatively, a fish-ladder could be provided for fish to traverse the flume. A gap is left under the paddles of the wheel to allow small stones and pebbles carried by the flow to pass under without obstructing and damaging the paddles.

A paddle height of 75 cm is proposed on a 1 m radius. This is coupled to the alternator by bicycle chains or a toothed drive belt geared to provide the required alternator speed.



Maximum power transfer from water to paddle-wheel occurs when the paddle centre velocity is half that of the water velocity. For this reason an independent means is provided for measuring the water velocity and a control system adjusts the alternator excitation current to achieve this. With a normal water velocity of 1 m/s, the paddle wheel will run at about 30 rpm; the alternator will need to run at a minimum of 2000 rpm to produce power, so a step up gearing of at least x66 will be required.

Actual power output for this design varies with the depth and velocity of the water. At minimum level, after a period of drought, it may be only 20-25 Watts; this is most likely in warm summer weather when electricity demand will normally be very low. With a normal water level, (50 cm at the flume), a power output of 400 W is expected. At maximum level a power output of 800-1100 Watts is anticipated; this is likely to occur in stormy weather when demand would be higher. The normal average consumption for a household is about 400 Watts, but this will vary from minute to minute through the day, and day by day through the year; so rechargeable batteries could help to match supply and demand.

Alternatively, the system could be used to reduce electricity bills whilst the household remains grid-dependent.

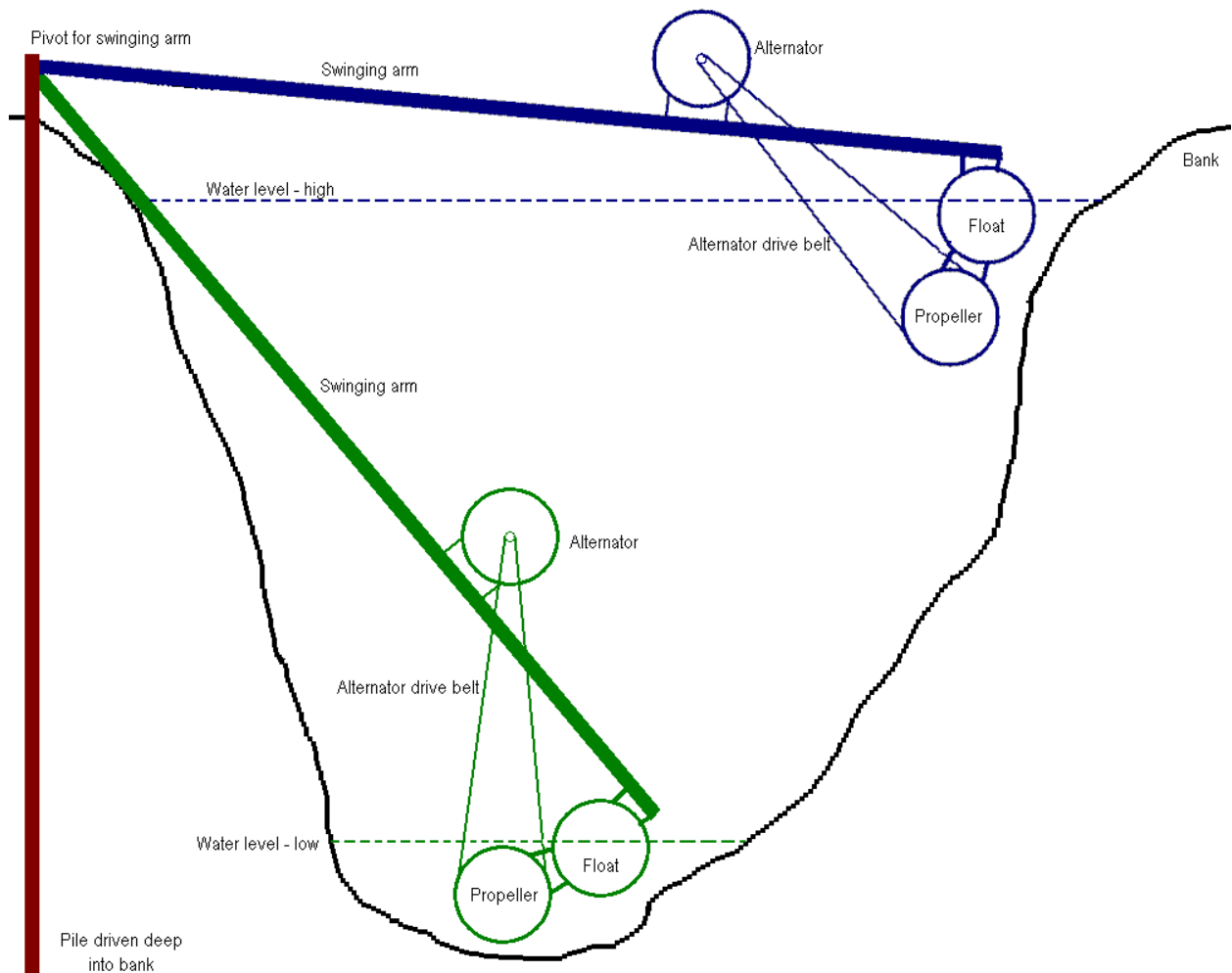
Reference:

Water Wheels or Hydraulic Motors: Jacques Antoine Charles Bresse. ISBN 1-4102-0711-0, copyright ©2003 by University Press of the Pacific. Reprinted from the 1876 edition.

Electricity from small-volume Flows

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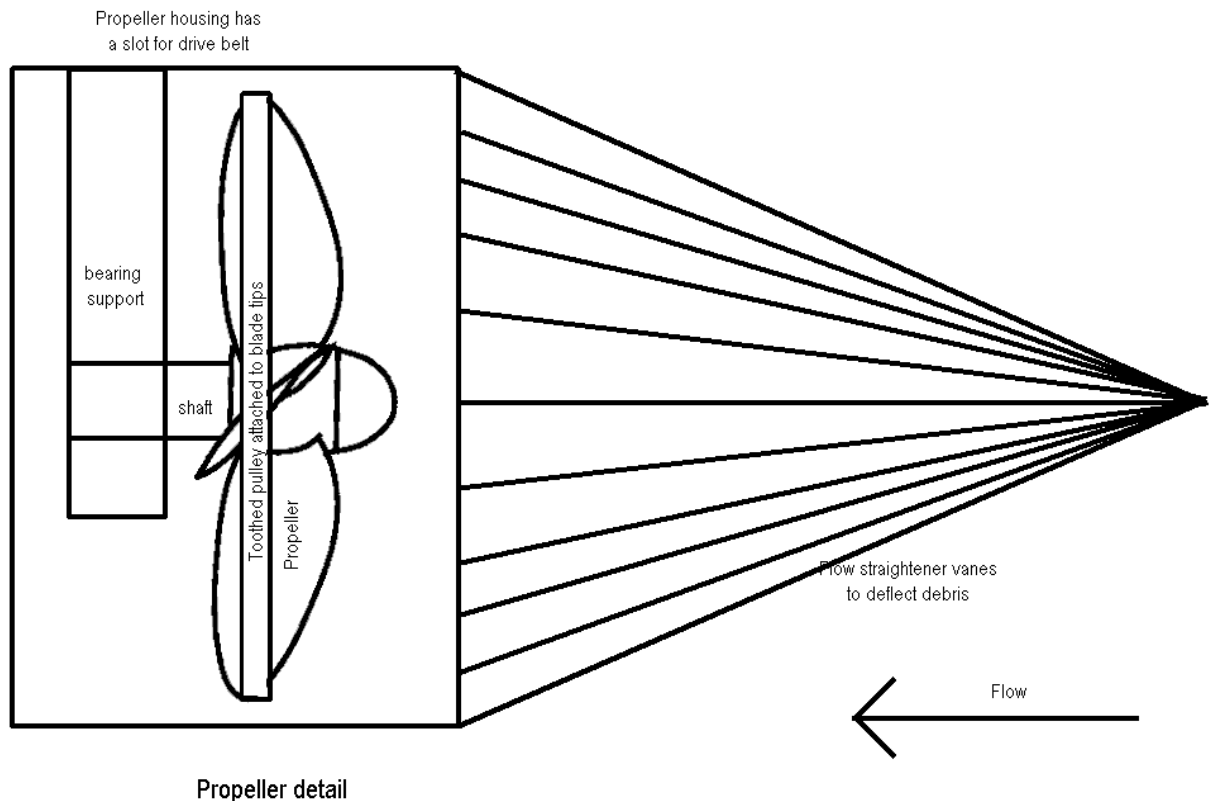
An even smaller system is possible for situations where the flow channel is very narrow and shallow but rapid. It consists of a propeller similar to those found on small outboard motors that is coupled to an alternator. It is suitable for fast-flowing watercourses of 15 cm depth or more. The propeller is enclosed in a short length of plastic or metal tube fitted with flow-straightener vanes on the upstream side. These flow-straightener vanes are conical on the upstream side to deflect any water-borne debris that may harm the propeller blades. The downstream edges of the vanes may carry a bearing to support the upstream bearing of the propeller. The vanes may be curved in the direction of rotation on the downstream edges to increase the efficiency of the propeller.



A large diameter pulley is attached to the propeller blade tips. The pulley is submerged in the water, but it is better if the alternator is out of the water; also the alternator needs a higher speed than the propeller is rotating and the alternator pulley can easily give an 8:1 or more rotational speed increase. For the obvious reason of slippage on a wet pulley, toothed pulleys and drive belt may be preferable to smooth.

The diagram shows a pile with a swinging arm attached to the top with a pivot. There are two of these with the swinging arms attached to each end of the float, and a tensioning cable positioned diagonally to maintain the geometry. The float is a long plastic cylinder sealed at each end; a length of 110 mm or 160mm plastic drain pipe could be used with end-caps to keep the water out. A 3m length will displace 60kg, which should be enough to support the propeller, alternator and swinging arms. Because the swinging arms are supported at the other end, only half of their weight needs to be supported. Similarly, by positioning the alternator closer to the pivot, a greater part of its weight would be supported.

Some detail of the proposed propeller housing is shown below. Its attachment to the float should allow clearance for the drive belt, and should allow some adjustment for drive belt alignment with the alternator drive pulley. The housing should allow the propeller to rotate freely even when the housing is resting on the bottom of the watercourse.



The amount of power generated by such a system will depend on the details of the steepness, depth and velocity of the watercourse, and of course, the size of the propeller. The smallest easily available propellers are those found on the smallest electric outboard motors, at about 80-90 mm diameter. This could generate 40 to 150W depending on flow rate. A 150mm diameter propeller could generate 200 to 400 W. This will not enable you to live off-grid, but could reduce electricity bills to a worth-while degree.