babyHydro

Small hydro from idea to operation

PowerSpout

PICO Hydropower DIY Briefing

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1. Pico Hydropower

A pico hydropower installation makes use of flowing water from a burn to create electricity. To do so the site needs both 'head' (vertical height between the intake and the turbine's outfall) and flow (of water that can be abstracted, used and returned downstream). The Pico size band is usually considered to be in the range 500W to 10kW. The electricity generated can be used just like that produced by a wind turbine or solar panel to off-set consumption at the house or farm, with the excess being exported. And just like wind and solar the electricity is eligible for Feed-in Tariffs.

However, hydro is different from wind and solar in that there are more components to consider, including; turbines, intake, penstock (pipe), and consents. These are not really difficult, but it must all be included at the design stage. We find that where the potential is 10kW or above then installers will be prepared to quote for doing the whole job. Where the power is 10kW or less is it almost certainly going to be a DIY project. But we here at babyHydro are keen to help.

2. Hydropower – the basics

Hydropower is created by applying a flow of water to a turbine. The quantity of power is measured in kilowatts and is a function of flow volume and hydraulic pressure at the turbine. Typically water is abstracted from a watercourse and carried by a pipe (penstock) down the side of the hill to the turbine. The turbine runner is turned by the water pressure and thus drives a generator to create electricity.

The power generated is a function of the head (height of column of water – thus pressure) and the rate of flow (cubic metres per second). The equation is:

$$\text{Power (kW)} = \text{Head (metres)} \times \text{Flow } (m^3/s) \times 5$$

Notes:

1) *Flow is the design flow – that is when the turbine is operating at full capacity*
2) *$1m^3/s$ is 1,000 litres/second*
3) *'5' is an approximation for the rate of acceleration due to gravity ($9.81m/s^2$) less system losses*

For different measures of head and rate of flow the most suitable class of turbine changes: there are three main classes – Pelton, Turgo and Propeller (Low-Head).

3. PowerSpout Pico Turbines

PowerSpout turbines are manufactured in New Zealand by EcoInnovation and installed all over the world. The PowerSpout website - www.powerspout.com – provides lots of information, including the countries in which they are sold.

They are manufactured in plastic and come in standard sizes – each producing a maximum design output of 1.6kW – when there is sufficient head and flow. If there is an abundance of water and load to be supplied, then multiple turbines can be installed (up to a maximum of 5) to increase the output power.

Turbine examples in situ:

	Pelton	Turgo	Propeller
Head Range:	**10 – 150 metres**	**5 – 40m**	**2 – 5m**
Flow Range:	**0.5 – 8 litres/second**	**6 – 15l/s**	**30 – 55l/s**

The PowerSpout website provides a Model Selection Chart that helps identify the best fit of turbine type. with available head and flow. The website also holds detailed Installation Guides of some 129 pages.

4. babyHydro

babyHydro has been appointed as the main dealer in Scotland for the PowerSpout range of turbines. Our main business is consultancy on the development of hydropower schemes and Project Management of construction. However, we are now importing PowerSpout turbines and assisting farmers and landowners in creating their own domestic scale hydropower installations as DIY projects. In addition to supplying the PowerSpout turbines the range of support services we provide include:

a) Scoping and outline design
b) Determination of optimum design flow – depending on client motivations (off-setting or energy maximisation for export)
c) Turbine selection
d) Intake structure design and supply
e) Specification of penstock and supply
f) Inverter selection and supply
g) Consenting – Abstraction Licence from SEPA and Planning Permission – guidance or full-compliance

5. Budget Costs and Potential Income

Budget Costs: In hydropower the costs are very much specific to individual sites. However, by way of providing an illustration of the likely expenditure you would need to allow for, we would recommend setting a budget along the lines of:

ITEM	BUDGET GUIDE COST
Individual Pelton, Turgo or Propeller turbine, with integral generator	£1,700
Intake (medium sized with integral wash-over screen (as supplied by babyHydro)	£750
Penstock (price per metre of 6bar (up to 60m head) with 100mm internal diameter is £7/m (100m required))	£700
Butt Fusion – Hire of welder	£500
Inverter (converting the DC generator output to AC)	£750
Consents:	
• SEPA Abstraction Licence and advert	£1,300
• Planning Permission	£500
TOTAL ex VAT	**£6,200**

Allow extra for any weir, powerhouse or other infrastructure you might require to suit your site.

Potential Income: Again, in hydropower the income is very much specific to individual sites. Estimating the flow available in a watercourse and selecting the optimum level of flow to be abstracted, as well as when it is available, are critical to the financial outcome. An illustration is provided below based on many assumptions:

Assumed head – 26 m
Assumed flow – 12 litres/second

Selection: One Pelton Turbine with an output power of 1.5 kW

If it was running at full capacity all of the time, the energy produced in a year would be:

1.5 kW x 8760 (hours in a year) => 13,140 Kilowatt-Hours

But this is unlikely to be possible – let us assume that the design flow (of 3 l/s) is only available for 50% of the year (we ignore partial flow conditions and dry spells).

Therefore the annual output energy is potentially:

13,140 kWh x 50% => 6,570kWh

Income from Feed-in Tariff: *(Reward for generation – irrespective of how the energy is then used)*

6,570 kWh x 7.75p (the projected FITS rate for Quarter 2 in 2018) => ***£509pa***

Cost saving from Off-setting: *The ability to off-set household consumption depends on how often the hydro installation is generating (subject to rainfall) while there is demand at the house (subject to usage). This is very difficult to measure. So let's assume that 50% of the energy generated is used at the house. Thus the Electricity Bill saving is:*

6,570 kWh x 50% => 3,285 kWh.

The cost of electricity is usually around 14p per unit (1 unit is 1 kWh). So the saving is

3,285 kWh x 14p => ***£460pa***

Exported Electricity: *The energy generated, but not consumed at the house is exported. However, for small generation at this level Ofgem do not expect the quantity to be measured. They have simply made an assumption and 'deemed' that where off-setting is being employed then 25% of the energy produced (which is measured) is used locally. Therefore 75% is 'exported'. Thus the Export Income is:*

6,570 kWh x 75% x 5.03p (FITS Export Rate) => ***£248pa***

Hence, under this illustrative scenario, the total annual 'income' or financial benefit would be:

ITEM	ILLUSTRATION ESTIMATE
Income from Feed-in Tariff:	£509
Cost saving from Off-setting:	£460
Exported Electricity	£248
ANNUAL TOTAL	**£1,217**

6. Getting Started

So, if this looks appealing and you want to make a start then the first four things you need to do are:

1. Identify a practical intake location
2. Identify a safe turbine location
3. Measure the head (the vertical distance between the intake and the turbine) in metres
4. Estimate the potential flow that will be available for the turbine – in litres/second. (Give us a call and we will describe the best way to do this)

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