PowerSpout

PICO Hydropower DIY Design Guide

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1. **Introduction**

This Design Guide is intended to provide an owner of a watercourse with an overview how to go about creating a hydropower installation. The principles of hydropower and a budget estimate of likely costs and potential income are provided in our PICO Hydropower DIY Briefing. EcolInnovation, the manufacturer of the PowerSpout turbines has produced an Installation Manual for the Pelton and Turgo turbines (129 pages) and a version for Low Head turbines (58 pages). They are very detailed but should be read before final decisions on design and preparation are made; links are provided at the end of this document.

2. **PowerSpout Pico Turbines**

PowerSpout turbines are manufactured in New Zealand by EcolInnovation and installed all over the world. The PowerSpout website - [www.powerspout.com](http://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.

There are three types of turbines each designed to work best with different combinations of head (vertical distance of column of water) and flow rate of water available:

<table>
<thead>
<tr>
<th>Class of Turbine</th>
<th>Range of Head (metres)</th>
<th>Range of Flow (litres/second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelton</td>
<td>10 – 150</td>
<td>0.5 – 8</td>
</tr>
<tr>
<td>Turgo</td>
<td>5 – 40</td>
<td>6 – 15</td>
</tr>
<tr>
<td>Propeller</td>
<td>2 – 5</td>
<td>30 – 55</td>
</tr>
</tbody>
</table>

*Table 1:*

The PowerSpout range of turbines has been in production for over 10 years and proven to be very reliable and long lasting. The parts are simple and easily swapped out for service/repair; unnecessary complications have been stripped out at the design stage.
Examples of turbines in situ:

**Pelton**

**Turgo**

**Propeller**

*Figure 1:*

Corresponding illustrations:

*Figure 2:*

The PowerSpout Installation Guide provides a Model Selection Chart (page 27) which helps identify the best fit of turbine type with the available head and flow.
3. **PowerSpout Installations**

A working hydropower scheme requires some components in addition to the turbine. These include:

- Intake
- Penstock (pipe)
- Powerhouse (shed)
- Tailrace
- Inverter
- Grid Connection or Batteries

Note: All of these apply to Pelton and Turgo turbines – propeller (LowHead) turbines are configured differently in regard to the flow of water.

### 3.1 Intake

The purpose of the intake is to abstract water from the burn, while letting a prescribed quantity pass for ecological reasons. The amount to be abstracted (Design Flow) and the minimum amount to be left in the burn at all times (Hands-off Flow), are defined by the Scottish Environmental Protection Agency (SEPA). The methodology for specifying these volumes is provided below.

The intake usually takes the form of a low weir in the burn which incorporates a chamber for capturing the water. These are normally designed with an inbuilt ‘wash-over’ screen which ensured that river debris (such as leaves, branches and small stones) continue their journey down the watercourse and are not ingested into the penstock, ultimately damaging the turbine. An example of an intake chamber is shown below:

![Figure 3: Illustration](image)

In larger hydropower installations the weir is usually constructed in concrete for robustness and longevity. But for smaller schemes such as pico-scale Pelton or Turgo then the use of large boulders and rubberised sheeting is usually sufficient. Due to the much lower volumes of water in the burn any damage due to winter storms for example can usually be easily and safely repaired.

![Figure 4: Example, embedded in stone weir](image)
3.2 **Penstock**

The penstock (pipe) carries the water from the intake chamber down the hill to the turbine. The internal diameter has to be chosen so as to convey the design flow without excessive losses due to friction, and the material selected to cope with the pressure. Each 10 metres of head will create 1 bar of pressure. Hence for the top 10 m the pipe can be PVC or light plastic but beyond that HDPE of an appropriate grade is recommended.

3.3 **Powerhouse**

The powerhouse (shed) is required to provide the turbine and generator with some protection from weather (in particular freezing conditions) and to contain some of the noise produce by the flow of water under high pressure. A basic timber shed is usually sufficient. This will also provide protection from inquisitive children; or adults.

The powerhouse, and enclosed turbine, should be placed as low as possible to maximise the head, but at a sufficient distance from the watercourse, and height above it, so as not to be at risk from flooding in times of spate.

3.4 **Tailrace**

When the water drops from the bottom of the turbine it is good practice to capture it in a sump and then channel it back into the watercourse without causing erosion and mobilising silt, which might adversely impact on fish downstream.

3.5 **Inverter**

The electricity produced by the integral generator is Direct Current (DC). If the installation is being used to charge batteries, that is, in an ‘off-grid’ system, then it can be fed directly via a charge controller. Where the electricity is going to be used to ‘off-set’ local consumption at the house or farm, or to be ‘exported’ via the Grid, then it needs to be converted to Alternating Current (AC) by means of an inverter – as is the case in solar panels.

3.6 **Construction**

The civils works required are straightforward but do require some early consideration:

i. Safe access to the site of the weir and availability of materials locally.

ii. The route of the penstock; it is recommended that it is buried along its full length but this might not be possible if there is exposed bedrock or dense tree roots.

iii. Uncoiling the penstock – if it is delivered as a continuous length on a drum it is likely to be under tension and can uncoil itself when released with significant and dangerous force.

iv. The connection of the inverter to the local electrical supply to the premises should be undertaken by a qualified electrician (preferably with experience of renewables).
4. **Consents – SEPA Abstraction Licence and Planning Permission**

**SEPA:** All hydropower schemes abstracting more than 0.5 litres/second require an abstraction licence from SEPA – which is in effect all of them. (Usually referred to as a CAR Licence – full title is Controlled Activity Regulation (Scotland)). Obtaining a licence is fairly straightforward, and usually granted, but it does involve quite a bit of detail, including:

a) Completion of CAR Application Forms A and D  
b) Providing design, ecological and environmental detail in ‘Supporting Information’  
c) Payment of a one-time fee of £1,224 (Simple Licence for all schemes under 100kW)

The application process normally takes about 4 months

**Local Authority:** All hydropower schemes (except those fully within the curtilage of a ‘garden’) require Planning Permission. Again, obtaining permission is quite straightforward and very seldom blocked. Required:

a) Completion of the application form - online  
b) Providing the same ‘Supporting Information’ as above  
c) Payment of a one-time fee around £500 – subject to size of the footprint of the installation.

5. **Practical DIY Activity**

If you are installing your own pico-hydropower scheme, you should determine the following details before the physical fun can start.

5.1 **Layout Design**

The first task is to decide on the best locations for the intake and for the turbine. These need to be reasonable flat to enable safe construction work but to have as big a difference in elevation as possible to maximise the available head. There must also be a practical route for the penstock between them and ideally all of it on land you own – otherwise you will need an agreement with the other landowner. Since you are going to be deriving income, they are likely to want a portion of it.

Locating the optimum positions for the intake and turbine can be difficult as several other factors need to be considered, including maximising the head, minimising the length of penstock (due to cost, steep gradients are preferable) and minimising the distance to the point of electrical connection.
5.2 Measurement of Head

Head is the vertical distance between the intake and turbine. There are several ways to measure it. First of all, you need to know where to put the intake. If you know how to do this, read on. If you need some advice, refer to Appendix 1 at the end of this document.

- **Google Earth** has a reasonable approximation, which is particularly suited to measuring high head differences. It doesn’t deal so well with areas that are relatively flat, or with unusual features such as gorges. Hence, much like their search engine, don’t take what Google says as absolute fact.
- The appropriate OS map, on paper or from Streetmap.co.uk, will show you contour lines, from which you can calculate a head difference. Again, this is an approximation and subject to errors.
- Altimeters are relatively inexpensive. The problem is that they will confuse changes in barometric pressure for changes in height. You can partially get round this by taking measurements in a steady high pressure period, also by taking repeated up/downhill measurements and averaging them out. If it is on a hill you walk up and down regularly anyway, this might not be so bad, but you need to take quite a few measurements to be sure of the results. They are inaccurate over low-head measurements, and hence not suitable.
- Sighted Measurement Using either a homemade ‘Level-Header’ or a Johnston Builders Level to estimate the head as described below:

  ➢ Construct the device using a spirit level combined with a vanity mirror attached at a 45° angle to the level. It will look a bit like this - the mirror needs to be adjusted to the correct angle so as to be able to see the spirit bubble at the same time as being able to look along the top edge of the level
  ➢ Have someone measure the height to your eyes when in a fairly relaxed pose (i.e. not bolt upright – it’s not a tallness competition!)
  ➢ Starting from where the powerhouse might be located, make a series of measurements by:
    - Looking upstream with the spirit level at your eye level
    - using the mirror to see that the bubble is central (and therefore that you are looking perfectly horizontal) you make note of the landmark upstream (e.g. a stone) which matches the line of the spirit level
    - climb to the spot you just noted and do the same again, counting how many times this happens, until you get to the intake
    - multiply the number of times this happens by your height-to-eyes, allow for part heights, and you have the answer – it is fairly accurate over smallish heads
  ➢ Buy a Johnson Level
5.3 Understanding Flow Measurement

This section explains how ‘flow’ is described by hydrologists and hydropower engineers.

The flow of water in a burn or river varies continuously as rainfall changes and water drains from a catchment area. SEPA record flows on major rivers, and some burns, across Scotland at their Flow Gauging Stations (FGS). This information is available publicly for free at – [http://nrfa.ceh.ac.uk/data/search](http://nrfa.ceh.ac.uk/data/search) By way of an example we will look at the FGS Falloch at Glen Falloch.

- Dumpy Level: A dumpy level is a more accurate level, mounted on a tripod. Normally, you would work downhill, setting the dumpy up at the top. A friend would hold a surveying staff, some distance downhill, so you can measure how far his/her feet are below the dumpy lens. You then set the dumpy where he was standing, and work your way downhill. It’s more accurate than a level-header. The units are relatively inexpensive (around £200).
- Topographical Survey: By far the most accurate but overkill and too expensive for a pico installation – unless you have a friend in the trade.
Figure 7:

The black line shows the actual flow through 2014 measured in cubic metres per second. The blue and pink borders show the highest and lowest flow recorded over the life of the FGS – measured over 60 years.

This presentation of data is of limited use to hydrologists. Much more useful is a version by the name of a Flow Duration Curve, shown below.

Figure 8:

The black line is the one of interest to us. It shows the volume of flow against the ‘percentage of time exceeded’ – thus, for example, we can see that for 30% of the year the flow was 5 cubic metres per second or more. Notice that the y-axis scale is logarithmic and the x-axis scale is
non-linear (expanded at each end). This is due to hydrologists at SEPA and elsewhere being particularly interested in the volumes at low flows and times of spate.

The key values of interest to us are:

i) \(Q_{\text{mean}}\) - the annual mean flow which is usually around \(Q_{30}\) (5 m\(^3\)/s in this example)

ii) \(Q_{90}\) - which is the figure usually required by SEPA for the Hands-off Flow (0.4 m\(^3\)/s in this example)

iii) \(Q_{80}\) - which is the figure usually required by SEPA for the variable Compensation Flow (0.7 m\(^3\)/s in this example). The requirement is that the total flow in the river within the depleted reach increases with the volume coming down the watercourse. This is usually expressed as the \(Q_{80}\) volume being guaranteed to remain in the burn when the flow is at \(Q_{30}\). The volume scales up gradually as the flow grows from the Hands-off volume.

Notes:

- Flow rates are measured in cubic metres per second – m\(^3\)/s
- One cubic metre is 1,000 litres
- In pico hydropower our flows are so small we state them in litres per second (l/s)

For schemes of up to 100kW, under normal circumstances, SEPA will permit up to 1.3 times the \(Q_{\text{mean}}\) to be abstracted. This would then be the ‘design flow’ or \(Q_{\text{design}}\).

However, in the design of a pico installation our priority is not to maximise the level of power, rather it to strike the right balance of power level and the time for which it is available, and thus able to off-set consumption.

In the illustration below \(Q_{\text{mean}}\) is 70 l/s. Therefore SEPA would permit us to abstract a \(Q_{\text{design}}\) of 100 l/s. But this rate of flow would only be available for 20% of the year. For the rest of the time the turbine would be working at less than full power and thus running inefficiently. (In larger hydro schemes the flow below \(Q_{\text{design}}\) is managed to keep the efficiency as high as possible – but these control systems are expensive and rarely appropriate for pico hydro).

So we would select a \(Q_{\text{design}}\) of 30 l/s which would result in the turbine operating at full output for about 65% of the year.

However, SEPA would require us to leave a Hands-off flow of \(Q_{90}\) in the river (10 l/s) thus we would have in fact 20 l/s available to deliver to the turbine. The resulting horizontal green band on the chart, between 10 l/s and 30 l/s, represents the flow that is available for generation.
Design Illustration:

**Flow (l/s) vs percentage exceedance**

**Explanation:**

a) The black line shows the nominal flow in the burn

b) The Hands-off Flow is deemed to be Q₉₀ – therefore 10l/s – resulting in the blue dashed line being available for abstraction

c) However, SEPA also require a variable Compensation Flow to be added to this. The quantity is usually set at being the volume at Q₈₀ (20l/s in this example), but is applied at Q₃₀, and added gradually as the volume increases – resulting in the red line being the actual quantity available for abstraction

d) The resulting available volume at Q₉₀ (usually around Q₃₀) is 50l/s

e) SEPA would normally permit an upper limit of abstraction of 1.3 times Q₉₀, which means the design flow could be as much as 65l/s. However, this quantity would only be available for 20% of the year (that is, Q₂₀).

f) If we reduce the design flow to 15l/s then it would be available for around 65% of the year. This would result in the turbine running at optimum efficiency for a significant portion of the year – thus maximising the quantity of energy produced and available for off-setting.
Notes:

- This approach is used to set the principles. The actual design flow would be chosen to ensure the combination of available head and the flow resulted in a turbine producing its maximum output power, and to achieve optimum off-setting of electricity consumption.
- This approach also removes some of the uncertainty that will exist around the actual flows available from the watercourse.
- Any environmental impact will be less pronounced due to less water being abstracted; this means the burden of proof is lower when it comes to demonstrating to the local planning authority and to SEPA that no major impacts will result from the installation.
5.4 Determination of Flow

In order to set the Design Flow for a particular pico hydropower installation $Q_{\text{mean}}$ and an approximation of the Flow Duration Curve (FDC) are required for the point of intended abstraction. In the construction of larger schemes a Flow Measurement Station is established close to the point of abstraction and flow rates monitored for 12 months. This is expensive and delays the development of schemes by a year – but it does provide good quality data. This is not required for a pico installation. There are four ways in which a fair approximation can be obtained, in increasing order of accuracy and decreasing order of complexity:

i) Carry out frequent measurements of the velocity of the water in the burn and correlate against the cross-sectional profile of the watercourse to obtain ‘spot’ flow rates. These are then time correlated against a nearby SEPA FGS. Time consuming, inaccurate and complex.

ii) Measure the rainfall catchment area of the proposed scheme: See example map below:

From the chart across select the value of $Q_{\text{mean}}$ per square kilometre for your location and multiply the area from the map by the volume.

For example, if your installation was located in red Zone 3 then the $Q_{\text{mean}} / \text{sqkm}$ would be $0.04 – 0.06$ cubic metres/second so assume at a rough figure of $50/\text{s/km}^2$. Therefore a catchment of 2 km$^2$ in this zone could yield a $Q_{\text{mean}}$ of around 100 l/s.
iii) From a map measure the catchment area of the proposed scheme. $Q_{\text{mean}}$ and $Q_{90}$ can be determined by cross comparing with a nearby FGS and using the relative proportionality of the catchments to generate the local $Q_{\text{mean}}$.

iv) Purchase a LowFlows 2000 report from Wallingford Hydro Solutions. It is likely that SEPA will require this data to presented to them in any application for a CAR Licence.

5.5 Intake

A small weir will have to be constructed to raise the level of the water - to get the abstracted flow into the chamber and thus into the penstock.

Safety first – the sites you choose have to be safely accessible for both construction (which may involve lifting heavy goods up/downhill) and occasional inspection visits. For all works that involve being in or near water, plan ahead by checking that good weather is forecast for long enough to do what you want to achieve. Aim to work after a period of dry weather. Do not approach, or attempt to enter, rivers/burns when they are in spate. Avoid working alone; tell people where you are and when you are expected to return.

- Gorges and reaches of very fast flow should be avoided. Good safe access for construction and maintenance is paramount.
- Simple and secure exit route for the penstock away from the intake and on to open ground
- Very flat areas should also be avoided as the weir would have to be wide or have very large wing-walls.
- Construction methods may be using local boulders coupled with rubberised sheeting (such as pond liner). It will of course suffer from some leakage but this may be a tolerable compromise compared to the difficulty and expense of creating a concrete weir.
- The intake to the penstock requires a ‘trash screen’ or grill to stop debris such as stones, twigs of leaves going down the penstock and blocking the nozzles or damaging the runner (or propeller in the case of low head turbines). We strongly recommend the use of a wash-over screen.
- Try to create a balance between maximising the head and minimising the amount of pipe you need – i.e. steep gradients are preferable
- Ref PowerSpout Installation and Design Manual pp27,34
5.6 Powerhouse (shed)
A small powerhouse needs to be erected to protect the turbine/generator

**Safety first** – electrical commissioning must be carried out by a suitably competent electrician.

- Maximise the head by having the turbine as low as possible
- While taking account of the above, ensure that the generators are located above areas where flooding may occur – an obvious flood plain would be a poor choice
- The generators do make some noise; we recommend keeping the units at least 30 metres from your home (or anyone else’s)
- All units are fully weatherproofed but it’s worth considering having them in an enclosure of some sort, especially if children/animals/neighbours etc may be present to take an interest in the goings-on. It could be a shed, GRP kiosk etc. This will also afford some protection from extreme cold and freezing conditions.
- While observing the 30m rule above, aim to minimise the distance from the generator units to your point of connection

5.7 Penstock route
Ideally penstock should be buried to hold it in place (due to the potentially high pressure it will be under) and to keep it protected from frost and UV light. It can be placed on the surface if there is extensive bedrock or tree roots to be avoided but aesthetically it is likely to be more pleasing if it is out of sight.

**Safety first** – coiled pipe in rolls is heavy (can topple and cause crushing injuries) and has ‘memory’, and so tends to spring open upon release and can cause serious injury. Familiarise yourself, and any others working with you, of the characteristics of the material you are working with, before attempting to manoeuvre, release, cut or lay coiled pipe.

- Plot out a route that is as straight as possible
- Try to select a route that has the penstock always sloping down the hill (that is, no high spots)
- If you cannot avoid this, it is relatively easy to ‘saddle’ air vents onto the pipeline – but do so before you bury it
- If air valves are required, you are going to need scour valves also, at the low points in the scheme where silt etc may accumulate over time

Ideally penstock should be buried to hold it in place (due to the potentially high pressure it will be under) and to keep it protected from frost and UV light. It can be placed on the surface if there is extensive bedrock or tree roots to be avoided but aesthetically it is likely to be more pleasing if it is out of sight.

5.8 Penstock specification and sourcing
The penstock needs to be adequately pressure rated and CE marking is highly recommended to ensure integrity of the material.

   a. Length and diameter
   b. Specification of penstock – expressed as SDR rating which is a measure of the internal diameter and wall thickness. This equates to the pressure the pipe will be able to withstand.
   c. There are several providers; builders merchants and online – for example www.pipestock.com

5.9 Turbine Selection

Now the head is known and a target value for $Q_{\text{design}}$ determined the turbine model selection chart (adjacent) can be used to identify the optimum type of turbine and the number of them appropriate to the site. Full details of how to use the chart are provided on page 27 of the Installation Manual.

To validate the guidance provided by the chart we strongly recommend experimenting with the PowerSpout advanced calculator to establish the technical specifics of the different turbine and installation configurations. The input information required is:

- Head (m)
- Design Flow (l/s)
- Penstock length (m)
- Electrical cable run (m)
- Optimum penstock (pipe) size (NB this is expressed as internal diameter – you then need to convert it to external diameter, which is how HDPE/MDPE is sold.

The output information is:

- Expected power output at the generator and at the point of consumption/connection

At time of installation the turbines will require some tailoring and adjustment to match the site specific conditions, such as head and flow. For example the nozzles of the Pelton and Turgo turbines need to be trimmed to deliver the optimum flow. We recommend that you familiarise yourself with the detail in the Installation Manual before proceeding.

5.10 Inverter

[Figure 12:]

- High head = PLT
- Medium head = TRG
- Low head is on separate calculator
A suitable inverter is required to convert the Direct Current output of the generator to mains voltage AC. For off-grid situations a charge controller or islanding inverter is required.

5.11 Energy and Income Forecasting

Energy is measured in Kilowatt-Hours (kWh). One Kilowatt-Hour is equal to one unit of charge – around 11p. If a 1kW turbine was running at full power for a year it would generate 8,760kWh of energy – since there are 8,760 hours in a year. However, there will be dry spells and thus periods when there will be no water in the burn, and times when there is reduced water and the turbine is running at less than design output. This is why setting Q\text{design} is so important.

The variables and impacting judgements are explained in the example below:

**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:

$$1.5 \text{ kW} \times 8760 \text{ (hours in a year)} \Rightarrow 13,140 \text{ Kilowatt-Hours}$$

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:

$$13,140 \text{ kWh} \times 50\% \Rightarrow 6,570 \text{ kWh}$$

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

$$6,570 \text{ kWh} \times 7.75p \text{ (the projected FITS rate for Quarter 2 in 2018)} \Rightarrow £509pa$$

**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:

$$6,570 \text{ kWh} \times 50\% \Rightarrow 3,285 \text{ kWh}$$

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. And thus 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:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ILLUSTRATION ESTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income from Feed-in Tariff:</td>
<td>£509</td>
</tr>
<tr>
<td>Cost saving from Off-setting:</td>
<td>£460</td>
</tr>
<tr>
<td>Exported Electricity</td>
<td>£248</td>
</tr>
<tr>
<td><strong>ANNUAL TOTAL</strong></td>
<td><strong>£1,217</strong></td>
</tr>
</tbody>
</table>

Table 2:

5.12 Income Tax and VAT

Householders are exempted from income tax on Feed-in Tariff income, provided the amount of electricity generated is not significantly more than your own domestic use. It is important to take proper advice on this from an accountant.

Where an installation is created by a single VAT registered installation firm VAT is charged at 5% on all of the equipment directly associated with a domestic installation\(^1\). This includes all fittings, pipe, intake etc. Ancillary components are not included; for example, if you wanted to build a fence around part of the installation. The 5% rate does not apply to DIY installations.

\(^1\) [https://www.gov.uk/tax-on-shopping/energy-saving-products](https://www.gov.uk/tax-on-shopping/energy-saving-products)
5.13 **Consenting – SEPA Abstraction Licence and Planning Permission**

Two formal consents are required for the construction and operation of a hydropower installation:

i. CAR Licence from SEPA

ii. Local Authority Planning Permission (or National Park)

These require the relevant application forms to be completed and additional information provided in the form of ‘Supporting Information’. Links to the forms are provided at the end of this document.

SEPA and Local Authorities are well versed in dealing with applications for hydropower schemes and are fairly supportive. However, we would recommend making early contact with them to inform them of your intent and to establish if they have any particular requirements for information to be included or indeed omitted due to the small scale.

The best point of initial contact with SEPA is through their dedicated e-mail address – hydro.enquiries@sepa.org.uk. You will then be given the name of a local SEPA Environmental Officer who will act as your single point of contact and provide guidance, including advising on the application fee required.

For Local Authorities you will need to contact your local Planning Department. Applications can be made online through e-Planning – https://eplanning.scotland.gov.uk The fee for making a planning application will be classed as ‘all other developments’ and will therefore be charged at the rate of £401 per 0.1 hectare (1000m²) of the scheme footprint. This is classed as the area contained within the ‘development extent’. This includes the intake, a sensible working corridor along the penstock route, the powerhouse shed and the cable-run to the point of connection to the property.

There is a great deal of information in the water/hydropower section of the SEPA website – www.sepa.org.uk/regulations/water/hydropower

Two SEPA forms are required to be completed; Form A and Form D and most of the latter is left blank since it covers all of classes of abstraction. These are available on their website.

Additional material is required and this is usually provided in the ‘supporting information’. The full details are at – www.sepa.org.uk/media/34306/guidance-for-applicants-on-supporting-information-requirements-for-hydropower-applications.pdf Do not be put off; this is for any and all hydropower schemes of any size.

For installations of up to 10kW it should be possible to provide only:

i. Location map

ii. Layout diagram – showing the main features. You can buy a map at low cost from the e-Planning website and annotate with red and blue lines showing development extent and ownership boundaries respectively.

iii. LowFlows Report – providing evidence of the probable flow in the burn

iv. Design Flow – the flow rate you want to abstract stated in cubic metres/second. Reiterate that this will be a figure below $Q_{\text{mean}}$, and state the appropriate $Q_{\text{figure}}$.

v. Hands-Off Flow – the flow rate you will be leaving in the burn stated in cubic metres/second – this will be $Q_{90}$
vi. A set of photos of the intake zone and point of return, with an item included to illustrate the scale such as a metre stick. Include photos of the burn at both locations when water level is high, medium and low. This will assist SEPA to characterise the burn.

vii. Provide a ‘Construction Method Statement’ describing how you will go about carrying out the engineering works, particularly in regard of working in the watercourse. State that construction will be according to all best practice as per SG-29 and the *Hydropower construction good practice guide*, then make sure that you implement these in your eventual construction works.

viii. A statement on the main ecological factors:
   a. Presence of bats? Avoid the need for bat surveys by declaring that you will not be cutting down any trees nor removing large branches.
   b. Presence of otters? Make a personal statement along the lines of: ‘The proposed hydro scheme lies within the curtilage of my garden/farms and I walk my dog up this reach of the burn every day and have never seen an otter’.
   c. Go to the [SNH SiteLink](http://gateway.snh.gov.uk/sitelink) and establish that you are not in any designated area - http://gateway.snh.gov.uk/sitelink. If your site is in, for example, an SSSI, this does not prohibit development, it just means the statutory bodies will look at it more closely to consider any implications.
   d. Any other European Registered Endangered Species? Go to the [National Biodiversity Network Gateway](http://nationalbiodiversitynetwork.org.uk) website to establish what, if any, sightings of endangered species have been reported in your area.
   e. Use your local knowledge of the burn to make observations in support of your application, for example if it is very steep, this indicates poor fish habitat. A statement on the presence of fish (or rather, absence of them) would be helpful. ‘The burn is very shallow and steep (see photos) and there are no fish present’. If possible get similar comment from the Local Fishery Trust.

### 5.14 Low-Head Installations – Differences

High head (Pelton turbines) and medium head (Turgo turbines) follow the process above. Low head installations have many features in common – but some differences:

- **Intake:** It is not essential for the intake to include a wash-over screen. The turbines can cope much better with a little water bourn debris, plus the use of the wash-over reduces the available head. A simple trash rack should be considered – to stop larger branches etc.
- **Penstock:** There is no penstock. The water for the installation is carried by means of an open lade (or inside a large pipe) at a gentle gradient to deliver the flow to the header tank.
- **Header Tank:** The header tank receives the flow and allows it to stabilise – turbulence disperse and air bubble rise. The turbine(s) is mounted in the header tank.
- **Draft Tube:** A draft tube with a maximum length of 5m carried the water down from the turbine to a ‘sump’ in the watercourse.
- **See the PowerSpout LOWHEAD specific documents:**
  - PowerSpout Advanced Calculator (LOWHEAD) - [www.powerspout.com/ih-advanced-calculator](http://www.powerspout.com/ih-advanced-calculator)
6. Summary of links to further information

PowerSpout website - www.powerspout.com


PowerSpout Advanced Calculator (PLT & TRG) - www.powerspout.com/advanced-calculator

PowerSpout Advanced Calculator (Lowhead) - www.powerspout.com/lh-advanced-calculator


Flow Gauging Stations (FGS) Data – http://nrfa.ceh.ac.uk/data/search

Wallingford Hydro Solutions - www.hydrosolutions.co.uk

Penstock – example source - www.pipestock.com

SEPA Hydropower Information - www.sepa.org.uk/regulations/water/hydropower

SEPA – CAR Application - Supporting Information - www.sepa.org.uk/media/34306/guidance-for-applicants-on-supporting-information-requirements-for-hydropower-applications.pdf


Sample Local Authority Planning Application Guidance – http://www.pkc.gov.uk/article/3728/Making-a-planning-application

SNH SiteLink - http://gateway.snh.gov.uk/sitelink/

National Biodiversity Network Gateway website - https://data.nbn.org.uk/

- End -