# PEAK POWER:

## THE QUICK GUIDE TO MICRO HYDRO

Friends of the Peak District

This report was written by Friends of the Peak District and is based on *Peak Power: developing micro hydro power in the Peak District*, the full technical report of the Peak Power project. The full report is available as a downloadable PDF from www.friendsofthepeak.org.uk

The Peak Power project was supported by grants from the Peak District Sustainable Development Fund, the East Midlands Community Renewables Initiative and the Chesterfield Steels Group.



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**DISCLAIMER**

This report is a short version of a full technical report produced by Friends of the Peak District with contributions from T4 Sustainability Ltd and Richard Pymm of the Devon Association for Renewable Energy, to investigate and promote the potential for renewable energy from micro hydro power installations in the Peak District. Neither report's purpose is to act as an expert feasibility study though we hope that, by focusing on specific sites and case studies, both reports promote the further development of micro hydro power.

The contents of this report represent the views of FPD, based in part on specialist technical input from T4 and DARE. This report is not binding on the Peak District National Park Authority or neighbouring planning authorities in the determination of any subsequent planning application which would be judged on the merits of any scheme coming forward. Any comments in this report relating to the Environment Agency do not prejudge any decision or guidance on licensing.



All landowners or other interested parties should be fully aware that further assessment will be required before the suitability of a site is fully understood. The content of this report does not constitute legal advice.

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*For further details on any of the issues, sites or case studies in this report, you should consult the full Peak Power technical report at* **www.friendsofthepeak.org.uk**

*Ladybower reservoir provides multiple benefits to the National Park: beautiful landscapes, recreation, drinking water and now hydro power (photo: Stephen Elliot)*

# NATIONAL PARKS, RENEWABLE ENERGY AND HYDRO POWER

Our national parks are the jewels in the crown of the British countryside, with laws and policies to protect them. But legal protection cannot stop climate change from altering precious habitats and landscapes, which may in turn reduce the immense social, economic and environment benefits that national parks provide.

We must do all we can to offset the impact of climate change. This means getting much more of our energy supplies from renewable technologies (powered by water, wind and sun) and saving energy.

However, renewable technology must not dominate or ruin the landscapes they are helping to save – so small scale technologies are the most suitable in our national parks. They also fit well because there is a relatively low demand for energy in rural communities without major industry.

Micro hydro power fits the bill perfectly. Many of our national parks - including the Peak District - are in upland areas with plenty of rain where fast flowing streams and rivers run down from the hills. The Doomsday book chronicles half a dozen mills in the Peak and, in the 18th century, the widespread use of water power to mass produce textiles heralded the industrial revolution.

The Peak District has a rich legacy of old mill sites waiting to be re-exploited in a 21st century 'green revolution'. Local water companies have kick-started this by installing turbines at many of their reservoirs – notably in one of the grandest Peak valleys: Longdendale, and more recently at Ladybower in the Upper Derwent.

Several old mill sites have recently been repowered to provide electricity for local homes and business. The challenge now is to learn from these examples and spread hydro power to a range of sites all over the Peak District, including those identified in this report.

*There are a range of old mill sites across the Peak District that are ripe for redeveloping hydro power, including Bamford Mill (left) and Edensor Mill weir at Chatsworth (right), both on the River Derwent (photos: Rod Egglestone)*

# ABOUT THE PEAK POWER PROJECT

Friends of the Peak District, with technical input from T4 Sustainability Ltd, have been identifying, surveying and assessing over 150 sites across the Peak District for their suitability for redeveloping hydro power. The large majority of the locations looked at have been old mill sites that have fallen into disuse but have the scope for redevelopment.

Recognising the significance of clean, green hydro power to the National Park and the East Midlands region, the project has been generously funded by the Peak District National Park's Sustainable Development Fund, the East Midlands Regional Assembly and one of FPD's corporate sponsors, the Chesterfield Steels Group.

The aims of the project were to:

- identify and assess as many potential micro hydro sites as possible in the Peak District, focusing mainly on old mill sites
- explain how hydro power works, what first steps need to be taken to assess site feasibility and how to seek further help, advice and funding
- promote viable sites to land owners and communities to increase the uptake of micro hydro power in and around the Peak District

We hope the project helps show how the urgent need to address climate change via renewable energy can be met, whilst respecting the special qualities of the Peak District's landscapes.

"The urgent need to address climate change can be met by hydro power, whilst respecting the special qualities of the Peak District's landscapes"

# PLANNING AND RENEWABLES

Government policy stresses the urgent need to address climate change by cutting carbon dioxide emissions. Developing much more renewable energy (RE) and saving energy are both key to achieving cuts. All planning authorities, including the Peak District National Park Authority (PDNPA), have a duty to encourage renewable and low carbon forms of power. In a national park, all development must be consistent with the need to conserve and enhance the special qualities of the PDNP.

Planning works in two ways:

- setting criteria for what is acceptable and unacceptable in certain locations when new developments or changes in land use are proposed
- setting targets for how much of a certain kind of development (e.g. numbers of houses, amount of renewable energy) should take place within certain timescales to meet society's needs. National parks are often exempt from targets, as development is the exception rather than the rule

For renewable energy, the 2008 Climate Change Act commits the UK to cut greenhouse gas emissions by 80% by 2050. European law also means we must ensure that 15% of all energy needs in 2020 is met by renewable sources.

This is equivalent to a 35% share of the total electricity supplied to UK homes and business. Currently only 5.5% of electricity comes from renewable sources. Thus the 2020 target will be very difficult to achieve unless we radically change how we generate and, perhaps more importantly, use energy.

Hydro power, mostly from large scale schemes in Scotland, currently provides about one fifth of UK renewable energy. While the scope for more large scale hydro is thought to be limited, studies show that there is lots of scope to increase the amount of 'micro' hydro power (where power output is less than 100 kilowatts or kW). The amount of electricity generated by micro hydro schemes has already risen five-fold since 1990.

Around 1.6 megawatts (MW, equivalent to 1000 kW) of hydro power has already been installed in the Peak District. For example, Chatsworth House and its awe-inspiring Emperor Fountain are powered by water, using a system dating back over a century but refurbished recently.

In addition, new hydro power schemes have just been completed in New Mills, financed by a groundbreaking community share offer enabling a 70 kW Archimedes screw to be installed (see below and the community case study on page 15), and at Alport Mill near Youlgreave, where an old mill site has been cleverly re-utilised to power Alport village (see the planning case study on page 12).

*An Archimedes screw at the Torrs hydro scheme at New Mills in High Peak provides cheap and plentiful power to local business and homes (photo: MannPower)*

# HOW DOES HYDRO POWER WORK?

Hydro power is one of the oldest forms of energy generation and for centuries – up to the start of the industrial revolution – was a major source of power in rural areas. Nowadays it uses the energy in moving water to turn a generator and thus produce electricity.

Hydro is one of the most efficient and reliable renewable energy technologies and offers the following key features:

- very efficient conversion of water power into electricity
- constant generation over long periods
- a high level of predictability, varying with annual rain patterns
- slow rate of change: the power output varies only gradually from day to day, not from minute to minute
- power fits demand in that output is greatest in winter
- it is a robust technology; systems can last for over 50 years (and many have lasted longer)
- low maintenance requirements and running costs
- reasonable payback (often 10 years or less) for grid connected systems

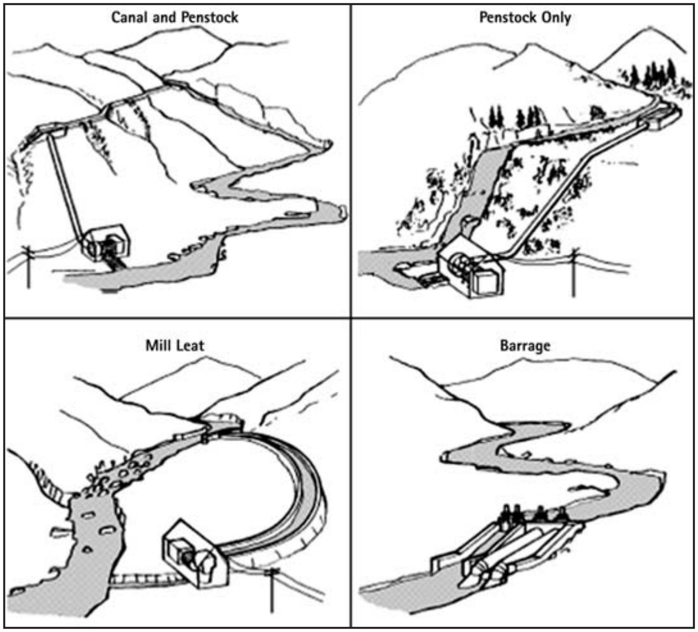
Potential power can be estimated by identifying the height the water drops (known as the head, usually created by a weir) in metres (m) and multiplying it by the flow (usually in cubic metres per second, $m^3/s$) and then times 6 (representing system efficiency at 60%).

As an example, varying the key factors of flow and head shows how the same power can be achieved in very different situations of head and flow:

HIGH HEAD: 6 x 40 metre head x flow of 0.25 $m^3/s$ = **60 kW** *or*

MEDIUM HEAD: 6 x 10 metre head x flow of 1 $m^3/s$ = **60 kW** *or*

LOW HEAD: 6 x 1 metre head x flow of 10 $m^3/s$ = **60 kW**




*Four main types of hydro scheme layouts (image: BHA/O.Paish)*

Although sites available for hydro schemes vary greatly, they can be categorised into four main types (see diagram above):

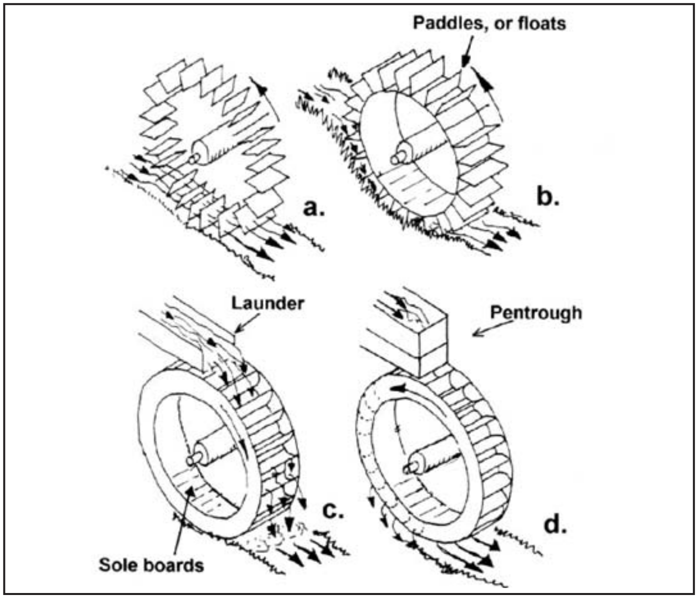
- the canal and penstock (pressure pipe) layout (medium-high head schemes)
- where a canal is not acceptable due to terrain or environmental considerations, then a penstock only can be used (medium-high head)
- where a scheme involves the development of an old mill site then the existing feed channel (often termed a 'leat') can be used (low head schemes)
- finally it is possible to use an existing weir by placing turbines or a screw generator in the weir face or immediately adjacent to the weir or by creating a new impoundment in the form of a barrage to create a head (low head)

# HYDRO TECHNOLOGIES

Humans have been using water to generate power for over 4000 years and during that time three main types of technology have been developed:

- waterwheels
- Archimedes screws
- turbines

For medium and high head sites (where the head is 10m or greater), the only realistic power source for generating electricity is a turbine. In the recent past, these have also been seen as the solution of choice for low head sites (head less than 10m). However, the cost per kW of electricity produced tends to increase as turbine size (capacity) decreases. For this reason, the two oldest technologies, the waterwheel and the Archimedes screw, can be more viable choices.



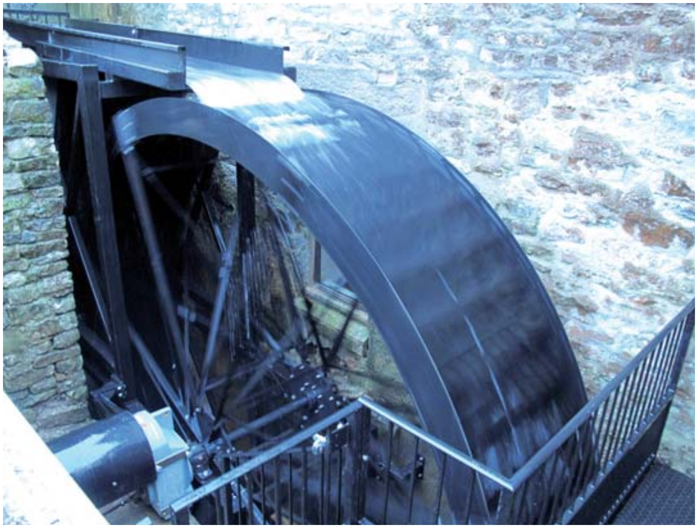

*Main types of waterwheel: a. undershot; b. breastshot; c. overshot; d. backshot (pitchback) (image: Mrs S. Foreman)*

## WATERWHEELS

There are four basic types of waterwheel (see top right) which can use head differences from 0.5-12m. The first only uses the flow of water; the others use water falling from height and therefore produce more power.

One advantage of waterwheels is that they are 'fish friendly', due to their low speed of rotation and large cells. Therefore fish screening measures may not be needed. Also, if fed by a mill pond, there may not be any need for screening, saving capital and operational costs.

A number of wheels have been reinstated in the Peak District, most recently at Calver Corn Mill (see right) which is expected to generate about 4 kW. This traditional wheel, made with modern materials (galvanised steel), was built locally. However, truly modern wheel designs still have to be sourced from outside the UK.



*The new wheel at Calver Corn Mill with the very compact generator on the left*

## ARCHIMEDES SCREWS

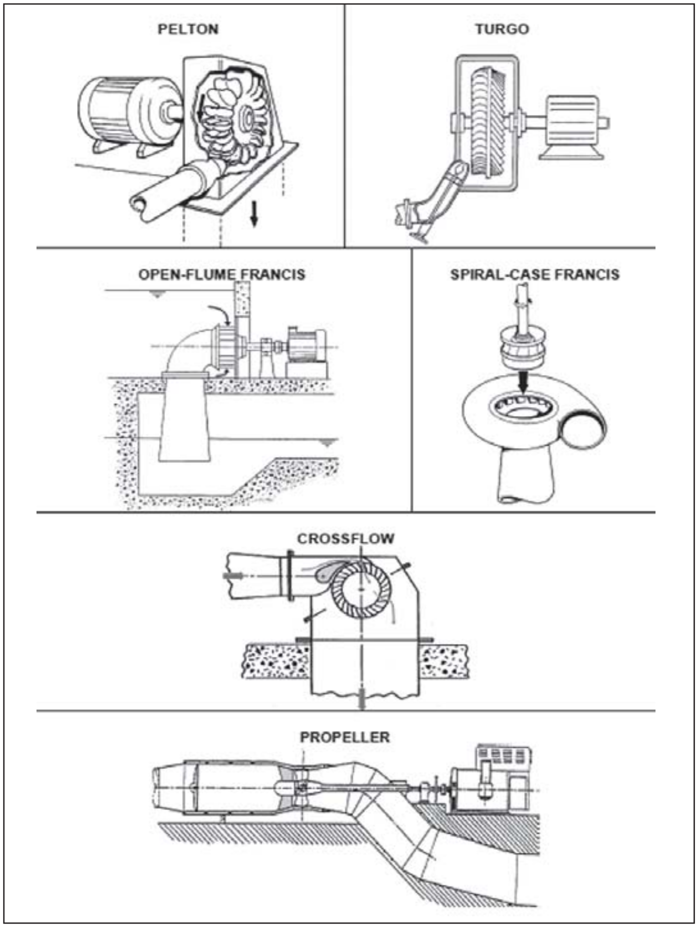
The Archimedes screw has been known since ancient times as a simple and effective machine for lifting water. In the late 20th century it was realised that it could also be used in reverse to produce electricity.

Archimedes screws offer a number of advantages:

- no complex control system as the screw matches the flow automatically
- high efficiency across a wide flow range (20-100% of design flow)
- robust, simple machinery so little maintenance required
- fish friendly so no fish screen required
- floating objects and debris simply pass through the screw removing the need for fine screening

In 2008 a 70 kW Archimedes screw was installed at New Mills in High Peak (see page 3 and the community case study on page 15). The equipment can also be buried to minimise visual impact in sensitive landscapes (see below left).

*A buried 1 kW screw at Bonfield Ghyll, North York Moors National Park (photo: MannPower)*




*The main different types of hydro power turbines (image: BHA)*

## TURBINES

There are two main types of turbine: the impulse turbine and the reaction turbine.

The impulse turbine operates in air. The water (under pressure due to the head) is first squirted through a nozzle. The resultant high speed jet of water strikes specially shaped cups which turn a wheel (called a runner). Examples of impulse turbines include Pelton, Turgo and crossflow (or Banki) turbines (see left).

The reaction turbine operates fully immersed in water and is enclosed in a pressure casing. Water flows over the turbine blades situated in the casing; this causes a pressure drop across the blades which makes the runner turn in a similar way to a windmill. Examples of reaction turbines include Francis, propeller and Kaplan turbines (see left).

The approximate relationship between head and type of turbine is given in the table below.

| Turbine Type | Operating Head | | |
|---|---|---|---|
| | High (>50m) | Medium (10-50m) | Low (<10m) |
| IMPULSE | Pelton<br>Turgo | Turgo<br>Crossflow | Crossflow |
| REACTION | | Francis | Francis<br>Propeller<br>Kaplan |

"Humans have been using water to generate power for over 4000 years"

*Disused turbines at Cressbrook Mill (Pelton on left: crossflow on right)*

*This refurbished Francis turbine will soon to be reinstalled at Flewitt's Mill, Ashford. It will provide the mill owner (Bob Griffiths, pictured) with power again, nearly a century after first being installed*

*A DIY 'pico' hydro power installation in Canada*

*Newly installed band screen at Alport Mill (photo: Derwent Hydro)*

Pelton turbines are ideally suited to the high heads and low flows of steep mountain streams. A Turgo functions similarly to a Pelton but can be more compact for an equivalent power output. The crossflow turbine (also known as a Banki) has come into widespread use fairly recently, partly because it is easy to make and hence relatively cheap. It can also operate over a wide range of heads from 3-100m. The picture (page 7, top) shows a pairing of Pelton and crossflow turbines (sadly currently disused) at Cressbrook Mill on the River Wye.

Propeller and Kaplan turbines are similar to a ship's propeller but work in reverse, i.e. with water causing the propeller to rotate. The Kaplan differs in that its blades can be adjusted to match the flow whereas propeller blades are fixed. An earlier variant on the propeller is the Francis turbine. Many thousands of these machines were installed from the 1920s to the 1960s and these can be readily refurbished, as is underway at Flewitt's Mill in Ashford in the Water (see page 7, bottom).

Because of the high cost of traditionally manufactured turbines (especially at smaller sizes, say below 10 kW: 'pico' hydro), there is now a burgeoning supply (particularly from the USA, Canada and the Far East) of low cost, plastic turbines suited to DIY schemes (see above left).

## SCREENS

Most hydro installations will need some form of screening to prevent either fish or debris from entering the power plant and causing injury or damage. There are many types of screens varying from simple self-cleaning drums to band screens with electrically powered sweep arms that rake off the accumulated debris (see above right). The Environment Agency are best placed to advise as to which type of screen is suited to a proposed installation.

# SCOPING A SITE FOR HYDRO

Two of the major barriers to developing a micro hydro scheme are the relatively high cost of site assessment and the large outlay of capital in implementing any project. Feasibility studies are usually undertaken by a consultant to establish the viability of the scheme. Hydro capital costs are more site specific than for any other form of renewable energy. This means that making initial cost estimates is difficult. To minimise costs and risks, there are three stages you can progress through before deciding to move forward with a scheme.

*Stage 1 Initial site assessment*

This can be a partly-DIY stage which seeks to answer two basic questions. Approximately how much electrical power can I generate? Are there any major 'show stoppers' (environmental, ecological, cultural heritage, planning or grid connection problems) which would prohibit the development?

*Stage 2 Preliminary site (pre-feasibility) study*

This is an interim stage which can be undertaken before a full feasibility study. It would be undertaken by an experienced hydro power professional at a cost of between £500 and £1,000. A short list of hydro power consultants and installers is given in the Appendix. Some costs towards renewable energy studies can be met by grants, including the BRE Community Sustainable Energy Programme.

*Stage 3 Feasibility study*

This stage, again undertaken by a professional, takes the project forward to the final design stage looking closely at costs, project finance, sale of electricity generated, and the necessary approvals and licences. The cost of a feasibility study can range from £3,000 for a domestic scheme to £10,000 for a commercial scheme.

*This pair of weirs at the site of Whitelee Mill on the River Dane near Danebridge could produce 34 kW of power, enough for many local homes (photos: Rod Egglestone)*

# INITIAL SITE ASSESSMENT

This provides a first estimate of potential power and identifies possible environmental or planning issues that would rule out a scheme.

### HEAD

The head **(H)** of water across the site will need to be measured (in metres), either:

- For medium-high head sites: crudely counting off the contour levels on an OS map or using a hand held GPS; for more accuracy a surveyor's (dumpy) level should be used *or*
- For low head sites: either physically measuring the water drop (tape measure or calibrated rule/staff) or, better, by surveyor's level

### FLOW

Flow **(Q)** can be measured in a number of ways:

- If you are on a sizeable river, you may be lucky enough to have a nearby gauging station operated by the Environment Agency. Flow data is available free from www.ceh.ac.uk/data/nrfa/index.html
- A notched weir can be set up to record daily flows which can then be averaged (see www.british-hydro.org/mini-hydro/index.html)
- A low cost desk estimate, using the HydrA computer model, is available from www.devondare.org at £50 per site or a more costly, but more sophisticated version at £175 per site from www.hydrosolutions.co.uk
- If time or resources do not allow for physical measurement or modelling, perceived flow can be estimated as follows: the speed of a float is measured over a defined distance and a rough cross-sectional area of the stream is calculated. Multiplying the speed (metres per second) by the area (metres squared) will give flow in cubic metres per second ($m^3/s$)

### POWER

A conservative yet realistic estimate of potential electrical power ($P_e$) can then be made using the formula:

$P_e$ (kW) = **6 x H** (head in metres) x **Q** (flow in $m^3$/sec)

Using the example shown earlier (*6 x 1 metre head x flow of 10 $m^3$/s =* ***60 kW***, see page 4), the amount of energy produced per year can then be estimated as follows (with 8760 being the number of hours in a year)

**Energy** (kWh/yr) = $P_e$ (kW) x **8760** x **CF**

and where **CF** = capacity factor which varies depending upon the flow used for hydro power but can be taken as 0.4 (i.e. that the system will be running for 40% of the year) for the initial assessment. Capacity factors for hydro are usually higher in reality (usually upwards of 0.5) but for initial estimates it is better to be conservative. Using the worked example above, energy capture would be

*60 kW power x 0.4 capacity factor x 8760 =* ***210,240 kWh per year or 210 MWh/y***

In relation to scoping potential environmental, planning and other site constraints, this is a usually the time to call for expert advice from both the relevant local planning authority (for most of the Peak District, the National Park Authority) and the Environment Agency – see below. This project also scoped major constraints at nearly 60 sites across the Peak and the results (see full technical report, Appendix B) can be viewed at www.friendsofthepeak.org.uk.

# OBTAINING LICENCES, PLANNING PERMISSION AND GRID CONNECTION

Developing a micro hydro scheme, especially within a national park, inevitably has the potential to create impacts on sensitive environments: the river, its margins and adjacent land and, of course, the surrounding landscape. Impacts may include changes in river flow, possible alterations to habitats, new structures in a sensitive area or the alteration of historic features. Connection to the grid may also become an environmental or planning issue as cables may need to be placed underground or on new overhead poles.

There are four main areas that usually need to be addressed, assuming that land, weir and bankside (riparian) rights are under your control (either through ownership or a lease):

- River/water related consents (from the Environment Agency)
- Planning permission for new structures or changes to land use (from the National Park Authority/local planning authority)
- Consents for alteration to scheduled monument and/or listed structures (from either English Heritage or the local planning authority, depending on scheduling/grade of listing)
- Connection to the grid, involving both technical and planning issues, especially if the nearest connection point is not adjacent to the site

## LICENCES

The main body for licensing micro hydro schemes (and hence assessing their impact) is the Environment Agency (EA). Environmental assessment will be required and this will usually involve having to get specialist help, usually from qualified consultants. Most sites present complicated issues that may require thorough assessment and so the EA warn that the time taken to assess impacts can be lengthy and this should be built into project plans and costs. Discussion with the EA prior to making licence applications will help minimise the risk of abortive work.

To remove water from a watercourse for a micro hydro scheme will require permissions from the EA in the form of water resources permits. There are three different types which can apply to a scheme depending upon its location and design:

- **abstraction licence** if water is diverted away from the main watercourse
- **impoundment licence** if a change to a weir is made or a new weir built
- **land drainage consent** to return the abstracted water back to the river

In addition **flood defence consent** is likely to be required for all schemes. This involves undertaking a flood risk assessment to ensure there is no adverse impact on flooding in the locality.

The amount of water that the EA will allow to be diverted for hydro (usually called the 'design flow') will be crucial to the economics of any scheme. This will depend on how much 'residual' (also called the 'hands off' flow) needs to be retained in the main watercourse for environmental reasons. Deciding the residual flow is often complicated and the recent *Good Practice Guidelines* issued by the EA (see www.environment-agency.gov.uk/business/topics/water/32022.aspx) explain how this works. Key issues affecting water abstraction are contained in what are termed 'Catchment Abstraction Management Plans' (CAMS) which exist for all major river systems and their main tributaries. These can be consulted at www.environment-agency.gov.uk/CAMS

## PLANNING PERMISSION

The National Park Authority's website (www.peakdistrict.gov.uk) has a large section devoted to planning advice and this is well worth consulting. Planners at the NPA should be consulted as early as possible on the general scope of a potential scheme and they should be able to advise as to which parts (if any) of a scheme may require permission, including listed building consents.

Prospective developers should call the NPA's Customer Service Team to initiate contact with the Planning Service. A planning officer can then co-ordinate a response, drawing in other specialist staff as required. An experienced hydro consultant or agent should also be able to give guidance on likely planning issues. For sites outside the PDNP, please contact the relevant local authority.

## PLANNING CASE STUDY: ALPORT MILL

In 2007 the Haddon Estate, owners of Alport Mill near Youlgreave, commissioned local hydro consultants and installers, Derwent Hydro Power (DHP), to scope a micro hydro scheme on the site of an old mill on the River Lathkill. DHP came back with a proposal to install a 30 kW turbine that would supply power to most of Alport village. The scheme would take advantage of the existing weir, intake, and tail race but with a new, buried pipe (see below) leading to a partly buried powerhouse. On the flip side, the River Lathkill (both upstream and downstream of the mill) is important for recreational fishing and is controlled by the Estate. The site is also close to important protected habitats.

After extensive pre-application consultation, two linked planning applications were made in summer 2008 to:

- build a new powerhouse
- allow alterations to part of the mill, which is listed

*Burying the pipe ('penstock') carrying the water from the intake to the powerhouse at Alport Mill (photo: DHP)*

The main planning issues were:

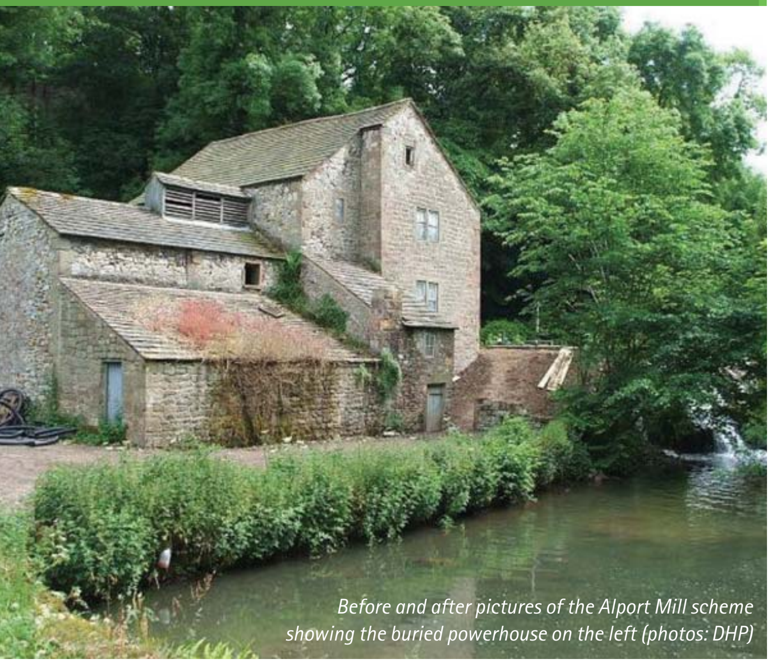
- the principle of the proposed development
- proposed design and external appearance of the powerhouse
- potential impact on the Alport Conservation Area
- potential impact on the setting of a listed building
- potential impact on features of archaeological interest and,
- potential impact on features of ecological interest

The principle of development was supported by a PDNPA policy which allows for small scale local energy generation. The powerhouse was felt to be modest in scale and, with suitable finishing (turf roof, external limestone walls – see right), would be visually acceptable and not affect either the Conservation Area nor the setting of the listed mill.

*The new turbine house at Alport Mill faced with local stone (photo: DHP)*

The plans had the potential to affect the historic and ecological value of the site. An archaeological desk based assessment was prepared to accompany the application. Subsequently a watching brief on excavations and building recording was carried out as mitigation for the scheme. In relation to ecology, mitigation measures to safeguard local species of special interest were also agreed and implemented.

No objections were registered to the applications and it was recommended for approval. The relevant planning consents were issued in October 2008. The scheme was implemented successfully in spring/summer 2009 and is now operational.



*Before and after pictures of the Alport Mill scheme showing the buried powerhouse on the left (photos: DHP)*

## ECOLOGY

Potential ecological impacts will need to be considered by both the EA and the NPA. Prime issues will include possible effects on fish, aquatic plants, insects, birds and local habitats. Surveys may be required to establish a baseline and assess possible impacts.

## CULTURAL HERITAGE ISSUES

All old mill sites have historic value and may also be listed or scheduled. Proposed works for a micro hydro scheme may either affect the historic fabric or the setting of a site or area. If the site is a Scheduled Monument (sometimes also referred to as a 'scheduled ancient monument' or SAM) or listed at either grade I or grade II* status, consent will be required from English Heritage.

Changes to listed structures below grade II* may need 'listed building consent' (as was necessary at Alport Mill, above) and this must be sought from the local planning authority. Applicants should consult the PDNPA (or other planning authority if outside the NP) in order that any archaeological/listed building issues can be identified at an early stage so that any necessary investigations and surveys can be commissioned.

## GRID CONNECTION

Consents for new electricity connections are handled by your local electricity supplier (also called distribution network operator or DNO). Schemes that will provide around 10 kW or more need a more complicated ('three phase') form of connection but your DNO will advise on this. Provision of any new connection will also be dependent on successful negotiation of relevant permissions to run wires or cables through adjacent land. The cost of providing a long connection may prove prohibitive at some sites. It is therefore wise to deal with this issue at a relatively early stage of any hydro project.

# GENERATING ELECTRICITY AND INCOME

Hydro equipment (turbines, screws, wheels) is usually connected to a generator to produce electricity. The generators can be connected to the grid or used to provide stand-alone power. In a grid-connected system, power is used locally, with the balance imported from, or exported to, the grid. The picture right shows the electrical control panel (and generator) for the modern 11 kW waterwheel installed at Lemsford Mill on the River Lea in Hertfordshire, which provides about 60% of day time demand to an office with 45 staff. Some export to grid occurs at night and weekends when on-site demand reduces, and this generates useful income too.

Recent changes to Government policy on small scale renewable energy generation mean that the prices paid for electricity generated by micro hydro will increase. This is because from April 2010 there will be a 'feed-in tariff' (FIT) that will pay 19.9 pence per kilowatt hour (p/kWh) for smaller hydro systems (power capacity ≤15 kW) and 17.8p/kWh for systems between 16-100 kW. This payment is made even if you don't export power to the grid. If you do export, you will receive another 3p/kWh. The payments are guaranteed for the next 20 years and will be linked to the retail price index (RPI) to protect their value. However to qualify for the FIT you need to use certified products and installers, which may rule out 'DIY' approaches. For information on feed-in tariffs see www.fitariffs.co.uk, www.decc.gov.uk and www.microgenerationcertification.org.

*Electrical control panel at Lemsford Mill, Hertfordshire (photo courtesy Ramblers Worldwide Holidays)*

# GRANTS

There is regional and national funding available for micro hydro schemes. The grants available often depend upon whether the scheme is a private or community venture, the latter usually attracting more support. Key national schemes include the BRE Community Sustainable Energy Programme and Community Action for Energy (CAfE) but other grants are now being withdrawn with the introduction of the FIT.

A useful listing of funds available for renewable energy schemes can be found at Future Energy Yorkshire's web site www.co2sense.org.uk/. In the North West, grants are available via Envirolink Northwest's Low Carbon Development Programme, see www.envirolinknorthwest.co.uk/.

Some planning authorities and the Peak District Sustainable Development Fund (SDF) have been willing to offer small grants towards small scale renewable energy projects in their area on an *ad hoc* basis. Exceptionally, larger sums may be offered to help support capital expenditure but the norm thus far is for assistance with project development. Local authorities and the SDF should be able to advise on the current availability of grants.

Currently there appear to be no regionally-dedicated funded streams for micro generation (other than national level grants) in the East or West Midlands regions. However, you can try to access EU funding streams for rural innovation and diversification (such as LEADER – available through the regional development agencies, RDAs), especially if the scheme can be linked with the farm-based economy.

# COMMUNITY SCHEMES

There are various funding streams available for community hydro schemes, depending upon the legal structure of the enterprise, which can take several forms, including a

- trust
- limited liability company (by shares or guarantee)
- community interest company
- industrial provident society
- charitable incorporated organisation or co-operative

Which structure is adopted will depend upon the particular circumstances of the scheme but usually the three most appropriate for a non-profit community business activity are a company limited by guarantee, a community interest company or an industrial provident society. These structures allow the use of 'equity' funding (capital raised, usually by a share offer) from 'social investors' who buy shares for social and community benefit rather than short term financial gain.

Water Power Entreprises ($H_2OPE$), a social enterprise company created to develop community hydro schemes (focusing mainly on Archimedes screw solutions), offers a bespoke model for communities to engage with. In essence, $H_2OPE$ manage scheme development from inception to fruition in return for a fee on completion of the project (or a proportion of subsequent income). Project funding is usually a mixture of grants, loans and a share offer. Projects successfully delivered so far include the Torrs hydro scheme at New Mills (see right) and at Settle in the Yorkshire Dales National Park. See www.h2ope.org.uk.

Energy4all Ltd is another not-for-profit organisation helping communities own a stake in renewable energy schemes (see www.energy4all.co.uk). Although their main successes have so far been with wind power, they are also interested in helping develop hydro projects.

## COMMUNITY CASE STUDY: TORRS HYDRO, NEW MILLS

Torrs Hydro was started in 2007 and is registered as an 'industrial and provident society for the benefit of the community'. This was done so the local community could own the hydro power scheme and benefit from it. To succeed, they needed to raise £360,000 – a real challenge! The aim was to do this via a mixture of:

- Grants
- Equity from investors (a share issue)
- Loans

Grants from the Peak District National Park, the East Midlands Development Agency and the Co-operative Group secured £165,000 – much more than the original grant target of 30% of the total capital expenditure. Shares totalling £126,000 were bought by 230 investors, most of whom were local people. The rest of the capital was loaned from the Co-operative Bank.

The scheme was installed by end August 2008 and the 70 kW Archimedes screw provides around 240,000 kWh of electricity per year. This is sold primarily to the local Co-op supermarket with any excess going to the grid. The scheme is expected to pay for itself within 12 years and profit will be spent to benefit the community. The scheme has regular open days – see www.torrshydro.org for details.

*An artist's impression of the proposed Torrs hydro scheme at New Mills. Creating the image was key to gaining local support and the eventual success of the project (image: Torrs Hydro)*

# PEAK POWER CASE STUDIES

A key part of the Peak Power project was to investigate in detail a range of sites that exemplified the different types of micro hydro opportunities existing in the Peak District. After desk studies of nearly 60 sites (see right), ten case studies were selected for basic pre-feasibility studies including estimating power output (see the table opposite):

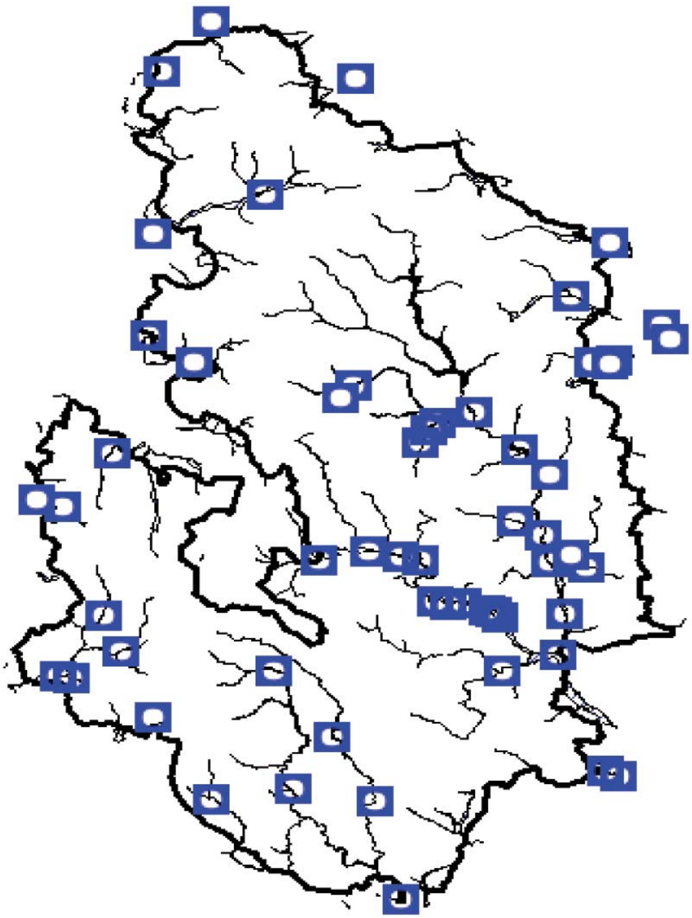
- Bamford Mill on the River Derwent
- Via Gellia Mills near Bonsall
- Diggle Mill on Diggle Brook near Saddleworth, Lancashire
- Marsden town weir on Butterley Brook in West Yorkshire
- Millthorpe weir on Millthorpe Brook in North East Derbyshire
- Whitelee Mill on the Dane near Danebridge in Cheshire
- Caudwell's Mill, Rowsley on the River Wye
- Grinds Brook in Edale, a non-mill, high head site
- Lumford Mill weir, between Ashford and Bakewell
- Edensor Mill weirs in Chatsworth Park

The sites vary greatly in the constraints to hydro development and power outputs. Although two (Marsden and Millthorpe weirs) fell squarely into the bracket of 'pico' schemes (less than 10 kW), where economic viability is often marginal, either community involvement or a willingness to do most of the civil and other works without outside contractors could enhance their developability. The enhanced subsidies for sub-15 kW schemes under the new Feed-In Tariff would also assist in reducing payback times.

The sole high head site, Grinds Brook in Edale, is unfortunately highly constrained by its own high quality natural environment but again an innovative pico scheme (c.5 kW) may be realisable as an alternative.

At the opposite end of the scale, a number of former mill sites on the main Peak District rivers of the Wye and Derwent offer good opportunities, including Bamford Mill (21-27 kW), Lumford Mill weir (50 kW), Caudwell's Mill (50 kW) and Edensor Mill weirs (43 kW and 56 kW) though the latter three sites may have significant historic environment issues to address. The Bamford Mill site appears to be the least constrained and there is significant local interest in progressing a scheme. On the River Dane, in the southwest Peak, excellent infrastructure at two weirs near Whitelee (see page 9) affords a good opportunity (34 kW) for a remoter rural scheme.

A number of light industrial sites on the edges of the National Park (Via Gellia Mills and Diggle Mill, where planning permission has been



*The location of 60 sites across the Peak – assessed for environmental, cultural heritage and grid connection constraints* given for conversion to houses) offer reasonable opportunities for on site power (both just over 10 kW). Via Gellia Mills near Bonsall is particularly promising given the artificial nature of the river environment; Diggle Mill would be a much more difficult scheme to develop but the key issue here is to protect future options by safeguarding the remaining millpond.

All the sites are recommended for further study. The total power capacity of the case study sites is also shown in the table below, showing that nearly 300 kW could be realisable (c.285 kW within the PDNP). These sites alone could power hundreds of local homes and businesses and provide wider benefits, if developed as community schemes or new rural/farm-based enterprises.

*The results from the ten Peak Power case study sites*

| SITE NAME | HEAD (m) | DESIGN FLOW (m³/s) | INSTALLED CAPACITY (RATED POWER) (kW) | MEAN ANNUAL ENERGY CAPTURE (MWh/y) |
|---|---|---|---|---|
| Bamford Mill | 2.50 | 1.81 | 27.0 | 216 |
| Bamford Mill# | 5.50 | 0.65 | 21.0 | 168 |
| Via Gellia Mills, Bonsall† | 4.00 | 0.49 | 10.7* | 45* |
| Diggle Mill | 22.0 | 0.09 | 11.6 | 58 |
| Marsden town weir† | 2.60 | 0.09 | 1.4 | 12 |
| Millthorpe weir† | 1.65 | 0.07 | 0.9 | 3 |
| Whitelee/Gig Hall weirs | 5.10 | 0.92 | 34.0* | 117* |
| Caudwell's Mill | 2.70 | 2.50 | 49.8* | 182* |
| Grinds Brook, Edale | 30.0 | 0.08 | 12.5 | 47 |
| Lumford Mill weir | 3.00 | 2.26 | 50.2* | 208* |
| Edensor upper weir | 1.64 | 4.90 | 43.0 | 204 |
| Edensor (Mill) weir | 2.10 | 4.90 | 56.0 | 261 |
| **Total capacity/output** | - | - | **297.9** | **1357** |
| *(capacity within PDNP)* | | | *(284.9)* | *(1297)* |

*# alternative scheme*
**mean output from range of turbine options*
*† site outside National Park*

# PROJECT OVERVIEW AND CONCLUSIONS

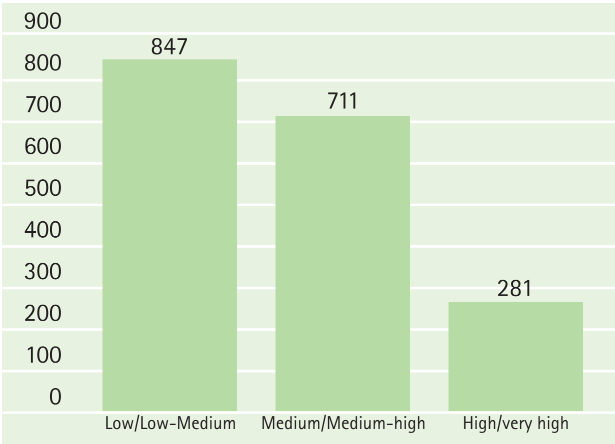
Through desk studies, consultation with parish councils, local community groups and other interested parties, the Peak Power project has identified a total of 162 sites across the Peak District National Park and immediately adjoining areas (120 inside the NP boundary, 42 just outside). Twelve sites already generate 1.6 MW of power and the potential to upgrade power output exists for at least two of these sites (Chatsworth's Emperor stream and at Caudwell's Mill). Of the 150 potential (currently undeveloped) sites, two (at Flewitt's Mill, see page 7, and Calver Corn Mill, page 5) should be producing power in early-mid 2010 and other schemes (e.g. Meadow Farm near Flash) are currently seeking licences from the Environment Agency.

For the remaining 147 sites, mostly old mill sites, the outlook is variable. At 80 or so sites there is worthwhile scope for further investigation. The majority of these sites (59) were subject to an in-depth constraints analysis and the ten case studies (see above) suggested c.300 kW of new power could be developed.

Of the remaining 70-odd sites, the potential for redevelopment is thought to be poor, with the main barriers being low flow and/or lack of infrastructure. Many low flow streams historically had mills where power could only be generated intermittently by storing water in a millpond and, in general, such sites are unsuitable for 'run of river' electricity generation. However if the pressure for new renewable energy (RE) sources, including micro generation, increases markedly, then some of these sites may become more viable, especially if more economic incentives are offered.

Finally, the project also examined previous studies of Peak District sites (see the table opposite, in order of power available) and calculated that as much as 1840 kW of power might be available as future potential capacity, although some sites face very significant environmental barriers to development. However a rough constraint analysis shows that the majority of potential capacity (at the left side of the graph below) face only low-medium constraints which is encouraging for future uptake.

*Potential PDNP hydro capacity according to level of site constraint*



## Potential hydro sites in the PDNP in order of their power capacity (kW)

| Site name/location | River/stream | Capacity kW | Output GWh/y# | Study reference | Constraints |
|---|---|---|---|---|---|
| Upper Derwent catchment | Derwent/Ashop | 700 | 3.4 | STW | Low-medium |
| Calver Mill | Derwent | 125 | 0.72 | ETSU | Medium |
| Litton Mill | Wye | 120 | 0.65 | ETSU | Medium |
| Chatsworth upgrade* | Emperor stream | 113 | 0.54 | Chatsworth Estate | Low-medium |
| Padley Gorge | Burbage Brook | 106 | 0.5 | ETSU | Very high |
| Cressbrook Mill | Wye | 94 | 0.52 | ETSU | Medium |
| Bar Brook, Baslow | Bar Brook | 88 | 0.39 | ETSU | Very high |
| Waterfall, Lathkilldale | Lathkill | 75 | 0.35 | LUC/ITP | Very high |
| Edensor lower weir | Derwent | 56 | 0.26 | FPD | Medium-high |
| Lumford weir | Wye | 50 | 0.21 | FPD | Medium-high |
| Edensor upper weir | Derwent | 43 | 0.2 | FPD | Medium-high |
| Caudwell's Mill upgrade* | Wye | 35 | 0.18 | FPD | Medium-high |
| Old Mill, Baslow | Derwent | 35 | 0.25 | ETSU | Medium |
| Whitelee Mill, Danebridge | Dane | 34 | 0.12 | FPD | Medium |
| Ashford Bobbin Mill | Wye | 30 | 0.14 | Townsend/FPD | Medium-high |
| Bamford Mill | Derwent | 27 | 0.22 | FPD | Medium |
| Flewitt's Mill, Ashford | Wye | 18 | 0.14 | Segen | Low |
| Lead Mill, nr Hathersage | Derwent | 17 | 0.08 | LUC/ITP | Medium-high |
| Edale | Grinds Brook | 12.5 | 0.05 | FPD | High |
| Diggle Mill | Diggle Brook | 12 | 0.06 | FPD | Medium-high |
| Meadow Farm, nr Flash | Dane | 12 | 0.06 | WRE | Medium |
| Brough Business Park | Bradwell Brook | 11 | 0.06 | Derwent Hydro | Medium |
| Raper Lodge, nr Alport | Lathkill | 10 | 0.05 | SY/Clarke | Medium-high |
| Ilam | Dove | 8 | 0.05 | Derwent Hydro | Medium-high |
| Calver Corn Mill | Calver Mill Sough | 4 | 0.02 | FPD | Low |
| Stoney Middleton | Stoke Brook | 4 | 0.02 | Derwent Hydro | Medium |
| **Total** | | **1840** | **9.24** | | |

**Notes:**

* existing sites: capacity noted is additional to current installed capacity

\# = where no output/annual energy capture estimated in original study, a capacity factor of 55% has been used

1. Many more sites (40+) examined by FPD desk/GIS constraints study but no head measured nor flow known. Some may provide additional capacity but difficult to estimate
2. Other sites where estimates made include Low Bradfield (0.8 kW), Gradbach Mill (<5 kW), Magpie Sough (2 kW), Harden Clough (1 kW), Swint Clough (2 kW) - all likely to be uneconomic to develop

*A fish-eye view of the Torrs hydro scheme at New Mills (photo Simon Clayton/Peak Digital Ltd)*

# RECOMMENDATIONS

**Based on the findings of this project and the evidence set out in the main technical report (including experiences and good practice noted from other areas, including other National Parks in England and Wales), we recommend:**

- In the short term, attention should be focused on developing the potential hydro sites identified with the highest capacity (>25 kW) and least constraint. These would include opportunities in the Upper Derwent reservoirs complex, Chatsworth Park and the large mills/weirs on the Wye, Derwent and Dane (Litton Mill, Cressbrook Mill, Lumford Mill, Caudwell's Mill; Bamford Mill, Calver Mill and Hodgkinson's Mill, Baslow; Whitelee Mill).

- Further workshops should be held to promote awareness of local micro hydro opportunities and to engage with site owners and local communities so schemes are progressed. The formation of a Peak District micro hydro users' group to share best practice and monitor progress should be actively considered. Such groups have proved valuable elsewhere.

- The National Park Authority should consider making available further resources, both in terms of staff time and grant aid (similar to the Brecon Beacon's Renewable Energy Assistance Programme), to enable the swifter implementation of a range of exemplar micro hydro sites throughout the Peak District, particularly in support of community-led projects.

- To fully realise the renewable energy potential in the Peak District and wider Peak sub-region, better grant aid for micro generation (including hydro) should be provided in the East Midlands region.

# APPENDIX: FURTHER USEFUL INFORMATION

| Information on hydro power and suppliers | Website | Notes |
|---|---|---|
| European Small Hydropower Association | www.esha.be | Technical information plus manufacturers/consultants |
| Renewable Energy Centre | www.therenewableenergycentre.co.uk | ditto |
| British Hydropower Association | www.british-hydro.org | ditto |
| Environment Agency | www.environment-agency.gov.uk/business | EA policy, guidance and research |
| Green Valleys project, Brecon Beacons | www.thegreenvalleys.org | Innovative hydro schemes in a national park |
| The Pedley Mill Trust | www.pedleywheel.org.uk | Technical information on waterwheels |
| Gants Mill, Somerset | www.gantsmill.co.uk/hydropower.htm | Organise regular hydro tours |
| Microhydropower business directory | www.microhydropower.net/directory/manufacturers.php | Manufacturers |
| Renewable Energy UK | www.reuk.co.uk | Technical information, DIY and <1kW schemes |
| Homepower Magazine | www.homepower.com | Website of renewable energy magazine |
| Sustainable products | www.thesustainablevillage.com | Small turbines for DIY schemes |
| Micro/pico generation systems | www.judyofthewoods.net/hydro.html | Experience of DIY scheme |
| Energy Systems & Design Ltd | www.microhydropower.com | Technical information |
| Microhydro internet group | www.groups.yahoo.com/group/microhydro | Self-help group |
| Derwent Hydro | www.derwent-hydro.co.uk | Local hydro consultancy, installer and scheme operator |
| Gilbert Gilkes & Gordon Ltd | www.gilkes.com/hydro.html | Turbine manufacturers and installers |
| Spaans Babcock Ltd | www.spaansbabcock.com | Archimedes screw suppliers |
| MannPower Consulting | www.mannpower-hydro.co.uk | ditto |
| RenewablesFirst | www.renewablesfirst.co.uk | Small scale hydro consultancy |
| Southeast Power Engineering | www.sepengineering.com | Hydro consultancy, installer and scheme operator |
| Western Renewable Energy | www.westernrenew.co.uk | ditto |
| Hydrowatt | www.hydrowatt.de/sites/english/home.html | Waterwheel manufacturer |
| **Information on renewable energy/grants** | | |
| Centre for Alternative Technology | www.cat.org.uk | Advice on wide range of RE technologies |
| Energy Saving Trust | www.est.org.uk | Run CAfE grant scheme |
| Peak District Sustainable Energy Group | www.derbyshirercc.org.uk/pdseg_intro.htm | |
| The Carbon Trust | www.carbontrust.co.uk | General information on renewable energy |
| EDF Green Fund | www.edfenergy.com | Grants |
| Community Sustainable Energy Programme | www.communitysustainable.org.uk | Big Lottery grant scheme |
| Green Highland Renewables Ltd | www.greenhighland.co.uk | Partnership developments |
| East Midlands Development Agency | www.emda.org.uk | Policy and grants |
| Sheffield Renewables | www.sheffieldrenewables.org.uk | Community action in South Yorkshire |
| Powerfromthelandscape | www.powerfromthelandscape.co.uk | Community hydro schemes in South Pennines |
| Peak District Sustainable Developmnt Fund | www.peakdistrict.gov.uk | Local source of development grants |

For further information on useful websites see Appendix E of the full technical report at www.friendsofthepeak.org.uk

"I am delighted to hear about the work which Friends of the Peak District and others are doing to explore the potential of micro hydro power. The challenges which face us on climate change are huge and will require a global agreement. But they also need small scale answers with individual households and businesses taking responsibility for doing something.

And that is where Friends of the Peak District's work fits in and why the case studies in this report are so valuable. They show just how viable hydro power is in lots of places"

**HILARY BENN MP**
**SECRETARY OF STATE FOR THE ENVIRONMENT, FOOD AND RURAL AFFAIRS**

"This report is an important stepping stone towards more hydro schemes of this type. It looks in detail at the wide variety of available and developing hydro technologies that can be used to create sustainable energy, while still protecting the special features of the National Park.

The report will also encourage local residents, community services, local businesses and others to consider harnessing water power as part of a move towards more sustainable lifestyles"

**NARENDRA BAJARIA CBE**
**CHAIR OF THE PEAK DISTRICT NATIONAL PARK AUTHORITY**

# Friends of the Peak District

## Our vision is of a living, working countryside that changes with time but remains beautiful forever.

Friends of the Peak District represents CPRE (Campaign to Protect Rural England) in the Peak District. We are a member of the Campaign for National Parks.

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