CLASP. Climate Change Local Area Support Programme

Planners Reference Guide: Micro Hydro




Hydropower contributes around 20% of the total renewable energy generated in the UK, but this is almost entirely from large high-head schemes in Scotland and Wales (e.g. Maentwrog hydro-electric power station in North Wales).

Micro hydro generally refers to systems under 500kW, although the Feed In Tariff covers schemes to 2MW. The North West (NW) has the greatest hydro potential in England with over 3,500 theoretically feasible sites for very small turbines (<20kW) and over 700 possible sites for turbines over 50kW.

There are two types of hydro scheme:

- High head, where the water is diverted away from the river/stream, impounded, and piped downhill into the turbine, and the energy output is reliant on the height of the drop
- Run-of-river, or low-head, where the water is diverted through the turbine over a short distance and the energy output is reliant on the flow rate of the water. These are frequently located at the site of an existing water barrier such as a weir.

The majority of schemes in the NW will be run-of-river, although there is potential for a few high-head schemes in Cumbria.

Output

The power output of a hydro scheme is a function of the height of the water drop, flow rate and the conversion efficiency of the turbine:

Power = Head x Flow Volume x Efficiency x Gravity

Energy Output = Power x Hours Run

One of the advantages of hydro power over other renewable electricity technologies is that the running hours tend to be high, and any variation in generation rate during the year is dependent on changes in the flow rate.

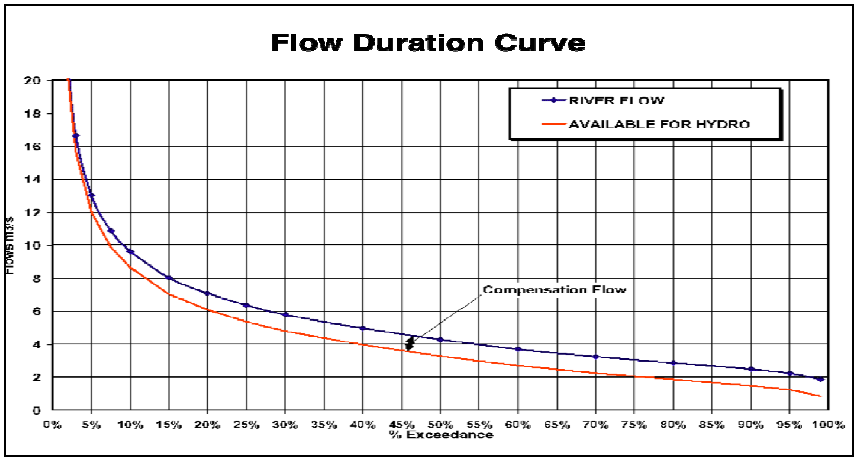
For low-head schemes, the gross head varies with river flow rate and can reduce when the river is high, as the water level below the barrier rises more than the level above the barrier.

The ratio of Actual Output to the theoretical maximum Rated Output is known as the Load Factor i.e. Actual Output = Load Factor x Turbine Rating x 8760 hours/year

The average Load Factor depends on the size of the turbine and location, but is normally in the range of 50% – 70%.

Water Flow and Turbine Sizing

Water flow can be estimated from either gauging station data or from rainfall and evaporation data for the catchment area. This is usually presented as a Flow Duration Curve, which shows the percentage of the year that the river flow is above a certain value. Turbines are then designed to match a percentage of the maximum flow rate, taking into account the minimum water level the Environment Agency requires to remain flowing over the weir.



A turbine specified to be able to extract the maximum amount of power from the flow (matched to high flow rates) will under-perform for the majority of the year, and consequently will take a longer time to pay back the capital investment.

Conversely, a turbine specified to operate at maximum output throughout the year (matched to low flow rates), will operate efficiently but not harness all the potentially-available energy.

Annual Output should be in the range 4,000 – 6,000 kWh/kW.

Environment Agency Permission

The most critical, and time-consuming, permission for a hydro scheme is from the Environment Agency, so the first thing for a scheme developer to do is talk to the EA.

The EA have just streamlined their procedures and have rolled them into a single permit. They have also put in place a single account manager for each scheme, and have written guidance for applicants, so the new system should be more efficient. EA permission covers

- Abstraction licence
- Impoundment licence
- Flood defence consent
- Fish pass approval

In order to gain permission, applicants will have to demonstrate they have dealt with all the following issues:

- Effects on ecology, biodiversity, hydrology, fisheries of any stretch of reduced flow (depleted reach) including weirs
- Assessment in changes of turbidity and impact on sediment & suspended solids
- Right of access to land
- Environmental Impact Assessment for schemes in a sensitive area or all over 500kW
- Ecological impact for designated rivers, species or habitats
- Land contamination – whether construction or operation poses a risk of polluting the waterway
- Impact on navigation and recreational users.

Installation and Maintenance

A hydro scheme is a major construction project, and involves a significant "at risk" investment before any energy is generated. A scheme is likely to take around 2 years from initial feasibility to operation, and many community/not-for-profit schemes take much longer, as they are dependent on a combination of voluntary and non-expert time and substantial fund-raising.

As with any engineering equipment, turbines require regular maintenance. The system will also require regular monitoring to optimise output and clearing of obstructions such as leaves & debris.

Grid Connection

Almost all hydro schemes will require permission to connect to the grid, and a grid connection report must be requested from the Distribution Network Operator (DNO), who may charge a fee of around £2,000 - 4,000 for this service. If any grid connection strengthening work is required, there will be an additional cost.

As most hydro schemes are located in rural areas at some distance from the nearest grid connection point, cabling costs can form a significant part of the budget.

Feed In Tariff (FIT)

FIT rates to March 2012 are shown below (these are expected to change for 2013 based on the outcome of the FIT Review). To qualify for FITs systems under 50kW must be installed by a Microgeneration Certification Scheme (MCS). Systems over 50kW must accredited through Ofgem's Renewable and CHP Register.

Technology	System Size	p/kWh	Years
Hydro	≤15 kW	20.9	20
Hydro	>15 kW - 100 kW	18.7	20
Hydro	>100kW - 2MW	11.5	20
Hydro	>2 MW	4.7	20

Costs (June 2011)

Installation costs for a medium-scale micro hydro scheme (30 – 100 kW) are in the range £7,000 - £12,000 per kW.

However, as hydro schemes have relatively high load factors, the payback should be between 4 – 8 years (including FITs), depending on the site and size of the system. This makes hydro (in a suitable location) one of the most cost-effective small-scale technologies.

Planning Considerations

Planning permission is required for all hydro schemes. The majority of the environmental impacts will be covered within the EA approval. The main planning considerations are:

- Visual impact: there are a number of structures that will be added to the environment. The turbine house is usually designed to fit in your landscape and will look like a small barn. There will be some form of barrier or weir, channelling with flow controls, debris and fish screens, and possibly a new fish pass and alterations to existing structures.
- Impact on historic buildings/structures: for example an old water mill.
- Noise: this can be easily mitigated for equipment within the turbine house. For external equipment e.g. Archimedes screw turbine, there will be a constant water movement noise when running, but this needs to be set against the background noise level of the river/weir. For very large schemes there may be a valid noise issue for residential buildings close to the site.
- Access: scheme could affect public access, like footpaths along the river, and public safety needs to be addressed; the scheme will also need ongoing operational access.
- Finally there will be some construction disturbance.

A consultation on permitted development rights for microgeneration was carried out in 2009/10, which included micro-hydro turbine houses, but as yet this has not been progressed.

Further Information

Planning for Renewable Energy: A Companion Guide to PPS22 - http://www.communities.gov.uk/publications/planningandbuilding/planningrenewable

Environment Agency pages on hydropower: http://www.environment-agency.gov.uk/business/topics/water/126571.aspx

British Hydropower Association: http://www.british-hydro.org

Permitted Development Rights Consultation (archived) - http://webarchive.nationalarchives.gov.uk/+/http://www.communities.gov.uk/publications/planningandbuilding/microgenelectriccars

Feed In Tariffs - www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/feedin_tariff/feedin_tariff.aspx

Microgeneration Certification Scheme - www.microgenerationcertification.org

Ofgem Renewable & CHP register - https://www.renewablesandchp.ofgem.gov.uk/

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