

Hydro–electric generating equipment

Peter Hensman

General points

Firstly every site is different and therefore for optimal performance requires a unique equipment solution

Secondly sites can have a dam which enables water to be stored and flows to be evened out between periods of rain and drought or they are run of river which means that their equipment has to be responsive to very variable flows. These days it is recognised that dams are not eco-friendly and most new schemes are run of the river.

The importance of efficiency

Water turbines can have very high efficiency. At optimum conditions many will convert over 90% of the energy in the water into power. To get the best efficiency (and the most power), the plant will generally have to be specifically designed for the site. This increases cost but gives a better return. So there is a trade off between output and cost.

The importance of head.

The power generated is a product of the head (fall) and the volume of water passing (the flow). The higher the flow, the larger and more costly the plant. When examining the potential of a site you must consider both head and flow but the higher the head the better because the site will be more economical. You must also remember that you cannot use all the flow. Some water has to continue to flow down the river.

High and low head sites

High head sites are those with heads, say, over 20m. They have a dam or an intake structure in the river and then a pressure penstock (an enclosed steel tube) leading down to the powerhouse. It may have to be buried for environmental reasons. The power house will probably hold an impulse turbine where the water is jetted against the wheel to make it turn

In low head sites there will normally be a weir in the river and a canal or millrace will run from it to the powerhouse. The turbine is likely to be a reaction turbine. Here the wheel is fully immersed in the water and is turned by both the pressure of water coming in and the suction of the water as it leaves

IMPULSE TURBINES

There are 3 principal types - Pelton, turgo and crossflow.

Pelton

Suitable for high heads and low flows - typically heads over 20m up to over 1000m. It is a wheel with buckets radially round the edge and has very high efficiencies – up to 95%. Jets are formed by spear or needle valves and are fired at the buckets. The turbine may be configured horizontally or vertically and can have up to 6 jets to achieve good efficiency across a broad range of flows.

Turgo

This is a patented Gilkes design, invented in 1919. Water is jetted through spear valves at an angle to the wheel on to curved blades. Turgos have a lower efficiency (probably 80-85%) but achieve peak efficiency over a broad range of flows so that sometimes you can get as much power as you would get from a higher efficiency machine with a more peaky efficiency characteristic.

They also have a higher specific speed than the Pelton which means that the installation can be more compact for the same flow and they are more tolerant of dirt and silty water than a reaction turbine.

They are normally built with one or two jets and operate on heads of 15m to 120m, overlapping both Pelton and Francis machines

Cross flow

These generally have 2 jets and the runner is cylindrical in shape with 37 blades round the edge. Water flows into the wheel tangentially across the centre of the cylinder and out of it on the other side. It strikes the wheel twice. Crossflow turbines generally have a lower efficiency but they are cheap. They operate on heads of 7-70m

REACTION TURBINES

As mentioned earlier, reaction turbines use pull as well as push and the runner is flooded. This means that they need to maintain tight clearances to achieve high efficiency. Otherwise the water will escape between the runner and the case rather than going through it.

Francis Turbine

This is the most well-known reaction turbine with its characteristic snail-like case. The range of heads covered is huge – from 5m -400m and they can have efficiencies of over 90%. The flow through the turbine is controlled by guide vanes which are opened and closed by a lever system.

Kaplan Turbine

For very low heads (less than 30m) the Kaplan turbine is often used. Here a variable pitch propeller is set in a draft tube and is turned by the water flowing past it. Again Kaplans have high efficiency (over 90%)

In recent years there have been increasing concerns about the harm caused to fish going through Francis or Kaplan turbines. It is also very difficult to keep fish (and rubbish) out of the turbines and a lot of effort can be spent in maintaining suitable screening arrangements.

The **Archimedes Screw** has been seen as an answer to this. This is the traditional screw which was used by the ancients to raise water but working in reverse. Water is introduced into the screw from the head race or pond and as it runs down the screw it turns it. The machine operates on low heads between 1 and 10m. It has a lower efficiency but can still be advantageous because of its fish friendly nature and its tolerance of leaves and rubbish.

Other considerations

Hydro-power is capital intensive. It doesn't cost much to run but capital costs are in the region of £2500 -£6000 per installed kilowatt and generally the smaller the scheme the higher the cost per kilowatt. If you build a hydro electric plant you are investing for your children even with the incentives currently offered by the Government. A quality plant will last for 50 years.

Small plug-in and go systems have up till now not been available but Gilkes has recently introduced a compact off the shelf range covering Pelton, crossflow and turgo turbines

Financing schemes are also available if required. The banks will provide loans or alternatively a Gilkes subsidiary, Gilkes Energy, will provide the finance by taking a stake in the equity of the scheme.

In February, the Northwest Regional Development Agency launched its Rural Carbon Challenge Fund which will provide grants from between £200,000-500,000 to community groups wishing to undertake renewable energy products. A copy of the press release is below. Envirolink may be contacted through their website www.envirolinknorthwest.co.uk

Want to know more

British Hydro-Power Association www.british-hydro.org

Gilbert Gilkes & Gordon www.gilkes.com

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The Rural Carbon Challenge Fund

A new £4 million fund – the first of its kind in the country - has been launched to support renewable energy projects in rural areas across England's Northwest.

Grants of between £200,000 and £500,000 are available through the Rural Carbon Challenge Fund and project delivery partners, Envirolink Northwest and the Energy Saving Trust, are now looking for Expressions Of Interest (EOIs) from charities, social-enterprises, community groups and micro-enterprises before the end of May 2010.

Launched in February 2010 at the Northwest Climate Change Conference, the fund aims to improve the diversification of the rural economy and develop new partnerships at a community level. The £4m funding has come from the European Agricultural Fund for Rural Development and the Department for Environment, Food and Rural Affairs (DEFRA) and is being led by the Northwest Regional Development Agency (NWDA).

Funding will go to projects from Cheshire, Cumbria, Greater Manchester, Lancashire and Merseyside. Applicants unsure whether or not their location is defined as rural can contact Envirolink Northwest directly to confirm.

Interest is encouraged from groups looking to:

- install renewable energy systems - especially wind, hydro and woodfuel
- set up or expand renewable energy businesses
- supply training and information for commissioning, designing, installing and servicing micro-renewable installations, including fitters, plumbers and heating engineers;
- offer training and information for community groups, social enterprises and charities on

developing and delivering projects

- conduct feasibility studies.

All projects should showcase best practice and offer an element of innovation, such as the first time demonstration of the technology in a rural setting.